District Development Committee
Mustang District
Government of Nepal

DISTRICT CLIMATE AND ENERGY PLAN

MUSTANG DISTRICT

With Technical and Financial Support from

Government of Nepal
Ministry of Environment
Alternative Energy Promotion Center

Prepared by:
CEPAD Consultants (P) Limited
Lalitpur, Nepal

May 2011

EXECUTIVE SUMMARY

Energy and climate are now commonly referred in policy debates as fundamental issues of sustainable development. Climate Change (CC) and Green House Gas (GHG) emissions have become central theme of policy process and emphasis have been laid on pursuing low carbon path to contribute to global initiative of CC mitigation, and pursue adaptation-centric sustainable development. One way to achieve low carbon development is to establish provision of sustained access to renewable energy sources to communities, for which, the Government of Nepal (GoN) established AEPC in 1996 to develop and promote renewable and alternative energy technology.

In Nepal, more than two-third of the energy needs are met by fuel wood, followed by farm residue, animal dung, fossil fuel, and hydropower (WECS, 2010). The rising demand for energy due to increased economic activities and population growth has progressively increased its dependency on biomass based energy with considerable environmental impacts at local level. The energy demand for high altitude areas such as Mustang is generally higher than warm and humid low altitude areas. Ironically, CC impacts have been felt visibly at higher altitudes. Nepal needs to adapt to the emerging problem of CC while also contributing to the global reduction of GHG emissions. Nepal's topographic diversity with its rich natural resources offers a substantial potential to develop clean energy using hydropower, solar, wind power, and biogas, which together can contribute to both adaptation and mitigation goals.

Since the District Development Committees (DDCs) are recognized as lead agency for effective local level planning and implementation of energy provisions, it is necessary that capacity of the DDC be strengthened to enable them in taking prudent approaches to analyze potential climate impacts, emerging trend of socioeconomic changes, and energy development potential at local level in order to plan for a long-term energy program based on their needs, aspirations, and capabilities. In order to facilitate the DDCs in conducting such analysis and develop district level climate and energy plan (DCEP), AEPC with the technical assistance from SNV and financial support from the UK's DFID has supported preparing a three-year DCEP for Mustang district, which is presented in this report.

Overall Objectives

The overall objective of the DCEP is to prepare CC adaptive decentralized renewable energy planning and ensure implementation of the plan which can contribute carbon mitigation and also addressing issues regarding gender and social inclusion. The specific objectives of the DCEP are to:

- outline energy need and resource assessment
- outline interventions of renewable energy technologies by mainstreaming CC and GSI issues
- identify capacity development needs for implementing a CC adaptive renewable energy plan
- outline implementation of the plan with identification of roles and responsibilities of different stakeholders

Methodology

Preparation of Mustang's DCEP began by taking stock of energy related information including, gender, social inclusion and climate change. DCEP guideline, though not finalized when the process began, provided enough background and support to the process. Both secondary literature study and primary information collection through field visits were done. Relevant information about energy scenarios, CC and gender and social dimension of energy planning were collected. Energy assessments also included documenting energy needs, available resources and technological and institutional assessment. The information collected was analyzed using a regional approach in which the district was segregated into northern, central and southern regions to capture the variation in natural and social context, and with a 'Systems Approach' that helped conduct systemic analysis of the existing situation.

Based on the existing situation and the potential impact of climate change, energy demand was projected for three different scenarios; namely business as usual, medium adaptation, and climate resilient, for the next ten years in each of the three regions. Assumptions were made to develop scenarios focusing on transforming the gender roles especially in collecting and managing energy at the household level and how provisioning of alternatives is climate resilient. A detailed renewable energy plan for the first three years based on medium adaptation scenario has been developed.

Findings

Mustang District has a population of just over 13,000 and is a popular tourist destination with more than 30,000 tourists visiting the area every year. With less than 3 percent of forest cover and without appropriate alternatives, the district faces acute shortages of energy. About 45 % of the population has no options other than the use of cattle dung. Though, gender and social disparity is not a burning issue in the district, increased pressures on managing energy rests on women and will be hard hit if emerging climate threat reduces potential of existing energy sources particularly biomass from grasslands. The custom of a single marriage in one generation has been a major strength of local population in managing scarce natural resources in some regions of the district. Major CC risks such as droughts and disturbances in precipitation patterns are already experienced in most parts of Mustang. The customs and practices that sustained populations in scarce resource conditions are, however, on the decline.

Social relations among populations have enabled them to share scarce resources such as water in a judicious manner among the villagers. Strong indigenous system of resource management still prevails. Inhabitants of Mustang are known for their historical long-distance trade during the winter and in the recent years their involvement in the tourism industry.

Mustang's DCEP focuses on developing reliable and affordable renewable energy in the shortest possible time to help a total expected population of around 20,000 by the year 2020 plus an additional 5,000 shifting population and nearly 30,000 tourists. The plan addresess how the provision of renewable energy (RE) can be climate resilient contribute to climate adaptation and bring transformation in gender roles and social inclusion. From the population point of view, the target population may not be as high as the rest of the country where more than sixty percent population do not have access to electricity and even those who have connections experience more time with power outages than supply. However, the case of Mustang brings forth the unique challenge of ensuring sustainable energy supply. The demands are very high while the options to supply energy are limited.

Establishing biogas has limited scope due to low temperatures, while the success rate of ICS also has limitations as the majority of the population burn goat and sheep dung. Solar energy has been popular and widely used, but its application is limited to illumination and in some cases heating water. Wind energy presents a promising future but its application has so far been restricted due to technological complications. The road access linking Mustang with the rest of the country has enabled people to import LPG to replace or compliment traditional sources of energy for cooking. Though it has eased the drudgery and added comfort to families, its reliability depends on the condition of the road that passes through many unstable hill slopes prone to landslides and floods. The use of fossil fuel for local transportation has soared rapidly. One of the world's best trekking routes is now relegated from the list of best ten routes due to the road. The long term energy solution to the energy problem of people in Mustang, and possibly for their economic prosperity lies in harnessing hydro power, wind and solar radiation available in abundance throughout the district.

Intervention Plan 2020

The detailed plan for intervention has been developed based on a Medium Adaptation Scenario for the next ten years until 2020, and the prioritization of the RETs as carried out by DCEP task force members. The prioritization was carried out on the basis of criteria including climate change, gender and social inclusion, and cost of the intervention. In addition, Mustang specific issues were also considered for prioritizing the intervention. Accordingly, mini (and small) hydropower received the highest score followed by concentrated solar, wind turbines, solar cookers, micro hydro, solar lighting and ICS. The plan identifies number of RETs to be promoted between 2011 and 2020. The following table summarizes the activities and required budget.

Renewable Energy Technology Intervention Plan

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Energy Supply (GJ)
Micro Hydropower (kW)	-	25	20	20	10	15	10	20	-	-	1,797.55
Mini Hydropower (kW)	- Ghami Mini Hydropower (850 kW)			-	-	-	-	-	-	7,582	113,567.84
Solar PV - SHS (No.)	116	166	168	47	48	50	51	53	54	56	161.20
Solar PV - Institutional	-	6	6	6	3	3	3	3	3	3	0.45
Concentrated Solar	-	-	50	50	50	-	200	-	-	300	9,736.74
Solar Parabolic Cooker (No.)	500	680	882	66	68	70	72	74	76	78	4,849.74
Solar Dryer (No.)	80	100	125	-	-	-	-	-	-	-	0.00
Improved Cooking Stove (No.)	196	226	228	140	82	85	87	90	92	95	45,643.08
Improved Water Mill (No.)	22	23	23	-	-	-	-	-	-	-	2,350.08
Biogas (Capacity 4m3) (No.)	7	8	10	7	7	5	5	5	5	5	858.09
Wind (kW)	-	-	40	-	-	-	40	-	-	60	1,048.57
Total											180,013.34

Detailed Implementation Plan 2011-2013

A detailed implementation plan has been developed for the first three year (2011-2013). The proposed RETs with implementation time line, number of interventions, location and other related details are given below.

Detailed Implementation Plan and Role of Institutions

Year	Total Target (2011-2013)	2011	2012	2013	Location	Awareness Building	Community Mobilisation	Demand & Information Collection	Designing of Project	Capacity Building	Resource Assessment	Financing Sources	Service Provider	Implementation	Monitoring	Evaluation
Micro Hydropower (kW)	45	0	25	20	Chhonhup (1)^, Chhoser(1), Surkhang(2)	DEEU, CBOs,NGOs	NGOs	DEEU, NGOs	DEEU/External Consultant	Operators/ Managers Tranining	DEEU	AEPC, DDC, VDC, Development Partners	Manufacturers, Installers, External Consultants	DEEU, NGOs	DEEU	DDC, AEPC
Mini Hydropower (kW)	0	0	0	0	Ghami VDC*	DEEU, AEPC	DEEU, NGOs	DEEU, External Consultant	External Consultant	-	AEPC, DEEU	AEPC,Promoters, Banking Finance	Manufacturers, Suppliers, Installers	AEPC, NGOs,Private Sector	AEPC, External Consultants, DEEU, DDC	AEPC, External Consultants
Solar PV - SHS (No.)	449	116	166	168	All VDCs	DEEU, NGOs, Solar Companies	DEEU, NGOs	Solar Companies, DEEU	-	Solar PV Users Tranining	DEEU, NGOs	AEPC, Users	Solar Companies	Solar Companies, Owner	DEEU, DDC	AEPC, External Consultants
Solar PV - Institutional	12	0	6	6	2 in each region**	DEEU, AEPC	DEEU, NGOs	AEPC, DEEU	DEEU, Solar Companies	-	DEEU, NGOs, Private Sector	AEPC, Development Partners, DDC, VDC	-	Solar Companies, Cooperatives, NGOs, CBOs	DEEU, AEPC	External Consultants
Concentrated Solar	50	0	0	50	Jomsom	AEPC, DEEU	DEEU, NGOs	AEPC, DEEU	External Consultant, Solar Companies	Operators/ Managers Training	AEPC, DEEU, Private Sector	International Development Partners, AEPC	Solar Companies	AEPC, DEEU, External Consultants	-	DDC, AEPC, Service Providers/Consultants
Solar Parabolic Cooker (No.)	2062	500	680	882	All VDCs	DEEU, NGOs, Solar Companies	DEEU, NGOs	DEEU, NGOs-SO	Solar Companies	Users Tranings	DEEU, NGOs	Owner, AEPC Subsidy	Solar Companies	Owner	DEEU	DDC, AEPC
Solar Dryer (No.)	305	80	100	125	All VDCs	DEEU, NGOs, Solar Companies	DEEU, NGOs	DEEU, NGOs-SO	-	Users Tranings	DEEU, NGOs	Owner, AEPC Subsidy	Solar Companies	Owner	DEEU	DDC, AEPC

Year	Total Target (2011-2013)	2011	2012	2013	Location	Awareness Building	Community Mobilisation	Demand & Information Collection	Designing of Project	Capacity Building	Resource Assessment	Financing Sources	Service Provider	Implementation	Monitoring	Evaluation
Improved Cooking Stove (No.)	649	196	226	228	All VDCs	DEEU, NGOs	DEEU, NGOs	ICS promoters	DEEU, NGOs	ICS Promoters Tainings	DEEU, NGOs	Owner, AEPC Subsidy	-	Owner	DEEU	DEEU, AEPC
Improved Water Mill (No.)	68	22	23	23	All VDCs	DEEU, NGOs	DEEU, NGOs	IWM Promoters (CRT/N)	CRT/N	Users Training	DEEU, NGOs	Owner, AEPC Subsidy	Manufacturers, Suppliers, Installers	Owner	DEEU	DEEU, AEPC
Biogas (Capacity 4m3) (No.)	25	7	8	10	Central and Southern Region	DEEU, NGOs, Biogas Companies	DEEU, Biogas Companies	Biogas Companies	Biogas Companies	Biogas users Traninigs	DEEU, NGOs	Owner, AEPC Subsidy	Biogas Companies	Owner	BSP Nepal	External Consultants
Wind (kW)	40	0	0	40	Kagbeni and Muktinath	AEPC	DEEU, NGOs	-	External Consultant	External Consultants	AEPC, External Consultant	International Development Partners, AEPC	Private Utilities	AEPC, DEEU	AEPC, DEEU	External Consultants

^ Number in parentheses represents the number of micro hydro scheme
**The location proposed for the Institutional Solar PV is yet to be identified. Feasibility study needs to be carried out.

Currently, southern and central Mustang receive electricity from national grid. Micro hydro plants serve a few settlements. This plan proposes micro hydro in isolated settlements with potential from nearby rivers. This proposition has been based on study of topographical maps including preliminary assessment of hydrology and geology. . Development of mini hydropower project at Ghami has been proposed due to its cost effectiveness and for supplying affordable and reliable electricity that can transform the traditional roles of women. Other RETs such as solar drier, ICS, biogas and wind are also proposed.

Financing Plan

Financial cost estimation includes the RET system cost, capacity building and other additional costs required for project completion. The cost for implementation of the proposed intervention plan is estimated to be about NRS 3,414,492,380 until 2020 (in 2010 price). Most of the projects would commence during the first three years and will cost NRS 515,920,041. The fund will be used for awareness campaigns, information and gap assessment for each technology types and design, project implementation, adequate trainings, and any other technical inputs not available locally.

Total Investment Cost for RETs Plan Implementation (in NPR)

Technologies	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Investment Cost (NPR)
Micro Hydropower (kW)	-	13,291,059	10,645,833	10,659,208	5,336,492	8,015,380	5,350,894	10,716,842	-	-	64,015,708
Mini Hydropower (kW)	-	-	212,916,652	-	-	-	-	-	-	1,917,373,459	2,130,290,112
Solar PV - SHS (No.)	3,183,348	4,557,294	4,623,267	1,292,835	1,332,047	1,372,499	1,414,233	1,457,292	1,501,723	1,547,573	22,282,112
Solar PV - Institutional	-	10,507,755	10,520,588	10,533,805	5,273,710	5,280,721	5,287,943	5,295,381	5,303,042	5,310,934	63,313,877
Concentrated Solar	-	-	75,147,054	75,241,465	75,338,709	-	302,168,147	-	-	455,222,875	983,118,250
Solar Parabolic Cooker (No.)	7,496,640	10,207,533	13,255,940	993,187	1,024,606	1,056,144	1,087,805	1,119,595	1,151,518	1,183,579	38,576,549
Solar Dryer (No.)	2,498,880	3,127,308	3,913,909	-	-	-	-	-	-	-	9,540,097
Improved Cooking Stove (No.)	3,669,793	4,233,077	4,279,433	2,634,311	1,551,357	1,598,468	1,647,073	1,697,223	1,748,969	1,802,367	24,862,071
Improved Water Mill (No.)	4,123,152	4,315,685	4,320,956	-	-	-	-	-	-	-	12,759,793
Biogas (Capacity 4m3) (No.)	437,304	500,369	626,225	438,909	439,476	314,329	314,758	315,201	315,657	316,127	4,018,356
Wind (kW)	-	-	17,534,313	-	-	-	17,626,475	-	-	26,554,668	61,715,455
Sub Total	21,409,117	50,740,081	357,784,170	101,793,721	90,296,397	17,637,541	334,897,329	20,601,534	10,020,909	2,409,311,582	3,414,492,380

Total Cost of Technology (2011-2013)	**429,933,367**
Non technology cost (20% of technology cost)	**85,986,673**
Total Cost	**515,920,041**

Monitoring and Evaluation Plan

Based on the following logical framework, Outcome Mapping has been proposed to carryout monitoring and evaluation of the proposed plan. Outcome mapping helps effective monitoring of the process by which a desirable change in behavior of implementing partners can be assessed against set progress markers. This approach is innovative compared to the evaluation of plans against only physical achievements or for number of interventions accomplished. It helps monitor change in the behavior of development partners in addition to the physical targets which is key for long term sustainability.

Logical Framework

Intervention logic	Objectively verifiable indicator	Means of verification	Assumption/risks
Overall objective			
To realize a low-carbon and CC resilient energy access – that enhances agriculture, water, and tourism/enterprise development, gender, social inclusion and livelihoods in Mustang through implementation of CC adaptive decentralized renewable energy activities.	Development plans of the district recognizing and promoting the concept of renewable source of energy to meet long term energy security and climate adaptation.	Development plans and review reports	Boundary partners are willing to extend cooperation and continue to involve in DCEP implementation; Natural hazards do not damage the Structures placed before the results are evident
Purpose			
Establish effective management system and build capacity for climate adaptation by developing a climate resilient and gender and social inclusive energy access to effectively address the long-term energy demands of the district.	Local communities using opportunities for improving energy security; Increased population and activities in ten years (2020) will not increase dependency on biomass for energy; Boundary partners supporting local communities in developing and using RETs by incorporating supportive activities in their annual programmes.	Survey, interview, evaluation reports, annual programmes of boundary partners	Energy policy continues to emphasize community focused RETs
Outputs 1. Understanding is enhanced about; energy sources and available options that are important to meet the energy demand; challenges in managing securing energy security; and the key management functions for promoting gender and social inclusive energy development path.	Communities taking part in energy dialogue actively	FGD, Interaction session	
Activity 1.1: Meeting of boundary partners to identify target population, groups, and energy users, pressure on resources, key points for intervention	Boundary partners playing active role in energy planning and meetings	Minutes of meetings	
Activity 1.2: Generate information about stream discharge, forest and grassland condition, and areas with energy shortage within each region.	Boundary partners and target groups aware of potential areas for intervention	Requests letters and applications	

Intervention logic	Objectively verifiable indicator	Means of verification	Assumption/risks
Activity 1.3: Support formulation of cooperatives and drafting of bylaws as needed for energy development activities.	Communities organized to formulate constitutions and norms for energy development	Minutes of meetings	
Activity 1.4: Support meetings to enhance gender and social inclusive management functions to maximize energy security.	Boundary partners aware of gender and social issues to be considered for energy security	Annual programmes supporting inclusive energy activities	
Output 2: Human capacity developed to implement the CC adaptive renewable energy plan.	Local communities raising issues such as flood damages or reduced flows impacting hydropower plants, diminishing grass growth in pasture during development discussions.	DDC development plans	Climate change adaptive responses continues to be priority of energy development
Activity 2.1: Conduct training on need assessment for energy, skill development, institutional building, gender and social inclusion.	Boundary partners aware of the training needs on social and institutional issues.	Training requests and actual events	No external threats nullify the effort
Activity 2.2: Conduct orientation training on DCEP objectives, activities, procedures and outcome mapping for boundary partners.	Communities and partners aware of DCEP vision and approach for energy security.	Number of request from the cooperative members	
Activity 2.3: Conduct training on climate impacts, anticipated energy scenario, and potential areas for promoting RETs for energy security and economic development including pumping of water for irrigation for boundary partners.	Communities seeking support from DCEP to develop energy activities to address emerging climate issues.	Number of request received	Funds available
Activity 2.4: Conduct shared learning sessions to exchange experiences and expectation with community members.	VDC plans mentioning energy related activities in a focused manner.	VDC annual programme	VDC continues to receive funds
Activity 2.5: Help formulate procedure for local resource mobilization.	Part of fund for energy development available from local sources.	Bank account	
Activity 2.6: Conduct exposure visits for community members.	Communities seeking support for RET development.	Number of request received	
Activity 2.7: Conduct school programmes.	Students aware of RET benefits.	Interaction	Students are willing to participate
Output 3: Development of renewable energy technologies and mainstreaming CC and GSI issues.	64% of hhs in the northern region & 58% in the district hhs use electricity for cooking. These hhs would have changed gender role for energy collection.	Survey report	People cooperate to provide partial labor for the construction of the structures
Activity 3.1: Establish micro hydro plants	45 kW electricity produced from micro hydro and available for cooking.	Completion report	
Activity 3.2: Help establish solar PV SHS	Households using PV SHS in all VDCs.	Observation	
Activity 3.3: Support building Solar	Boundary partners gaining	Survey report	

Intervention logic	Objectively verifiable indicator	Means of verification	Assumption/risks
PV Institutional	knowledge about institutional use of PV in all regions.		
Activity 3.4: Help establish piloting of Institutional Concentrated Solar system	Boundary partners gaining knowledge about institutional use of Concentrated Solar system.	Survey report	Cooperation from the army camp continues to be available
Activity 3.5: Establish solar parabolic cooker	Households using solar parabolic cooker in all VDCs.	Observation	Communities continue to provide support
Activity 3.6: Support households and institutions for establishing solar drier	Households and institutions using solar drier in all VDCs	Observation	
Activity 3.7: Support ICS installation in remaining households that lack such devices	Households using ICS in all VDCs	Observation	Households continue to accept ICS
Activity 3.8: Support biogas installation (4m^3 capacity)	Biogas technology suitable for colder areas is in use in 25 households of southern and central Mustang.	Completion report	Suitable technology available
Activity 3.9: Support developing wind energy	Wind energy being used to produce electricity in two villages.	Completion report	
Output 4: Continue to explore possibilities of developing degraded land for horticulture and vegetable for improving income basket in northern Mustang by pumping water using renewable energy	New income sources developed using unconventional energy sources.	VDC reports	Water continues to be available, unprecedented flood does not damage the structures

ACKNOWLEDGEMENT

We wish to thank SNV for entrusting CEPAD team for carrying out DCEP for Mustang District that hangs on a delicate balance between tremendous opportunities for tourism and horticulture development on one side and emerging stresses of changing climate on the other which could pose a major hurdle in the path of sustainable development. We consider this work as an opportunity for most of us in the team to reflect our own knowledge and understanding about CC issues in a place like Mustang and attempt to explore the unknowns that would help make communities in Mustang climate resilient. We acknowledge the guidance and support of Mr. Jeremy Stone of SNV, which helped us focus on the intersection of energy planning, gender and CC. We also have received valuable suggestions and crucial inputs from Mr. Ranjan Parajuli of AEPC both in the field during the field visit and while developing the plan. We have received helpful information and insights from the Mr. Shyam Raj Adhikary LDO Mustang, Mr. Krishna Prasad Panthi, Dr. Narayan Chaulagain and Raju Laudari of AEPC during the Kathmandu stakeholder consultation. Mani Kumar Gyanwali (Former LDO) and other task force members provided us valuable suggestions during the early stage of the Mustang DCEP plan preparation. We thank them all. The offices of ACAP, DDC, Soil Conservation, and CDO provided district information and their published documents on various sectors and issues including food security, resource management, trade and commerce, development problems, and area specific issues including social issues of local communities in different areas within Mustang. We acknowledge their help. Mr. Nabin Ruwali, AEEO of DDC who provided us with key energy specific documents. Mr. Jhanka Nath Paudel, Mustang CDO office shared his valuable insights on CC impacts in Charang based on his decade long experience working as a VDC secretary. We cannot miss thanking VDC secretaries of various VDCs including from Chharang, Mr. Bhes Raj Regmi and Tukuche, Mr. Kebal Prasad Dhungana, who had gathered in Jomsom for a district meeting, when we were their for sharing their mind map of resource management in different location of Mustang. Mr. Sakh Bahadur Lalchan, Ms. Lalchan, Ms. Sharmila Thakali, Mr. Paras Thakuri and Hari Maya Gurung of ACAP, Mr. Bishnu Hirachan, Anand Sherchan, Ms. Rita Gauchan of Kalapani, Ms. Chhini Gurung, Mr. Jhyampa Gurung shared with us the change process over the last decades and their insights on preparing a climate and energy plan. We would also like to acknowledge the efforts of community members and key informants of Jomsom, Jharkot, and Kobang VDCs for sparing time to answer our questions and accepting us as their friends in developing a future plan to manage their energy – a critical subject that occupies a key place in their daily lives.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ACAP	:	Annapurna Conservation Area Project
AD	:	Anno Domini
ADB	:	Asian Development Bank
AEEO	:	Assistant Energy and Environment Officer
AEPC	:	Alternative Energy Promotion Center
APROSC	:	Agricultural Projects Services Centre
ATM	:	Automated Teller Machine
BAS	:	Business As Usual Scenario
BS	:	Bikram Sambat
BSP	:	Biogas Sector Partnership
CA	:	Constituent Assembly
CBO	:	Community Based Organization
CBS	:	Central Bureau of Statistics
CC	:	Climate Change
CDM	:	Clean Development Mechanism
CDO	:	Chief District Officer
CFL	:	Compact Fluorescent Lamp
CRS	:	Climate Resilient Scenario
DCEP	:	District Climate Energy Plans
DDCs	:	District Development Committees
DEECs	:	District Energy and Environment Committees
DEES	:	District Energy and Environment Sections
DEEUs	:	District Energy and Environment Units
DEPPs	:	District Energy Perspective Plans
DESRs	:	District Energy Situation Reports
DFID	:	Department for International Development
DSCO	:	District Soil Conservation Office
ESAP	:	Energy Sector Assistance Program
FGD	:	Focus Group Discussion
GCM	:	General Circulation Model
GHG	:	Green House Gases
GIS	:	Geographic Information System

GMHP	:	Ghami Micro Hydro Project
GON	:	Government of Nepal
GSI	:	Gender and Social Inclusion
GSI	:	Gender and Social Inclusion
hh	:	Household
ICIMOD	:	International Center for Integrated Mountain Development
ICS	:	Improved Cooking Stove
INGO	:	International Non Governmental Organization
IPCC	:	Intergovernmental Panel on Climate Change
ISET	:	Institute for Social and Environment Transition
KII	:	Key Informant Interviews
LAPA	:	Local Adaptation Plan of Action
LDO	:	Local Development Officer
LEAP	:	Long Range Energy Alternative Planning
LPG	:	Liquefied Petroleum Gas
MAS	:	Medium Adaptation Scenario
MCP	:	Minimum Criteria Performance
MCT	:	Main Central Thrust
MDSA	:	Mustang Development Service Agency
MRMG	:	Mountain Resource Management Group
NAPA	:	National Adaptation Program of Action
NEA	:	Nepal Electricity Authority
NGO	:	Non Governmental Organization
NMDS	:	Northern Mustang Development Service
NPC	:	National Planning Commission
NTFP	:	Non Timber Forest Product
NTNC	:	National Trust for Nature Conservation
OM	:	Outcome Mapping
PPCR	:	Pilot Program on Climate Resilience
PPP	:	Public Private Partnership
PRA	:	Participatory Rural Appraisal
RCUP	:	Resource Conservation and Utilization Project
RE	:	Renewable Energy

RETs	:	Renewable Energy Technologies
SDC	:	Swiss Agency for Development Cooperation
SHDB	:	Small Hydro Development Board
SHS	:	Solar Home System
SNV	:	Netherlands Development Organisation
SREP	:	Scaling Up Renewable Energy Programs
SWERA	:	Solar and Wind Energy Resource Assessment in Nepal
T&D	:	Transmission and Distribution
TCS	:	Traditional Cooking Stove
TWG	:	Thematic Working Group
UNCDF	:	United Nations Capital Development Fund
VDC	:	Village Development Committee
WECS	:	Water and Energy Commission Secretariat

Units of Measurement

^{0}C	:	Degree Celsius
GJ	:	Giga Joule
Ha	:	Hectare (1 Ha = 10,000m^2)
Kg	:	Kilo Gram
kJ	:	Kilo Jolule
kW	:	Kilo Watt
kWh	:	Kilo Watt-Hour
MJ	:	Mega Joule
mm	:	Millimeter
MT	:	Metric Ton
MW	:	Mega Watt
MWh	:	Mega Watt-Hour

1. Introduction to DCEP

1.1. Background

Energy and climate are now commonly referred in policy debates as fundamental issues of sustainable development. Climate change (CC) and Green House Gas (GHG) emissions have become a central theme of policy processes and emphasis has been laid on pursuing low carbon paths for development. One way to achieve low carbon development is to establish provision of sustained and universal access to renewable energy sources to communities that is gender and social inclusive. The Government of Nepal (GoN) recognizes that the energy sector has both economic as well as environmental impacts and therefore has been promoting energy provision in order to contribute to energy supply and environmental protection at local level and also supports CC mitigation at global level. That the GoN established AEPC in 1996 to develop and promote renewable and alternative energy technology shows that Nepal is committed to protect its environment and simultaneously contribute to global initiative of CC mitigation.

Even though Nepal's per capita energy consumption is around 14.32 GJ (WECS, 2010), the regional energy demand within the country varies substantially due to elevation, climate, and population density. The high altitude areas such as Mustang District are generally cold, making energy needs for cooking and heating many times higher than low altitude areas that are warm and humid. Overall, more than two-thirds of the energy needs are met by fuel wood, followed by farm residue, animal dung, fossil fuel, and hydropower (*ibid*). The rising demand for energy due to increased economic activities and population growth has progressively increased its dependency on biomass based energy with considerable environmental impacts at local level. The demand for fossil fuel has both environmental and economic consequences. Though Nepal emits negligible amount of GHG, communities have already started experiencing its impacts. Nepal needs to adapt to this emerging problems while also contributing to the global reduction of GHG emissions. Nepal's topographic diversity with its rich natural resources offer a substantial potential to develop clean energy using hydropower, solar, wind power, and biogas which together can help achieve both adaptation and mitigation issues.

In order to translate national commitments to environmental protection and simultaneously contribute to global initiatives of CC mitigation, the District Development Committees (DDCs) have been recognized as lead agency for effective local level planning and implementation of energy provisions. The District Energy and Environment Sections (DEES) and the District Energy and Environment Units (DEEUs) of the DDCs are key in developing and promoting Renewable Energy Technologies (RETs). Development of renewable energy systems to address CC issues require that understanding of potential CC impacts, emerging trend of socioeconomic changes, and energy development potential at local level needs to be enhanced. The diverse topographic and climatic conditions as well as socioeconomic situations in districts make it necessary that capacity of the DDC be strengthened to enable them to take a prudent approach to analyze these factors and plan for a long-term energy program based on their needs, aspirations, and capabilities.

In order to facilitate the DDCs in conducting a thorough analysis and develop district level climate and energy plan (DCEP), AEPC with the technical assistance from SNV and financial support from the UK's DFID is now embarking on piloting of a three-year DCEPs in three districts including Ilam, Makawanpur and Mustang. This report presents DCEP for Mustang District.

1.2. Rationale

Mustang district is situated in the trans-Himalayan region of the country at an altitude of about 3000 meters. Unlike other areas of Nepal, where snow clad mountains are seen in the north, peaks of Nilgiri, Tilicho, and Dhaulagiri in Mustang are seen in the south. The district has harsh climate with maximum temperature hovering between 22 and 26 degrees Celsius, while the minimum temperature ranges between (-2.7) and (-9) degrees Celsius. The night time temperature usually falls below 5 degrees. Permafrost occurs during winter at lower elevations.

Annual average precipitation which mainly comes in the form of snow is about 300 mm. Snow covers the district for around 3 months. Previously, summer rains used to be only occasional and sporadic; however, it has become regular in recent years. Hail storms have also started to come. Wind blows from south to north every day reaching an average speed of 50 Naughts with gusts as high as 90 Naughts. During the nights, cold wind of mild speed blows from the opposite direction. As a result of low precipitation, high wind and high altitude radiation, desiccation effect in Mustang is very high. Vegetation is sparsely distributed. Growth rate of plants is extremely low. Settlements with farmlands are mostly located along the Kali Gandaki River. Though it is yet to be documented, the changing climate will have, if it is not happening already, a very rapid and lasting impact on these interplaying natural and human resources affecting supply and demand of energy.

Mustang is a popular tourist destination for trekkers. More than Twenty-three thousand tourists visited Mustang in 2007 (NTNC, 2008). In addition, thousands of Nepali and Indian pilgrims visit Muktinath, a must-visit holy shrine of Hindus as well as Buddhists. Total number of visitors has reached over 37,000 in 2010. The demand for energy for cooking, heating and maintaining hearths in hotels and lodges is exceedingly high and soaring rapidly. The remaining forests of the inner valleys are getting thinner. During winter in Northern Mustang, water for kitchen can only be made available by melting ice. Animal dung is the only fuel used in the households. Even though there is high potential for tapping wind energy, it has not been fully explored, except some unsuccessful pilot ventures. With new road access up to the Nepal-China border, tourist arrival will increase and boost economy but, not without added pressure on already a weak energy system.

Because women and girls spent a substantial amount of time in gathering cattle dung, fuel wood, including fetching water, cooking food for the family, it limits their engagement in educational and income-generating activities. Women's' time is consumed in producing and processing food without any forms of mechanical/electrical appliances and cooking either using conventional dung-cake stoves or ICS. Despite substantial efforts in the last decades in provisioning energy for lighting purposes in Mustang District, the traditional role of women and girls remains unchanged. Gender bias is a primary cause of poverty because it prevents women from obtaining an education, training, health services, legal status and other capabilities and opportunities to combat it. Thus, the efforts to empower women and to bring them to decision making level challenges existing hierarchies of power and requests equitable gender relations so that women can have control over their lives. Provision of RETs sufficient household needs enables transformation of women and poor people's life and livelihoods. An immediate and a longer term energy development plan that values gender, social inclusion and climate change issues is necessary to ensure a sustainable energy pathway for Mustang.

In addition, Mustang's DCEP can serve as a pathway for other districts in Nepal for preparing a similar energy roadmap that is climate resilient, gender sensitive, socially inclusive and that does not lock-in to a fossil fuel pathway especially considering the Government of Nepal's declaration of a second state of emergency in March 2011 for reducing power cuts to in the next 4.5 years.

1.3. Objectives of DCEP

1.3.1. Overall objectives

The overall objective of the DCEP is to prepare a CC adaptive decentralized renewable energy plan and ensure implementation of the plan which can contribute to carbon mitigation and address gender and social inclusion issues in order to realize 'Mustang as a showcase of low-carbon and CC resilient energy access – that enhances agriculture, water, and tourism/enterprise development, gender, social inclusion and livelihoods'.

1.3.2. Specific objectives

Some of the specific objectives of the DCEP are;

- To outline energy needs and and identify resource availability and use
- To outline interventions of renewable energy technologies by mainstreaming CC and GSI issues
- To identify the capacity development needs to implement the CC adaptive renewable energy plan
- To outline implementation of the plan with identification of roles and responsibilities of different stakeholders

1.4. Overview of Mustang District

Physical

Mustang District is located in the Dhaulagiri zone of the western development region of Nepal. It borders with the Manang, Maygdi and Dolpa districts on the east, south and west sides respectively. On the north lies the autonomous region of Tibet. The elevation ranges from 2100 m in the southern part to 5400 m and above in the north. The high peaks rise up to 8168 m. The entire district is drained by the 'Kali Gandaki' River flowing from north-to-south. The River is laden with heavy sediment giving it the name '*Kali*', which literally means 'black'. The tributaries meet the River almost perpendicularly, dissecting the mountains east and west. Most of the human settlements are found at 2100 m to 4000 m elevation along the Kali Gandaki River.

Major villages are Lete, Kobang, Tukche, Marpha, Jomsom, and Chuksang. Other important villages are Muktinath, Ghami, Charang, Lo-Manthang, Surkhang, Chhonup and others. Muktinath has great religious significance. It is also a major tourist and pilgrimage destination point. The salient feature of the district is summarized in Table 1.

Table 1: Salient feature of Mustang District

Development Region	Western
Zone	Dhaulagiri
District	Mustang
Constituency	One
Ilaka	9
Municipalities	None
Number of VDC	16
Political Boundary	Manang (East), Autonomous region of Tibet, China(North), Dolpa (West), Myagdi (South)
Location	Latitude: 28 ^{0} 20' – 29^0 05' ; Longitude: 83 ^{0} 30' – 84^0 15'
Altitude	2100 m – 5400 m with peaks rising to 8168m
Climate	2000-3000 m (Temperate); 3000-4000 m (Subalpine); 4000-5000 m (Alpine)
Temperature	Max. : 22-26 ^{0}C Min. : (-2.7) – (-9) ^{0}C
Precipitation	Rainfall: 400 mm; Snowfall: 15 -30 cm (not in water equivalent)

Source: District profile of Mustang 2053

Jomsom, the district headquarters, is located in the southern central part of Mustang. Climate, vegetation and land use between north and south of Jomsom are different. Jomson is used as a reference for the purpose of comparing climate, vegetation condition, socioeconomic, and most importantly the overall energy demand and supply between the areas north and south. In this report too, the areas north of Jomsom will be referred to as northern Mustang, and south of Jomsom will be referred as southern Mustang.

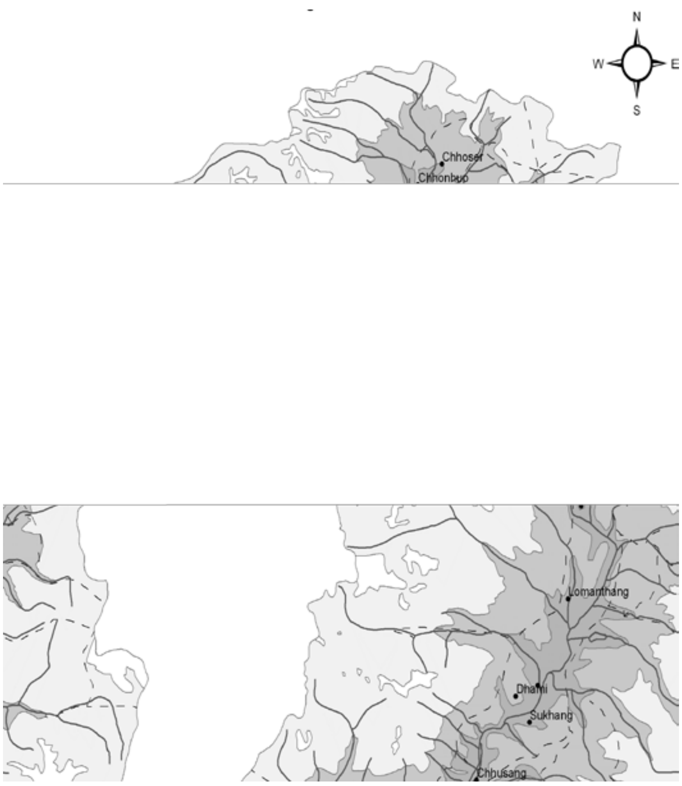


Figure 1: Mustang district with major settlements

Climate

Mustang has three climatic zones: (i) alpine (4000 to 5000 m), (ii) sub alpine (3000 to 4000 m), and (iii) cool temperate (2000 to 3000 m). Annual average precipitation is about 300 mm at the lower elevations, most of which falls as snow, but some precipitation occurs in summer. However, in the last few years snowfall in the southern Mustang has failed, and instead more rainfall has been observed in winter. The only long term climate records available are from Jomsom. For two third of the area in the district, north of Jomsom, no data is available and there are no snowfall records. Areas north of Jomsom and at all areas higher in altitudes than Jomsom receive a greater share of annual precipitation in the form of snow.

Mean annual temperature varies between 5 to 16^{0}C but day and night temperature differences are substantial. The January mean minimum temperature drops as low as minus 0.9 ^{0}C and July mean maximum temperature is around 21^{0}C in Jomsom. However, this record represents the inhabitated areas where temperature monitoring is done and does not represent temperature of areas in the higher elevations. Typically, there are two seasons: predominating is a long winter (September - March) with a short summer (May-July) and a very short spring and autumn in between. Above timberline the mean annual temperature is near zero.

There are two types of wind that sweep the entire area 12 hours a day, year round. The wind that blows from south-to north starts in the morning and dies down in the evening. The wind funnels through the gap between Annapurna and Dhaulagiri, (the deepest gorge in the world), and blasts over Mustang. It starts from the valley near the village of Kobang (southern Mustang) and picks up speed as it reaches Marpha. The average wind velocity is about 50 knots an hour, however, the occasional gusts can reach as high as 90 knots and hour and above. The north-easterly that blows from the Tibetan plateau toward the south starts in the early morning and dies down about 9 in the morning. The north-easterly is very cold, with lower velocity than the south wind, and blows only from September through February or March. This wind causes most of the permafrost in the area.

Radiation

One of the key features of the environment at higher elevations is the shorter effective path-length through which the sun's rays travel. There is also a decrease in turbid, scattering and absorbing moisture in the atmosphere at high elevations. Diffused radiation is less at high elevation than at lower elevations, but increases during cloudy conditions. Blue and ultraviolet portion of the spectrum are high, and the incoming solar-short-wave radiation is greater, thus raising the temperature of the surface slightly higher than the ambient air temperature. But the surface cools rapidly at night causing a frequent-freeze thaw cycle of the bare ground, which has an extremely negative impact on the soil biology.

Hydrology

Most of the area in Mustang lies above 3000 m elevation with the high peaks in excess of 7500 m. These peaks on both sides of the valley are covered with snow year around, and when melt feed tributaries and the Kali Gandaki River. Major tributaries are Tange and Mustang Khola that drain the north-eastern part, and Chilling, Samar and Sandok Khola which drain north-western region. Other tributaries are Jhong, Dhampus, and Thapa khola, running through deep gorges and falls. List of major tributaries are given in Annex 2.

Even though Mustang is rich in water resources, only a small part of it has been used for economic use. The groundwater table varies from a few to several meters deep. Water flow in tributaries and Kali Gandaki increases due to snowmelt at higher altitudes during the monsoon season. Occasional rainfall in the southern and central regions bring flood causing substantial damages in Mustang owing to its fragile geology.

Landuse

Mustang district has a total area of 3,573 sq.km.(NTNC, 2000, DDC 2065). Landuse classification of this area shows unusually skewed distribution among various uses. About

14,584 hectares is covered by forests. Agriculture occupies only about 4,025 hectares of the area, of which about 3,242 hectare is classified as cultivated and about 783 hectare is non-cultivated. Grassland covers a large part of about 144,703 hectares, while the rest of the land is under snow, rock outcrops, flood plain and others.

Table 2: Land use Category and Area

Land use type	Area (hectares)	Percentage (%)
Forests	14,584	4.09%
Agriculture	4,025	1.13%
Cultivated	3,242	
Non cultivated	783	
Grassland	144,703	40.58%
Wetland	92	0.03%
Snow covered	30,591	8.58%
Settlement	320	0.09%
Rock outcrop	150,573	42.23%
Others	11,677	3.27%
Total	356,565	100.00%

Source: District profile of Mustang, 2053; NTNC 2008

**The area under different land use totals to be more than the district area as mentioned in the district profile. A cross check can be made by calculating the total area from the given land use figures. If 147,679 hectares of grassland is 40.7% of the total area (NTNC, 2009), the total area of Mustang comes up to be 3625 sq.km, which is higher than the published figure by about 5000 hectares*

Forests

Mustang has a very small area under forest, most of which are in the southern Mustang. Forest cover declines from south to north. From Marpha to Jomsom the forest cover decreases northward so sharply that the mountain slopes become more and more barren within a distance of less than 6 kilometers. The trees decrease in height and canopy cover. From Jomsom north, the mountains are completely devoid of trees except some wind protected pockets. Tree species found in such pockets on leeward side are of *Betula* and *Juniperous* species. Areas at high altitude have scarce vegetation. With the exception of Lete, Kunjo, and Kobang, where forest cover is fairly dense, people living in Mustang have a very strong tradition of protecting the existing forests. However, forest floor litter is collected for animal bedding, which in turn is used as compost.

Table 3 shows distribution of forest and shrub land in the VDCs. Many VDCs in the north have no forest and shrub land. Lete and Kobang VDCs in south have forests, but no shrub land. It must be stressed that forest and shrub land are important source of firewood.

Table 3: Forest, Pasture and Shrub land cover in the VDCs of Mustang

Region	VDC	Total area (sq. km)	Forest		Pasture		Shrubland		Others
			Area	%	Area	%	Area	%	
Northern	Chonnup	98.79	0	0.00%	72.44	73.33%	0	0.00%	26.35
	Lomanthan	282.25	0	0.00%	140.67	49.84%	0	0.00%	141.58
	Chhoser	347.78	0	0.00%	221.16	63.59%	0	0.00%	126.62
	Surkhang	771.16	0	0.00%	305.75	39.65%	0	0.00%	465.41
	Chharang	337.7	0	0.00%	66.28	19.63%	0	0.00%	271.42
	Ghami	213.7	0	0.00%	86.54	40.50%	0	0.00%	127.16
	Chhusang	493.95	0	0.00%	184.43	37.34%	16.8	3.40%	292.72
	Total	**2545.33**	**0**		**1077.27**		**16.8**		**1451.26**
Central	Kagbeni	279.23	1.34	0.48%	104.65	37.48%	4.22	1.51%	169.02

Region	VDC	Total area (sq. km)	Forest		Pasture		Shrubland		Others
			Area	%	Area	%	Area	%	
	Jhon	53.42	0	0.00%	30	56.16%	1.34	2.51%	22.08
	Muktinath	55.44	0	0.00%	31.67	57.12%	0	0.00%	23.77
	Jomsom	163.24	30.06	18.41%	71.54	43.83%	11.74	7.19%	49.9
	Marpha	123.99	24.85	20.04%	35.76	28.84%	1.84	1.48%	61.54
	Total	**675.32**	**56.25**		**273.62**		**19.14**		**326.31**
Southern	Tukeche	124.99	18.81	15.05%	29.56	23.65%	7.55	6.04%	69.07
	Kobang	75.6	20.48	27.09%	30.49	40.33%	0	0.00%	24.63
	Kunjo	71.57	27.53	38.47%	23.92	33.42%	0.67	0.94%	19.45
	Lete	53.42	22.77	42.62%	12.17	22.78%	0	0.00%	18.48
	Total	**325.58**	**89.59**		**96.14**		**8.22**		**131.63**
Grand Total		**3546.23**	**145.84**		**1447.03**		**44.16**		**1909.2**

Source: District profile 2065

**Total area calculated is less than the area given in land use table. Discrepancies like this are often encountered in the secondary information about Mustang.*

Agriculture

Agriculture land occupies the lowest area and is generally found in and around villages, except for a few isolated apple orchards away from villages. Unlike other areas in the country, cultivation in Mustang is done only on the terraced benches that have adequate irrigation facilities. In the south, two crops a year are grown. They include primarily naked barley and buckwheat, but some maize and millet are also grown. In the north, only one crop a year is grown. The difference is primarily due to temperature and moisture stress. There are suggestions made in reports that irrigation is a deciding factor of number of crops grown (NTNC, 2008). The various types of crops grown are given in Table 4.

Table 4: Types of crops, area and production

Crop	Area (ha)	Production (MT)
Wheat	950	2081
Buck wheat	820	1631
Maize	739	921
Barley	545	1117
Potato	525	4651
Naked barley	481	1010
Oilseeds	59	61
Pulses	54	65

Source: District profile 2065

Expansion of agriculture land is limited by lack of irrigation and water development. Every square meter of irrigable land has therefore been put under cultivation, and is highly manured and managed. Key informants in the field suggest that chemical fertilizer is seldom used in Mustang; rather compost manure is commonly used to replenish soil fertility. All irrigation systems in Mustang are gravity flow type. Hence, a vast area along the river valley remains fallow because of lack of water facility, and not because of soil characteristics. Pumping water from rivers to dry terraces has been a dream of farmers in many villages.

Mustang has a very high potential for horticulture development. Currently, it produces about 3088 tons of fruits, of which 71 percent is occupied by apple. Mustang exports more than 800 tons of apples currently. Walnut ranks second in the list of fruits grown occupying 23 percent of total fruits produced. Other fruits include peach, apricot, grapes, pear, almond, and plum. The percent share of various fruits grown is given in Table 5.

Table 5: Types of fruits and their share of fruits produced in Mustang

Type of fruit	Percent share
Apple	71
Walnut	23
Peach	3
Plum	2
Pear	1
Apricot	< 1
Grapes	< 1
Almond	< 1
Others	< 1

Source: District profile 2065

Farmers brew apples and other fruits producing brandy. Mustang brandy is very popular and is in high demand. Producing brandy requires a huge amount of firewood. With the road access that connected Mustang with Myagdi, export of apple has become easy in the last two years. Despite the encouraging situation for export fresh fruits, farmers will continue to distill brandy to meet the rising demand for it.

Vegetable production is as promising as fruits due to its favorable climate for winter vegetables. Southern and central Mustang produces significant amounts (1600 metric tons) of vegetables such as cauliflower, cabbage, mustard, and radish. Garlic and onion are also produced. One of the noteworthy facts is that these vegetables are grown in summer when they are either expensive or not available in other areas in the country. Local traders mention that vegetables and fruits from Mustang is superior in quality to the ones found elsewhere and fetch higher price. Even though vegetables are not exported currently, access to irrigation water can boost vegetable production making it one of the major export products of Mustang. Onion and garlic in particular hold a great potential for export.

Existing Irrigation Systems

There are about 353 irrigation facilities of temporary or permanent types in the district. Only 13 % of total cultivation land available is irrigable which is about 9850 ha. About 62 % of this irrigable land is supplied with irrigation facilities. The irrigation systems of Mustang district are presented in Table 6.

Table 6: Irrigation system in Mustang district

S No	Irrigation system	Command area (ha)	VDC
1	Tetang	28	Chhusang
2	Arka	40	Chhoser
3	Falyak	36	Kagbeni
4	Syang	42	Marpha
5	Lyanku	NA	Kobang
6	Lomanthang	76	Lomanthan
7	Nyamgel	30	
8	Tamu Khola Saur Phat	28	Kobang
9	Charang	50	Charang
10	Gyantangthang	NA	Kagbeni
11	Hukum	15	Muktinath
12	Thini	90	Jomsom
13	Jharkot	50	Muktinath
14	Ghami	100	Ghami
15	Dhakmar	90	Ghami
16	Gyakhar	NA	Lomanthang
17	Chui	NA	Lomanthang

S No	Irrigation system	Command area (ha)	VDC
18	Nyamdo	NA	Chhonhup
19	Jhong	NA	Jhong
20	Ghara	NA	Surkhan

(Source: DDC Profile 2067-2068)

Existing drinking water systems

Based on the data available form DWSDO, there are about 62 water supply projects in the district. These projects are serving about 14305 populations. The various organizations involved in these sectors are presented in Table 7.

Table 7: Key organization involved in water supply projects

SN	Organisation	No of Scheme	Benefit HH	Population
1	ACAP	3	104	605
2	CARE NEPAL	16	522	2691
3	CWSS	5	299	1616
4	DDC	5	134	692
5	DWSO	28	1537	7968
6	HELVETAS	2	95	456
7	UNDP	1	25	100
8	VDC	1	8	39
9	WDB	1	29	138
Total		62	2753	14305

(Source: DWSDO, Mustang 2062)

Rangeland

Rangeland occupies the second largest area in Mustang. As opposed to agriculture, rangeland is owned by communities and hence is over exploited and highly deteriorated. In the south, high precipitation and less wind favors plant growth in contrast to northern Mustang where vegetation is extremely poor. In the south, crop farming and animal husbandry are widely practiced. In the north, however, animal husbandry predominates. Free grazing is very common. In summer, after the snow melts, high pasture are open, and people from adjoining districts bring their animals into southern Mustang to graze on these high pastures. In northern areas, animals were taken to the Tibetan plateau for grazing when the areas in Mustang were covered by snow. This practice has been gradually declining with repeated denial from the Tibetan authorities to allow animals from Mustang to cross the border.

Animal Husbandry

Animal husbandry is lifeline of peoples' livelihoods. Animals provide meat, butter, wool, hide, and are used for transport. In northern Mustang, animals are also the major source of dung used for cooking and heating. Mustang has over 69,000 animals of which 68% are goats and 10% are sheep. There are about 2933 (4.2%) yaks and 5549 (7.8%) cows. Horses, mules and donkeys total about 4168 (5.99%). There are also about 1872 joes (*Jhoppa* in Nepali), a cross breed between yak and cow. Poultry constitute about 7,600 (Table 8).

Table 8: Types and number of animals

Types of animals	Cow	Buffalo	Goats	Sheep	Yak	Joe	Horse/mule/ donkey	Total	Poultry
Population	5549	78	47864	7084	2933	1872	4168	69548	7640
Percent	7.8	0.11	68.82	10.18	4.21	2.69	5.99	100	

Source: District profile 2065; CBS 2007

Cows, sheep, and goats are common in central and southern Mustang, while buffaloes are found only in southern Mustang. Yaks and goats are more popular in Upper Mustang, particularly in villages bordering Tibet. Number of animals per households is about 22. Lack of adequate grazing area and labor has made it difficult to raise animals and as a result the number of animals is declining gradually. The impact is felt in energy sources. Use of LPG has increased due to reduction in animal number.

Demography

Mustang has a very low population density. According to the District Development Plan 2066/67, the total population of Mustang is 13851, of which 7137 are male and 6714 are female (Table 9). The male female ratio is 1.063. The number of total household is 2581 with an average household size of 5.3.

Table 9: Population of Mustang

Total Population (2010)	**14,981**
Male	7137
Female	6,714
Total Households	2581
Total Population	13,851
Average Household Size	5.3

Source: Based on District Development Plan B.S 2066/67 and Charang Household Survey 2010.

The ethnic composition is dominated by Gurungs that occupy about 59.3 percent (some reports also mention it to be 62 percent) of the total population followed by Thakali occupying about 24.5 percent. Dalit constitute about 8.2%. Magar and Thakuri are nearly 3% each (Table 10).

Table 10: Ethnic composition in Mustang

Ethinicity	**Gurung**	**Thakali**	**Magar**	**Dalit**	**Thakuri**	**Others**
House holds	1527	630	79	211	74	55
Percentage (%)	59.3	24.5	3.1	8.2	2.9	2

Source: NTNC 2008: NIDI, 2006

Education

Literacy rate in Mustang is about 61.38 percent, which can be disaggregated as 68.6 percent for southern and central Mustang, while the north has 48.1 percent. Between male and female, the literacy rate is 67.3 and 55.47 percent respectively. There are about 46 primary schools, the number for which fluctuates depending upon the number students enrolled. With 10 lower secondary and 5 secondary schools, In addition there are 3 Tibetan and 5 monk schools, one technical school, 4 private schools, and 16 kinder gardens schools (Table 11).

Table 11: Literacy rate and number of schools

Literacy %	61.38 (68.6 for Lower; and 48.1 for Upper Mustang)
Male Literacy %	67.3
Female Literacy%	55.47
Number of Campus	Campus None
Number of high School	5
Number of LS school	10
Primary School	46
In addition to the government run schools, there are 4 private, 16 kinder garden, 3 Tibetan and 5 Monk schools as well as 1 technical school in Mustang.	

Source: District profile 2065

Mustang has total of 2319 students attending primary schools, 328 in lower secondary schools and only 134 in secondary schools. Compared to the total population, Mustang has a high number of schools per capita. However, the number of students in each school in northern Mustang is quite low. Some schools have less than 10 students. The number of teachers in primary schools is about 277, which varies slightly from year to year. Total number of teachers of all levels is about 355. (Table 12)

Table 12: Number of teachers and students of all level

School Level	Teachers			Students		
	Male	Female	Total	Male	Female	Total
Primary	204	73	277	1175	1144	2319
Lower Secondary	45	1	46	178	150	328
Secondary	37		37	75	59	134
Total	286	76	355	1410	1353	2763

Source: District profile 2065

Economy

Statistically, Mustang has a large population (80.8%) engaged in agriculture followed by trade (6.75%). Foreign employment has served about 3.9% of the population. Share of population engaged in different occupation is given in Table 13. However, agriculture only provides a small share in the income, and thus the families need to engage in other economic activities to support families. Existing data sources do not mention the share of income from tourism though it receives a large influx of both international and domestic tourist.

Table 13: Population engaged in different occupation

Types of occupation	Percent of people involved
Agriculture/animal husbandry	80.8
Trade	6.75
Foreign employment	3.9
Civil service	1.9
Others	6.2

Source: District profile 2065 BS

The lowest agricultural potential and fewest off-farm employment opportunities cause the seasonal migration of able-bodied people. Despite the unique landscape and richness in land and water resources, the potential for economic development has remained dismal because the area has inadequate transportation facilities to make the best use of available options. Mobility was only possible either on foot or on horses' back. Transportation of goods used to be done by porters and mules, *jhoppa*, and goats. But the recent introduction of roads has changed it in many villages. Goods are transported by tractors, and bus and jeeps are available in the central and southern Mustang. There also road access from the Tibetan side. Trucks from across the border carry food and other essential items from Tibet to Northern Mustang. Northern mustang is also connected to Jomsom by seasonal road. ADB is assisting the GON to improve road access to northern Mustang.

The economic situation within the region is skewed. The poor live in the north and at higher elevations. The Thakali people, who have settled from Ghasa to Jomsom, specialized in long-distance barter trade in the nineteenth century and early twentieth century and accumulated capital for investment, which led to the existing economic gradient from south to north. Lately, development of year round tourism in the south has further steepened the economic gradient. In the north, many people migrate to other cities within Nepal and to India during winter to carry out trade. They return home in the spring with household supplies necessary for the remainder of the year. The young and the old remain in the village during winter.

Livestock can be said to be the base of the poor living made by the people. Although, the rural economy depends on natural grazing, little effort has been diverted to its development. The main reasons are its remoteness, harsh climate and inadequate knowledge about the available potential resources.

1.5. Organization of the report

This report provides a district climate and energy plan for Mustang. Immediate plan (2011-2013) and a longer term plan until 2020 is presented. The report has been divided into following five chapters:

Chapter 1: Introduction

Chapter 2: Process and approach

Chapter 3: District climate scenario, situational assessment of energy sources, types of energy sources used for various uses, gender and social inclusion and institutions

Chapter 4: Data analysis and scenario development

Chapter 5: District energy plan which includes detailed implementation plan, financing plan, as well as monitoring and evaluation plan. The last part of section 5 also provides conclusions and recommendations for future course of action based on the findings with respect to the guideline provided by AEPC for DCEP preparation.

2. DCEP Process and Methodology

Natural resources and energy are directly linked with climate. Since availability and access to these resources is vital for survival; climate, energy, and society are closely interconnected. Alteration in the ecosystem services affects the livelihood of the people who depend on them for survival, particularly in mountains where the balance between human needs and natural environment is delicate, and the hardest hit by this change will be those that are socially and economically vulnerable including women, elderly and children population.

How can gender roles be transformed? How can Renewable Energy Planning be Climate Resilient? These were two key questions to examine how gender, social dimension and CC interplay in climate and energy planning in Mustang - both of which, revolve mainly around how we understand the impact of climate change, and how do we develop plans to address energy as well as other basic needs of communities.

2.1. Mustang DCEP Process

Figure 2 presents the process as suggested in the guidelines (MoE, 2011) for the preparation of Mustang's DCEP. The process began by stock taking of energy related information including, gender, social inclusion and climate change. DCEP guideline, though not finalized when the process began, provided enough background and support to the process followed.

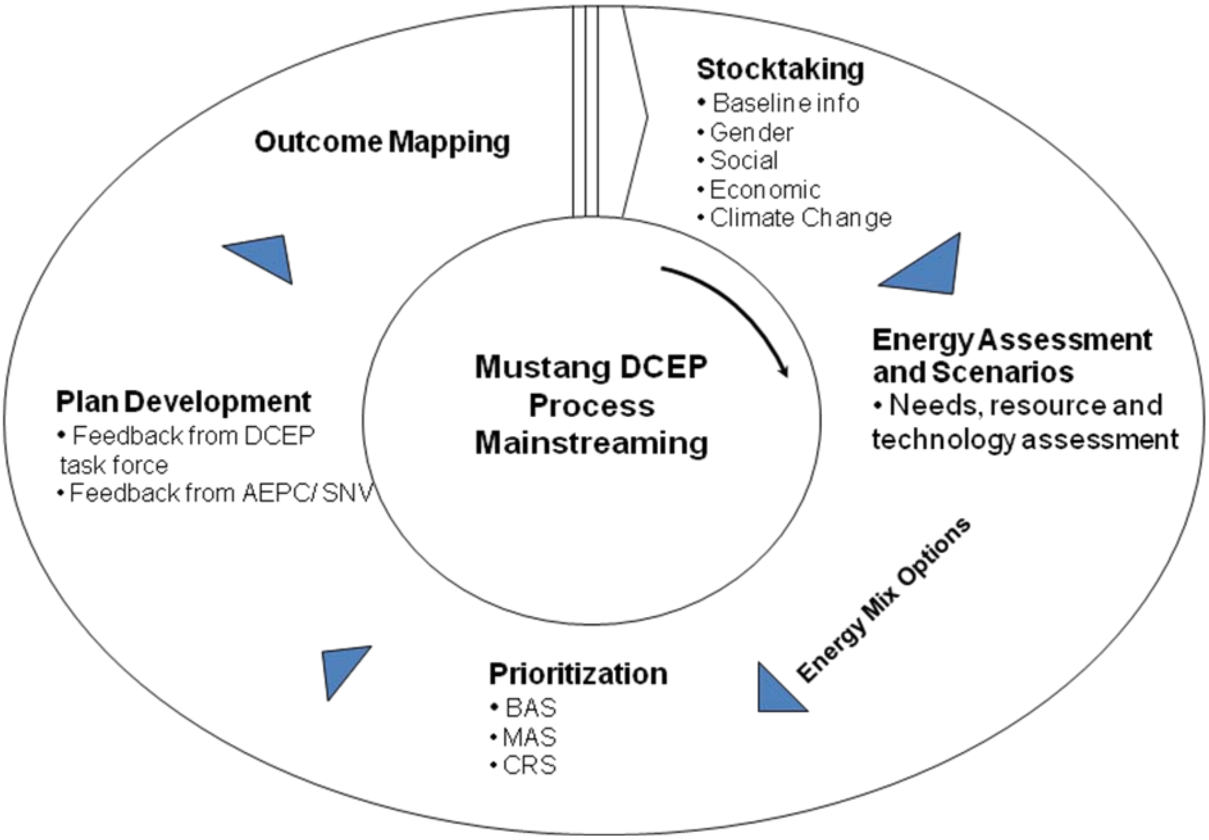


Figure 2: Mustang DCEP Process

The segregation of Mustang District into three regions: Northern, Central and Southern Regions and the use of a Systems Approach are unique to the preparation of Mustang's DCEP. These approaches have been described in the approach section of this chapter.

CEPAD team believes that the preparation of DCEP is an iterative process and best achieved if the process is followed annually or at least in a bi-annual basis. Data gaps and absence of a proper planning process tool hinder this process. Coincidentally, the process of collecting segregated data at household level has begun for VDCs in Mustang in 2010. Information and data collected from these VDCs can be utilized to revisit energy planning using the Mustang DCEP Process.

The formation of Mustang's DCEP task force has institutionalized the DECP process. This was facilitated by AEPC prior to the initiation of plan preparation to ensure the district involvement and contribution to the planning process. The task force was formed with the following representative members (Table 14).

Table 14: DCEP task force members for Mustang

S.N.	Name	Role	Organisation
1	Mr. Mani Kumar Gyanwali[1]	Chairperson	Local Development Officer, Mustang
2	Mr. Shakal Dev Sharma	Member	District Technical Officer, Mustang
3	Mr. Kishun N Chaudhary	Member	NGO Federation Member
4	Mr. Umesh Kumar Dhakal	Member	Chief District Officer, Mustang
5	Mr. Nabin Ruwali	Member Secretary	District Energy and Environment Officer, Mustang
6	Mr. Sun Prasad Thakali	Member	Nepal Electricity Authority, Mustang
7	Mr. Paras Singh	Member	ACAP

CEPAD team collected relevant information about energy scenario, CC and gender and social dimension of energy planning. AEPC's DCEP guideline was used as a basis for data acquisition and to frame questions for community consultations and interactions with the DCEP task force.

The following section describes the steps of its approach used for the preparation of Mustang DCEP.

2.1.1. Stocktaking

Stocktaking was done through consultations, discussions, meetings, literature reviews and through data collection.

Two major interactions were carried out in Mustang. The first meeting was held with DCEP taskforce members on 28 November 2010 and was facilitated by AEPC. The second interaction was held at Jharkot, Muktinath with community members on 29 November 2011. These consultations helped understand district perspectives on DCEP. It was evident that a blanket plan for Mustang would not represent the situation within the district with high variability in areas of energy.

The orientation cum stakeholders meeting was held at DDC office in Jomsom on 28 November, 2010. The Local Development Officer (LDO) of Mustang, who is also a member of the task force, chaired the meeting attended by among others the Program Officer of

[1] Mr. Mani Kumar Gyanwali (ex-LDO of Mustang) was later transferred to another district and Mr. Shyam Raj Adhikari officiated as Chairperson of DCEP task force.

AEPC and District Energy Officer. The meeting was briefed about the scope of DCEP and the purpose of field visit by CEPAD team. The LDO explained the energy situation in the district and laid out the path that DDC Mustang would like to take to develop energy plan in the short and long term. Emphasis was laid on developing energy options to meet the energy demand of people in the northern Mustang, where animal dung and dead or dying Caragana plants that are on the decline is the only source of energy. It was apparent from the meeting that CC would add further uncertainty to the grassland sources that are vital to maintain animals and thereby the dung production. The list of the participants in the orientation cum stakeholders meeting is listed in Annex 4.

Data were collected based on the criteria such as geographical representation, ethnic composition, accessibility, resource status, energy development status, climate impacts, and economic opportunities, and consultation with taskforce members. Prior to collecting data, CEPAD team members and its field representative were provided with an orientation for the type of data and information that the study intended to collect. Data were collected using both primary and secondary sources. The primary sources included focused group discussion, key informants (villagers and VDC secretaries), and personal communication (project officials and entrepreneurs in Jomsom). Information on vehicles operating in the district was collected at Beni of Myagdi District, Ghasa, Jomson and Muktinath. The question in these points mainly focused on newly operated public transport and the services they were providing, its significance to the economy and livelihood of Mustang people, vehicular movement and fuel requirement and supply.

A checklist to guide focus group discussions and key informants surveys along with primary data collection was prepared focusing on the following topics:

- The extent of diversity in energy uses;
- The current socioeconomic activities engaged in and the incomes made from on-and off-farm activities;
- The extent of the locals' dependence on forest resources for energy;
- The needs and potentials of and the constraints hindering the development of alternate energy sources;
- Ongoing-energy development activities;
- Active CBOs and NGOs working at the community level to promote energy saving devices; and
- People's vision of energy conservation and their aspirations

2.1.2. Energy Assessment

Energy needs, resource, institutional and technology assessments were carried out to conduct Energy Assessment. The following sections provides snap-shot on what they meant and how they were carried out:

2.1.2.1. Energy Needs Assessment

Energy needs was assessed by collecting information from published documents that provided ball park information in most cases and for the entire district. The second source of information was the VDC profiles that are being prepared. Detailed information about energy status at household level for Charang village was obtained from the VDC secretary. Disagregated figures for energy needs of the households and commercial purposes were collected from individual contacts with household members and hotel owners in Jharkot, Thini, and Kobang. Commercial energy needs were collected only from central Mustang, which can be used as reference for other commercial sectors in northern and southern areas with some coefficient. Energy demand for industrial sector was only collected for breweries which are widely practiced. Although there are some sawmills in the southern area, they operate only a few months a year. The saw mills were not included because of their minimal share. Verification of the data obtained was done for those figures that were either too high or too low. Energy needs assessments and its linkage with other major sectors is presented in subsequent chapters.

2.1.2.2. Resource Assessment

Resource assessment was done on the basis of information provided by DDC annual publication, publication of the district agriculture office, and soil conservation office. The data from these documents were about land use, area under different crops, forest area, grassland, and number of different types of animals raised at homes. With regards to electricity, information was collected from DDC records, ACAP documents and personal references with officials at these offices. Information was also collected from household consumers and commercial sectors regarding future demand that they thought would arise. Fossil fuel records were collected from transport operators and fuel suppliers who carry stock of fuel. Aviation fuel could not be assessed because the area does not have refueling facility.

Assessment on available energy source with respect to climate change, gender and social inclusion was carried out during the Key Informant Interview (KII) and meetings. Biomass being the predominant source of energy, its availability for each of the VDCs, current use, the hardship was obtained. The study team used the information obtained through these KII and meetings to explore detailed impacts on biomass, how women, poor communities and households on the lower rung cope with existing energy situation. Direct CC impacts on water and indirect impacts on agriculture, water supply, micro hydropower schemes were also explored. Mustang's unique gender context and particularly how it has positive and negative responses to energy management at the household were studied.

2.1.2.3. Institutional Assessment

The following five key areas for institutional assessment were agreed jointly by SNV AEPC, Practical Action and CEPAD for preparing DCEPs. The Study Team carried out scoping exercise to map out the actors, their roles, capacity gaps and external influences during the district visit, literature studies and during the district consultation process.

1. What are the institutions/actors?
2. What are they doing?
3. What relations exist among them?
4. What capacity/capability exists and what is needed?
5. What enabled/what disabled?
6. What are the external influences?

Capacity assessment was done through interactions with the DCEP taskforce and during meetings with key agencies. Previous assessments carried out on capacity building such as short term and long term training needs for various institutions on micro-financing options, along with one-two-one interactions with participants of previous exchange visits were carried out. The findings for institutional assessment are presented in Chapter 3.

2.1.2.4. Technology Assessment

Due to diversity in energy uses, a wide variety of technologies have been used by people in Mustang from traditional wood burning metal stoves, use of LPG to modern air conditioners, and energy saving devices including CFL have been introduced in the area. Devices utilizing solar energy have also been widely used. Assessment of these technologies was done based on documented records and from group and individual contacts. Attempts were also made, though with no significant success, to understand technologies that had been used as pilot projects in using the wind energy.

Technology evaluation and prioritization assessment was done during the Mustang Stakeholder Consultation Workshop. The findings on technology prioritization are presented in Chapter 4.

2.1.3. Demand Projection

Projection of energy demand was made to assess the likely gaps between demand and supply. Technological options to meet the gap was laid out and the list of potential interventions was presented before the stakeholders at the workshop to prioritize the technological option based on set criteria such as climate change, gender and social inclusion; and cost and other factors specific to Mustang. Prioritized list of technological interventions were then selected for planning. They were used to draw potential development intervention for three different scenarios: i) the business as usual, ii) medium adaptation, and iii) fully climate resilient. Since the secondary data did not provide most of the information required to project future energy situation; for example, the reduction in firewood consumption due to import of LPG; assumptions were made based on communities' perception and consultant's judgment. A comparison of all three scenarios was done to evaluate the strength and weakness. It was found that the medium adaptation scenario best represents the strong case for planning purpose.

Chapters 3, 4 and 5 present details on technology prioritization, plan development and outcome mapping (monitoring and evaluation tool).

2.2. The Regional Approach

There are two distinct areas in Mustang–upper and lower Mustang with 10 and 6 VDCs respectively. This distinction has been historic and has found relevance in terms of development indicators, accessibility, demography, and economic resource base. Most data for Mustang is categorized for upper and lower regions. However, the variability in natural resource, climate, demography, economy and traditions vary significantly from south to the north Mustang. The middle area has a mixed demographic composition, with perhaps the highest economic activities.

Considering these unique characteristics, it is suggested to segregate the district into three areas, and for the purpose of clarity name them as the northern, central, the southern

Mustang. With this division, seven VDCs would fall under northern Mustang, five VDCs would fall under central Mustang and four VDCs fall under the southern Mustang. NTNC (2009) has also used the three distinct sub-zones on the basis of geographical features. For energy planning purpose, in addition to geographical features, it is suggested to consider the precipitation, forests and wind condition to designate the region. Accordingly the regions have been divided as following (Figure4).

1. Southern Mustang: Four VDCs of Lete, Kunjo, Kobang, and Tukuchhe have been included in the southern Mustang. Southern part of Mustang is a narrow gorge between Annapurna and Dhaulagiri mountain chains. Only small pockets in the valley are habitable. Due to its proximity to the snow clad mountains and glaciers, the area remains cold during night. Water in the streams and springs are very cold even in summer. However, the population density per habitable area is high due to relatively calm weather and its proximity to the middle hills.

Figure 3: Regional Approach for Mustang

The area is abundant vegetation cover due to adequate precipitation it receives in winter and summer. Soils remain moist and wind erosion is minimal. Meadows and grassland offer high land pasture to yaks and sheep and goats. Animals from adjoining villages of middle hills are brought here for grazing when snow melts. The time of animal movement coincides with the hot summer of the midhills when forage in the midhill forest is at the lowest. The land along the Kali Gandaki River is mostly rocky and hence not suitable for agriculture; however, the plain areas in inner pockets are. Some isolated pockets of farmland also exist on high areas. Orchards have been developed in sloppy land of the hills as well. Animals raised include cows, buffaloes, goats and sheep. Some farmers have also raised poultry. The village of Pahirothaple is located at lower altitude in the extreme south of the district and hence is warm. Therefore, people have installed some biogas plant, even though there is no shortage of firewood.

Since the area is rich in forests, people use large quantity of firewood for domestic consumption. Collecting firewood is expensive in Mustang due to higher wage rate. If there is an alternative to firewood, people would accept it even if it means less efficient than traditional stoves that consume large quantity of firewood.

2. Central Mustang:

Five VDCs of Marpha, Jomsom, Kagbeni, Muktinath, and Jhong have been considered as central Mustang. The central part of the district has different features. The mountains begin to be short in height, while the valley of Kali Gandaki begins to widen. Both sides of Kali Gandaki have fertile river- terraces used as farmlands.

Climatically, the middle area enjoys both dry and wet conditions. Average annual precipitation gradually declines as one move from the south to central Mustang. It receives some rain in summer, but a significant amount of snow in winter. Sometimes heavy rains are reported while some winter sees no snowfall. Wind begins to pick up speed from central Mustang. With less precipitation and high wind, the soil remains dry, trees are stunted and the growth period declines to 3-4 months. Due to the dryness, the only plants available are thorny bushes and *cargana* shrubs. Ground grasses begin to grow immediately after the snow starts melting in summer, making fodder available for animals

The area has seen a significant growth in horticulture plantation in these fertile terraces in the last three decades. The area is inhabited by Gurungs and Thakalis, with very small population of Dalits and other minority groups. .

The district headquarters of Jomsom with all administrative offices and airport is located here. The famous deity of Muktinath lies here. It is also the commercial area of Mustang with most hotels and business centers.

3. Northern Mustang:

Seven VDCs of Chusang, Ghami, Charang, Lo-Manthang, Chosher, Chonup and Surkhang is grouped as northern Mustang, which is characterized by cold and dry climate. The northern part of Mustang is dry as it receives no rainfall, but snowfall occurs in winter. Wind in the valley begins to lose speed. The heights of the mountains are low. One can see rolling mountains in some areas. There is no forest in this part of the district, except in some inner pockets where moisture is available. Popular and salix trees are seen planted along the river banks and at terrace risers. The grassland has sparse vegetation cover. Weedy stunted plants such as *caragana* is found distributed sparsely. Streams and springs freeze during winter making water availability extremely poor. The river valley is quite wide, and therefore has plenty of area available for agriculture; however, due to water and temperature stresses only one crop a year is grown in the area. Energy demand is met mostly by dung and small shrubs, which are on the decline.

The roles of women vary considerably in these three regions, with women in the northern region heavily involved in collection of fuel for household purpose compared to the central and southern region. Three VDCs of Charang, Muktinath, and Kobang representing northern, central and southern Mustang respectively, have been selected for data collection.

2.3. The System Approach

As resilience of a society depends on how the overall system, within which it operates, is structured, the societal risks and vulnerability to existing and emerging stresses require an understanding of various interdependent and interconnected variables of the system. The system can be explained using an analogy of warp and weft yarn of a fabric. The resilience of the fabric depends on how strong is the warp yarn to withstand the stresses, but the outcome (the benefit including the options that one seeks to obtain from the system) depends on how and what type of weft is woven around the warp. Translating this concept to CC adaptation with focus on natural resource, recent methods have used a system approach to analyze systems' complexity.

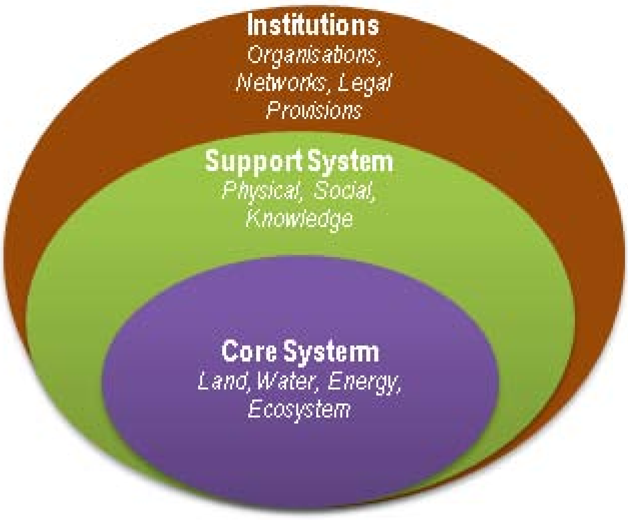


Figure 4: System Approach

The three key systems to be considered would include: the core system that contains the land, the water, the energy and the ecosystem (say the warp). The core system provides the base for livelihood and socioeconomic development. However, the state of core system in terms of management and utilization depends on support system including the social capital, physical infrastructure, and the state of knowledge (the weft). A prudent management of the core system requires a strong and informed support system. The third system that would be looked at is the institutions, networks and legal landscape, which are crucial for an effective support system managing the core system sustainably.

Translating the system concepts in Mustang, the key components of core system including land, water and ecosystems are relatively stable in the southern Mustang, whereas it is fragile in the north. A fragile core system can only be managed in a sustainable way if the support system and institutions supporting them are strong, whereas a stable core system remains resilient even if the support system and institutions are not so strong. Comparing the situation between the south and the north in Mustang, it appears that the south does not have as strong a social network and systems such as winter migration and single marriage in one generation that are deeply embedded in the socio-cultural settings in the north. Likewise, customary laws in these two areas are as different as the level to which the formal institutions have been able to influence the local informal institutions. Formal institutions can be effective with some effort in making changes in behavior of energy users in the south, while it may face substantial challenge in the north to penetrate in to local situations. This is one of the reasons why formal institutions are able to function well with success in central area where both core and support systems are moderately stable, whereas efforts of most formal institutions have remained ineffective in northern Mustang. It is not because the northern Mustang is remote but because very few formal institutions made an effort to work with the support systems. Any future effort should work more with the support system and the institutions than with core systems only.

With regards to the source of energy, the components of the **core systems** in Mustang are water, vegetation farm residue, animal dung, and sparsely distributed shrubs. Water resources for energy production is abundant, however its utilization is restricted by remoteness and by high rate of erosion and unstable landscapes. Vegetation is sparse in most part of Mustang, and hence cannot be taken as a major source of energy, though it has remained so traditionally. Wind has been taken by many development experts as a potential source of energy, however, it has limitations of being very high speed at times, and blows only during day time, whereas electricity is required at night. Saving energy produced from wind energy for night time is a major engineering challenge. Some piloting was done in the past with very limited success. A detailed study of wind character at different elevation for different season would help harness this huge energy source. In addition, it requires tailor-made equipments with higher level of financial backup and sustained technical services, which at present does not seem feasible. From a study done in 1979 by one of the authors of this Plan, Mustang has 25% higher radiation compared to the mid hills. This is because of Mustang's higher elevation (elevation of Jomsom is about 8800 ft). Due to less cloudy days in Mustang, solar radiation is available for most part of the year.

The **support system** has been relatively stable in Mustang. In all three regions, social coherence (despite the difference in demographic composition) has remained very strong. Resources are distributed amicably through community decisions. Communities have lived in harmony with minimal disputes concerning land and water. *Dalits,* whose population is about 8.2 percent do not depend on land resource for livelihood as much as the rest of the communities do, and hence their role in decision making is minimal. *Dalits* and other minorities live on wages and earnings from services they provide. In general, the community members help each other to undertake business transactions or ensure that each one gets equitable share in business opportunities when they arise.

The traditional practices and local knowledge systems are still intact in northern Mustang, whereas they are on the decline in central and southern Mustang. *Aamchi* (practitioner of Tibetan medicines) is an important element of society among northern Mustangis. Dead bodies are seldom cremated; rather they are fed to fish and vultures. Polyandry is practiced to avoid fragmentation of land and fixed assets. Second son and daughters in the family dedicate their lives in the service of monastery as *Lama* and *Jhuma*. Historically, people the in northern Mustang region have migrated temporarily to adapt to extreme winter conditions.

The last leg in the systemic analysis is to understand the **institutions** that determine how the support system functions, which in turn guides the management of the core system. This system includes organizations (formal and informal), networks, and legal provisions (customary and statutory). It must be stressed that formal institutions only came to Jomsom in 1975. There were about 30 offices established including the district court, the office of land reform, and a small unit of border post. The largest unit established was the army barrack and high altitude training center located in Jomsom and Kaisang (a place located near Jomsom that was previously used as hiding camp by *Khampas*) respectively. The new offices added to the economy with presence of about 300 government staff and over 500 army personnel. Since they are located in the central part of Mustang, the economic benefits mostly stays there and do not go to northern Mustang. The formal institutions also added pressure on the meager natural resources such as fuelwood and on food supply, which is mostly imported from adjoining districts and Pokhara.

With regards to the legal provisions, the traditional customs continue to dominate justice systems. Law and order are mostly maintained by customary laws. Formal court cases in Mustang are almost nonexistent. The deep rooted local traditions and customs are seen in managing energy sources. Houses are seen with stacks of fire wood on roofs, which indicates how well ensured a family is in meeting energy requirement. In northern Mustang where firewood is extremely scarce, households save heaps of dung. Dung is collected from animal sheds, pastures or from grazing areas around the villages.

People do not take regular baths and avoid using water for sanitary purposes because of the cold and freezing weather. Standing tress of *Populous* and *Salix* along terraces and walking trails are considered precious. The trees are protected as they help break wind speed. The branches are used as firewood. Leaves are used as forage or bedding materials for cattle.

2.4. Limitations of the Study

The followings are the limitations experienced in the preparation of Mustang's DCEP.

1. Quality of secondary data is largely questionable and often superficial. Population, its projection, livestock population, area under agriculture and production details varies between different literature. District Energy Situation Report (DESR, 2008) prepared by DDC, which this study draws heavily from, for example, gives such brazen information as the district having 178 traditional water mills, 246 diesel operated mills, 279 electric mills. One has to use their own judgment when utilising secondary information.

2. Local climate is distinctly different in northern, central, and southern Mustang and climate data representing these areas is absent. Extrapolating hydro-meteorological data from meteorological stations in Jomsom in the central region does not reveal the situation in southern and northern areas.

3. Information on rainfall published in various reports are not reliable. The figures quoted from the district profile (NPC) are used in most literature where total annual rainfall in the district is given as 7 mm (without mentioning the time period) which is very low. Analysis of long term climate data is not possible as hydro meteorological data from Lomanthang and Muktinath station are missing for a number of years.

4. The number of schools has varied from year to year, as some of them were merged when the student enrollment was nil, and reopened when students enroll.

5. It was also felt that during group discussions in the field, there was a tendency among local people to overstate the situation. Cross checking the primary information from proxy sources is rather difficult due to; i) sparsely located neighboring villages or community, and ii) the homogeneity of demography, where people do not wish to contradict among themselves. It was difficult to pin point the average amount of firewood consumed in a house. In the same manner, the information about the amount of liquor produced is not available. It takes a substantial amount of energy to distill liquor. It was also found contradicting to note that Mustang is a food deficit region, but the demand for government supplied food is declining. People prefer to buy rice in the market than from the government run Food Corporation.

6. Mustang receives subsidies on essential goods, draws attention and funds for development activities. People expect support for transport subsidy on LPG, which is justifiable in meeting the energy need for an area so poor in local energy sources. However, such policy may hinder development of other clumsy but sustainable sources of energy and avoid mal-adaptation.

7. Mustang's arid environment and its unique landscape is overwhelming. Visitors including researchers and data collectors usually romanticize the natural vastness of the area and the comfort one finds in trekking routes and hotels. This is reflected on most write ups about Mustang, while presenting facts without substantiating them.

8. People from the northern Mustang start to migrate south beginning mid-November. As field work on DCEP could only begin last week of November, it posed limitations to the study team to carry out interactions with communities in northern Mustang.

9. The DDC started preparing profiles for all sixteen VDCs, which is expected to be completed by middle of 2011. The profiles, except for a draft one for Charang VDC, were not available to map the existing use of energy – especially the use of LPG gas. These profiles should be used to update the DCEP Mustang once complete.

Available information on Mustang is mostly on tourism and cultural aspects of Mustang that depict more fascinating stories about the district than the actual condition. This is particulararly sparse for the energy sector. In many of the reports collected the forest cover for instance has been mentioned as low, and the cold climate is often mentioned by many reports, but none of them reveal how the energy sources have been maintained or mobilized.

3. District Situation: Climate, Energy, Gender, Social Inclusion and Institutions

This chapter provides a situation report of Mustang's climate, energy, gender, social inclusion and institutions.

3.1. Climate and Climate Change

In November 2010, newspapers were rife with 'climate refugee' stories from Mustang District. According to newspapers, more than half of 16 households from Samjung and 22 households from Dhe of Upper Mustang migrated due to lack of drinking water and irrigation. The papers reported that springs have dried out and grasses had stopped growing in the pasture. Consequently, agriculture and animal husbandary suffered. The villagers had complained that with their main sources of livelihoods in jeopardy, they had no option but to leave. CEPAD team further explored the situation during their field study to get a clear understanding of climate change, water and energy situation and sought local feedback on how these communities could be made resilient against such adversaries.

The following case of Samjung gives us an indication of water and energy requirement for sustenance of a small settlement.

Samjung is a settlement of 15-17 households along a mountain slope in Chhoser VDC of northern Mustang. A network of canals conveyed water from the upper catchment areas to a number of ponds dug upstream of the settlement. These ponds helped recharge water and provide moisture/feed the springs in the fields situated below the settlements. The key-informants of the area mentioned that the springs in the area are yielding less quantity of water each year. And more importantly, the springs and moisture that used to serve the fields below the settlements are moving downhill. Fields that do not get moisture/spring water for irrigation cannot be farmed.

Though there are no specific in-depth studies to identify the reason of such change in water yield, the key-informants mention that the amount of snow fall has dramatically decreased. And the frequency of intense rainfall episodes has increased. People now use umbrellas in these areas which until a few years back were never seen.

A team of 14 Constitution Assembly (CA) members affiliated with a Parliamentary Action Team on Environment, Climate Change and Disaster Risk Reduction (PAECD) participated in a CC impact study visit to Mustang on 21 to 23 September, 2009. The team gave the following descritions on the local level impacts in Mustang District:

- *Winter snowfalls have changed from regular features to rare events leading todecline of snow deposits, and exposing black rocks of high mountains where permanent snow cover used to be a key feature.*
- *Warmer and dry winter and high temperatures have devastated apple farms in lower part of the Mustang. Quantity and quality of apple productivity have declined sharply.*
- *Clay roofed houses have been weakened by unusual intense rains where such phenomena did not exist. These houses were designed to manage snowfall only.*

- *Water sources are drying up.*
- *Killing of livestock particularly goats has suddenly increased due to diseases linked to unusually dry and warmer weather.*
- *Most of the traditional crops have suffered new types of diseases while the warm weather crops and vegetables are being successfully farmed.*
- *Wild fires have emerged as a major contributing factor for deforestation and degradation.*
- *Due to receding glaciers and permanent snow line as well as intense road links in Mustang have threatened sustainability of trekking tourism.*

The CA member's report emphasized the following point which is relevant to the DCEP for Mustang.

"The practice of using firewood for cooking and heating among camps of security forces, local businesses and local households should be immediately replaced by available alternative fuel saving technologies like gas, kerosene, improved cooking stoves, biogas plants and solar cookers."

Peoples' perception about changing climate

According to the local people, precipitation in summer has gradually increased over the years with occasional intense rainfall. Snowfall in winter used to occur in December but now it is usually late. Snowfall in February has become common. In southern Mustang snow has turned into rain bringing rainfall in winter. Temperature in winter has generally increased, and hence, winters are less cold and less frosty than in the past. Rainfall is getting more erratic with long droughts and sudden heavy rains. Due to delayed snowfall, soil moisture is reduced affecting grass growth. The snow disappears rapidly due to early thawing in March. The greenery in grasslands lasts only for a short period. As a result, fodder production has reduced. Local communities consulted mentioned that areas to the east of Kali Gandaki are experiencing severe impacts compared to the areas to the west.

Water flow in the streams and springs has reduced. It has affected water supply for household. Villagers in Dhe in northern Mustang have abandoned their villages due to unpredictable flow levels in the stream and timing of seasonal springs. The rain in central Mustang has caused major problems for the structure of the houses. . Houses in Mustang are built up of mud-wall and mud roof, to insulate the rooms from extreme cold. Generally, the snow deposited on the roof is removed as soon as the snowfall recedes. However, with the snowfall turning into rain, the roofs now leak and the mud walls are frequently damaged by rain splash.

Weather hazards have been noticed in terms of increased frequency of avalanches, flash floods, windstorms, and hailstorms. The river valley is getting windier. Hailstorms are a new phenomenon for Mustang. Apple fruits in Mustang used to be spotless, because they never got beaten by hailstorms, but things are changing. They get damaged by hailstorms now.

There are benefits too. The weather has become relatively comfortable, especially to the older people. They find their villages more comfortable to live in, than in the past. There are more tourists coming to the area during post monsoon months due to dry and warm weather – which might add to the tourist influx.

Table 15 summarizes the observed and expected CC impacts in Mustang District.

Table 15: Observed and Expected Climate Impacts in Mustang District.

Impact area	Observed impact
Changes in temperature, wind and precipitation	• Winters are less cold and less frosty • The river valley of Kali Gandaki is getting windier • Less snowfall in winter • Increased rain and snowfall after winter • Unusually intense summer rainfall
Weather hazards	• Increased frequency of avalanches, flash floods, windstorms and hailstorms • Rainfall patterns are getting more erratic with long droughts and sudden heavy rains • More loss of life and property from harsh weather incidents
Forests/ shrubs/grass	• Altitude of tree line is rising • Grasslands are less green because reduced snowfall results in moisture deficiency and less grass production
Agriculture	• Bigger tasty apples at higher altitudes where it used to be too cold for apple farming • Apple orchards and nursery farms are emerging at higher elevations • Successful farming of cucumber, chilli and tomatoes in open gardens (without a greenhouse)
Water supply and housing	• Reduced water flow in local streams and springs • Unpredictable fluctuation in flow levels and timing of seasonal spring recharging • More roof leakage and wall erosion in traditional mud houses • Water supply is a major problem leading to the abandonment of some old settlements in Mustang
Lifestyle/business	• Older people find their villages more comfortable due to warmer winters • Tourism businesses are more profitable due to longer drought periods during post monsoon months • Agricultural businesses suffer due to reduced irrigation and variable precipitation patterns

Source: Dahal, N 2004, Perception of Climate Change in the Himalayas
http://www.tiempocyberclimate.org/newswatch/feature050910.htm

3.1.1. Temperature

The overall temperature in Mustang is likely to increase in coming years, with higher rate of increase in the northern most part of the district, while the southern most part will experience a moderate rate of increase in temperature (MOPE, 2004). The temperature will rise in the range of 0.12°C in the northern most part, whereas, the rise will be in the range of 0.06-0.12°C in most part of the district. Mustang district shows a high decreasing trend of maximum temperature (PA, 2009).

The southernmost area where there are high mountains and a narrow gorge is likely to experience a temperature rise of about 0.03-<0.06°C (Figure 5). The shaded areas in the map is based on the projection done by the initial national communication (MOPE,

Red: 0.12°C
Pink: 0.06-0.12°C
Yellow: 0.03-<0.06°C
Light Green: 0.03->0.0°C
Green: 0.0°C

Figure 5: Temperature pattern in Mustang

2004), which has provided isothermal lines developed by computer model and not on the actual measurement in the field.

3.1.2. Precipitation

The Intial National Communication (MOPE, 2004) has made precipitation projections for the country. According to which, the General Circulation Model projection of precipitation scenario against observed precipitation values indicate more intense pre and post monsoon precipitation with drier winter and spring, whereas highly noticeable increase is found especially during June and July, while slightly lower than observed precipitation amounts are estimated for August. The northern Mustang is likely to get increased precipitation while it will show some decline in the central and southern Mustang.

DST (2008) analyzed the existing precipitation records between 1980-1995 within Kali Gandaki corridor and found that the precipitation in Mustang is currently declining, with some part in the extreme south having no change in precipitation. The areas with changing precipitation within the Kali Gandaki corridor is shown in the accompanying map (Figure 6).

Figure 6: Precipitation pattern in Mustang

According to the monthly distribution of precipitation within the corridor (Table 16) it appears that the precipitation is on the rising trend in January and February, while it is on the declining trend in other months. There has been no change in precipitation in August and November. However, the annual average precipitation is declining with reduced precipitation intensity. It must be pointed out that the precipitation record given in Table 17 is from two stations located in the northern and central Mustang, which sadly does not indicate the precipitation trend of southern Mustang.

Table 16: Changing precipitation character in Mustang

Precipitation	Between 1980-1995									Average Annual	Intensity
	Winter				Summer						
Month	**Jan**	**Feb**	**Mar**	**Apr**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**		
Trend	↑	↑	↓	↓	↓	↑↓	↓	↓	↑↓	↓	↓

(Source: DHM 2000) *(Increase: ↑, Decrease: ↓, No Change: ↑↓)*

The key informants mentioned that the Kali Gandaki also forms as a divide for areas that are experiencing increased water shortage – with areas to the east of Kali Gandaki experiencing more water shortage (decreased precipitation) compared to the areas west. Snowfall has decreased in amount and duration. Drought was observed at *Kagbeni* due to low snowfall last year. Usually snowfall used to be in Kartik/Manshir*, to Falgun*, now Kartik to Baishak. Previously wind blowed from Manshir and now throughout the year from both directions. People perceive increase in temperature compared to previous years. As per the NAPA Public Health TWG report, the days are getting hotter (NAPA 2010).The following table shows the temperature and precipitation of Jomsom in Mustang.

Table 17: Temperature and Precipitation in Mustang

Month	Temperature (degrees centigrade)		Rainfall (mm)
	Avg. Maximum	Avg. Minimum	Average*
April-May (Baishak)	21.67	8.25	0.19
May-June (Jetha)	23.37	12.51	0.54
June-July (Ashar)	22.66	13.97	2.63
July-August (Shrawan)	22.53	13.86	1.25
August-September (Bhadra)	21.94	11.08	0.9
September-October (Ashoj)	17.92	5.27	0.64
October-November (Kartik)	14.45	0.44	-
November-December (Mangshir)	13.7	0.25	-
December-January (Poush)	11.7	-1.41	-
January-February (Magh)	9.53	-1.92	0.33
February-March (Falgun)	14.43	2.23	1.02
March-April (Chaitra)	19.88	5.84	0.27

*(Source: Jomsom Weather Station, Jomsom Airport as cited in Mustang District Profile 2065) * The figures are not only missing for few months bit are incorrect as well. It does not show which year the figures belong to.*

A combination of changes in temperature and precipitation determines the local climate impacts. If the temperature regime changes as projected, one can expect that southern Mustang is likely to become more humid because of lack of change in precipitation but a slight increase in temperature. Increased temperature will turn snow into rain and thus there is likelihood of more flash floods, and erosion than if it had only received snow as in the past. In central Mustang, rise in temperature and reduced precipitation would mean that the drought condition will be exasperated. Decreased precipitation during March and April indicate that there will be less moisture available for vegetation at a time when they begin to grow. Increased precipitation of January and February is likely to bring more rain than snow, altering the entire ecosystem that have adapted to snow until now. It will also affect slope stability imitating more arroyo and sediment generation.

3.2. Energy

Initiatives on small scale energy installations have a long history in Mustang. The first hydropower project was built in 1979. Experiments to tap wind energy for running water pumps and generating electricity were done in the early 1980s. Running water was used to maintain temperature for storing apple. Many such limited and innovative experiments carried out previously did not get the broad network of support or were further backed up institutionally.

The energy demand for cooking and heating in hotels and lodges are exceedingly high in Mustang; this will further increase with the growing number of visiting tourists in the district. Motorized transport has further eased access to imported fuel. The expectations are that those increments will lead to a spurt in energy. Following are some of the key energy sources being used or having potential for development in Mustang.

3.2.1. Biomass Energy

The vegetation cover gradient in Mustang tapers from south to north. Around 28 percent of the land in the south is covered by forest, and about 3 percent with shrub. Pasture or grassland occupies about 30 percent of the land area. Forest cover gradually declines in central Mustang, where it covers only 8 percent of the land area. But pasture area increases to 40 percent. Shrub land occupies only 3 percent of central Mustang. Discussion with the local people suggested that the deforestation rate was very high until few years ago, which has reduced after a ban was imposed on using firewood for cooking and heating. In northern Mustang, there is no forest, whereas pasture occupies about 42 percent of the area. Shrub land covers less than 1 percent of the area. The use of biomass energy comes from grasses converted into dung.

CC impact on the biomass resources needs to be examined in line with the existing vegetation cover gradient. The southern region will benefit from change in temperature and precipitation (snow converted to rainfall). It may promote shrub growth, which provides energy source without hampering the tree forests. The climate impact will benefit a population of 2634 in the south The central part is likely to remain largely stable if the change in snowfall is compensated by rainfall for forest and shrubs. However, reduced snow will hamper the growth of pasture. Since energy demand is met by forest and shrubs, the negative impact is unlikely. Increased snowfall, as has been recorded in the last few years, may enhance plant growth in the northern Mustang. But, the change in its timing (from December to February) of snowfall will delay the availability of forage hampering dung production. Hence, severe adverse impact will be felt in northern Mustang than the other two regions.

While carrying out planning for energy, it must be kept into consideration that the north has limited biomass (particularly loose biomass with the use of twigs, roots and cattle dung) and hence using any energy technique that requires biomass base has limited scope in northern Mustang. In central Mustang, the options are diverse with decreased dependency on biomass, while southern Mustang is largely stable in maintaining a biomass base for energy.

Table 18: Fuel Wood Supply Potential in Mustang District

Region	Type	Fuel wood potential			Fuel wood Supply		Energy Potential
		Gross	Accessed	Yield	Gross	Accessed	
		Ha	Ha	ton/hectare/yr	tonn/yr	tonn/yr	(GJ)
Northern	Forest	-	-	-	-	-	-
	Pasture	107,727.00	32,318.10	0.06	1,939.09	1,163.45	13,496.04
	Shrubland	1,680.00	336.00	0.375	126.00	75.60	876.96
Central	Forest	5,625.00	3,375.00	0.3125	1,054.69	632.81	9,492.19
	Pasture	27,362.00	8,208.60	0.06	492.52	295.51	3,427.91
	Shrubland	1,914.00	382.80	0.375	143.55	86.13	999.11
Southern	Forest	8,959.00	5,375.40	1	5,375.40	3,225.24	48,378.60
	Pasture	9,614.00	2,884.20	0.07	201.89	121.14	1,405.18
	Shrubland	822.00	164.40	0.3125	51.38	30.83	357.57
Overall Mustang	Forest	14,584.00	8,750.40	1.31	6,430.09	3,858.05	57,870.79
	Pasture	144,703.00	43,410.90	0.19	2,633.50	1,580.10	18,329.13
	Shrubland	4,416.00	883.20	1.06	320.93	192.56	2,233.64
Total		163,703.00	53,044.50		9,384.51	5,630.71	78,433.56

(Source: Based on District Profile 2065)

Table 19: Agricultural Residue Supply Potential in Mustang District

Crop Type	Area (Ha)	Production (MT)	Residue Ratio	Residue Supply for Energy Use Supply (MT)	Energy Production Potential (GJ)
Maize	525	780	198.843	18.293	228.669
Millet	4	4	3.5	0.322	4.025
Wheat	635	1301	1931.139	177.664	2220.81
Barley	311	311	272.125	25.035	312.94
Oil seed	35	30	45.108	4.149	51.874
Total	1510	2426	2450.715	225.463	2818.318

(Source: CBS 2007)

Cattle dung is the primary source of energy. Overall energy potential from cattle dung is estimated to be 695450.75GJ of energy assuming 75% of the dung produced is collected and available as energy after drying. Southern Mustang does not use cattle dung as fuel except for the fourteen houses that have bio-gas plant. Other households mostly use fire wood as the main source of residential energy. Table 20 shows total number of livestock and corresponding energy potential. Assumption made in estimating cattle dung is given in Table 21.

Table 20: Animal Waste Supply Potentiality in Mustang District

Livestock Type	Number	Dung Production per Animal	Dung Production	Dung Collection/Ratio Available for Energy Use	Energy Production
		kg	MT	MT	GJ
Goat	47864	456.25	21837.95	19654.15	214623.37
Buffalo	78	4380	341.64	307.47	3357.64
Cow	5549	4380	24304.62	21874.1	238865.81
Joe	1872	4380	8199.36	7379.42	80583.31
Yak	2933	4380	12846.54	11561.88	126255.80
Sheep	7084	456.25	3232.07	2908.86	31764.83
Total	**65380**		**70762.18**	**63685.96**	**695450.75**

(Source: Based on District Profile 2065)

Table 21: Assumptions for Estimating Cattle Dung

Animal	Dropping	Source/Assumptions
Cow	12 kg per day	BSP Nepal
Joe	12 kg per day	Assuming Joe and Cow having the same amount of daily droppings
Buffalo	13.2 kg per day	Considering the relatively larger body size of buffalo in comparison to cow, it's dropping is a multiplication of cow dropping by a factor of 1.1(estimated)
Yak	14.4 kg per day	Considering the relatively larger body size of Yak in comparison to cow and buffalo, it's dropping is a multiplication of cow dropping by a factor of 1.2(estimated)
Sheep, Goat	1.25 kg per day	Assuming average weight of sheep and goat as 25kg and considering 5% of body weight as daily droppings(estimated)

With 695450 GJ per year, cattle dung is considered as the major energy source for most of the Mustangi population. Almost 100 percent households in northern Mustang and 10 percent households in central Mustang rely on cattle dung as the main energy source.

3.2.2. Hydro Energy

Based on issued licenses and estimated calculation, Mustang district has hydropower potential of about 1500 MW, out of which only 451 kW has been tapped so far. The Kaligandaki River is the major river of the district that borders all the VDCs except Chhusang and Kagbeni. Nup Chhu (West river) and Shar Chhu (East river) are the two headwaters of the Kaligandaki river that begins from Tibetan plateau nearby Lomanthang. The river then flows southwest under the name Mustang Khola. After the confluence of Mustang Khola and Jhon Khola coming from Muktinath, the river is named Kaligandaki. A part of this river valley in the southern Mustang forms the deepest gorge in the world named as Kaligandaki Gorge or Andha Galchi between the mountains Dhaulagiri (8167 m) to the west and Annapurna (8091 m) to the east.

About 137 rivers and rivulets serve as major and minor tributaries of the Kaligandaki River. Major rivers are Parun Khola, Dhechyan Khola, Tuna Khola, Charan Khola, Yak Khola, Ghami Khola, Yamdi Khola, Kyalunpa Khola, Panppu and Thapa Khola etc with numerous rivulets. The lists of perennial river/ rivulets are presented in Annex 2.

There are around 104 ponds and lakes of various size in Mustang. Except Chhoser in the north, Jhong and Muktinath in center and Tukuche and Lete in the south, all other VDCs have lakes and ponds. Damodar Kund, Agarchhu, Kekyap, Ghyaka, Dhau Dhundhun, Naktan, Dhuya, Tawa, Purkun, Muli, Tin, Dhumba, Titi and Dhegau are the well known lakes/ ponds of Mustang. Lakes and ponds serve as sustainable storage recharging watersheds and providing buffer against floods.

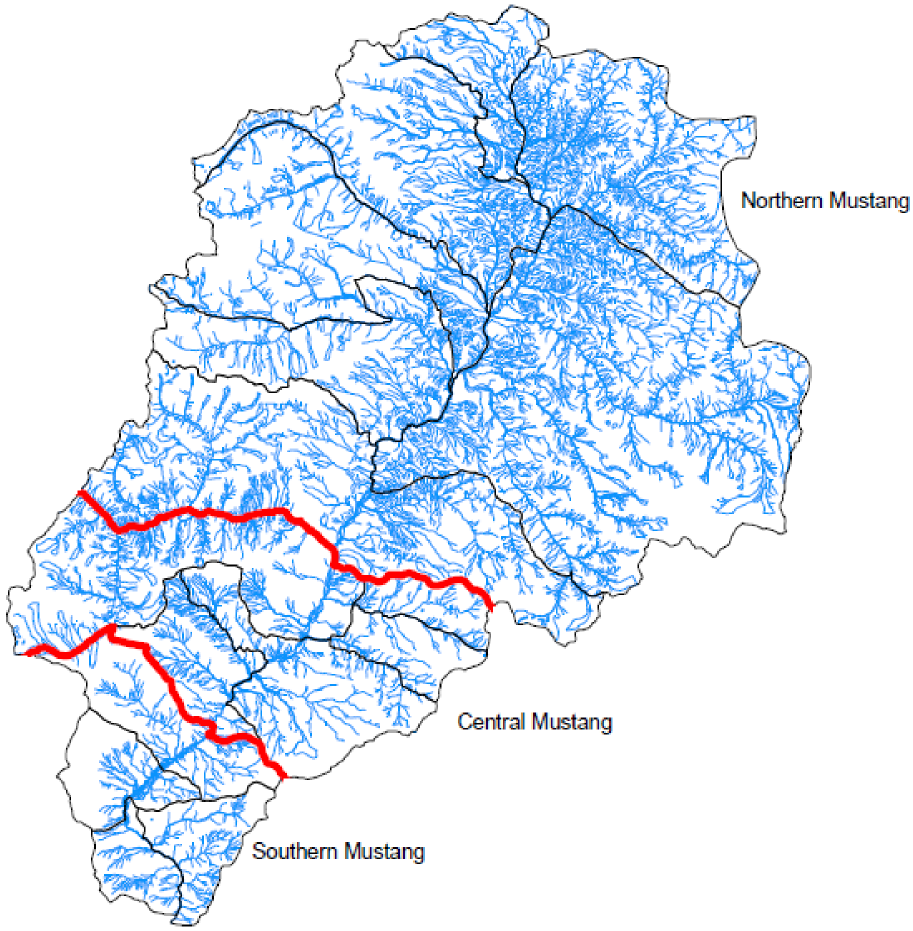


Figure 7: Rivers and Rivulets of Mustang District

Microhydro

Altogether 14 micro hydro projects have so far been developed in Mustang. The first micro hydro was built in Ghatte Khola with installed capacity of 10 kW to electrify Naurikot settlement of Kobang VDC in 197. The latest commissioned project was Chhusang MHP (Capacity: 15 kW) at Narsin Khola to electrify the Tetang settlement of Chhusang VDC in 2003 under the technical and financial support of RADC. These power plants serve about 15 – 20 remote settlements of 10 VDCs of the district.

The micro hydro plants situated in Muktinath, Kobang, Kunjo and Lete VDCs have become dysfunctional following the expansion of national grid to these areas. Decreased water flow at the source has also been the reason of some of these power plants ceasing to operate. Table 22 provides details of existing microhydro plants in Mustang .

Table 22: Existing Microhydro Stations in Mustang

S. N	Name of the project	Capacity (kW)	VDC	Source	Served settlement	Status	Remarks
1	Chhonup, MHP 1	15	Chhonup	Nyamdo Khola	Nyamdo, Nhichung	-	1989 DCS
2	Chhoser MHP 2	10	Chhosar	Yara Khola	Arka, Sisa, Bharcha	-	1986 DCS
3	Lomanthan MHP 3	29	Lomanthan	Kimling Khola	Durang, Namara, Dhikha	Running	1989 DCS ACAP
4	Charan MHP 4	15	Charang	Charan Khola	Charang	-	1989 DCS ACAP
5	Maran Committee MHP 5	5	Charang	Maran Khola	Marang	-	1990 DCS
6	Maran MHP 6	25	Charang		Saukre	-	2001 RADC
7	Chhusan MHP 7	15	Chhusang	Narsin Khola	Tetang	-	2003 RADC
8	Tangbe MHP 8	10	Chhusang		Tangbe	-	1986 DCS
9	Jhon MHP 9	15	Jhong	Jhon Khola	Jhong	Dysfunction	1989 DCS
10	Muktinath MHP 10	25	Muktinath	Muktinath Khola	Purang, Gumba	Dysfunction	1991 DCS
11	MHP 11, RP Serchan	10	Kobang	Ghatte Khola	Naurikot	Dysfunction	1979 DCS
12	Koban MHP 12	10	Kobang	Larkyu Khola	Larjung	Dysfunction	-
13	Srot San Ayojana MHP 13	7	Kunjo	Panpu Khola	Sari, Chyachu	Dysfunction	1984 NSE
14	Jilla Panchayat MHP 14	5	Lete	Lete Khola	Thalyang	Dysfunction	1983 DCS

(Source: DDC, AEPC/ ESAP, 2011)

Mini Hydropower

Jomsom Mini Hydropower Plant of installed capacity 240 kW in Tukuche VDC is owned by Nepal Electricity Authority (NEA) and the energy produced is fed to the national grid. The plant was running with huge loss due to poor management, high overhead costs and operational difficulties by NEA. It leased out the plant to private sector for operation in Poush 2050 BS (1994). Presently, the plant is in operation with reasonable profit by Sweta Bhairab Power Company. Despite minor technical difficulties, the private company has been able to operate the plant efficiently with regular operation and maintenance works.

National Grid

Integrated National Power System (also called as 'grid') has been extended from Tatopani in Myagdi to Lete, Kunjo, Koban, Tukuche, Marpha, Jomsom, Kagbeni, Chhusan, Muktinath and Jhong VDCs. Almost all the households in these VDCs have been fed by grid. Major tourist areas such as Lete, Tukuche, Marpha, Jomsom and Kagbeni and pilgrimage area like Muktinath is being electrified via grid (Figure 8).

The national grid serves about 1500 HHs of the 9 VDCs mentioned above which covers about 58 % of the total hhs of the district. The domestic consumption is about 85 % whereas, commercial and industrial load covers about 1 % and 1.5 % of the total load available respectively. Based on the present consumption scenario, about 96.5 MWh energy per annum is consumed by the district through the grid.

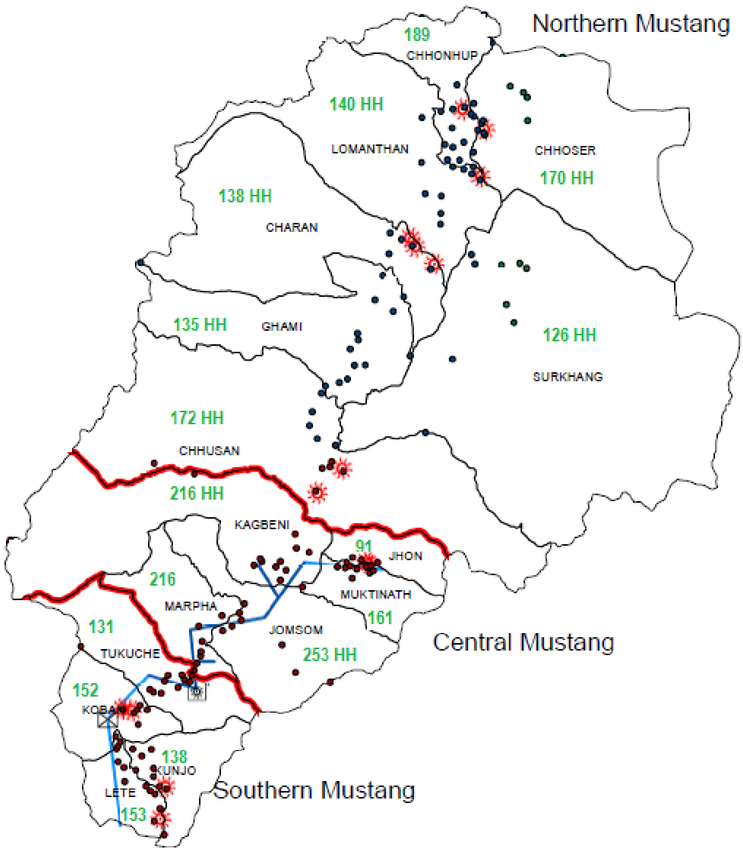


Figure 8: Existing Micro, Mini Hydro and National Grid in Mustang

There is an existing 33/ 11 kV substation at Larjung of Koban VDC from which the 11 KV transmission line system has been extended to the Central Mustang. Another 220/132/33 kV station is proposed at Dana of Myagdi district which is expected to be commissioned by 2014/15.

Hydropower Inventory/ Feasibility Study

Numbers of private sectors have applied for study license of hydropower power projects on the potential rivers/ rivulets of the district. About 22 projects are under the various stages of the study. These hydropower projects will generate about 652 MW in total. However, there is great possibility for increase in installed capacity during the subsequent detailed studies. The list of hydropower projects based on the installed capacity is presented below (Table 23 - Table 27).

Table 23: Application for survey license (Capacity < 1 MW)

S. N.	Project	Capacity (MW)	River	Promoter	VDC
1	Dhaiku Khola	0.974	Dhaiku	Research & Dev Group	-
2	Syan	0.9	Syan	Hydro Support P. Ltd.	-
3	Tangchhahara	0.5	-	Usha Gauchan	Kobang
4	Dhekyu Khola SHP	1	Dhekyu	Bishnu Arpan Gurung	Chhusan
5	Pankyu Khola SHP	0.91	Pankyu	Ranjit Lalchan	Marpha
6	Pharam Khola SHP	0.784	Pharam Khola	Ranjit Lalchan	Marpha
7	Panda Khola SHP	0.6	Panda	Desert Snowland Hydropower Pvt Ltd	Muktinath

(Source: DDC, DOED, 2011)

Table 24: Application for survey license (Capacity: 1 – 25 MW)

S. N.	Project	Capacity (MW)	River	Promoter	VDC
1	Kunjo Small Hydropower Project	2.7	Panpu	Subash Gauchan	Kunjo
2	Middle Kaligandaki	18	Kali Gandaki	Shree Angu Panta	-
3	Dhaiju Khola	2.5	Dhaiju	Jomsom Hydropower Pvt. Ltd	-
4	Ghilunpa Khola HPP	7	Ghilunpa	Prabhu Energy Pvt Ltd	Jhong, Jomosom, Kagbeni, Muktinath
5	Ghami Khola HPP	8	Ghami	Prabh Energy Pvt Ltd	Jomosom, Marpha
6	Ghatte Khola SHP	6	Ghatte	Krishna Lal Gauchan	Kowang
7	Lumbuk Khola SHP	2.4	Lumbuk	Suryodaya Hydropower Nepal Pvt Ltd	Kagbeni
8	Chhuama Khola HPP	2.5	Chhuama	Nepal Electricity Kathmandu Pvt Ltd	Chhoser
9	Marfa Kaligandaki HPP	10	Kali Gandaki	United Houses of entrepreneurs Pvt Ltd	Jomosom, Marpha, Tukuche

(Source: DOED, 2010

Table 25: Survey license for generation (Capacity < 1 MW)

S. N.	Project	Capacity (MW)	River	Promoter	VDC
1	Thini Khola	0.999	Thini	Chandeshwari Hydro Pvt. Ltd	-

(Source: DOED,2010

Table 26: Survey license for generation (Capacity: 1 – 25 MW)

S. N.	Project	Capacity (MW)	River	Promoter	VDC
1	Upper Panpu Khola	6.75	Panpu	Dibash Bahadur Basnet	-
2	Tanchhahara Small	2.4	Tanchhahara	Krishna Lal Gauchan	-
3	Thapa Khola	11.2	Thapa	Mount Kailash Energy Co. Pvt. Ltd	-
4	Jhon Khola HPP	2.2	Jhon	Prabhu Energy Pvt Ltd	Jhon, Jomosom, Kagbeni, Muktinath

(Source: DOED 2010

Table 27: Survey license for generation (Capacity > 25 MW)

S. N.	Project	Capacity (MW)	River	Promoter	VDC
1	Kali Gandaki-Koban	100	Kali Gandaki	Ambeswor Engineering Hydropower Pvt. Ltd	-
2	Kaligandaki Gorge	164	Kali Gandaki	NECT - HIM JV	Lete, Kunjo, Narchang, Dana

(Source: DOED 2010)

3.2.3. Solar Energy

The solar resource map (SWERA, 2006) of Nepal shows a 4.7 kWh/m^2/day annual average Global Horizontal Solar Irradiance and a higher potential in the North Western region (5-5.5 kWh/m^2/day). The Solar Resource Map developed by NREL is of a bit higher capacity (6-6.5 kWh/m^2/day). Communities in Chhoser and Chhonup have universal coverage for solar lighting.

Table 28: Annual Average Solar Radiation in Mustang District

District	Annual Direct Solar Radiation Kwh/ m^2/day	Annual Global Solar Radiation (kwh/m^2/day)	Annual Tilt Solar Radiation (kwh/ m^2/day)
Mustang	5.021	5.063	6.379

(Source: SWERA Final Report (GIS Part), 2006)

A large number of households and institutions in Mustang already use an array of solar technologies including solar photovoltaic systems, solar cookers, solar driers, solar photovoltaic water pumping systems, solar thermal water heaters etc. What is required in the days ahead is to promote concentrated solar systems to capture large quantity of solar energy and feed into local and national grid systems.

3.2.4. Wind Energy

Jomsome Bajar ma bara baje hawa sarara – a famous Nepali song captures the wind situation in Jomsom valley. The trans-himalayan region situated between two 8,000 meter peaks, Annapurna and Dhaulagiri, the Kali Gandaki River forms the deepest valley in the world. The unique orographic conditions of the ancestral Krishna Gandaki River (shown below via space shuttle) create extreme diurnal wind patterns.

(Source: ISET 2009)

Figure 9: Space shuttle image showing the Kali Gandaki gorge

In 1979 the first ever wind mill was installed in Jomsom to pump water from Kali Gandaki and to test if harnessing wind potential is viable. This initiative was based on a very short study of wind speed and duration. The assembly snapped with a wind gust (over 90 naught) which was not considered in the design. This initiative was carried out by the Resource Conservation and Utilizatino Project (RCUP). The Jomsom wind pump experience is alive among a few people in Jomsom Bazar and project staff involved in the set up. Media and other studies have overlooked this experience and consider Kagbeni Wind Project as the first of its kind in Mustang.

Kagbeni wind mill has set a bad precedence for harnessing wind energy in Nepal. Two turbines each of 10 kw each had been installed by Nepal Electricity Authority. The turbines did not function as designed and the wind mills snapped. Faulty design and structural failure were cited as reasons for collapse. The use of old turbines already damaged due to floods whilst in storage was the cause of the collapse along with the high wind gust.

Some key-informants also mentioned that the wind-speed has also decreased. “It is not felt strongly.” Others said that this might not be true and people have started using jeep to travel these days. There is a general criticism that wind (as well as solar) does not generate energy during nights. However, informants during the key-informant interview mentioned that a way out is to generate wind energy - and concentrated solar- and sell it to grid.

Apart from AEPC's role in wind energy, there are other small scale initiatives in Mustang. One of such initiative is carried out with the support of Virginia University, (c/o Mr. Pandey, Associate Professor) which has established a wind monitoring site in Jomsom to carry out detailed study on wind potential. It was also reported that the team is also studying CC impacts in Mustang.

Though wind resource is less studied in Nepal, Mustang District has the most wind related assessments and studies done so far. However, these assessments and studies are only limited to calculate the potential of a particular site(s) and have not yielded substantial investments to harness wind energy. Number of reports mention that Mustang District has the highest wind potential in Nepal with a potential of about 200 MW wind power in the 12 km corridor from Kagbeni to Chhusang generating about 500 GWh electricity annually. Though this has been only the location that has been identified as wind potential in Mustang District, a detailed study could surely reveal a substantial potential in the district.

Long term wind data in Mustang is available from the station located at Jomsom airport and few other meteorological stations. The purpose of measuring wind at the airport is for aviation purpose only and gives an indicative measure of wind potential and cannot be used to generate district level wind maps. Wind masts of 10 and 20 meter height were installed in Kagbeni (2820 meters asl) and Thini (2645 meters asl). Both stations are being managed by AEPC. Wind speed has a high variability within Mustang District with lower wind speed in the northern and southern Mustang compared to central-Mustang. Wind velocity is higher along the Kali Gandaki valley and diminishes in the inner valleys.

The ground measured wind data were recorded from automatic data logger NRG 9300SA. Wind data have been collected for the following periods: Kagbeni: April 2001-Feb 2006 and Thini: April 2001-Jun 2007.

Table 29: Wind Data for Thini Station, Mustang

Month	At 10m height				At 20m height			
	Average wind speed m/s	Average Max wind speed m/s	Average Min wind speed m/s	Extreme max wind speed m/s	Average wind speed m/s	Average Max wind speed m/s	Average Min wind speed m/s	Extreme max wind speed m/s
January	4.5	10.1	2.1	13.9	4.8	10.7	2.1	14.9
February	4.5	9.8	2.1	16.2	4.8	10.5	2.2	17.9
March	5.5	12.2	1.1	15.9	5.9	13.0	1.3	16.8
April	4.9	12.2	0.5	15.9	5.2	13.0	0.6	16.7
May	5.9	12.6	0.8	15.8	6.2	13.2	0.7	17.3
June	7.1	12.4	1.4	16.4	7.3	12.5	1.4	17.1
July	6.6	11.5	2.5	15.2	6.8	11.5	2.6	15.0
August	5.9	11.1	1.3	13.6	6.0	11.1	1.4	13.6
September	5.7	10.6	1.1	14.3	5.8	10.6	1.2	14.5
October	4.9	11.9	0.5	16.1	4.9	11.8	0.5	16.5
November	4.5	12.4	1.1	16.0	4.6	12.5	1.0	16.3
December	4.3	10.8	1.5	14.7	4.4	11.1	1.5	15.0
Annual	5.4	11.5	1.3	16 Jun	5.6	11.8	1.4	17 Feb

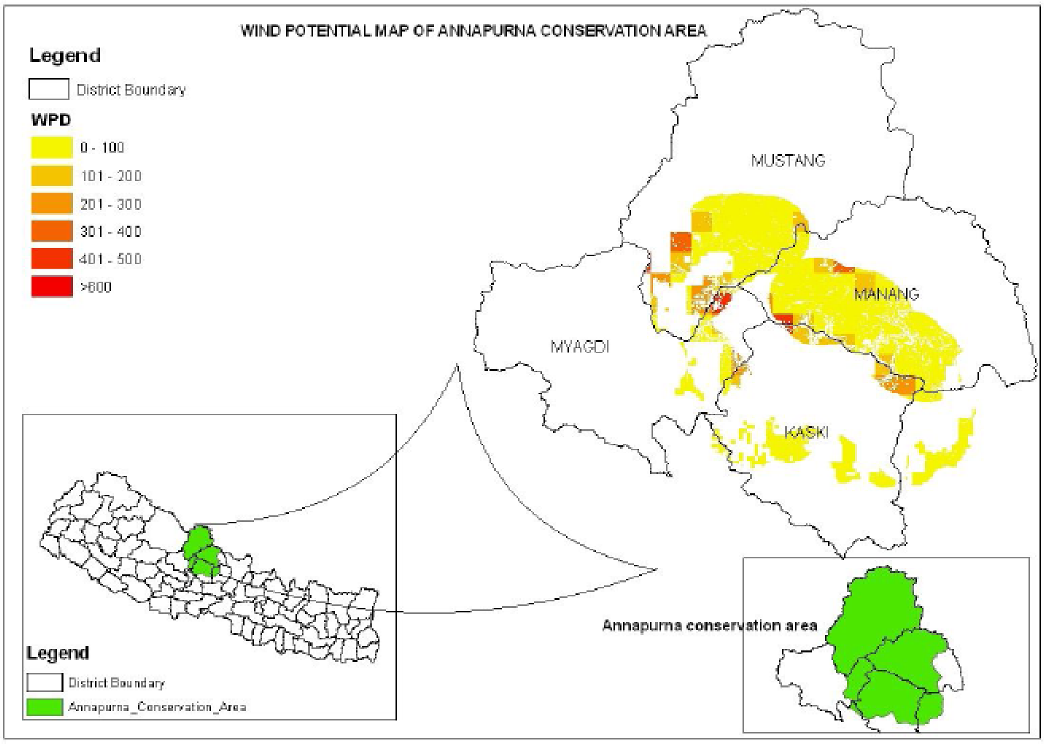
(Source: SWERA Final Report, 2006)

Table 30: Wind Data for Kagbeni Station, Mustang

Month	At 10m height				At 20m height			
	Average wind speed m/s	Average Max wind speed m/s	Average Min wind speed m/s	Extreme max wind speed m/s	Average wind speed m/s	Average Max wind speed m/s	Average Min wind speed m/s	Extreme max wind speed m/s
January	4.8	10.61	2.45	15.2	5.19	11.28	2.78	16.2
February	5.0	11.46	2.13	22.2	5.40	12.10	2.36	22.9
March	6.5	14.33	2.08	22.1	6.99	15.07	2.28	23.0
April	6.1	14.74	1.10	19.1	6.50	15.44	1.18	19.8
May	7.4	16.28	1.24	20.2	8.01	17.22	1.41	21.1
June	8.9	16.74	2.20	19.7	9.68	17.81	2.50	20.9
July	8.3	15.41	3.19	18.5	9.06	16.35	3.72	19.7
August	7.3	14.66	2.37	17.7	7.94	15.53	2.59	18.7
September	7.3	14.20	2.05	16.7	7.95	15.06	2.33	17.7
October	6.0	15.20	1.25	17.9	6.49	16.15	1.33	19.0
November	5.5	13.23	1.86	17.1	5.81	14.01	1.81	18.1
December	5.3	12.25	2.26	19.1	5.58	12.93	2.29	19.6
Annual	6.5	14.1	2.0	22 Feb	7.1	14.9	2.2	23 Mar

(Source: SWERA Final Report, 2006)

According to SWERA Study 2006, compared to other four[2] stations, Kagbeni and Thini Mast Stations possess high wind resource potential.



(Source: SWERA Final Report (GIS Part), 2006)

Figure 10: Wind Potential in Annapurna Conservation Area

[2] The other stations are in Okhaldhunga, Nagarkot, Palpa and Ramechhap districts

3.2.5. Traditional Water Mills

There are 68 functional Traditional Water Mills (TWM) in Mustang. The location of these TWMs is presented in Table 31.

Table 31: Traditional Water Mills in Mustang District

Region	VDC	No. of TWM
Northern	Chonnup	3
	Lomanthan	3
	Chhoser	5
	Surkhang	4
	Chharang	3
	Ghami	4
	Chhusang	6
Central	Kagbeni	3
	Jhon	6
	Muktinath	6
	Jomsom	3
	Marpha	1
Southern	Tukeche	4
	Kobang	8
	Kunjo	4
	Lete	5
Total		**68**

(Source: DESR Mustang, 2010)

3.2.6. Bio-gas Potential

Even though Mustang district is located in the high altitude, the biogas potential cannot be ignored in the district. As per a 2008 study on biogas potential, 943 hhs own livestock and land, and it is technically feasible to install 491 biogas plants (BSP & NBPA, 2008). Market potential exists for 475 biogas plants. There are already 14 bio-gas plants installed in the Southern Mustang. The cold climate hinders the propagation of bio-gas technology in the central and northern region. The VDC wise biogas potential in Mustang is presented in Table 32 below.

Table 32: Biogas Potential in Mustang District

Region	VDC	HH with Livestock and Land	Technical Potential Biogas HH	Market Potential Biogas HH
Northern	Chonnup	151	79	76
	Lomanthan	109	57	55
	Chhoser	132	69	66
	Surkhang	38	20	19
	Chharang	95	49	45
	Ghami	102	53	51
	Chhusang	17	9	9
Central	Kagbeni	64	33	32
	Jhon	34	18	17
	Muktinath	53	28	27
	Jomsom	37	19	19
	Marpha	62	32	31
Southern	Tukeche	21	11	11
	Kobang	12	6	6
	Kunjo	12	6	6
	Lete	4	2	2
Total		**943**	**491**	**472**

Source: BSP Nepal 2008

Table 33: Summary of Household served with RETs

Source/Technology	Households (existing beneficiaries)

Source/Technology	**Households (existing beneficiaries)**
Lighting	
Solar Home System	842
Micro/Mini Hydro and grid connected	~ 2000 hhs
Cooking and other thermal needs	
Biogas	14
ICS	2064
Traditional	517
LPG	No exact data on LPG use was available. However, 43 hhs in Charang use LPG for cooking purpose.

3.2.7. Non –renewable Energy

Kerosene remained a prominent commercial energy used for illumination in Mustang. Petromax and wick lamps were used in the district until electricity became available in the late 1970s. Currently, large populations (more than 90%) have either electricity or solar power system for lighting, which has reduced the demand for kerosene for lighting purpose. However, the use of kerosene for cooking has increased after the restriction on firewood collection especially in central part of Mustang, and through subsidies provided by programmes such as NTNC. In the past, Kerosene depots have been established with a grant of NRS Two Hundred Thousand each in Lo Manthang, Tsharang, and Chhuksang. These depots are in operation in locations where projects provide grant for subsidizing kerosene. As of 2004, the depots provideed kerosene for Rs. 52 per liter while outside it sells for Rs. 60 per liter (GEF, 2004). The use of Liquid Petroleum Gas (LPG) has soared high within the last two years, with road access. The quantity of LPG cylinders used in Mustang District is not available through any source. However, in Charang VDC alone 40 hhs out of a total of 138 hhs use LPG. Most hotels and restaurants in the district use LPG for cooking purpose. Other commercial energy include petrol and diesel for vehicles and occasionally for generators. Most of this fuel comes via road from Myagdi district except the few trucks coming from Tibet, which bring their own diesel.

3.3. Gender and Social Inclusion

Various studies have noted that gender issues in Mustang are far more balanced than in the hills. Some even label it as more controlling. Undoubtedly, women in Mustang are far more resourceful and responsible for managing resources than women in the midhills. They are key to managing knowledge and information. They take part in agriculture and other economic activities. They are seen in the forefront in running hotels and serving the tourists. It is women who do all the internal business for her household. All the small deals from buying a broom to selling her farm products like potato and other vegetable (in the local market) is done by her. But when it comes to making big decisions and going outside household boundary, it is always her husband. Public meetings are not only important for deciding about future activities, but also for obtaining information. But due to extra work load and lack of knowledge women show little interest to get involved in public space (Thapa 2009).

Based on her study, Thapa (2009) revealed that despite of wielding relative power for freedom, women are not as empowered as one would think, due to structural constraints based on gender and negative ideologies. In her study in Kobang, she found that women are subject to the same levels of gender inequity as midhill women. There is a lack of gender balance in negotiations concerning family and community matters. Though men don't object to women's participation in training, they are unable to understand that women are more laden due to extra involvement in trainings and meetings. Moreover, women do not try to challenge or change gender relations. For women themselves, trainings and meetings do not hold any meanings.

This finding has a string bearing on analyzing energy dimension because, it is well known that any shortage in energy sources affect women more than men. Whether it is the stress of CC on traditional resource base or introduction of alternative energy sources, the role of women and other disadvantaged groups in decision making is crucial. According to Thapa (2009), various factors have contributed to passive participation and restricted input of women in decision making process. A main obstacle to decision making is the limits set by gendered daily working routines. They have access to resource but not control over the resources. Though very often they are encouraged, they are not empowered to negotiate their space, which has obstructed women to be part of decision making process but also shows the comparative lower status that is ascribed to women.

Women are central in energy utilization and management. Whether it is those who depend on traditional sources of energy or alternative sources, women are in the forefront, and their role is important in sustainable management of energy sources. In addition, the impact of CC on energy sources such as forests is shrubs are going to affect women's workload. Therefore, the discussion on energy planning need to take into account how women and socially marginalized population of the society are represented in managing and utilizing energy sources. A look at the social order and position of women and socially marginalized groups will help analyze the situation.

The demographic structure in Mustang differs considerably from south to north. The ethnicity in south is dominated by Thakalis where as in the north it is the Baragaule or Gurungs, locally referred to as Bista. The central Mustang has a mixed feature. In Jomsom and surrounding areas the ethnic composition is dominated by Thakalis but in areas such as Kharkot Gurungs dominate the composition. Marriage patterns vary in the regions and are in stark contrast with the customs practiced in the south, mainly with Hindu traditions. In the northern region, the practice of bridegroom living permanently in the wife's house after marriage, locally known as *makpa* is prevalent. We will discuss the scenario in the south and north as they differ significantly.

Owing to their involvement in trade and tourism related enterprises, the Thakalis – more importantly Thakali women- are economically better off compared to the Gurungs in the northern Mustang. Interviews with women leaders revealed that women in the north have a stronger decision making role than economically better off women of the south. Even though, both husband and wife work for the betterment of household welfare and wife contributes equally, climatic change affects men and women differently because they have different roles in their household and society and different rights and access to resources. The causes of their vulnerability and their experience of it are different, as are their capacities to cope with and adapt to. Gender is one factor affecting people's inequitable vulnerabilities and capacity to cope with and adapt to impacts. Class, caste, race, and ethnicity are additional stress factors that increase women's vulnerability.

Gender as a social institution is good as far as it maintains equality among both men and women. Ironically, the links between a society's gender ideologies are closely tied to wider systems of power and prestige which has created gender gap in development. Low status caused by gender as well as prevailing caste division especially for the women from poor families results in low self-esteem which in turn forbids women not only from access to resources but also institutions. Gender inequality and subordination is largely the result of structural forces operating at the level of culture, society, economy and politics (Hust 2004).

There is no involvement of Dalit women in any institutions at prominent post. All the higher post which has been reserved for women has been occupied by the Thakali and those which has been reserved for Dalit, it is Dalit men who are at that post. Along with caste, economic differentiation is crucial for gender equality. The women who belong to low caste and are economically unprivileged possess lower status than upper caste and rich women. Another important factor which determines women status is the level of education. Those women who are educated can speak and can well bargain. But regrettably, their involvement in communal decision is almost zero. This might be probably because these women who are educated are young to raise their status in front of old women. Factors, namely, age, caste and economic status are the constraining factors.

Polyandry and Resource Management

While analyzing the gender issues and its relation with resources in northern Mustang, the emphasis must be laid on the unique social institution of the area – polyandry. Polyandry is widely practiced in northern Mustang, in which a single woman shares multiple men as husbands at a time. People here adhere to this practice of ‘one marriage for one generation.’ In polyandry, one man stays with the cattle in the pastures; another might follow the herds towards the lowland for business. A third one stays in the village looking after children, the elderly, the estate and the property. Hence, they are involved in a delicately balanced rhythm of movement for trade and transhumance. Men spend a considerable length of time away from their homes, leaving the burden of managing resources on women.

It is a cultural response to a prolonged absence of male member in the family, and hence is perceived, as a security measure for the rest of the family members as. It also helps reduce pressure on the number of marriage to a minimum; thereby avoiding economic burden, and the risks of conflict in the family. There are also those who believe polyandry as a survival strategy of the poor; a strategy of keeping the household property and estate consolidated; and a way of maintaining a pool of workforce together that would help cope with economic hardships. Polyandry escapes successive fragmentation of the household property. Brothers can engage in different production fronts. As a result, polyandry has helped maintain better livelihood in a resource constrained society such as Mustang.

In polyandry, the gender relation is in sharp contrast to monogamy, because a centrally located single male figure does not exist. All husbands are on equal footing. The presence of one woman amidst many men positions her as the center of kinship within the family. It is the women’s prerogative to assign paternity, which strengthens her position within the power hierarchy of the household. This makes the women locus of communication and medium of contact for all co-husbands. Regarding property, the women have access to, if not ownership of, all production frontiers: trade, transhumance and agriculture. She can have control over every economic activity throughout the year. Despite the fact that the male-head has recognized authority in all the decisions, in practice, unlike in southern Mustang, the women in northern Mustang have pragmatic power to influence such decisions. Because of this, any intervention to improve energy situation has to consider involving women.

Based on the traditional inheritance system, only the eldest son inherits the property and other members of the family have access to resources through eldest sons. This is one of the major social differentials that determine the access to water and hh's role in managing energy.

The overall ethnic composition is dominated by Gurungs with about 47 percent of the total population followed by Thakali with about 17 percent. Dalits are about 10 percent of the population. Magar, Chetri, Lepcha, and Bahun constitute about 4 to 6 percent each. The remaining 7 percent is composed of other minority groups such as Thakuri, Tamang, Bhote, Sherpa, Newar, Rai and others (Figure 11).

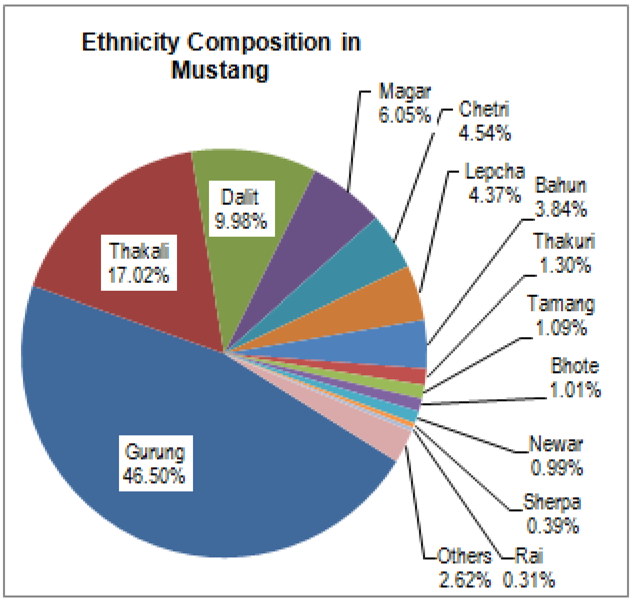


Figure 11: Overall ethnic composition of Mustang

Regional specific ethnic composition

Northern Mustang: The northern region has about 74 percent of the population constituted by Gurungs followed by 12 percent of Lepcha. There is no Thakali in the north. The remaining 14 percent of the population is composed of nine ethnic groups (Figure 12). Their development status is the lowest in Mustang.

Central Mustang: The central region is dominated by Gurungs with 47 percent population followed by 21 percent population of Thakali. About 9 percent of the population in Central region is of Dalits (Figure 12).

Southern Mustang: Regional disintegration the ethnic composition elucidates ethnic domination in each region. The south is dominated by Thakali with 37 percent population followed by Dalit and Magar with 26 and 17 percent respectively. Gurungs constitute only 3 percent (Figure 12). People in this region are highly developed in terms of education, health, and economy.

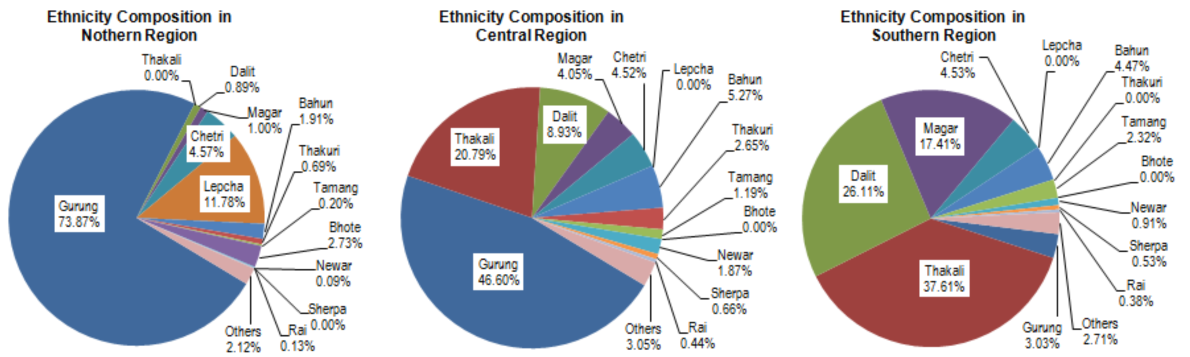


Figure 12: Region wise ethnicity composition

3.4. Institutions

There are two types of insituions: the formal and the informal institutions. Formal institutions such as government and non-government organizations were assessed based on the list provided by the DDC and District Administration Office in Jomsom. Information about social institutions such as *Dhikuri*[3] and Polyandry were noted from key informants. Emerging institutions such as committees of transport entrepreneurs, contractors and their institution were recorded from business people. Some of the traditional institutions and its implications on renewable energy, such as the collection of local capital, kind contribution for community based initiatives were also recorded from group discussion. The study team noticed strong ownership of community based initiatives by these informal institutions and the practice to create regulatory mechanism. These institutions are also central in regulating modern changes such as curtailing the number and specification of vehicles plying within the district.

District Energy and Environment Unit (DEEU) has been established in Mustang DDC for the promotion of renewable energy activities and environmental sustainability. DEEU coordinates renewable related planning and implementation activities with a multitude of organizations such as Annapurna Conservation Area Project (ACAP) with support from National Trust for Nature Conservation (NTNC) and related line agencies. ACAP has been working in the region focused on conservation and renewable energy technologies. Other key NGOs working on RETs in Mustang are Mountain Resource Management Group (MRMG) Mustang Development Service Agency – an INGO, is effectively working on promoting energy programme.

There are altogether Eleven financial institutions including two commercial banks, one development bank (Machhapuchhre Bank also has an ATM machine in Jomsom Bazar) and 8 cooperatives in the district. Among the cooperatives, three are consumer cooperatives, three are electricity users' cooperatives and two other types. Apart from formal institutions, several individual donors from various countries such as Japan, USA Europe and many other countries have provided assistance from time to time for building local infrastructures mainly schools, community buildings and energy related interventions such as subsidy in the

[3] *Dhikuri* are age-old informal institutional practices to generate and mobilize local resources and in the design of regulatory mechanism.

purchase of solar home lighting systems, parabolic cooker and in most cases for paying the transportation and cost of porters. .

What are these formal institutions doing?

ACAP is involved in the promotion of energy technologies – both renewable and non renewable. It has promoted back boiler, solar water heater, pressure cookers, kerosene stoves, and established kerosene depots with support to private sector. It has supported building hydro-power plants in Mustang District, but has no bio-gas support yet in Mustang District.

ICIMOD had a number of study and pilot program in the Mustang. One such pilot project is the 'Development of Sustainable Energy for Rangeland, DESR I' that began in 2007. The long term objective of the project was to enhance the livelihoods of the people and their livelihoods of the people and their environment by designing and supporting development of environment friendly technologies. The pilot objective was to establish knowledge base on household energy situation and to carry out on-site testing of suitable technologies. Apart of other technologies, the pilot program also supported portable parabolic and wooden box type solar cookers, modified version of three types of metallic improved cook stoves, and portable and fixed type solar lamps in northern Mustang. ICIMOD also worked with porters working for tourists. ADB has provided support for HIMALI project that focuses on pasture, high land agriculture, and protecting *Caragana* shrub – the only remaining but declining shrub in Northern Mustang

What relations exist among these institutions?

All formal institutions working within a district, in principle, is coordinated by the DDC. For that reason, the formal institutions in Mustang maintain working relation with the DDC as demanded by the programme. The DDC platform, however, does not necessarily create working relation between and among the institutions. The working relation is largely based on responsible individuals rather than institutions. Most formal institutions are guided by their parent organization in planning and implementation. That the annual programmes of these institutions are approved by the DDC before they are submitted to the ministries, does not guarantee that they are funded by the parent organizations. Further, evaluation of the progress is done by parent organizations, the institutions become extension of the parent organizations rather than development partners of the DDC.

What capacity/capability exists and what is needed?

People from Mustang are well known for their entrepreneurship skills, and hard work. They have shown time and again their capability of planning and implementing innovative ideas and methods that meet their needs and are suitable for local environment. For example, even though, it is a mountainous area, the villages are located along the river bank and were connected by wide trails, local people began using tractors and motor cycles for local transport long before road reached the area. Though, it was expensive, people managed to ferry petrol and diesel by choppers and ponies to maintain motorized transport between villages. Establishing internet, telephone connections, air conditions, use of large size kerosene heaters were introduced in the area by people long before they became common in other areas. ATM machines are functional in Jomsom while many of other hill/mountain district headquarters have none. Storing apples in water-cooled 'storages' were developed to preserve apples. The fact that Mustang maintains food security for at least a year, even though it does not produce any rice, explains how efficient people are in planning prudently.

Any development effort presenting successful models, therefore, have a very high chance of replication and upscaling. The models, however, need to provide benefit in the short as well as long term.

What enabled/what disabled?

Historical isolation and disconnectedness with mainstream Nepali State power forced people from Mustang to survive on their own. They had to find solutions to the problems from within their own means. Be it meeting food, shelter or other requirements, people had limited choices. It is evident even today that people in Mustang show perhaps one of the most efficient ways of using land resource, recycling nutrients in soil, and saving energy sources. All possible areas that can be used for food production have been used to their fullest capacity. Farmers do not depend on chemical fertilizers but recycle human waste to replenish soil nutrients. The concept of 'save energy' is deeply internalized by the people. Once fire wood is used, say for example for distilling alcohol, the charcoal is saved every 10 – 15 minutes before they turn into ash. Social cohesion is very strong. Community decisions are adhered to strictly.

The integration of people of Mustang with outside world has added to their prosperity, but not without some adverse consequences. It has weakened their social capacity to manage resources. The open access to outsiders in Mustang after the Khumpa operation of 1971, spurted growth of formal institutions like security forces, government organizations and I/NGOs. The new group of people added pressure on to the local resources, but the scope for resource development was very limited. Like elsewhere, people in Mustang opt for better life outside the area, which has reduced the workforce available, and local capacity for innovation and enterprises.

What are the external influences?

Presence of development organization, tourism, visitors, and increasing integration of market are some of the visible external influences. There is very vibrant private sector that caters to the increasing demand of development and services needed by visitors. This can also be observed from the widespread use of Chinese make of Improved Cooking Stove (ICS). ICIMOD 2010 (a) estimates that 690/985 households (70%) use Chinese ICS in upper Mustang alone.

Emerging institutions

With its unique socio-cultural set up and geographical location, two situations are clearly merging in Mustang. One in which the traditional way of living continues on the dilapidated resource base. The other one is the situation created by new interventions and development activities. Most of the economic activities driven by growing tourism, construction works, and establishment of offices have reinforced the disparity that existed among three areas of the district. The new institutions of market have generated opportunities mostly for the inhabitants of the central part, whereas the southern part has not benefited equally. The northern part remains isolated.

Due to the growing market connection and expanding formal institutions such as banking and prospects for commercial activities, people in central part of the district have been enabled to look for technology and services in order to switch from traditional to modern energy saving devices. They have access to kerosene, LPG and electricity. They have stopped using firewood. LPG is used in the kitchen, while kerosene is used for heating.

Electricity, though not expensive, have been used for illumination and not for cooking. Further, due to their economic ability and access to the information sources, they have widely used electricity saving devises such as CFL.

Though the road to Pokhara through Beni has made import of LPG and kerosene possible for a much reduced transport cost, the import situation hangs in a precarious balance. The volatile market of fossil fuel with fluctuating supply, and the road that remains closed for 2-3 months during rainy season necessitates people to maintain both traditional and modern sources of energy. Constructing a road through one of the most difficult terrain between Mustang and Myagdi (where lies Main Central Thrust) in itself is a remarkable engineering feat. However, its maintenance and keeping it operational is a challenge. There is no formal institution in place to maintain the road. The problems so far have been solved by transport operators. Even if a formal institution is in place to maintain the road, the financial back will probably remain weak to support functioning of the road. What this implies with respect to the energy scenario in Mustang is that the supply of fossil fuel based energy sources is shaky. Therefore the energy plan for Mustang has to consider other potential areas that have less or no risks.

4. Data Analysis and Scenario Development

4.1. Energy Consumption

Calculation of energy consumption in various sectors was done based on primary as well as secondary information. Data from different sources contradicted, or appeared unrealistic, biased or inaccurate. In these situations, assumptions had to be made, which were later validated in the field from key informants. Table 34 presents the assumptions and references made for calculating energy consumption.

Table 34: Assumptions and References for Estimating Fuel Consumption

Fuel type		Calorific Value	Calorific Value Source
Fuelwood	4.8 *bhari*# per month per household (hh) for Northern Region, 9.6 *bhari* per hh per month for Central Region and 12 *bhari* per month per hh for Southern Region,	15MJ/kg	IPCC 2006
Dung Cake	15 *bhari* per month per household for all the three regions of Mustang	10.92MJ/kg	http://eprint.iitd.ac.in:8080/bitstream/2074/431/1/kanind95.pdf
Kerosene	1 liter per household per month in northern and southern region and 5 liter per household per month in central region	37.1MJ/liter	IPCC 2006
LPG	0.5 cylinder per month per household, in northern and southern region and 1 cylinder per month in central region assuming one cylinder being 14.2 kg	46.1MJ/kg	IPCC 2006
Petrol	Total amount of petrol litres entering Mustang	36.4MJ/liter	IPCC 2006
Diesel	Total amount of diesel entering Mustang	36.8MJ/liter	IPCC 2006

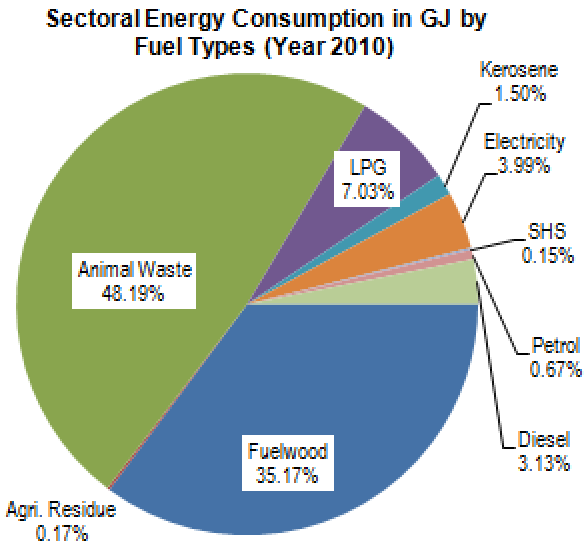
 # 1 bhari = 25 kgs both for fuel wood and dung cake

Baseline energy consumption has been estimated for three key sectors: the residential, commercial, and transport. Since industrial sector is not developed in Mustang, the energy demand for industry such as brewery and few saw mill have been considered within commercial sector. Among the sources of energy, Mustang does not use coal and charcoal. The sectoral energy consumption and the sources providing energy have been given in Table 35. Total energy consumption of Mustang is estimated at 162,774.20GJ which accounts for 0.04 percent of overall national energy consumption of 401 million GJ (WECS, 2010).

Table 35: Sectoral Energy Consumption of Mustang (Year 2010)

S.N.	Fuel Type	Residential Sector		Commercial Sector		Transport Sector		Overall	
		Unit	GJ	Unit	GJ	Unit	GJ	Unit	GJ
1	Fuelwood,MT	3,125.22	46,878.26	691.21	10,368.28	-	-	3,816.43	57,246.54
2	Agri. Residue,MT	22.55	281.83	-	-	-	-	22.55	281.83
3	Animal Waste,MT	38,082.70	47,060.89	19,234.64	31,373.92	-	-	57,317.34	78,434.81
4	LPG,kg	4,338.70	6,589.76	7,272.00	4,860.97	-	-	11,610.70	11,450.73
5	Kerosene,KL	65.62	2,434.51	-	-	-	-	65.62	2,434.51
6	Electricity,MWH	820.29	5,104.24	386.02	1,389.66	-	-	1,206.31	6,493.90
7	SHS, Units	842.00	244.68	-	-	-	-	-	244.68
8	Petrol,KL	-	-	-	-	30.00	1,092.00	30.00	1,092.00
9	Diesel,KL	-	-	-	-	132.00	5,095.20	132.00	5,095.20
	Total	-	108,594.16	-	47,992.84	-	6,187.20	-	162,774.20

Residential sector consumes 66.71% of the total energy, the largest share of energy. Commercial sector consumes 29.48%. Transport sector draws only 3.80%.



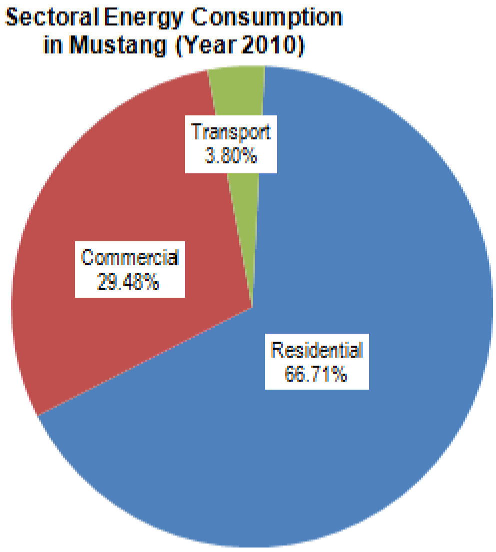


Figure 13: Energy Consumption in Mustang

On the supply side, animal waste provides 48.26% of the energy consumed, followed by fuel wood 35.22%. Electricity and other commercial energy sources supply only about 16.35%.. Farm residue provides about 0.17% of the energy consumed.

Mustangi household have efficient energy management practice. The use of various types of cattle dung, twigs, roots, fire wood at different cooking times exhibit their skills.

This house in Muktinath judiciously uses all possible sources of energy including dung, firewood, twigs, charcoal, solar and electricity to maintain energy security.

Figure 14: Energy security at household level.

4.1.1. Regional Picture

Analysis of climate impact and GS dimension viz a viz energy consumption need to be done for each region within the district. A fairly detailed energy calculation was possible for Charang VDC in the north, for which detailed information was available. The data for other VDCs were not available, however, Charang was taken as a sample VDC to generate energy situation for the northern region. Information for Muktinath and Kobang VDCs were collected through group interaction, observation, and key informants.

Table 36 gives a comparative figure for energy consumption of different regions. In the northern region, biomass provides 96.52% of the energy while, fossil fuel provides about 2.47% of the energy. RET provides the rest 1.01% energy. Fossil fuel and RETs have been fairly recent introduction and have helped the communities in reducing some of the drudgery, but has not helped significantly in reducing dependency on the biomass for energy. Animal waste is on the decline for lack of herders and reduced number of animals. In the central region, the share of biomass is about 82.03% while fossil fuel and RETs contribute 12.52% and 5.45% respectively. In the south, biomass increases to 91.77% while fossil fuel reduced to 2.37% compared to the central region. The southern Mustang has the highest RETs contributing (5.86%) to energy supply. The comparison between regions helps understand the linkages between energy situation and the potential impact of climate change.

Table 36: Baseline Energy Consumption for residential sector

Energy Source	Northern		Central		Southern		Total	
Units	GJ	%	GJ	%	GJ	%	Units	%
Fuel wood	1,842.26	3.40%	20,239.20	36.35%	24,796.80	82.21%	46,878.26	33.49%
Animal Waste	50,289.88	92.90%	25,324.30	45.49%	2,820.64	9.35%	78,434.81*	56.04%
Agri. Residue	116.84	0.22%	102.33	0.18%	62.68	0.21%	281.85	0.20%
Biomass Total	**52,248.98**	**96.52%**	**45,665.83**	**82.03%**	**27,680.12**	**91.77%**	**125,594.92**	**89.73%**
LPG	1,243.90	2.30%	4,885.43	8.78%	460.43	1.53%	6,589.76	4.71%
Kerosene	93.20	0.17%	2,085.76	3.75%	255.54	0.85%	2,434.51	1.74%
Fossil Fuel Total	**1,337.10**	**2.47%**	**6,971.20**	**12.52%**	**715.97**	**2.37%**	**9,024.27**	**6.45%**
Hydropower	453.38	0.84%	2,884.09	5.18%	1,766.77	5.86%	5,104.24	3.65%
SHS	92.88	0.17%	151.79	0.27%	0.00	0.00%	244.68	0.17%
RET Total	**546.26**	**1.01%**	**3,035.88**	**5.45%**	**1,766.77**	**5.86%**	**5,348.91**	**3.82%**
Total	54,132.34	100.00%	55,672.90	100.00%	30,162.86	100.00%	139,968.10	100.00%

** Note: The total energy consumption from the animal waste is reported as 78,434.81 GJ. It is assumed that 60% (47060.89GJ) of this energy is used for residential purpose by households and the remaining 40% (31373.92 GJ) is assumed to be used by household for commercial activities e.g. household brewing.*

4.1.2. Climate Change Impact

CC impact in Mustang has been visible as indicated by the national communication projection. A general impression is that the temperature is generally rising and there is a shift in precipitation pattern. The annual precipitation is declining with a shift in rainfall trend. The winter precipitation is increasing, while it is declining in March and April (Table 16). March is the main season of plant growth and reduced moisture at this time means retarded growth of shallow rooted plants. Some of the visible and felt impact of climate change viz-a-viz biomass availability and power generation is summarized in Table 37.

Table 37: Observed and Expected Climate Impacts

Change in meteorological variable	Impact on biomass availability	Impact on power generation
Increase in temperature	Positive - provided that no other resources constraints plant growth.	Positive – snowmelt

Change in meteorological variable	Impact on biomass availability	Impact on power generation
Increase in average precipitation	Positive in the south and central, but may lead to increased erosion and subsequently impact grassland.	Sediment pulse could lead to damages to intake site and turbines
Decrease in average precipitation	Decrease plant growth already stressed by dry climate	Not known as the stream discharge depends on hydrological boundary extending to snow areas outside the basin boundary
Droughts	Biomass will decline further	Low flow will decrease power generation
Glacier melting	Very small area contributed by glacier melt water and thus the impact not significant	Serious impact on the plants fed by glacier melt water
Floods	Very low in flood plains where no vegetation exists, but landslides on hill slopes severely impacts vegetation	Damage to plants and transmission lines likely
Increase in storms	Already a windy place, but decrease if storms affect area where biomass is sourced	Decrease in power production if structures damaged

(Source: NTNC 2008)

Translating the observed and anticipated climate impact with respect to energy sector within Mustang needs to be focused on two points: (i) the impact of increased temperature and changed precipitation on vegetation; and (ii) the demand for energy for cooking and heating. As such the increased rain and warm winters will have positive impact on the growth of vegetation, but delayed and possibly increased snow might impact the grass growth negatively due to moisture stress at the time of growth. People have already experienced some negative impact on grass as they are less green now than before due to moisture deficiency. In the central region the impact will have a mixed result on vegetation. Likewise the increased temperature has positively impacted agriculture. Terefore, the central and southern Mustang will generally benefit from expected climate change, while the north, which already suffers from energy shortage will be hard hit.

Reduced grass production could have serious impact on the pasture and subsequently on the animal health affecting dung production. Even with the introduction of commercial and RET sources of energy in the last decades, a large quantity of energy is met by biomass and hence a slight decline in the grass production or its availability (which is yet to be established with change in snowfall time) will have significant impact on the energy equation. The situation with regard to climate and vegetation in the central part will not be as serious because the share of fossil fuel (of course a significant part of it is used in transportation as well) and RET is much larger here. Slight decline in vegetation growth will not impact the energy equation as significantly. In the south, it is evident that even if fossil fuel and RET are readily available and contribute significantly to the energy supply, the share of biomass energy is about 90 percent. The climate impact is likely to impact the growth of trees and shrubs positively and hence the biomass energy would continue to occupy important and reliable source at normal growth trend of energy demand.

4.1.3. Climate and GS Analysis

According to the demographic composition, the northern area is dominated by Gurungs, while the Thakalis dominate the south. Social tolerance within these groups is largely guided by their traditional social relations. Resource allocation and distribution are carried out based on the traditional methods, in which it is ensured that no house is left without benefiting from the resources of energy. Economic ability of the family determines how much firewood and other source of energy they get to use. This is obvious to some extent from the per capita energy consumption as shown in Figure 15.

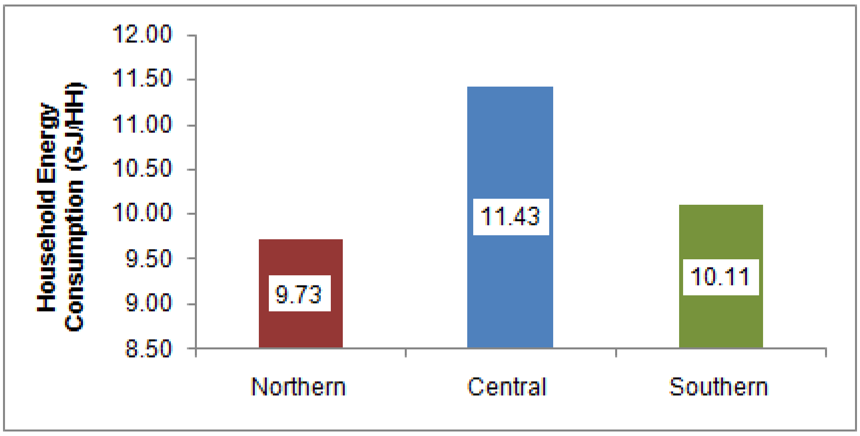


Figure 15: Per Household Energy Consumption across region

It is also to be noted that the central region has the highest per capita energy consumption which is met by multiple sources, whereas in the south even though the per capita energy consumption is low, the sources are varied. But, all the requirement of energy is met through dung in the north.

Now, we can superimpose the social dimension on the energy consumption pattern across the regions in Mustang. Mustang has a significant population of Dalits (8.2%) and other groups (2.1%). In addition, there are homeless (implying landless) people. Landless people, most of whom are from dalit community, represent a small number of about 5%. Menial workers continue to come to Mustang even today during harvest and construction season. It must be noted that the dalits are mostly present in southern Mustang with 140 households. Except in Lomanthang and Chuksang VDCs, the other VDCs in the north do not have dalit population. In central Mustang, there are about 62 dalit families (Table 38)

Table 38: VDC wide distribution of ethnic minority

Region	VDC	Dalit households			Total
		Damai	Kami	Sarki	
Northern	Chonnup	-	-	-	0
	Lomanthan	-	17	-	17
	Chhoser	-	-	-	0
	Surkhang	-	-	-	0
	Chharang	-	-	-	0
	Ghami	-	-	-	0
	Chhusang	1	2	-	3
	Total	**1**	**19**	**0**	**20**
Central	Kagbeni	1	4	-	5
	Jhon	-	2	-	2
	Muktinath	-	4	-	4
	Jomsom	6	12	-	18
	Marpha	19	13	1	33
	Total	**26**	**35**	**1**	**62**

Region	VDC	Dalit households			Total
		Damai	Kami	Sarki	
Southern	Tukeche	7	12	-	19
	Kobang	11	12	-	23
	Kunjo	28	35	-	63
	Lete	15	13	7	35
	Total	**61**	**72**	**7**	**140**
Grand Total		**88**	**126**	**8**	**222**

(Source: District Profile 2065)

Since dalits are poor and do not have ownership of the land, their access to energy sources is poor. Despite large forest areas in southern Mustang, migrants and landless people do not enjoy the same right over sources as done by native population. Access to resource is determined by land ownership. People in Mustang generally do not sell land to people other than their own community members. Therefore, the migrants usually do not own land. In practice, their access to traditional energy sources such as firewood depends on their relation with the native population. Some of them are involved in collection of firewood from forests, and hence can avail themselves with needed firewood. Those who cannot collect wood make do with what little they get from nearby areas or farm residue, which they get from the farms in which they work as laborer.

Contrary to the common understanding of the impact of CC on natural resources being adverse, southern Mustang is likely to benefit from it. Vegetation including shrubs and woody plants will grow better producing more energy sources. More shrubs and woody plants will subsequently benefit minority groups with increased access The response of alpine tree species to the warm condition is difficult to assess at this stage.

The warming of winter will only marginally benefit the poor, because overall temperature and particularly night temperature would still be much lower. On the contrary, the minorities in central Mustang may not be as fortunate, because the area is likely to get delayed snowfall, which will impact the plant growth adversely; and increased rainfall will enhance erosion, which again will have negative consequences on the vegetation growth. Though there are only 20 households of dalits in northern Mustang, they will be hardest hit by changing climate and its impact on biomass. Even if the system of distribution of energy sources continues as they have adapted now, the decline of the resource base will put pressure on the supply affecting these minorities.

4.1.3.1. Regional Gender Analysis

Because women are key figures in all household activities including cooking, brewing, and food processing; the availability of energy sources and the ease with which it is available affects women. Energy is vital for women engaged in commercial activities such as running teashops, and hotels. In fact, most households along the Kali Gandaki trail serve foreign as well as domestic tourists and trekkers with hot meals and beverages. Hotels are run by women, with a few exceptions. Shortage of energy especially for cooking will not only affect these businesses but also income sources of the households. Disintegrating the likely impacts of CC on energy sources and subsequent impact on women in three areas within the district shows that there is a sharp difference. The following Table 39 presents the region wise comparison of the climate impact with regards to the gender perspective.

Table 39: Region wise comparison of the climate change impact and gender

Climate Change Impact	Northern Mustang	Central Mustang	Southern Mustang
Increased rain	***Positive impact*** • Increased prospects for apples increase income that would enable women to buy sources such as LPG.	***Negative impact*** • Storing firewood in the traditional way would be difficult; • Increased erosion in farms add burden on women to manage land and maintain farm income; • Mobility gets restricted as walking with load on the back for women troublesome on muddy trails.	***Mixed impact*** • Increased income from vegetables; • Storing firewood in the traditional way would be difficult.
Reduced and/or delayed snow	***Negative impact*** • Less soil moisture would reduce grass growth leading to less dung that would add burden on women to travel longer distances to collect dung.	***Negative impact*** • Would severely impact horticulture and the income thereof adding burden to find income sources to buy LPG and electricity; • For those using combination of energy sources, a decline in biomass or dung would mean to spend more cash on LPG and electricity.	***Negative impact*** • Loss of apples reduces farm income, which needs to be supplemented by other sources (e.g. hotel) that would demand additional energy sources.
Increased temperature	***Positive impact*** • Early thawing of ice would save fuel that otherwise have to be used in melting ice to make water available for kitchen.	***Positive impact*** • Would be positive for women as drying of fruits and vegetables would be easy; • Saves fuel in cooking as the water becomes warmer.	***Positive impact*** • Drying of cereals, vegetables, and fruits can be easy; • Saves fuel in cooking as the water becomes warmer; • TCS may become less relevant.
Increased growth of vegetation as a result of higher temperature and rain	***Positive impact*** • May encourage women using ICS to save fuel; • Do not need to inhale smoke while cooking nor they need to spend time doing utensils blackened by the smoke; • Growth of shrubs will be improved providing some solace to energy shortage.	***Mixed impact*** • Change in the availability of firewood would not affect women as long as electricity and LPG is available; • People may revert back to TCS defying current restriction on burning firewood.	***Positive impact*** • Increased availability of vegetation stabilizes firewood price.

4.1.3.2. Adaptive Capacity

Adaptation to the stresses is not new to people in Mustang. A hard way of life and harsh living conditions in one of the most unfriendly environments made people in Mustang adapt to multiple stresses emanating not only from natural but also from social, economical and political transitions since historical times. Despite the varied demographic composition and different economic condition, the adaptive capacity of people is common throughout the district. Recapping the relationship between sources and their livelihood would explain how has the adaptive capacity have been one of the noteworthy characters of people in

Mustang. Social structure, costumes and culture have shaped their behavior in such a way that social discrimination is almost nonexistent. Discrimination that once would experience is only between landless migrant workers including dalits and local people. Some dissimilarity exist between Gurungs and Thakalis, however, it does not pose any threat to resource management as they do not share the same resource. Since Thakalis are in the forefront in trade, business, and politics; the Gurungs in the north feel isolated and discriminated to some extent in district level decision making. However, the decentralization of development works have improved the perceptions in the last decades.

Gender equality is quite remarkable. Women play important role in key decision made at household level. But, there are research reports that suggest that women's position in community decision making is still dominated by men. The costume of one marriage in one generation places women at the core of decision making. Though people during the focus group discussion suggested that the costume is on the decline, its contribution to resource management cannot be underestimated. Decision about landuse, animal husbandry, crop selection, manure preparation is done by women in a family. She is also the one who takes care of the house and the farm when men move out for trade. Managing energy during the cruel winter is the responsibility of women. Division of work is well defined across gender and women of the family have the final authority to settle family disputes.

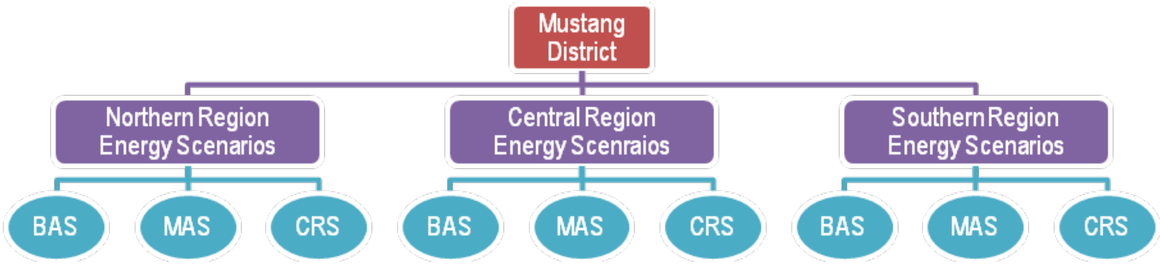
4.1.4. Trend Analysis

Until the construction of Chokhopani hydropower project in Tukuche in the early 1980s, the major source of energy in Mustang was biomass for heating and cooking, and kerosene for lighting. Diversification of energy sources continued with introduction of solar cookers, solar driers, solar heaters, and biogas in the 1990s. Trials were also made to use wind energy to generate electricity. ICSs were introduced to save firewood and conserve depleting forest resources. Electrical appliances such as air-conditions have been introduced for heating in hotels. Automobiles were introduced for local transportation. With road access to the market in Pokhara, Mustang imports LPG for cooking. Within a period of three decades, Mustang has transformed from a biomass based energy consumer to a diverse energy user. The share of RET and fossil fuel together amounts to be nearly 11% of the total energy consumption. The rest is yet met by biomass based form of energy.

The trend in other sectors is also noteworthy. The population growth rate has remained less than 1% between 1991 and 2001. In fact, it has reduced in some villages due to out migration. The number of tourists visiting the area has increased substantially after 2006, primarily due to changed political context. The official record shows that more than 23,000 tourists visited the area in 2009. The number of tourist in 2011 is expected to reach more than 37000. With increased flights to and from Pokhara, the Indian tourist visiting Mustang has increased to more than 200 a day during spring and autumn. Number of hotels has also increased from less than 50 to nearly 140 in two decades.

4.2. Scenario Development

Demand for energy will continue to increase due to rise in population, increased economic activities, and improved lifestyle over a period of time, putting additional pressure on the existing resources. It will deplete the resource base and subsequently the availability of energy. On the other hand, the emerging global environmental change will increase stresses on energy sources, particularly on grasslands, which will undermine its ability to supply required energy. The need would be at least to continue to meet the energy demand of the people under the changing climate condition. The desirable would be to improve the living condition of the people, with focus on relieving women and girls from this traditional role in collecting cattle dung for cooking purpose, and improving their lifestyles. With this understanding the future energy situation has been projected for three scenarios: i) Business as Usual Scenario (BAS); ii) Medium Adaptation Scenario (MAS); and iii) Climate Resilient Scenario (CRS).



BAS – Business as Usual Scenario; MAS – Medium Adaptation Scenario; CRS – Climate Resilient Scenario

Figure 16: Energy Scenario development for Mustang

4.2.1. Business as Usual Scenario (BAS)

Under the business as usual scenario, use of energy would rise in a linear manner with population and economic activities. Even though the population growth between 1991 and 2001 has remained less than 1% in Mustang, the projection for 2011 has been done based on the national population growth rate. Energy needs of the increasing number of tourists and hotels have also been calculated on the basis of the growth in the last decade.

4.2.2. Medium Adaptation Scenario (MAS)

Under medium term adaptation, it is assumed that the households currently using renewable energy for lighting will be able to using hydropower for cooking. Remaining households (currently not using RET) will have access to micro-hydro for lighting. Additional 20% of the total renewable energy use will be used for adaptation purpose (e.g pumping irrigation, drinking water, agriculture promotion and to meet the need of additional tourists). The need for additional energy is also evident from the fact that only 62% of the total irrigable area in Mustang District is irrigated by about 353 irrigation systems. Around 2500 ha, though currently being cultivated, has no access to irrigation facilities. Availability of water is a major concern for these cultivable lands. Apart from this, there is a considerable amount of area that can be farmed if adequate water is pumped from nearby sources. We assume, under a medium adaptation scenario, this total area to be additional 2500 ha. and, under a climate resilient scenario 5000 ha, mostly in the central and northern regions. People consulted also mentioned that sources of drinking water supply are also experiencing decreased discharge. In these cases too, energy is required to pump water. One such example for additional energy need is presented in the figure below. The use of biomass and fossil fuel will remain the same as that of 2010 baseline consumption.

Figure 17: Additional Energy Demand Consideration under MAS

4.2.3. Climate Resilient Scenario (CRS)

A climate resilient scenario would require that adaptation and mitigation measures are fully operational. Current global scenario with political disturbance Arab World and North African region, and the disaster in Japan would have lasting impact on the fuel price in the days to come. "Longer-term demand for fossil fuels could remain high as other nations revisit plans for their nuclear electricity production," a World Bank report[4]. "This situation demands revisiting how we generate and consume energy, and how we save our societies from being locked in burning fossil fuels. In fact, the DDC has been consistently receiving demands to subsidize capital cost and transportation cost for the use of LPG from communities living in the northern Mustang. They are in a dilemma as whether such practice should be endorsed. Therefore, one of the assumptions has been to reduce dependency on fossil fuel.

The following table provides the summary of the key assumptions in various scenario developments for Mustang.

Table 40: Key assumption in various scenarios

Scenario/assumption	BAS	MAS	CRS
Population growth 2010-2011	1%	1%	1%
Population growth beyond 2011	2.09%	2.09%	2.09%

[4] http://www.thejakartaglobe.com/bisworld/japans-nuclear-shortfall-may-lead-to-hike-in-energy-prices/430944 Accessed on March 25, 2011

Scenario/assumption	BAS	MAS	CRS
GDP growth rate *	4%	4%	4%
Other assumptions	-	• Households currently using renewable energy for lighting will be able to use electricity for cooking. • Households not having access to RET currently will use electricity for lighting. • 20% additional energy would be required to meet adaptation needs.	• 100% households use electricity for cooking and lighting. • Use of fossil fuel for residential purpose would be negligible. • 50% additional renewable energy will be required for adaptation purpose. • Use of biomass (firewood and dung) is reduced by half of the baseline use of 2010.

** GDP growth rate has not been taken as a variable for energy demand projection; however, it is assumed that the change in affordability for energy due to the GDP growth will continue to be constant with the population growth. Thus the GDP growth rate for Mustang is assumed to be same as the national average of expected 4% for the next 10 years.*

4.3. Scenario for Each Region

4.3.1. Northern Region

The total energy demnd for northern region in the year 2020 for Business as Usual Scenario, Medium Adaptation Scenarion and Climate Resilient Scenario are 70,594.47 GJ, 69,360.16 GJ and 50,644.86 GJ respectively. The energy demand by fuel types for the northern region in the year 2020 under different scenarios is presented in the Figure 18.

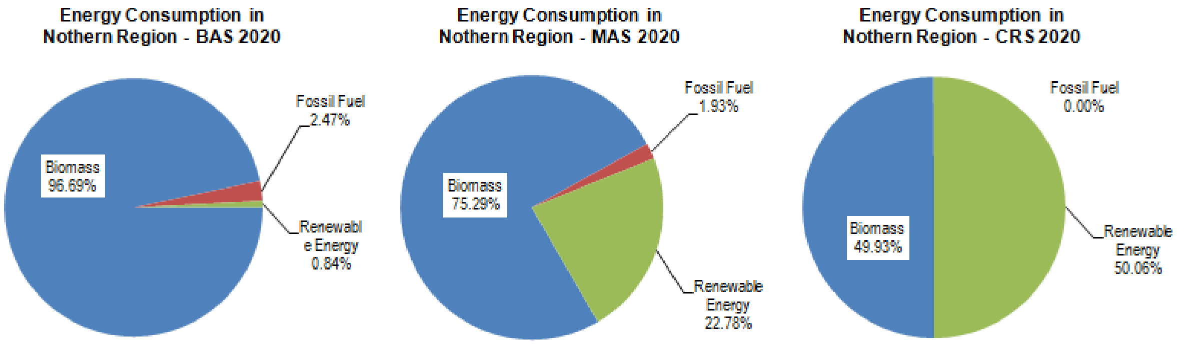


Figure 18: Energy Demand in Northern Region under different scenarios for 2020

4.3.2. Central Mustang

The total energy demnd for central region in the year 2020 for Business as Usual Scenario, Medium Adaptation Scenarion and Climate Resilient Scenario are 72,728.33 GJ, 69,974.54 GJ and 44,284.25 GJ respectively. The energy demand by fuel types for the central region in the year 2020 under different scenarios is presented in the Figure 19.

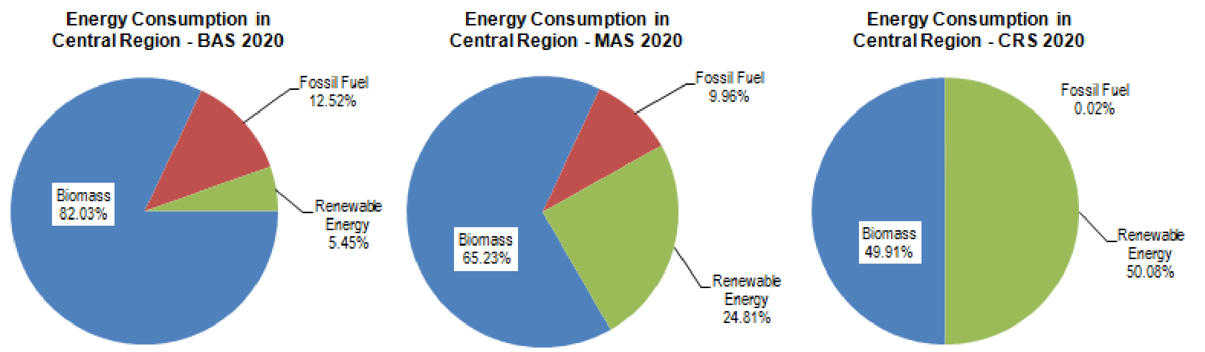


Figure 19: Energy Demand in Central Region under different scenarios for 2020

4.3.3.Southern Region

The total energy demnd for southern region in the year 2020 for Business as Usual Scenario, Medium Adaptation Scenarion and Climate Resilient Scenario are 39,403.27 GJ, 39,321.28 GJ and 26,842.12 GJ respectively. The energy demand by fuel types for the southern region in the year 2020 under different scenarios is presented in the Figure 20.

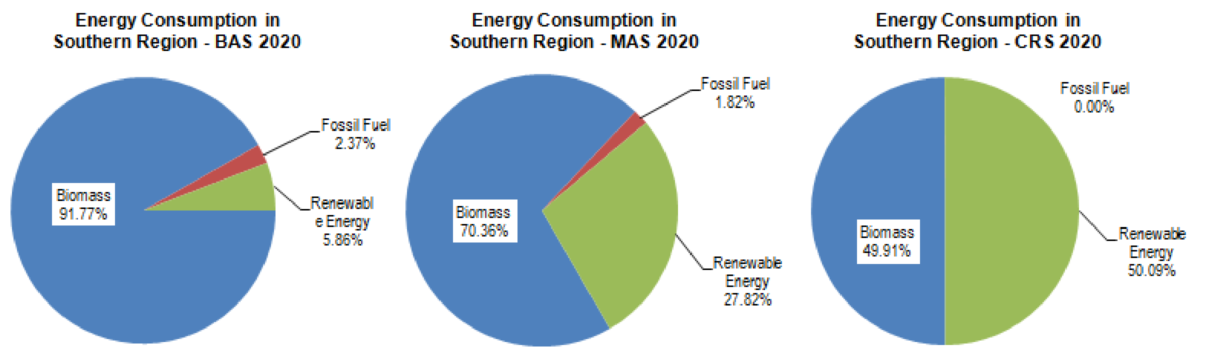


Figure 20: Energy Demand in Southern Region under different scenarios for 2020

4.4. Additional Energy Demand

4.4.1. Water for Pumping

In addition to the above energy demand scenario under different conditions, there are areas, which, if provided with energy, can help open opportunities for economic prosperity. Communities in the following communities have expressed additional energy demand to meet water requirements within the last few years.

Table 41: Settlements Requiring Additional Energy for Pumping Water

Settlements	Requirement	Source of Energy	Remarks
Thangjung and Chabule	Pumping for irrigation	Hydropower, wind or solar	-
Tangbe, Chhusangg	Pumping for irrigation	Wind	Potential for horticulture and vegetables
Tetal, Chhusangg	Pumping for irrigation	Wind/hydropower	-
Dhaharchowk	Pumping for drinking and irrigation	Wind/ hydropower	Existing spring yield reduced, water insufficient
Falyak	Pumping for drinking	Wind/ hydropower	Existing spring yield reduced, insufficient

Settlements	Requirement	Source of Energy	Remarks
	and irrigation		for irrigation
Ghiling	Pumping for irrigation	Wind/ hydropower	Very fertile area. Chhusangg village holds the right of Yamda river which is situated 6-7 kilometers from Ghiling

4.4.2. Solar Water Heating

Currently about 106 solar water heaters of 500 liter capacity each are being used across Mustang. This includes 101 systems in hotels, assuming each hotel has one system and 5 numbers of institutional solar water heating systems. Considering the need to raise the water temperature from 10 degrees to 60 degrees centigrade with 365 days of system operation, total energy consumption is estimated to be 4043.1 GJ.

Table 42: Energy Consumptions from solar water heating

Solar Water Heaters	Institutional	Hotels	Total Energy Consumption
SHS numbers	5	101	
System Size (liters)	500	500	
Operating days per year	365	365	
Hot Water production per year(liters)	912500	18432500	
Energy per liter for 10-60 deg. Cent gradient (KJ)	209	209	
Energy Produced(KJ)	190712500	3.85E+09	
Energy Produced (GJ)	190.7125	3852.393	4043.105

4.5. Technology Prioritization

"Haami lai ni-sulka adhyanro hoina sa-sulka ujyalo deu." (literally translated as 'we don't need darkness for free give us light for a price' in Nepali) is a common expression often heard from people of all walks of life in Mustang.

Mustang's DCEP envisions a universal coverage of climate resilient, gender sensitive and socially inclusive reliable energy source at affordable price for sustainable development, optimistically within a short of time. This demands capturing the uniqueness of Mustang as well as specific needs of different areas where the natural and social systems differ significantly. In addition, it considers opportunities for using energy sources that are unique to Mustang. For example, energy produced from wind and concentrated solar sources could be directly fed into the grid, or used to pump water (irrigation or drinking water) for communities where clean water is not available/insufficient or decreasing. In places where there is no possibility of grid connections, possibilities cannot be ruled out to integrate the energy produced from wind and solar with energy storage technologies such as pumping water for producing micro-hydro/hydro electricity.

The DCEP has projected various interventions for the next ten year until 2020 with detailed plan for the first three year only. The detailed plan is based on the medium adaption scenario (MAS). The prioritization of technology for detailed plan was conducted at the stakeholders' consultation, and the results are given in Table 43. Technologies such as biogas has not been included in the prioritization evaluation as their scope is limited to only small regions in Mustang.

It was agreed in the consultation meeting that the criterion for prioritization of technology should include aspects related to broader areas of climate change, gender and social inclusion, and other criteria including the cost and Mustang specific factors, with assigned weightage value of 40, 20, and 40 respectively. These criteria were further divided into sub-criteria. Weightage of each sub-criterion was fixed. The proposed energy technologies were evaluated for each criterion and scored on the basis of scoring range as High, Medium, or Low. The justification for the assigned value is given in Table 44.

Table 43: Technology Prioritization Criteria

Technology	Climate Change (40)			Gender and social Inclusion (20)			Other criteria (40)		Total score
	Vulnerability to climate change	**Contribution to climate mitigation**	**Contribution to climate adaptation**	**Contribution to change in gender roles**	**Contribution to social inclusion**	**Contribution to poverty reduction**	**Cost Factor**	**Mustang specific issues**	
Assigned Score	**20**	**10**	**10**	**5**	**5**	**10**	**30**	**10**	**100**
Scoring Range (L-Low, M-Medium, H-High)	L: 13-20 M: 6-12 H: < 6	L: < 3 M: 4-7 H: > 7	H: > 7 M: 4-7 L: < 3	H: > 3.3 M: 1.7-3.2 L: < 1.6	H: > 3.3 M: 1.7-3.2 L: < 1.6	H: > 7 M: 4-7 L: < 3	L:< 10 M: 11-20 H: > 20	H: > 7 M: 4-7 L: < 3	
Solar Lighting	18	2	2	1	1	3	20 *	5	52
Microhydro	4	5	5	2	2	5	25	5	53
Large Hydropower	12	10	10	5	5	9	30	9	90
ICS	8	1.5	3	1.5	1	3	20	3	41
Solar Cooker	18	2	2	3	1.5	4	25	9	64.5
Wind turbines	12	8	9	5	5	9	15**	10	83
Concentrated Solar	17	8	9	5	5	9	25	10	88

Table 44: Justification for the Technology Prioritization Criteria

Technology	Climate Change			Gender and social Inclusion			Other criteria	
	Vulnerability to climate change	Contribution to climate mitigation	Contribution to climate adaptation	Contribution to change in gender roles	Contribution to social inclusion	Contribution to poverty reduction	Cost Factor	Mustang specific issues
Solar Lighting	Does not affect solar lighting	Low fossil fuel replacement	Limited use	Small area for changed role	Individual use	Saves money spent on kerosene	Battery replacement cost is high	Less cloudy days
Microhydro	Streams could dry	Helps replace some fossil fuel	Helps pumping water from lower elevations	Fuel collection reduced, support household chores	Single source of energy helps bring community together	Time and energy available for economic activities	Reduced energy cost	Isolated villages, but streams available
Large Hydropower	Rivers less affected by CC	Helps replace most fossil fuel	Energy available for most uses affected by CC	Burden to collect dung reduced, men start cooking, cleaning	Brings community to use one source of energy	Energy no longer constraint for economic activities.	Lowest energy cost	Feasible areas available
ICS	Vegetation dependent	Contribution by increased efficiency only	Adaptation by saved fuel only	Saved fuel and smoke	Individual use	Health improved, time saved	Low cost equipment	Not good for heating
Solar Cooker	CC does not affect	Low fossil fuel replacement	Limited use	Burden reduced	Individual use	Saves fuel collection time	Cheaper than biomass in the long term	High radiation, clear sky
Wind turbines	Climate has no huge impact on wind	Reduces fossil fuel demand for generators, water pumps	Energy produced even if streams dry out	Burden to collect dung reduced, men start cooking, cleaning	Single source of energy bring community together	Helps small and cottage industries	Provides energy for pumping irrigation & drinking water	Windy valley
Concentrated Solar	CC does not affect	Helps replace some fossil fuel	Independent of conventional source of energy	Burden to collect dung reduced	Brings groups to use one source of energy	Energy no longer constraint for economic activities.	Cheaper than biomass in the long term	High radiation, clear sky

The technology receiving high score in aggregate were considered suitable as they would: be less vulnerable to the emerging climate change; contribute to adaptation and mitigation; and cost low. In addition, they would help in contributing to change in gender roles as well as poverty reduction and be more socially encompassing. The prioritization helped to maintain balance among various criteria in selecting the technology.

Potential technology based on climate, gender, social inclusion and other criteria have been given in Table 45 below in order of priority. Higher number underscores the suitability of the technology in terms of the parameters used in prioritization. However, it does not take in to consideration the time frame for which the technology is being considered.

Table 45: Technology Prioritization based on criteria

Technology	Climate and GSI based Score
Large Hydropower	90
Concentrated Solar	88
Wind turbines	73
Solar Cooker	64.5
Micro hydro	53
Solar Lighting	52
ICS	41

The findings from the evaluation exercise shows that concentrated solar and wind turbine have a higher priority. However, we believe that a mix of energy options –'energy platter' – is required to address the CC uncertainties. Improved Water Mills (IWM) and biogas plants have not been considered during the prioritization exercise as their total number is insignicant and neither likely to increase drastically, more so during the short term plan period of 2011-2013. The detailed plan for medium adaptation scenario with prioritized technology is presented in chapter 5

5. Plan Design

This chapter shed light on intervention plan, implementation plan, financing plan, monitoring and evaluation, and concluding remarks with recommendations based on energy supply/ demand assessment made in the previous section, future demand estimation for MAS for 2020, and addressing climate change and GSI issues.

5.1. Renewable Energy Technology Intervention Plan

Based on our previous energy supply/demand assessment, future demand estimation for Medium Adaptation Scenario for 2020 for Mustang district, number of RETs have been identified and proposed. The choice of the technologies has been guided by the technology prioritization evaluation based on CC and GSI considerations. Further, these technologies have been chosen based on available market, proven technology, delivery mechanism of technology, technological acceptance which is further elaborated in the Table 44. All the technologies identified are proposed with respective RET targets with the clear timeline activities in the intervention plan (Table 46).

Table 46: Renewable Energy Technology Intervention Plan

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Energy Supply (GJ)
Micro Hydropower (kW)	-	25	20	20	10	15	10	20	-	-	1,797.55
Mini Hydropower (kW)	Ghami Mini Hydropower (850 kW)			-	-	-	-	-	-	6,732	113,567.84
Solar PV - SHS (No.)	116	166	168	47	48	50	51	53	54	56	161.20
Solar PV - Institutional	-	6	6	6	3	3	3	3	3	3	0.45
Concentrated Solar	-	-	50	50	50	-	200	-	-	300	9,736.74
Solar Parabolic Cooker (No.)	500	680	882	66	68	70	72	74	76	78	4,849.74
Solar Dryer (No.)	80	100	125	-	-	-	-	-	-	-	0.00
Improved Cooking Stove (No.)	196	226	228	140	82	85	87	90	92	95	45,643.08
Improved Water Mill (No.)	22	23	23	-	-	-	-	-	-	-	2,350.08
Biogas (Capacity 4m3) (No.)	7	8	10	7	7	5	5	5	5	5	858.09
Wind (kW)	-	-	40	-	-	-	40	-	-	60	1,048.57
Total											180,013.34

5.2. Detailed Implementation Plan

Detail implementation plan presented in Table 47 shows the RET types and their respective target for the first three years period starting 2011. All the efforts have been given to make the plan very clear describing, who will be doing what during the proposed implementation period and the steps that need to be followed.

Table 47: Detailed RET Implementation Plan and the Role of Institutions

Year	Total Target (2011-2013)	2011	2012	2013	Location	Awareness Building	Community Mobilisation	Demand & Information Collection	Designing of Project	Capacity Building	Resource Assessment	Financing Sources	Service Provider	Implementation	Monitoring	Evaluation
Micro Hydropower (kW)	45	0	25	20	Chhonhup(1)^, Chhoser(1), Surkhang (2)	DEEU, CBOs,NGOs	NGOs	DEEU, NGOs	DEEU/External Consultant	Operators/ Managers Tranining	DEEU	AEPC, DDC, VDC, Development Partners	Manufacturers, Installers, External Consultants	DEEU, NGOs	DEEU	DDC, AEPC
Mini Hydropower (kW)	0	0	0	0	Ghami VDC*	DEEU, AEPC	DEEU, NGOs	DEEU, External Consultant	External Consultant	-	AEPC, DEEU	AEPC,Promoters, Banking Finance	Manufacturers, Suppliers, Installers	AEPC, NGOs,Private Sector	AEPC, External Consultants, DEEU, DDC	AEPC, External Consultants
Solar PV - SHS (No.)	449	116	166	168	All VDCs	DEEU, NGOs, Solar Companies	DEEU, NGOs	Solar Companies, DEEU	-	Solar PV Users Tranining	DEEU, NGOs	AEPC, Users	Solar Companies	Solar Companies, Owner	DEEU, DDC	AEPC, External Consultants
Solar PV - Institutional	12	0	6	6	2 in each region**	DEEU, AEPC	DEEU, NGOs	AEPC, DEEU	DEEU, Solar Companies	-	DEEU, NGOs, Private Sector	AEPC, Development Partners, DDC, VDC	-	Solar Companies, Cooperatives, NGOs, CBOs	DEEU, AEPC	External Consultants
Concentrated Solar	50	0	0	50	Jomsom	AEPC, DEEU	DEEU, NGOs	AEPC, DEEU	External Consultant, Solar Companies	Operators/ Managers Training	AEPC, DEEU, Private Sector	International Development Partners, AEPC	Solar Companies	AEPC, DEEU, External Consultants	-	AEPC, External Consultants
Solar Parabolic Cooker (No.)	2062	500	680	882	All VDCs	DEEU, NGOs, Solar Companies	DEEU, NGOs	DEEU, NGOs-SO	Solar Companies	Users Tranings	DEEU, NGOs	Owner, AEPC Subsidy	Solar Companies	Owner	DEEU	DDC, AEPC

Year	Total Target (2011-2013)	2011	2012	2013	Location	Awareness Building	Community Mobilisation	Demand & Information Collection	Designing of Project	Capacity Building	Resource Assessment	Financing Sources	Service Provider	Implementation	Monitoring	Evaluation
Solar Dryer (No.)	305	80	100	125	All VDCs	DEEU, NGOs, Solar Companies	DEEU, NGOs	DEEU, NGOs-SO	-	Users Tranings	DEEU, NGOs	Owner, AEPC Subsidy	Solar Companies	Owner	DEEU	DDC, AEPC
Improved Cooking Stove (No.)	649	196	226	228	All VDCs	DEEU, NGOs	DEEU, NGOs	ICS promoters	DEEU, NGOs	ICS Promoters Tainings	DEEU, NGOs	Owner, AEPC Subsidy	-	Owner	DEEU	DEEU, AEPC
Improved Water Mill (No.)	68	22	23	23	All VDCs	DEEU, NGOs	DEEU, NGOs	IWM Promoters (CRT/N)	CRT/N	Users Training	DEEU, NGOs	Owner, AEPC Subsidy	Manufacturers, Suppliers, Installers	Owner	DEEU	DEEU, AEPC
Biogas (Capacity 4m3) (No.)	25	7	8	10	Central and Southern Region	DEEU, NGOs, Biogas Companies	DEEU, Biogas Companies	Biogas Companies	Biogas Companies	Biogas users Traninigs	DEEU, NGOs	Owner, AEPC Subsidy	Biogas Companies	Owner	BSP Nepal	External Consultants
Wind (kW)	40	0	0	40	Kagbeni and Muktinath	AEPC	DEEU, NGOs	-	External Consultant	External Consultants	AEPC, External Consultant	International Development Partners, AEPC	Private Utilities	AEPC, DEEU	AEPC, DEEU	External Consultants

^ Number in parentheses represents the number of micro hydro scheme

**The location proposed for the Institutional Solar PV is yet to be identified. Feasibility study needs to be carried out.

Table 48: Three Year Activity Plan

Activity	Unit	Year			Responsible agency
		2011	2012	2013	
1. Understanding is enhanced about; energy sources and available options that are important to meet the energy demand; challenges in managing securing energy security; and the key management functions for promoting gender and social inclusive energy development path.					
Activity 1.1: Meeting of boundary partners to identify target population, groups, and energy users, pressure on resources, key points for intervention.	Times	1	-	-	DEEU
Activity 1.2: Generate information about stream discharge, forest and grassland condition, and areas with energy shortage within each region.	Times	1	-	-	DEEU, AEPC
Activity 1.3: Support formulation of cooperatives and drafting of bylaws as needed for energy development activities.	Times	1	1	1	DEEU, NGOs
Activity 1.4: Support meetings to enhance gender and social inclusive management functions to maximize energy security.	Times	1	1	1	AEPC, ACAP, NGOs
2. Human capacity developed to implement the CC adaptive renewable energy plan.					
Activity 2.1: Conduct training on need assessment for energy, skill development, institutional building, gender and social inclusion.	Times	2	2	-	DEEU
Activity 2.2: Conduct orientation training on DCEP objectives, activities, procedures and outcome mapping for boundary partners.	Times	1	-	-	DEEU
Activity 2.3: Conduct training on climate impacts, anticipated energy scenario, and potential areas for promoting RETs for energy security and economic development including pumping of water for irrigation for boundary partners.	Times	1	-	-	ACAP, NGOs
Activity 2.4: Conduct shared learning sessions to exchange experiences and expectation with community members.	Times	1	1	1	NGOs, CBOs
Activity 2.5: Help formulate procedure for local resource mobilization	Times	1	-	-	DEEU, NGOs
Activity 2.6: Conduct exposure visits for community members.	Times	-	2	2	DEEU
Activity 2.7: Conduct school programs on Mustang specific energy and climate issues.	Times	1	1	1	ACAP, AEPC
3. Development of renewable energy technologies and mainstreaming CC and GSI issues.					
Activity 3.1: Establish micro hydro plants	kW	-	25	20	DEEU, AEPC-ESAP
Activity 3.2: Help establish solar PV SHS	No.	116	166	168	DEEU, AEPC
Activity 3.3: Support building Solar PV Institutional	No.	-	6	6	DEEU, AEPC
Activity 3.4: Help establish piloting of Institutional Concentrated Solar system	No.	-	-	50	DEEU, AEPC
Activity 3.5: Establish solar parabolic cooker	No.	500	680	882	DEEU, AEPC
Activity 3.6: Support households and institutions for establishing solar drier	No.	80	100	125	DEEU
Activity 3.7: Support ICS installation in remaining households that lack such devices	No.	196	226	228	DEEU, ACAP
Activity 3.8: Support biogas installation (4m^3 capacity)	No.	7	8	10	DEEU, AEPC
Activity 3.9: Support developing wind energy	kW	-	-	40	AEPC

Activity	Unit	Year			Responsible agency
		2011	2012	2013	
4. Continue to explore possibilities of developing degraded land for horticulture and vegetable farming by pumping or bringing water that uses renewable energy for improving income basket in northern Mustang	There is no target set for this activity, but needs to be carried out to benefit from comparative advantage of the area.				DEEU

The plan after getting endorsed by the DCEP task force will be executed by the DDC Mustang with the necessary cooperation with boundary partners. The implementation plan is focused for the first three years so for the subsequent years until 2020, is explained in the intervention plan with the comprehensive details of technology types (Table 47).

5.2.1. Micro hydropower development

Only a few settlements are being electrified by micro-hydropower plants in the district with Southern and Central Mustang being electrified by national grid. Micro hydropower plants have been proposed based on cluster settlements and available nearest resources. This proposition has been made on preliminary assessment of topography, hydrological study and preliminary geological study of each proposed project sites based on the available topographical maps.

Ten promising micro hydropower sites with various capacities have been proposed in various Northern settlements. However, it is strongly recommended to re-verify proposed capacities after the field visit. Settlements have been prioritized on the basis which is yet to be electrified with an anticipation that national grid expansion would take at least five years to reach and next to the electrified settlement by existing micro hydropower projects.

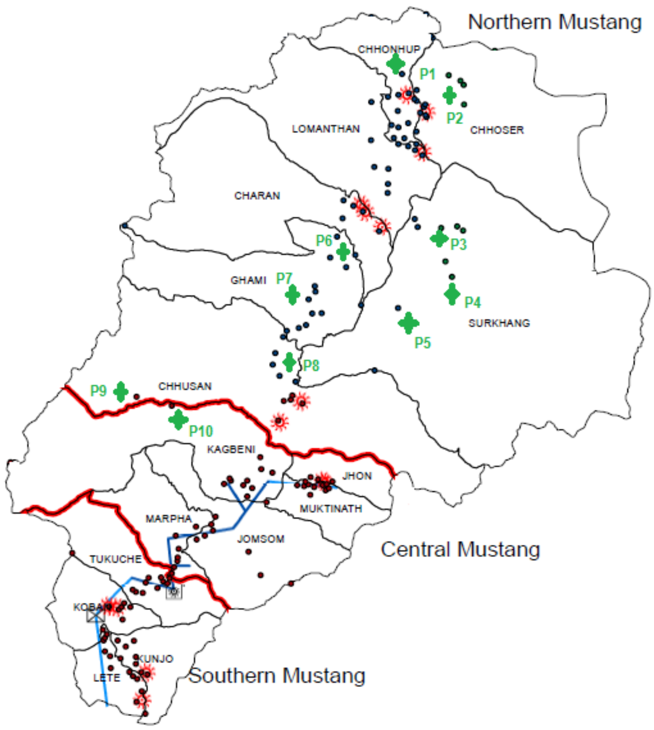


Figure 21: Proposed Micro hydro power project

Two years of project period has been allocated for implementing each micro hydropower project. Pre-development activities such as, detailed feasibility study, resource mobilization, contract and tendering and field mobilization will take about one year. And the construction, supervision and monitoring and testing and commissioning will take another one year.

Table 49: Promising micro hydropower projects in Mustang

S.N.	Micro Hydro project	Source	VDC	Capacity (kW)	Beneficiary Settlement
1	P1	Hyunjun Khola	Chhonhup	15	Bharma, Chumjun, Yachebu, Garphu, Ghom, Dhuk
2	P2	Samjon Khola	Chhoser	10	Samjon
3	P3	Puyun Khola	Surkhan	10	Surkhan, Yaragau, Gharagau, Khete
4	P4	Dhechyan Khola	Surkhan	10	Dhegau, Phanyakawa
5	P5	Tange Khola	Surkhan	10	Tange
6	P6	Ghami Khola	Ghami	15	Dhakmar, Ghami, Akiama
7	P7	Tama Khola	Ghami	10	Tamagau, Ghilin, Sanboche
8	P8	Samarkyun Khola	Chhusan	20	Samar, Bhena, Kyuten, Chaile, Ghyakar, Kyuten Chaile, Ghyakar
9	P9	Ghaldan Ghuldun Khola	Chhusan	10	Ghok
10	P10	Dhundok Khola	Kagbeni	10	Santa

The proposed micro hydropower project (PM1) in Chhonhup VDC will also address the Decision No: 42 (Gha) of the District Council Meeting (067/68).

Constraints

In context of 58 % of the households being electrified by National Grid and possibility of immediate expansion of grid to the Northern Mustang, it is not a wise to plan micro hydro and drag the development. It is essentially required to supply electricity facilities at earliest bearing in mind the resource crunch of the Northern Mustang. Most importantly, it is the responsibility of the ‘State’ to deliver the electricity service to the Mustangi. Further, Table 45 shows that Micro hydro as less priority technology based on climate, gender, social inclusion and other criteria. Moreover, 120 kW of total energy by proposed micro hydro projects is not sufficient to meet the MAS energy demand in 2020. Taking into consideration above facts, the combination of Mini and Micro hydro Projects have been prioritized for detail implementation with the time frame of maximum 5 years which is further elaborated in the subsequent headings.

5.2.2. Mini hydro with four Micro hydro projects

Tunu Khola, Charang Khola, Ghami Khola and Ghilunpa Khola are the key rivers spotted for mini hydropower project development. Among the above mentioned projects, one or two mini hydropower project would be a sufficient priority looking into the available load centers and its proximity. Further, it would be cost effective to go for the development of one or two mini hydropower projects for supplying affordable and reliable electricity supply to remaining 42 % households.

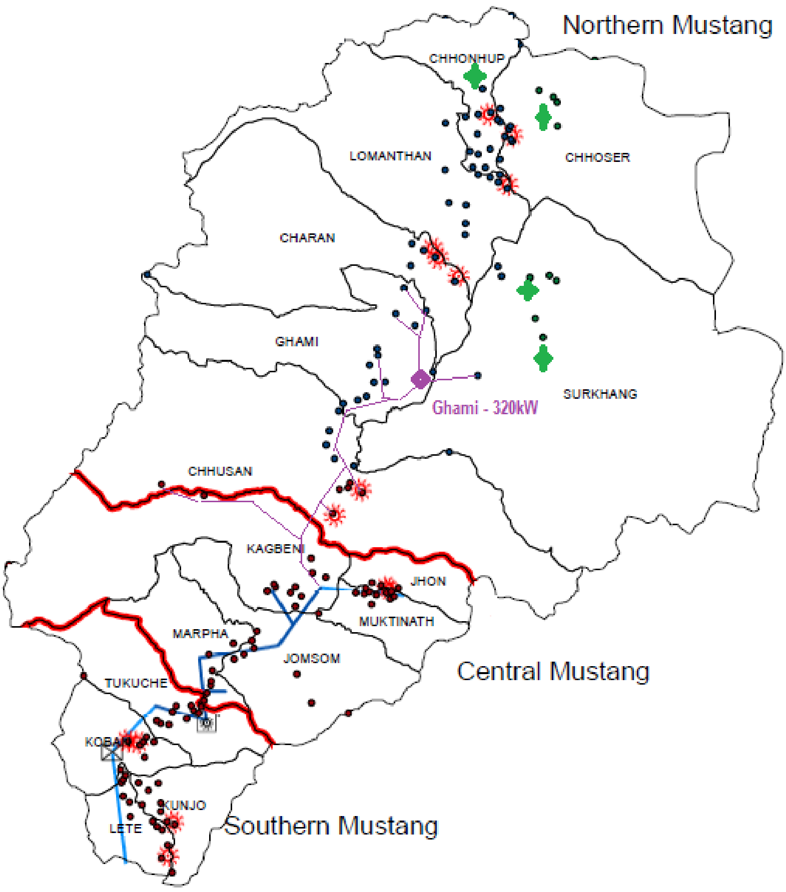


Figure 22: View of proposed Mini Hydro with 4 Micro hydropower project

The proposed plan prioritizes a 'Ghami Mini Hydropower Project (GMHP)' in line with 4 micro hydropower projects development in the district.

It is to be noted that technology prioritization matrix shows high priority for Mini/small/big hydro with total score of 90 based on climate, gender, social inclusion and other criteria.

Domestic lighting is not only their requirement but also for space heating (due to the cold climatic condition), commercial, industrial and other productive uses are their ultimate requirement. Charang VDC of the Northern Mustang is evidence for need of additional energy besides domestic lighting. A 100 percent household is being lightened up by Solar Home PV system. Despites lighting, the people from this VDC are looking for reliable and sustainable electricity at affordable costs.

DDC in collaboration with ACAP has already conducted Feasibility Study on Ghami Khola for mini hydropower development. The installed capacity of the project is 320 kW. 'District Council' held on 067/68 has made decision (Decision No.: 42, Nha) for extending grid up to Ghami at earliest by seeking financial and technical support from the external sources. This decision indicates that sooner or later the grid would be extended to Northern Mustang. This activity would create two major set back. Firstly, micro hydropower 'Users' would switch to the grid for quality and reliable electricity. Consequently, all the projects would dysfunction and share the same fate as of micro hydropower plants of Southern Mustang. Secondly, technical and financial investment made on proposed P5 to P10 micro hydropower projects would go in vain.

Box 1: Ghami Mini Hydropower Project at a glance

Ghami Mini Hydropower Project is a run-off-the-river type with installed capacity 320 kW producing annual energy of 2.58 GWh. The design discharge is about 330 lps and gross head is of 127.24 m. The project will utilize existing irrigation canal which will be upgraded for accommodating total water of 580 lps for irrigation and energy generation. The detailed engineering design of the project has been prepared by North Engineering Company (P) Limited in association with Sanima Hydro and Engineering (P) Limited.

The Project will serve 978 households of Ghami, Charan, Surkhan, Lomanthan, Chhoser and Chhunup VDCs. The total project cost is about NPR 291 Million and cost per kW of about NPR 911,111. The resulting financial indicators are FIRR of 10.29 %, NPV of NPR 1.0 Million, B/C ratio of 1.04, loan repayment period of 10 years and energy tariff of about NPR 10/kWh. A construction period of about two years has been anticipated.

The capital cost was reasonably high due to specific site conditions, expensive local workforce & materials, long transmission & distribution lines. Now, with road access, there is a room for cost reduction. Further, it could be connected with existing national grid which would increase load factor. Existing installed capacity would not be sufficient to meet growing energy demand from domestic, commercial and industrial sectors in the project area. Hence, it is strongly recommended to upgrade the project's capacity.

This particular project has been suggested as "Feasibility Study" is complete which would greatly reduce pre-development activities. However, the feasibility studies need to be re-visited as the project cost is too high. One of the key reasons for higher costs is due to transportation, transmission and distribution line costs, which now is reduced by the road access. The GMHP would suitably fit into first 3 year plan.

The GMHP prioritization has been made on the following considerations;

- Serves immediate need of Northern Mustang
- Provides reliable, sustainable and affordable source of energy
- The project is ready for construction however, it requires up gradation and revised study
- Construction of Mini Hydropower Project would require shorter gestation period
- In-country expertise and resources are readily available
- Transmission and distribution lines of about 62 km (estimated) would cover households of Kagbeni, Chhusang, Ghami VDCs and few settlements of Surkhang VDC.

Development of GMHP would ensure energy security, provide energy for water and irrigation, secure health and in addition take low carbon path to preserve environment .

Table 50: Implementation plan for micro hydropower projects

S.N.	Micro hydro	First 3 Year Plan		
		2011	2012	2013
1	Ghami Mini Hydropower Project			
	Revision and Upgradation Study			
	Resource Mobilization			
	Contract and tendering			
	Mobilization			
	Construction & Supervision			
	Commissioning & testing			
2	Micro Hydropower, P1	P1		
3	Micro Hydropower, P2	P2		
4	Micro Hydropower, P3		P3	
5	Micro Hydropower, P4		P4	

Since grid expansion to remote VDCs would be costly, four micro hydropower projects (P1 to P4) have been proposed for Chhonhup, Chhoser and Surkhang VDCs to electrify unserved settlements (Figure 22 and Table 50) .

Although micro hydropower projects have been proposed for meeting short term energy demand, the settlements from these VDCs would tend to go for reliable and sustainable energy source by the time grid extends up to Ghami. Hence, a different approach as described in **“Recommended Project for Rural Electrification”** has been proposed in order to provide affordable, reliable and sustainable electricity to those settlements.

5.2.3. Other RETs

In addition to hydropower projects, other RETs have been proposed in two different phases, one with first 3 years plan and another with vision 2020. In first 3 years plan, Solar PV home system of 449 units has been proposed in all VDCs. Similarly, solar parabolic cooker (2062 units), Solar Dryer (305 units) and ICS (649 units) in all VDCs have been proposed.

Two solar systems (institutional) in each region, concentrated solar in Jomsom, bio-gas plants (25 units) in central and southern regions and pilot windpower plants in Kagbeni and Muktinath VDCs (subject to wind study) has been proposed.

Please refer to Table 46, Table 47 and Table 48 for details on RETs intervention plan, target, and implementation and activity plan.

5.3. Energy for Water (Dire need for additional energy demand)

Agriculture and other livelihoods too depend on energy. CC impacts on water, energy scarcity and implications on life and livelihood in Mustang shows how **“energy from water”** situation is changing to **“energy for water”** The situation of Thangjung and Chabule is one such case exhibiting the requiremenet of additional energy for agriculture purpose.

Thangjung and Chabule are the only nearby areas from “Dhe” Village which can be farmed but requires irrigation. The area is situated near the confluence of Dhe River and Kali Gandaki but require irrigation and energy to make it inhabitable. More than 2000 *Ropanis*[5] (around 100 hectares) of land in these two areas can be developed for farming. The settlement from “Dhe” can be resettled in Thangjung and Chabule.

It was known through the key-informant interview that there are two options for making irrigation water available:

i. open channel flow by constructing an intake along Dhe river, or
ii. using a pumped irrigation system

The gravity fed irrigation requires 2200 meters (16 mm diameter) high density polyethylene pipe, as the conveyance has to pass through an extremely unstable slope.

The second option is to construct a pumped irrigation system that pumps water first to a height of 50 meters and then to 58 meters (two different levels). Figure 23 shows layout of the proposed systems.

[5] 101. 75 hectare. 1 hectare = 19.65 Ropanis of land

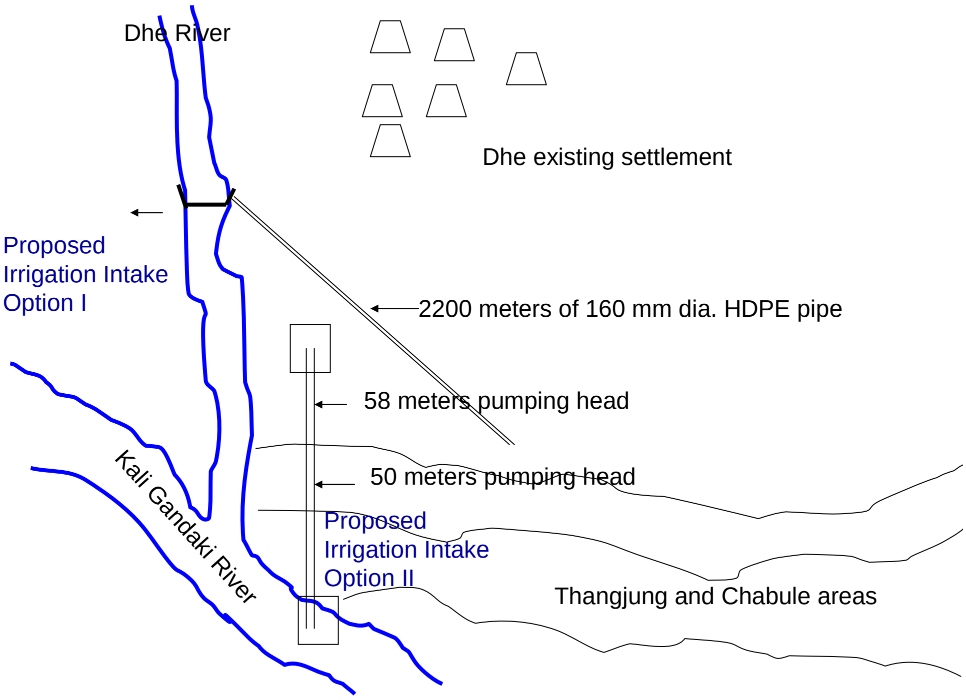


Figure 23: Schematic drawing of irrigation potential in Thangjung and Chabule areas

A preliminary estimate of cost shows that building the irrigation system costs NRS 5 Million. Local communities are ready to contribute labour and local materials required for the construction of irrigation system. The emerging situation reveal that the need of "Energy for Water" is becoming crucial for communities in drier areas of Mustang.

5.4. Financing Plan

A mechanism for channeling fund/grant, management of fund, resource mobilization and investment on RETs is further elaborated in subsequent sections. Financing plan include cost for capacity building, technology dissemination, implementation and monitoring of the proposed programmes and plans in the district.

5.4.1. District Energy Fund (DEF)

A district energy fund (DEF) shall be established at DDC. This mechanism would help in channeling fund/grant from various sources to DEF. A management committee shall be formed to look after the DEF. The potential soruces for DEF is shown in Figure 24.

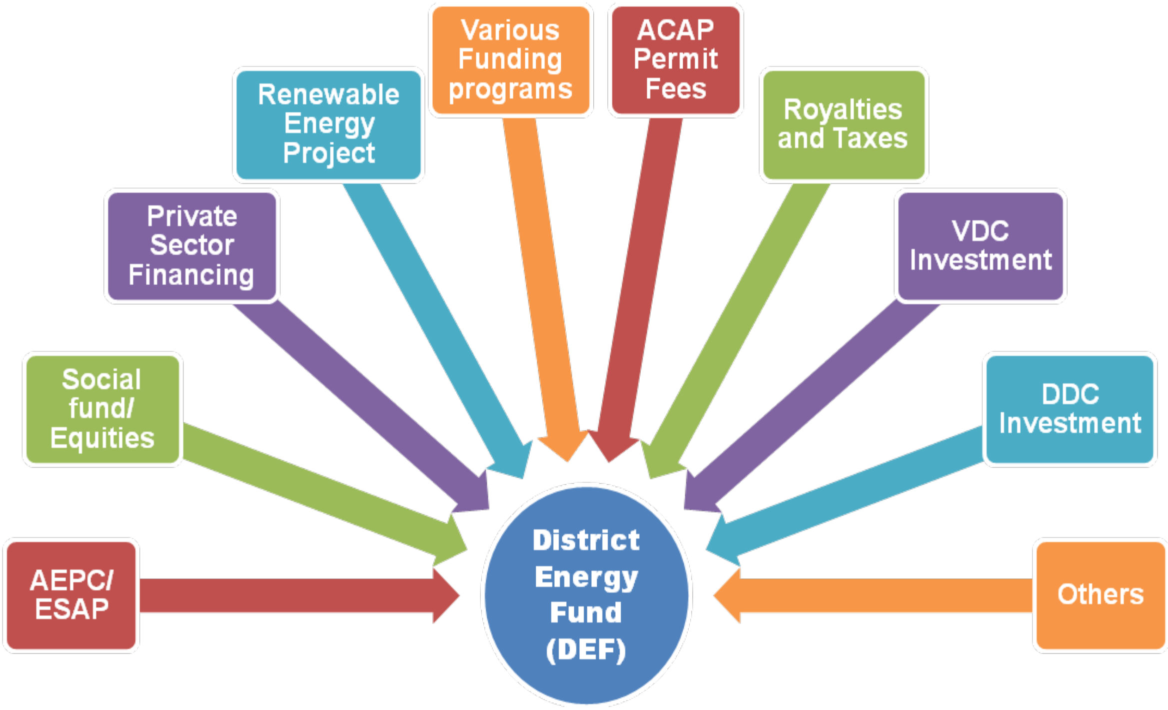


Figure 24: Channeling of funds from various sources

5.4.2. Unit cost of RETs

Unit cost for each RETs has been adopted based on the prevailing market price and trends. About 20 % of unit cost has been added up for the preparation, awareness building, campaigns, technology dissemination, logstics support to VDC/DDC and data base etc (Table 51).

Table 51: Unit Cost of RETs

Technologies	Unit	Unit Cost of the technology	Capacity Building Cost per Unit of System	Total Unit Cost of the System
		NPR	NPR	NPR
Micro Hydropower (kW)	NPR/kW	425,000	85,000	510,000
Mini Hydropower (kW)	NPR/kW	200,000	40,000	240,000
Solar PV - SHS (No.)	NPR/ System	22,000	4,400	26,400
Solar PV - Institutional	NPR/ System	1,400,000	280,000	1,680,000
Concentrated Solar	NPR/kW	1,200,000	240,000	1,440,000
Solar Parabolic Cooker (No.)	NPR/ System	12,000	2,400	14,400
Solar Dryer (No.)	NPR/ System	25,000	5,000	30,000
Improved Cooking Stove (No.)	NPR/ System	15,000	3,000	18,000
Improved Water Mills (No)	NPR/ System	150,000	30.000	180,000
Biogas (Capacity 4m3) (No.)	NPR/ System	50,000	10,000	60,000
Wind (kW)	NPR/kW	350,000	70,000	420,000

5.4.3. Total Investment cost of RETs

The implementation plan is proposed to start from mid 2011, so adequate funding and grants plus national and international technical assistance from various development partners is crucial. The proposed RETs are needed to strategically implement in coordination with various boundary partners with their technical and financial assistance wherever required. Financial cost estimation includes the RET system cost, capacity building and other additional cost that would arise until the project completion. The estimated cost for the implementation of the proposed intervention is NRS 3,414,492,380 until 2020. While most the pilot project would commence during the first three years, NRS 515,920,041 is estimated for this period. Additional funds will be required for preparatory works including awareness building, campaigns, information and gap assessment for each technology types, installation of data stations and for further research work. About 20% of the technology cost has been estimated for such activities.

Table 52: Total Investment Cost for RETs Plan Implementation (in NPR)

Technologies	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Investment Cost (NPR)
Micro Hydropower (kW)	-	13,291,059	10,645,833	10,659,208	5,336,492	8,015,380	5,350,894	10,716,842	-	-	64,015,708
Mini Hydropower (kW)	-	-	212,916,652	-	-	-	-	-	-	1,917,373,459	2,130,290,112
Solar PV - SHS (No.)	3,183,348	4,557,294	4,623,267	1,292,835	1,332,047	1,372,499	1,414,233	1,457,292	1,501,723	1,547,573	22,282,112
Solar PV - Institutional	-	10,507,755	10,520,588	10,533,805	5,273,710	5,280,721	5,287,943	5,295,381	5,303,042	5,310,934	63,313,877
Concentrated Solar	-	-	75,147,054	75,241,465	75,338,709	-	302,168,147	-	-	455,222,875	983,118,250
Solar Parabolic Cooker (No.)	7,496,640	10,207,533	13,255,940	993,187	1,024,606	1,056,144	1,087,805	1,119,595	1,151,518	1,183,579	38,576,549
Solar Dryer (No.)	2,498,880	3,127,308	3,913,909	-	-	-	-	-	-	-	9,540,097
Improved Cooking Stove (No.)	3,669,793	4,233,077	4,279,433	2,634,311	1,551,357	1,598,468	1,647,073	1,697,223	1,748,969	1,802,367	24,862,071
Improved Water Mill (No.)	4,123,152	4,315,685	4,320,956	-	-	-	-	-	-	-	12,759,793
Biogas (Capacity 4m3) (No.)	437,304	500,369	626,225	438,909	439,476	314,329	314,758	315,201	315,657	316,127	4,018,356
Wind (kW)	-	-	17,534,313	-	-	-	17,626,475	-	-	26,554,668	61,715,455
Sub Total	21,409,117	50,740,081	357,784,170	101,793,721	90,296,397	17,637,541	334,897,329	20,601,534	10,020,909	2,409,311,582	3,414,492,380

Total Cost of Technology (2011-2013)	**429,933,367**
Non technology cost (20% of technology cost)	**85,986,673**
Total Cost	**515,920,041**

Table 52 shows how DDC need to mobilize the budget for RET promotion in line with detailed implementation plan. Further, it would help to explore other possibilities for intermediary fund/grant and investment (such as, MFIs, Cooperatives, Finance Company etc) to fulfill fund gaps, if any. Hence, it has a greater implication both on resources and adaptation process.

5.4.4. Key Actors for financing (Resource Mobilization)

AEPC is the key actor which would play a crucial role in technology promotion by helping in financing the RETs. Besides, DDC and VDC would play important role for financing. DDC would be play catalytic role in mobilizing tourism royalty and other benefits for fund raising. Similarly, DDC and VDC would play vital role in community mobilization and private participation. This would help in developing projects based on Public - Private Partnership (PPP) model. Further, financial institutions shall be brought in for debt financing. ACAP and other district level line agencies could be helpful in raising the funds.

DDC with support of AEPC could mobilize CDM benefit as additional support however; it is a lengthy and tedious process for qualifying.Deficit funds as shown in Table 53 is expected to be injected by International developmental/donor agencies such as SNV, REP for the successful implementation of the RETs.

Table 53: Key Actors for financing

Technologies	Unit	AEPC Subsidy Contribution	DDC	VDC	Tourism Royalty	Bank Financing	Private Participation	Community Contribution (cash/Kind)	Other sources (deficit)
		%	%	%	%	%	%	%	%
Micro Hydropower (kW)	NPR/kW	40%	5%	5%	5%	10%	5%	10%	20%
Mini Hydropower (kW)	NPR/kW	10%	1%	1%	1%	30%	10%	5%	42%
Solar PV - SHS (No.)	NPR/ System	40%	5%	5%	5%	-	-	10%	35%
Solar PV - Institutional	NPR/ System	75%	1%	1%	1%	-	10%	-	12%
Concentrated Solar	NPR/kW	40%	1%	1%	1%	-	10%	-	47%
Solar Parabolic Cooker (No.)	NPR/ System	50%	5%	5%	5%	-	-	-	35%
Solar Dryer (No.)	NPR/ System	50%	5%	5%	5%	-	-	10%	25%
Improved Cooking Stove (No.)	NPR/ System	25%	5%	5%	5%	-	-	10%	50%
Improved Water Mill (No.)	NPR/System	25%	5%	5%	5%	-	-	10%	50%
Biogas (Capacity 4m3) (No.)	NPR/ System	30%	5%	5%	5%	-	-	10%	45%
Wind (kW)	NPR/kW	50%	1%	1%	1%	-	10%	-	37%

5.4.5. Other Actors for Financing

Apart from the financial resources described in the earlier sections, following sources of finances has to be explored and tried in Mustang within 2011-2013. .

- Grant support from “Renewable Energy Project (REP)”, a project co-funded by the European Union and the Government of Nepal
- Royalities from the hydropower plants – few projects are under study and will come into construction in next 4-5 years.

- Ring fence a portion of ACAP permit fees for district renewable energy fund.
- The DCEP task force estimated that there was a loss of forty million rupees of revenue in 2010 as there was no custom post in the Nepal-China border. The construction of the road linking Pokhara and Jomsom and the Chinese border has increased the flow of goods.
- Harness social fund for equities. Social fund almost in every VDC. Migrant workers from USA, Canada, Japan, and many countries in Europe contribute to the social fund.
- Scaling Up Renewable Energy Programme (SREP)
- Mobilise resources from existing savings and credit groups. As of 2004, twenty savings and credits in northern Mustang alone had a saving of NRS 2,2774,880 saving and to date, Rs. 2,274,880 has been generated (GEF, 2004).

5.5. Possible Linkages to Various Programs for Funds

5.5.1. Linkage with NAPA, LAPA, CIF and Other Programs

The Government of Nepal is currently undertaking a number of iniatiatives around climate change, energy and knowledge base. The following section describes linkages with some of these initiatives and identifies any collaboration for Mustang District.

According to National Adaptation Program of Action (NAPA) vulnerability assessment, Mustang district falls in the Moderate[6] (0.269-0.428) range. NAPA process has identified nine priority areas and all prirotiy areas have high relevance to Mustang District. Mustang DDC needs to capitalize on the findings of NAPA to draw additional resource for implementing activies identified.

Local Adaptation Plan of Action (LAPA) report though in a draft stage, mentions the support program will provide support to local institutions and vulnerable communities to benefit from access to clean energy technology and practices (solar/wind energy, biogas, improved cooking stove, bio briquette, small microhydro). The program has a very high relevance to Mustang. However the current program is intended to help the communites in two critical watershed areas of the Karnali and Rapti River Basins of the Mid and Far Western Nepal. The draft LAPA report also considers co-benefits of energy and adaptation and it has potential to offer opportunities in switching from high to more low carbon and climate resilient development options.

5.5.2. Linkage with Climate Investment Fund Supported Programs

Nepal has been identfied for Pilot Program on Climate Resilience (PPCR) and the Scaling up Renewable Energy Program (SREP) through the Climate Investment Fund. The Government of Nepal is in the last stage of preparing Strategic Program on Climate Resilience. The November 15-21, 2010 mission report identifies five components to be

[6] Other categories are Very High (0.000-0.068), High (0.069-0.268), Low (0.429-0.647) and Very Low (0.648-1).

considered. The total amount of financing available for Nepal is USD 50 Million in grants and USD 60 Million in credit. CEPAD team considers that the five components identified for the PPCR program has the following relevance to the DCEP preparation process. The exact investment projects are yet to be identified and thus the PPCR interventions in Mustang district are not known.

Table 54: PPCR components and their relevance to Mustang DCEP

PPCR Component	Component Focus areas	How can Mustang DCEP benefit from PPCR investments?
Component I: Building Climate Resilience of Watersheds and Water Resources in Mountain Eco-Regions	Activities in component I will focus on implementing existing watershed management plans (WMP), preparing and implementing new WMPs for water resources protection, addressing ways to improve the reliability and availability of the water supply, promoting livelihood improvement activities, and biodiversity conservation. Watersheds from	Mustang district could benefit from investments on water resource protection – and thus increased water availability and reliability for hydro-power systems, irrigation and drinking water.
Component II: Building Resilience to Climate-Related Extreme Events	Activities in component II will focus on the installation of real-time hydro-meteorological infrastructure, and information nationwide, the establishment of early warning systems for priority vulnerable communities, and the creation of climate risk insurance / finance programs for vulnerable communities, home owners and women.	New and real time hydromet systems in Mustang District will help in getting accurate information for designing energy systems, early warning and in insurance program.
Component III: Mainstreaming Climate Risk Management in Development	This component will facilitate the integration of CC risk management into development planning by preparing climate risk management guidelines and procedures, and implementing a comprehensive program of capacity building for CC risk management at the national, sectoral, district and local levels, targeting both the public sector and civil society	Vulnerability and capacity analysis along with adaptation planning support to Mustang DDC and VDCs.
Component IV: Building Climate Resilient Communities through Private Sector Participation	This component will improve access to climate resilient technologies and reduce market barriers that prevent the private sector from playing a key role in building climate resilient communities. Activities will focus on investments in climate resilient technologies to support food security, manage disaster risk and promote infrastructure climate proofing, as well as building capacity and enhancing access to finance to build more climate resilient communities	Possible opportunity to make hydropower investments in Mustang District climate resilient.
Component V:	Ensure the sustainability and resilience of certain endangered species in the context of climate change	Very little direct linkages with DCEP.

5.5.3. Linkage with the WB-WECS initiative on GIS Knowledge Base

WECS with the support of the World Bank is preparing a national GIS knowledge base for all water (hydropower, irrigation, water supply) related projects in Nepal. The framework for this work has been completed and preliminary results shared with key stakeholders. Work continues to incorporate detailed data into the GIS based knowledge base. Annual energy planning for Mustang can benefit from this knowledge base.

5.6. Monitoring and Evaluation Plan

The proposed DCEP requires people to reduce pressure on biomass energy and become proactive in supporting RET development and use. To this end, the plan proposes to bring about changes in the behavior of communities including their dependency on forest and grassland resource for energy; the development agencies which provide support to improve livelihoods; professionals who seek better understanding of the CC impact in Mustang; the market institutions which use opportunity for making profit without considering energy sustainability; and the government which play a key role in generating new knowledge about sustainable energy development. The proposed plan includes ‘hard’ activities (for example, building 45 micro hydro systems, implementing 649 ICSs, or installing 2062 solar cookers) as well as ‘soft’ activities (such as building awareness, improving coordination, developing skills and social and gender inclusion). Through these activities the DCEP hopes to bring about long term macro-level changes in energy sector. The conventional technique of monitoring and evaluating (as suggested in table 55) generates feedback on the physical progress of implementation and its impact on energy development, but not necessarily on how changes are taking place, without which long term energy sustainability will not be possible.

Outcome mapping (OM), in contrast, focuses on measuring changes in the behavior of the people and organizations with whom DCEP works most closely by focusing on those results – or “outcomes” – that fall strictly within the DCEP’s sphere of influence. The OM helps monitor outcomes and change in behavior of key actors at local and district level, which is essential to assess contribution made by the DCEP in achieving the desired goals, and continue to make necessary adjustments as and when deemed necessary to correct the actions. Details about OM concept and procedures can be found in Sarah, et. al., (2001). It is suggested that physical progress of the implementation be monitored using indicators as given in the monitoring framework (Table 55), while the process and desired behavioral changes be monitored using OM (Table 56 - Table 73).

Table 55: Monitoring Framework

Outputs/Activities	Physical intervention to be monitored as per the implementation schedule
Output 1: Understanding is enhanced about; energy sources and available options that are important to meet the energy demand; challenges in managing securing energy security; and the key management functions for promoting gender and social inclusive energy development path.	
Activity 1.1: Meeting of boundary partners to identify target population, groups, and energy users, pressure on resources, key points for intervention	One meeting held in the year I with boundary partners
Activity 1.2: Generate information about stream discharge, forest and grassland condition, and areas with energy shortage within each region.	Required surveys done in the year I to generate required information
Activity 1.3: Support formulation of cooperatives and drafting of bylaws as needed for energy development activities.	Community mobilized for each energy development activity prior to implementation in all years.
Activity 1.4: Support meetings to enhance gender and social inclusive management functions to maximize energy security.	Meetings held for gender and social inclusive management for each energy development activity prior to implementation in all years.
Output 2: Human capacity developed to implement the CC adaptive renewable energy plan.	
Activity 2.1: Conduct training on need assessment for energy, skill development, institutional building, gender and social inclusion.	2 trainings are held each in the year I and II for boundary partner officials.
Activity 2.2: Conduct orientation training on DCEP objectives, activities, procedures and outcome mapping for boundary partners.	One orientation meeting held in the year I
Activity 2.3: Conduct training on climate impacts, anticipated energy scenario, and potential areas for	A week-long training organized in the year I

Outputs/Activities	Physical intervention to be monitored as per the implementation schedule
promoting RETs for energy security and economic development including pumping of water for irrigation for boundary partners.	
Activity 2.4: Conduct shared learning sessions to exchange experiences and expectation with community members.	One shared learning session held each year upon completion of implementation
Activity 2.5: Help formulate procedure for local resource mobilization	Procedures are prepared in the year I.
Activity 2.6 : Conduct exposure visits for community members	2 exposure visits in year II and two in year III organized
Activity 2.7: Conduct school programmes	One school programme for a week held once every year for three years.
Output 3: Development of renewable energy technologies and mainstreaming CC and GSI issues	
Activity 3.1: Establish micro hydro plants	25 and 20 kW produced through micro hydro in the year II and year III respectively
Activity 3.2: Help establish solar PV SHS	116, 166, and 168 PV SHSs will be established in three consecutive years
Activity 3.3: Support building Solar PV Institutional	12 solar PV as institutional system will be established, 6 each in year II and year III
Activity 3.4: Help establish piloting of Institutional Concentrated Solar system	50 concentrated solar system will be established in the year III
Activity 3.5: Establish solar parabolic cooker	500, 680, and 882 solar parabolic cookers will be installed in the years I, II , and III respectively.
Activity 3.6: Support households and institutions for establishing solar drier	80, 100, and 125 solar drier will be used in households and institutions in the year I, II, and III respectively.
Activity 3.7: Support ICS installation in remaining households that lack such devices	196, 226, and 228 ICS will be installed in the year I, II, and III respectively.
Activity 3.8: Support biogas installation (4m^3 capacity)	Total of 25 biogas will be installed
Activity 3.9: Support developing wind energy	40 kW energy will be produced using wind energy in the year III
Output 4: Continue to explore possibilities of developing degraded land for horticulture and vegetable farming by pumping or bringing water that uses renewable energy for improving income basket in northern Mustang.	
This activity will continue as other energy activities are being implemented	-

The following narrative briefly describes OM procedures and provides detailed account of the steps involved. OM has three stages as following:

Stage I: At the outset, OM attempts to answer following four questions:

- What is the vision to which the plan intends to contribute?
- Who are the boundary partners that the plan works with?
- What are the changes that are being sought? and
- How will the plan contribute to the change process?

Outcome challenges: The answers to these four questions describe what each boundary partner can contribute to the vision and what behavioral changes are sought for that. For instance, for a sustainable energy environment, in addition to the local communities shifting from unsustainable biomass based energy to sustainable RET; DDC or other organizations will need to relate energy development with their regular development activities. Hence, there will be different outcome challenge statement for each boundary partner at local, district, and strategic partners' level. They will be referred to as outcome challenges 1, 2, and 3 respectively.

Progress Marker: Progress markers are set to represent desired change for each boundary partner. They mark progress from the minimum changes the plan expects to see (ones that are very easy to achieve) to ones the plan would like to see (active learning) and then to the ones would be achieve in the long term (transformative changes). The progress markers developed for boundary partners at the local, district, are strategic levels are presented in Table 56 - Table 58.

Strategic map: This map identifies the strategies the DCEP will adopt to meet each outcome statement. The map shows specific strategy supporting a particular challenge statement (Table 59).

Stage II: Outcome and performance monitoring

A framework for monitoring the plan of activities by using the progress markers identified in the stage I has been developed to clarify directions with boundary partners and to monitor outcomes (Table 60). Outcomes monitoring for each boundary partner is given in Table 61 to Table 71. Strategy monitoring will be done to evaluate strategy adopted (Table 72).

Stage III: Evaluation planning

An evaluation plan helps DCEP set priorities so that it can channel resources and activities where they will be most useful. An evaluation plan indicating the main elements to be evaluated have been developed (Table 73).

5.6.1. DCEP Outcome Mapping

Based on the above framework the vision, mission, and outcome challenges and progress markers for boundary partners have been developed for DCEP Mustang as following.

Vision: The DCEP envisions that communities and organization in Mustang will have a better understanding of sustainable energy development, and will change their attitudes and behaviors towards a long term energy security in the context of climate change. The DCEP partners will be able to develop a coordinated approach to support energy security through exchanging learning and best practices suited for specific environments.

Mission: The DCEP intends to support communities in undertaking RET development by identifying boundary partners and engage with them so that knowledge about RET and its importance for energy security is shared. The DCEP will identify plan of actions to meet the specific energy needs of the communities and at the same time support climate adaptation through appropriate measures in the long term. The plan will help implement these activities and carry out monitoring and evaluation.

5.6.1.1. Boundary partners

The following are the boundary partners of the DCEP classified by levels.

Local level	:	Local communities, CBOs, VDCs, and local leaders.
District level	:	District Development Committee (DDC), Annapurna Conservation Area Project (ACAP), District Soil Conservation Office (DSCOs), Mustang Development Service Agency (MDSA)
Strategic partners	:	Chief District Office, AEPC, and SNV

Outcome Challenge 1 (local level partners)

The DCEP intends to see local communities recognize the energy issues, implement RETs, provide cash/kind contribution, gain experience in planning and implementing energy related programme in partnership with government and nongovernment organizations. They will be able to contribute more to the decision-making process for energy security and climate adaptation. They will be able to seek external support and expertise to implement RETs. VDCs incorporate the energy activities in their program, provide partial funds, and support communities through meetings. The DCEP expects that local NGOs will incorporate the concept of promoting RETs into their programmes. It also expects that local leaders will emphasize conservation of declining biomass source for its true value.

Outcome Challenge 2 (district level partners)

Organizations such as DDC, ACAP, DSCOs, and MDSA are the district level apparatus which works with communities. The DCEP intends that these agencies and existing service providers to emphasize the importance of DCEP activities. They will incorporate respective activities in their annual program in support of DCEP (for example, conservation works implemented in hydropower plant area). They will contribute to motivate other agencies working in the area to initiate collaborative projects.

Outcome Challenge 3 (strategic partners)

Chief District Office, AEPC, and SNV have been recognized as strategic partners for DCEP implementation. They are instrumental in providing necessary persuasive backup and suggestion wherever required to promote RETs.

Table 56: Progress markers for Outcome Challenge 1

Progress Marker	Local communities	VDCs, CBOs	Local leaders
Expect to see	• Act as focal point for RET. • Acquire new skills in using RE. • Use suitable RETs to meet at least part of energy need. • Are ready to form cooperatives for rural electrification	• VDCs allocate funds to invest in RET activities. • Encourage communities to support RET implementation. • CBOs take part in RET implementation. Activities:1.3, 1.4, 2.3, 2.4, 2.5,	• Attend meetings and share ideas and be open to energy issues. Activities: Cross cutting
Like to See	• Assess gaps and opportunity in RET uses. • Request for training on increasing energy efficiency.	• Disseminate the ideas and insights generated by the project in meetings. • Incorporate energy activities in annual plans • CBOs develop programmes in RET promotion	• Help coordinate DCEP with other development programmes
Love to see	• Advocate the outcomes of the RET outside the village. • Seek information on CC impact on energy sources.	• Playing a key role in planning debate at district level. • CBOs champion in RET implementation	• Advocate the outcomes of the RET at district level

Table 57: Progress markers for Outcome Challenge 2

Progress Marker	DDC	ACAP	AEPC	DSCO	Service providers
Expect to see	• Coordinate timely implementation of DCEP activities as spelled out in Table 47	• Include proposed activities of DCEP in its annual programme.	Provide technical backup for RET implementation.	• Provide technical backup to communities in erosion control	• Provide services to communities where applicable to

Progress Marker	DDC	ACAP	AEPC	DSCO	Service providers
	• Monitor progress of DCEP implementation as per the targets set in the monitoring framework (Table 55)	• Provide technical support to community on different RETs. (Activities: 1.4, 2.3, 2.7, 3.7)	(Activities: 1.2,1.4, 2.7, 3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.9)	measures around hydropower plants areas. (Activities:1.2, 1.4, 2.1)	implement RETs. Activities: Cross cutting
Like to See	• Mobilize financial resource from other sources • Avail necessary technical skill and expertise for innovation •	• Provide feedback to project implementation • Align annul activities in support of DCEP. • Help evaluate effectiveness of DCEP activities.	• Help develop low cost RETs suitable for cold climate.	• Allocate its resources for soil water conservation in hydropower plant sites • Help build synergy between RET and natural resource management.	• Take DCEP as reference to diversify and adjust their services regularly.
Love to see	• Evaluate, update and adjust DCEP to match emerging context	• Incorporate key activities of DCEP in their regular program. • Create database for climate information. • Engage with other line agencies to promote RETs.	• Help conduct pilot programmes to tap wind energy	• Influence policy terrain by incorporating some of the features of the DCEP strategy in biodiversity conservation.	• Champion in suggesting improvement s in RETs applicability for enhanced energy efficiency.

Table 58: Progress markers for Outcome Challenge 3

Progress Marker	CDO	SNV	Donors
Expect to see	• Help in resolving conservation related conflicts. Activities: Cross cutting	• Help find funding sources in the initial years to implement DCEP. (Activities:3.1, 3.2, 3.8, 3.9)	• Provide funds to initiate DCEP implementation. Activities: Cross cutting
Like to See	• Help coordinate support from other agencies not directly related but may have a role in facilitating the project implementation	• Help explore possibility of harnessing wind energy in association with AEPC.	• Help pilot wind mills and gravity ropeways for multiple uses
Love to see	• Lead advocacy of the RET approach in policy debates	• Help explore possibility of diversifying energy programme to include other development priorities	• Support integration of energy programme and other development activities.

Table 47 presented detailed implementation plan and the role of institutions involved. The following strategic map (Table 59) intends to categorize the institutional roles more specifically as causal, persuasive or supportive; and define whether it is targeted to the group or the environment within which the groups functions.

Table 59: Strategic Map

	Strategy	Causal	Persuasive	Supportive

	Strategy	Causal	Persuasive	Supportive
Outcome Challenge 1	Aimed at community groups, NGOs, VDCs	Group level	Group level	Group level
		Provide budget for implementing proposed activities (refer to financial plan in (Table 52)	Meeting for coordination, training for new knowledge and skills, field visits for exposure	Expert support, Networking, Access to information
	Aimed at groups' working environment	*Environment level*	*Environment level*	*Environment level*
		Provide guidelines for groups formation, include women in all activities, key logistics for VDC, CBO	Village level meetings, dissemination of information through workshops	Learning network, Action network, Boundary partners working together supporting each other
Outcome Challenge 2	Aimed at ACAP, DSCO, Service providers	*Group level*	*Group level*	*Group level*
		Provide budget, logistics, and necessary staff on project basis	Orientation meeting, Coordination meeting, workshops, training	Sharing network, access to information, feedback system from field activities, response mechanism
	Aimed at groups working environment	*Environment level*	*Environment level*	*Environment level*
		Provide guidelines for implementation procedures, Include women in the field staff	Access to information, develop message system	Networking of boundary partners
Outcome challenge 3	Aimed at Chief District Office, AEPC, and SNV	*Group level*	*Group level*	*Group level*
		Provide budget for subsidy of RET and related activities	Workshops, meetings	-
	Aimed at working environment	*Environment level*	*Environment level*	*Environment level*
		-	Workshops	Networking

Table 60: Monitoring worksheet -1

Information details							
Monitoring priority	**Monitoring agency**	**Why**	**When**	**Information provider**	**How often**	**How**	**Tool used**
Boundary partners' achievement and outcomes	DDC	Find gaps	After six months of DCEP implementation	Boundary partners	Six monthly	Each partner filling questionnaire	Outcome journal (Table 61 - Table 71), one table one partner
Program strategies	AEPC	Change strategy	Annual	DDC	Annual	Workshop	Strategy and performance journal (Table 72)
Organizational practices	DDC	-	-	Boundary partners	-	-	Project response (Table 73)

Table 61: Monitoring worksheet 2.1: For outcome

Outcome challenge 1			**(Work dating from …… to……….)**	**Who**
Expect to see				Community Groups
H	M	L	Act as focal point for RET.	
H	M	L	Use suitable RETs to meet at least part of energy need.	

Outcome challenge 1			**(Work dating from …… to……….)**	**Who**
H	M	L	Acquire new skills in using RET.	
H	M	L	Are ready to form cooperatives for rural electrification	
Like to See				
H	M	L	Assess gaps and opportunity in RET uses.	
H	M	L	Request for training on increasing energy efficiency.	
Love to see				
H	M	L	Advocate the outcomes of the RET outside the village.	
H	M	L	Seek information on CC impact on energy sources.	

Table 62: Monitoring worksheet 2.2: For outcome

Outcome challenge 1			**(Work dating from …… to……….)**	**Who**
Expect to see				VDCs, CBOs
H	M	L	VDCs allocate funds to invest in RET activities.	
H	M	L	Encourage communities to support RET implementation.	
H	M	L	CBOs take part in RET implementation	
Like to See				
H	M	L	Disseminate the ideas and insights generated by the project in meetings.	
H	M	L	Incorporate energy activities in annual plans	
H	M	L	CBOs develop programmes in RET promotion	
Love to see				
H	M	L	Playing a key role in planning debate at district level.	
H	M	L	CBOs champion in RET implementation	

Table 63: Monitoring worksheet 2.3: For outcome

Outcome challenge 1			**(Work dating from …… to……….)**	**Who**
Expect to see				Local Leaders
H	M	L	Attend meetings and share ideas and be open to energy issues	
Like to See				
H	M	L	Help coordinate DCEP with other development programmes	
Love to see				
H	M	L	Advocate the outcomes of the RET at district level	

Table 64: Monitoring worksheet 2.4: For outcome

Outcome challenge 2			**(Work dating from …… to……….)**	**Who**
Expect to see				DDC
H	M	L	Coordinate timely implementation of DCEP activities	
H	M	L	Monitor progress of DCEP implementation	
Like to See				
H	M	L	Mobilize financial resource from other sources	
H	M	L	Avail necessary technical skill and expertise for innovation	
Love to see				
H	M	L	Evaluate, update and adjust DCEP to match emerging context	

Table 65: Monitoring worksheet 2.5: For outcome

Outcome challenge 2			**(Work dating from …… to……….)**	**Who**
Expect to see				ACAP
H	M	L	Include proposed activities of DCEP in its annual programme.	
H	M	L	Provide technical support to community on different RETs	
Like to See				
H	M	L	Provide feedback to project implementation	
H	M	L	Align annul activities in support of DCEP.	
H	M	L	Help evaluate effectiveness of DCEP activities.	
Love to see				

Outcome challenge 2			**(Work dating from …… to……….)**	**Who**
H	M	L	Incorporate key activities of DCEP in their regular program.	
H	M	L	Create database for climate information.	
H	M	L	Engage with other line agencies to promote RETs.	

Table 66: Monitoring worksheet 2.6: For outcome

Outcome challenge 2			**(Work dating from …… to……….)**	**Who**
Expect to see				AEPC
H	M	L	Provide technical backup for RET implementation.	
Like to See				
H	M	L	Help develop low cost RETs suitable for cold climate.	
Love to see				
H	M	L	Help conduct pilot programmes to tap wind energy	

Table 67: Monitoring worksheet 2.7: For outcome

Outcome challenge 2			**(Work dating from …… to……….)**	**Who**
Expect to see				DSCO
H	M	L	Provide technical backup to communities in erosion control measures around hydropower plants areas.	
Like to See				
H	M	L	Allocate its resources for soil water conservation in hydropower plant sites	
H	M	L	Help build synergy between RET and natural resource management.	
Love to see				
H	M	L	Influence policy terrain by incorporating some of the features of the DCEP strategy in biodiversity conservation.	

Table 68: Monitoring worksheet 2.8: For outcome

Outcome challenge 2			**(Work dating from …… to……….)**	**Who**
Expect to see				Service Providers
H	M	L	Provide services to communities where applicable to implement RETs.	
Like to See				
H	M	L	Take DCEP as reference to diversify and adjust their services regularly.	
H	M	L	Champion in suggesting improvements in RETs applicability for enhanced energy efficiency.	
Love to see				
H	M	L	Influence policy terrain by incorporating some of the features of the DCEP strategy in biodiversity conservation.	

Table 69: Monitoring worksheet 2.9: For outcome

Outcome challenge 3			**(Work dating from …… to……….)**	**Who**
Expect to see				CDO
H	M	L	Help in resolving conservation related conflicts.	
Like to See				
H	M	L	Help coordinate support from other agencies not directly related but may have a role in facilitating the project implementation.	
Love to see				
H	M	L	Lead advocacy of the RET approach in policy debates.	

Table 70: Monitoring worksheet 2.10: For outcome

Outcome challenge 3			**(Work dating from …… to……….)**	**Who**
Expect to see				SNV
H	M	L	Help find funding sources in the initial years to implement DCEP.	

Outcome challenge 3			**(Work dating from …… to……….)**	**Who**
Like to See				
H	M	L	Help explore possibility of harnessing wind energy in association with AEPC.	
Love to see				
H	M	L	Help explore possibility of diversifying energy programme to include other development priorities	

Table 71: Monitoring worksheet 2.11: For outcome

Outcome challenge 3			**(Work dating from …… to……….)**	**Who**
Expect to see				Donors
H	M	L	Provide funds to initiate DCEP implementation	
Like to See				
H	M	L	Help pilot wind mills and gravity ropeways for multiple uses	
Love to see				
H	M	L	Support integration of energy programme and other development activities.	

Table 72: Monitoring worksheet 3: Outcome and strategy (to be filled by DDC)

Monitoring date: ……………………..			
Required information	**Required details**	**Focus**	**Description**
Description of change	For the information recorded earlier as high, medium or low	DCEP approaches, practices, and partners' behavior	
Contributing factors and actors	Which factors were seen responsible to bring about the changes?	Full description	
Sources of evidence	How can the factors seen as responsible be substantiated?	Minutes of meeting or attendance of participants	
Unanticipated change	Lessons learned/ Changes required/ Reactions	Not expected, but positive	
Strategy to be monitored	What did the project do? With whom? When?	Description of activities	
	How did the activities influence change in outputs of the boundary partner(s)	Effectiveness	
Follow-up	Required changes	Key lessons	
Date for next monitoring.………………			

Table 73: Monitoring worksheet 4: Project response

	Responsible partner	**Timing**
What should the project keep doing?		
What needs to be changed in order to improve?		
What practices need be added?		
What practices need to be dropped (practices that did not produce results, or require too much effort or too many resources to produce result)?		
Is there any issue that the project needs to evaluate in greater depth? If yes, What? When? Why? How?		

5.7. Conclusion and Recommendations

Mustang district provides unique opportunity to build on a mix of different renewable energy sources, and together demonstrate a mix of both positive and negative impacts of climate change on its water and vegetation. On this setting, the DCEP identifies a number of RETs that responds to the current energy gap, helps transform gender roles, and are climate resilient. Except for wind, concentrated solar and the use of mini-grid, the proposed sources of energy builds on the RET capacity that already exists. Mustang can demonstrate leadership in providing affordable and universal access to RET in less than ten years.

Obtaining secondary segregated data on energy use, social and gender for Mustang has been difficult. This situation, to a great extent, is being improved through the collection of segregated data by DDC for all 16 VDCs. The data of Charang VDC, for example, was available in a draft format during the DCEP preparation period. It provided clear and a comprehensive picture of energy situation within the VDC at hh level. Lack of adequate data, and information on energy use for the rest of the areas along with inconsistencies in available data/information has been a key hurdle in the preparation of this DCEP.

Three energy scenarios were analyzed for developing the energy plan. The business as usual scenario (BAS) would only help meet the energy demand without taking into consideration the CC , while under the climate resilient scenario (CRS) the use of biomass and fossil fuel will not have a carbon foot print by 2020. A major river basin is a better planning unit to run a CRS rather than at the district level. For a realistic path, this DCEP has proposed a detailed intervention plan for medium adaptation scenario (MAS) that envisions a situation where the use of biomass and fossil fuel for residential purpose to remain constant by 2020 compared to the base year 2010, and the growing energy needs are met through RETs. MAS also requires additional energy requirement for urgent adaptation needs. Transformation of gender roles and addressing RET in the context of climate change is not possible without providing electricity for cooking to substitute fire-wood and cattle dung especially in the central and northern mustang.

Energy planning is a dynamic process, and hence, needs periodic revision to improve it based on new data and emerging knowledge. For which, the capacity of Mustang DDC and DEEU needs strengthening in taking prudent approaches in analyzing potential climate impacts, emerging trend of socioeconomic changes, and energy development potential to plan for a long-term energy program. Staff at Mustang DDCs and particularly the DEEU requires training on the use of tools such as outcome mapping or any other appropriate monitoring and evaluation.

Mustang is renowned for specialized niche products. Buckwheat, naked barley, garlic, onions and several herbs grown in Mustang bear unique quality and price. Fruits and vegetables are are ingredients to various cuisines. With the opening of the road up to the Nepal-China border, access to market has been secured. These specialized agriculture produces can now be used as a means of adaptation to climate change and food security. However, it requires additional energy for irrigation (pumping) and processing work. Erstwhile situation of “Energy from Water” in Mustang is changing to “Energy for Water” in unexpectedly short time.

Mustang has potential to sell electricity (and products that has embedded energy) to the national grid. As the grid has already connected central and southern Mustang, developing mini hydro projects in the northern Mustang can supply electricity to the grid and earn cash income for communities. Funding from government sources, private sector and through individual investments make small hydropower more attractive in the context of Mustang. The energy situation in Mustang requires development community led small hydropower jointly with Mustang DDC and private sector.

The guidelines for DCEP are quite comprehensive and help planners to follow a process. The idea is to enable DDCs to build the plan themselves with the help of these guidelines. With the level of information as demanded by the guidelines on resources, social and gender dimension, and scenario development; it is difficult for DDC personnel to capture the essence of the guidelines without technical backup for initial years. Else, instead of the guidelines helping distill the information to formulate the plan, the guidelines are used to reinforce a preconceived idea of energy development.

Finally, RETs are not only important when other source become expensive or unavailable, but also have important role to play in managing energy situation. The irony is that the short term gain or comforts provided by unsustainable energy sources will continue to lure consumers even among educate masses. This has been experienced by district authorities and organizations working in Mustang where communities demand subsidies for fossil fuel. A great deal of educating is needed to promote RETs, and Mustang offers a suitable case for this where imported fuels are just beginning to make their way through.

Based on the above understanding, the following recommendations have been made in implementing the DCEP.

- Mustang DDC to form three representative regional working groups each for northern, central and southern regions to identify barriers, avoid duplication, coordinate capacity building initiatives and in the implementation of RET investments. The three separate working group jointly conduct quarterly or at least bi-annually consultations and provide forum for regular comment from communities and commitment from interested development partners. These groups would assist the DDC during the annual planning process and assist DEEU in assessing the additional energy requirement for adaptation purpose and also guide subsequent data collection and updating process.
- A proper assessment of settlements where water stresses have been experienced within the recent years needs to be carried out.
- Investment on RET programs should target VDCs with the least coverage, highest fuel hardship, high poverty, remote and that are more likely to impacted by climate change.
- Explore potential for developing mini hydro in northern Mustang for future economic growth and to meet additional energy requirement for adaptation to CC. There is a need for energy policy for Mustang District. Provisioning of sustainable renewable energy to all current national policy does not capture the nuance for Mustang.
- Providing additional energy requirement to address climate change adaptation such as in pumping water for irrigation and drinking water purpose has to be piloted within the first three years of the plan i.e 2011-2013. Created dependencies on fossil fuel through grants to establish kerosene depots, subsidies on kerosene and LPG should gradually be eliminated by providing longer term clean energy alternatives.
- Mustang DDC is currently in the process of preparing VDC profiles for all sixteen VDCs, which can be a very useful tool in mapping the existing use of energy – especially the use of LPG gas. It is recommended that VDC level detailed information also need to include other relevant information such as climate impact on water and vegetation as well as GSI situation.

- Promote RET for longer term, educate people that unsustainable sources means increased burden on the economy. The DDC should commit provisioning reliable and affordable energy to hundred percent of the households within much before year 2020. It can be done by setting annual targets of serving around 100 households with a diversified portfolio of energy.
- Encourage and provide incentives for the development of ropeways for carrying goods in and out of Mustang.
- Other agencies such as AEPC, Ministry of Energy, Ministry of Environment, Ministry of Local Development to Assist Mustang DDC to draw resources for implementing the plan.

References

AEPC, (undated document), Wind Energy Prospectus

CBS 2007: Statistical Data (CD ROM), Central Bureau of Statistics, National Planning Commision Secretariat, Kathmandu, 2007.

CBS, 2065: *Jilla Ko Bastugat Bivaran* (District profile) Mustang 2065, Published by CBS Branch Office Baglung, Nepal.

Dahal, N. (2004): Perceptions of Climate Change in the Himalayas, http://www.tiempocyberclimate.org/newswatch/feature050910.htm

DDC 2066/67: District Development Plan, Mustang District Development Committee 2066/67

DDC 2067/68: District Development Plan, Mustang District Development Committee, 2067/068

DESR 2008: District Energy Situation Report, Mustang, 2008/2009

DHM, 2000: *Daily Precipitation Records of Bheri, Rapti and Dhaulagiri Zone, Through 1996*, Department of Hydrology and Meteorology, June, Kathmandu,

GEF, 2004, (Unpublished working document), The Nature and Role of Local Benefits in GEF Programme Areas, Case Study of Upper Mustang Bio-diversity Project.

Gurung K., 2005: Gender dynamics in sustainable livestock and pasture land management, A case study of indigenous people from upper Mustang, Mustang District, Nepal. Master final thesis paper, submitted to faculty of Clark University, Worcester, Massachusetts, in partial fulfillment of requirement for the degree of Masters of Arts in Development of International Development, Community and Environment, Massachusetts.

ICIMOD, 2010 a, Case Study on Sustainable Micro Financing Options for Disseminating Tested Technologies at Project Sites in Nepal, Centre for Micro-Fianance (CMF), Nepal

ICIMOD, 2010 b, Suitable Micro Financing Options for RETs, Training to the Savings and Credit Group Representatives of Upper Mustang, Centre Micro-Fianance (CMF), Nepal

ICIMOD, 2010: Gender Perspectives in Mountain Development, New challenges and innovative approaches, Sustainable Mountain Development, No. 57 Summer, 2010.

Interim District Development Plan, Mustang (059/60-063/64)

ISET 2008: Enabling Adaptation to Climate Change for Poor Populations in Asia through Research, Capacity Building and Innovation, Report from Adaptation Study Team to the International Development Research Centre, Coordinated by ISET, Published by ISET-Nepal at Format Graphics, Kathmandu, July 2008.

Messerschimidt, (undated), People and Resource in Nepal: Customary Resource Management Systems in the Upper Kali Gandaki, Proceedings of the Conference on Common Property Resrouce Management, http://books.google.com/books?hl=en&lr=&id=cCkrAAAAYAAJ&oi=fnd&pg=PA455&dq=mustang+nepal&ots=Kw8z_K6GyY&sig=Ov24sW7SAF-Xo-0hkqClTcsGmgU#v=onepage&q=mustang%20nepal&f=false , Date of access

MoE 2011: District Climate And Energy Plan (DCEP) Preparation Guideline (draft), Government of Nepal, Ministry of Environment, Alternative Energy Promotion Centre (AEPC)., UKAID, SNV, Kathmandu, 2011.

MOPE (2004) Initial National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change, Ministry of Population and Environment of Nepal

Mustang DDC, 2053, District Profile of Mustang District

Mustang DDC, 2065, District Profile of Mustang District

NAPA 2010: *National Adaptation Programme of Action (NAPA)*, GoN, Ministry of Environment,Nepal.

Nepal: (2011): Pilot Program for Climate Resilience (PPCR), World Bank / ADB / IFC Joint Mission Report 15-21 November 2010, Aide Memoire, 10 December 2010 http://www.ppcrnepal.gov.np/documents.html

NIDI, 2006: Nepal District Profile. Nepal Development Information Institute (NIDI), 2006.

NTNC, 2008: Sustainable Development Plan, Mustang (2008—2013), National Trust for Nature Conservation, Kathmandu, 2008

PA, 2009: Temporal and Saptial Variability of Climate Change over Nepal (1976 – 2005). Practical Action, Katmandu.

Sarah et. al. 2001: www.outcomemapping.ca/download.php?file=/resource/files/OM_English can be accessed for detailed information about the tool.

SWERA Final Report, 2008, Solar and Wind Energy Resource Assessment in Nepal, AEPC UNEP and GEF

SWERA Final Report (GIS Part), 2008 b, Solar and Wind Energy Resource Assessment in Nepal, AEPC UNEP and GEF

Thapa G., 2009: How gender affects decision making - A case study of Tibeto-Burmese Women in Kobang VDC, Mustang, Nepal, Thesis submitted in the partial fulfillment of requirements for the Master's in Resources and Human Adaptations, Department of Geography, University of Bergen, Norway.

Annexes

Annex 1: General Information of Mustang

General Information

Development Region	:	Western
Zone	:	Dhaulagiri
District	:	Mustang
Number of constituency	:	One
Number of Ilaka	:	9
Number of Municipalities	:	None
Number of VDC	:	16
Political Boundary	:	East - Manang district West - Dolpa district North - China's Autonomous Region of Tibet South - Myagdi district
Latitude	:	28 20^0N – 29 05^0N
Longitude	:	83 30^0E – 84 15^0E
Altitude	:	Maximum Altitude – 8000m Minimum Altitude -
Climate	:	Rain shadow area Cold temperate general Alpine to tundra from higher altitudes
Temperature	:	Maximum – 26^0C Minimum - $(-9)^0$C
Average Annual Rainfall	:	184 mm Snowfall in winter

Land use Pattern:

Total Area	Agriculture		Forests	Grazing Land	Wetland	Snow	Rock	Settlement	Others
	Cultivated Land	Non-cultivated Land							
3573 Sq. km	3242 ha	4025 ha	12,324 ha	147,679 ha	92 ha	3059 1 ha	150573 ha	320 ha	16912 ha

(Source: Mustang District Profile 2065)

Population

House holds	Average HH. Size	Total Population	Male Population	Female Population	Population density per sq. km.	Population Growth Rate
3243	4.62	14981	8180	6801	4	Negative between 1991 and 2001 census

(Source: CBS 2001 Census)

Settlements: out of total households 266 (10.32%) are homeless and people living in public buildings are 129. Of the total houses, only 13 houses are *pakki* and of them 4 have RCC roofs while 9 have tin. The rest 2563 houses have been built with wood and other local materials and have mud roof.

Population 6 Years of Age and Over by Literacy Status and Sex, 2001

Total	Male	Female	Can't Read & Write			Can Read Only			Read & Write			Not Stated		
			Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
13406	7334	6071	5549	2359	3191	836	481	355	6938	4467	2471	83	29	54
Percent	55	45	41		52	6		5.8	52		41	<1		

(Source: CBS 2001 Census)

Women constitute about 45 percent of population, of which about 21 percent can either read or read and write. A total of 52 percent can read and write , 6 percent can read only , 41 percent of population are illiterate. Of those who can read and write about 36 percent are women.

Population Projection by Sex, 2001 - 2021 (Medium Variant)

2001			2006			2011			2016			2021		
Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
14981	8180	6801	16076	8617	7459	17163	9017	8146	18323	9428	8895	19617	9874	9744

(Source: CBS 2007)

Ethnic composition

Ethnicity	Gurung	Thakali	Dalit	Magar	Thakuri	Others
No. of Households	1527	630	211	79	74	55
Percentage	59.3%	24.5 %	8.2 %	3.1 %	2.9 %	2.1 %

(Source: Mustang District Profile 2065)

Religion

Hindu	Buddha	Islam	Kirat	Jain	Christian	Sikh	Bahai	Others	Total
3787	11123	7	3	9	49	-	-	3	14981

(Source: Mustang District Profile 2065)

Education

Literacy %	Male Literacy %	Female Literacy %	No. of Campus	Number of Higher Secondary School:	Number of High School:	Number of Lower Secondary School:	Number of Primary School:
74%	74%	69%	-	1	7	9	51

(Source: Mustang District Profile 2065)

Teachers and Students in School

Level	Gender	Primary Level	Lower Secondary Level	Secondary Level	Higher Secondary Level
Teachers	Male	157	47	49	-
	Female	78	5	1	-
Students	Male	831	252	113	16
	Female	952	271	109	26

(Source: Mustang District Profile 2065)

Number of Schools, Teachers and Students Enrolled

Level	Years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average
Primary	No. of Schools	67	67	65	65	67	66	72	50	67	66	65

Level	Years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average
	Teachers	218	231	277	297	261	261	283	289	282	276	267
	Students enrolled	2419	2296	2232	2049	2724	2022	2005	2020	1465	1830	2106
Lower Secondary	No. of Schools	16	19	19	19	19	16	18	9	20	16	17
	Teachers	47	52	52	47	50	50	55	65	52	55	52
	Students enrolled	337	334	368	386	639	354	389	431	425	502	416
Secondary	No. of Schools	6	6	6	6	9	7	9	8	8	8	7
	Teachers	22	32	37	37	39	39	41	44	42	50	38
	Students enrolled	141	131	128	153	245	158	178	207	181	226	174

(Source: Mustang District Profile 2065)

The number of schools has been reported changing from time to time. The number of primary school has dropped from 72 in 2003 to 50 in 2004, but the number of teacher has increased. The same also applied to the number of secondary schools. The reasons for such drop are not known. According to the available figures, the average number of primary schools is 65, which has enrolled about 2100 students. The number of teachers in primary schools is about 267, which varies slightly from year to year. The students in the lower secondary schools are about 416 in 17 schools. About 52 teachers are employed in these schools. Mustang has only 7 high schools with 174 students. There are 38 teachers in high schools.

Health

District Health Office	District Hospital	Primary Health Centre	Health Post	Sub-Health Post	Ayurvedic Aushadhalaya
1	1	1	8	7	1

(Source: Mustang District Profile 2065)

Crop Production

Crop	Naked barley	Barley	Wheat	Maize	Buck wheat	Potato	Pulses	Oilseeds
Area (ha)	481	545	950	739	820	525	54	59
Production (MT)	1010	1117	2081	921	1631	4651	65	61

(Source: Mustang District Profile 2065)

Estimated Area (hectares) and Production (Mtons) under Food Crops, 1997/98 to 2006/2007

Food Crop	Year	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	Average
Wheat	Area	400	478	878	875	875	679	675	641	641	635	667
	Production	530	574	1408	1520	1520	1675	1050	1100	1100	1301	1178
Maize	Area	520	520	142	140	150	522	525	525	525	525	409
	Production	680	624	165	197	195	910	766	780	780	780	588
Millet	Area	-	-	-	-	-	-	-	-	-	4	4
	Production	-	-	-	-	-	-	-	-	-	4	4
Barley	Area	850	1015	544	544	544	445	360	437	437	311	548
	Production	990	1187	660	806	806	867	350	613	513	311	710

(Source: CBS 2007)

Estimated Area (hectares) and Production (Mtons) under Cash Crops, 1997/98 to 2006/2007

Cash Crop	Year	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	Average
Oilseed	Area	10	50	59	50	50	25	25	35	35	35	37
	Production	10	35	38	35	35	26	25	31	31	30	30
Potato	Area	520	500	506	500	425	225	225	232	232	232	360
	Production	6000	3550	3586	3550	3500	2239	2240	2330	2330	2308	2308

(Source: CBS 2007)

Number of Holdings Area and Fragmentation of Holdings, 2001/02

Holdings				Fragmentation						
Number	Area (ha)			Total no. of parcels	Average no. of parcels	Number of holdings consisting of parcels				
	Wet	Dry	Total			1	2-3	4-5	6-9	10 and over
2,685	525.3	727.7	1,253.0	10,885	4.1	250	1,130	803	369	129

(Source: Mustang District Profile 2065)

Number of Households with Livestocks, 2001/02

Cattle		Yak / Nak / Chaunri		Buffalo		Goats		Sheep	
No. of Holdings	No. of Head	No. of Holdings	No. of Head	No. of Holdings	No. of Head	No. of Holdings	No. of Head	No. of Holdings	No. of Head
2,139	9,134	160	1,293	36	109	1,014	47,239	58	1,826

(Source: Mustang District Profile 2065)

Number of Cattles and Livestocks, 2001/02

Cow	Buffalo	Goats	Sheep	Yak	Joe	Horse/mule/donkey	Poultry
5549	78	47864	7084	2933	1872	4168	7640

(Source: Mustang District Profile 2065)

Number of Holdings and Holdings Reporting Birds, 2001/02

Poultry								Other birds					
Total		Chicks		Cocks		Hens		Ducks		Pigeons		Others	
No. of holdings	Number of birds	No. of holdings	Number of birds	No. of holdings	Number of birds	No. of holdings	Number of birds	No. of holdings	Number of birds	No. of holdings	Number of birds	No. of holdings	Number of birds
1,050	8,777	449	3,502	572	1,370	866	3,905	10	58	5	17	-	-

(Source: Mustang District Profile 2065)

Number of Tourists by Nationality, 1997 to 2006

Year	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	Average
All Nepal	421857	463684	491504	463646	361237	275468	338132	385297	375398	383926	396014
Percent Change	7.17	9.91	6.00	-5.67	-22.09	-23.74	22.75	13.95	-2.56	2.27	-
6 pc going to Mustan g	25311	27821	29490	27818	21674	16528	20287	23117	22523	23035	23760.

(Source: CBS 2007)

A total of 20000 tourist visited Mustang, which is about 6 percent of tourist arrival in Nepal. Since, tourist arrival at national level has fluctuated over the years, average number of tourist has been calculated on the basis of arrival in 2009. An average of 23,000 tourist are expected to visit Mustang annually.

Annex 2: List of perennial rivers/ rivulets in Mustang district

S. N.	Name of perennial river/stream	Beneficiary VDCs	Beneficiary settlements
1	Agarchhu Khola	Chhonhup	
2	Hyunjun Khola	Chhonhup	Bharma
3	Chhuama Khola	Chhonhup/Lomanthan	
4	Khukyu Khola	Chhonhup/Chhoser	
5	Nyamdo Khola	Chhonhup	Nyamdo, Nhichun, Chumjun
6	Nhichun Khola	Chhonhup/Chhoser	Nyamdo, Nhichun
7	Kimalin Khola	Chhonhup/Lomanthan	Kimalin
8	Kyunchhama Khola	Chhonhup/Lomanthan	
9	Chhorak Dokpo Khola	Chhonhup/Lomanthan	Thingar, Phuwa, Namgyal &
10	Sicha Phui Khola	Chhoser	Yachebu, Garphu, Ghom, Dhuk
11	Dunu Khola	Chhoser	
12	Ghoiche Khola	Chhoser	Arka, Sisa, Bharcha, Nenyul
13	Nakta Toppu Khola	Chhoser	
14	Samjon Khola	Chhoser	Samjon
15	Chhikyu Toppu Khola	Chhoser	
16	Kuwapani Khola	Chhoser	
17	Tunu Khola	Chhoser	
18	Chhunsun Khola	Chhoser	
19	Iti Khola	Chhoser	
20	Yarsan Khola	Chhoser	
21	Salde Khola	Chhoser	
22	Chiprun Khola	Chhoser	
23	Chhuchhu Gumba Khola	Chhoser	
24	Mapchi Khola	Chhoser	
25	Yamarto Khola	Chhoser	
26	Chaka Khola	Chhoser,Surkhan	
27	Parun Khola	Chhoser,Surkhan	
28	Amaka Khola	Surkhan	
29	Dhimi Khola	Surkhan	
30	Puyun Khola	Surkhan	Dhigau, Surkhan, yaragau, Gharagau, Khete
31	Ghyumapani Khola	Surkhan	
32	Dhechyan Khola	Surkhan	Dhegau, Phanyakawa
33	Parsye Khola	Surkhan	
34	Damodar Kund Khola	Surkhan	
35	Tange Khola	Surkhan	Tange
36	Yak Khola	Surkhan	
37	Samena Khola	Surkhan	
38	Dhakrun Khola	Surkhan	
39	Rijun Prama Khola	Surkhan	
40	Tumlin Khola	Surkhan	
41	Chanje Khola	Surkhan	
42	Yamkan Khola	Surkhan	
43	Namta Khola	Surkhan	
44	Itiya Khola	Surkhan	
45	Buwa Khola	Surkhan	
46	Nale Khola	Surkhan	
47	Rijun Chwa Khola	Surkhan/ Chhusan	
48	Tathatha Khola	Lomanthan	
49	Dhangna Khola	Lomanthan	

S. N.	Name of perennial river/stream	Beneficiary VDCs	Beneficiary settlements
50	Ghyun Khola	Lomanthan/Charan	
51	Thulun Khola	Lomanthan	
52	Charan Khola	Lomanthan/Charan	saukre, maran, charan, Ghar gumba
53	Syoda Khola	Charan	
54	Chinge Khola	Charan	
55	Naktan Khola	Charan/Ghami	
56	Dhuya Khola	Charan/Ghami	
57	Ghopan Khola	Ghami	
58	Ghami Khola	Ghami	Dhakmar, Ghami, Akiama, San
59	Dhakmar Khola	Ghami	Dhakmar
60	Tama Khola	Ghami	Tamagau, Ghilin, S'boche
61	Yamta Khola	Ghami	
62	Sanboche Khola	Ghami	
63	Chunsi Khola	Ghami/ Chhusan	
64	Bhena Khola	Chhunsan	
65	Jhuwa Khola	Chhunsan	
66	Samarkyun Khola	Chhunsan	Samar, Bhena, Kyuten, Chaile, Ghyakar
67	Ghyakar Khola	Chhunsan	Kyuten, Chaile, Ghyakar
68	Chhinoho Khola	Chhunsan	
69	Sumba Khola	Chhunsan	
70	Narsin Khola	Chhunsan	Chhusan, Tetan, Chhomnan
71	Nari Khola	Chhunsan	
72	Dhinkyo Khola	Chhunsan	Tanbe
73	Yamdi Khola	Chhunsan	Ghok &
74	Lhanhimar Khola	Chhunsan	Santa
75	Ghaldan Ghuldun Khola	Chhunsan	
76	Mukchun Khola	Chhunsan	
77	Kilunba Khola	Chhunsan	
78	Nayaban Khola	Chhunsan	
79	Bhabja Khola	Chhunsan	
80	Tayak Tabja Khola	Chhunsan	
81	Simkoghiu Khola	Chhunsan	
82	Yakchhu Khola	Chhunsan	
83	Upper Rijun Khola	Chhunsan	
84	Bherol Khola	Chhunsan/ Kagbeni	
85	Kyalunpa Khola	Chhunsan/ Kagbeni	
86	Ghilunpa Khola	Chhunsan/ Kagbeni	
87	Testhan Khola	Kagbeni	
88	Jharche Khola	Kagbeni	
89	Dhundok Khola	Kagbeni	
90	Dhunju Karma Khola	Kagbeni	
91	Dhaka Lumba Khola	Kagbeni	
92	Konjokki Khola	Kagbeni	
93	Lumbuk Khola	Kagbeni	Phalyak, Dhagarjun, Panlin
94	Pan Khola	Kagbeni	
95	Kolunba Khola	Kagbeni	
96	Rataula Khola	Kagbeni	
97	Lower Jhon Khola	Kagbeni	Kagbeni
98	Tangarghiu Khola	Jhon	
99	Thoron Khola	Jhon/ Muktinath	
100	Jhon Khola	Jhon/ Muktinath	Putak, Jhon, Chhyongur in
101	Chhuche Khola	Muktinath	Khinja, Kunjok, Jharkot, Lhatuk, Puran,
102	Jhamlunna Khola	Muktinath	Ranipauwa, Gumba and Muktinath in
103	Madek Khola	Muktinath	

S. N.	Name of perennial river/stream	Beneficiary VDCs	Beneficiary settlements
104	Panda Khola	Muktinath	Lupra
105	Upper Panda Khola	Muktinath/ Jomsom	
106	Thini Khola	Jomsom	Thini, Kaisan, Jomsom, Hadi Gau
107	Puchchardhon Khola	Jomsom	
108	Lanpoghyun Khola	Jomsom	
109	Dhumba Khola	Jomsom	Dhumba, Samle, Dhunche than
110	Murghyuna Khola	Jomsom	
111	Dumwa Khola	Jomsom	
112	Syan Khola	Jomsom/ Marpha	Syan, Marpha, Apple farm, Dhonga, chhairo,
113	Sechi Khola	Marpha	Laki
114	Ponkyu Khola	Marpha	
115	Pharam Khola	Marpha	
116	Chhahare Khola	Marpha	
117	Dhokyu Khola	Tukuche/ Marpha	
118	Dudhpani Khola	Tukuche	
119	Thapa Khola	Tukuche	Chiman gau, Dhunche, Kali Odar, Jhodage,
120	Chiman Khola	Tukuche	Tukuche, Dhorenjhan, Chokhopani,
121	Chokhopani Khola	Tukuche	Dhasache, Nelejhan Syalam, Kyupar (Lhau)
122	Larjun Khola	Koban	
123	Gurusanbai Khola	Koban	
124	Ghatte Khola	Koban	Khanti, Koban, Larjun, Naurikot, Sekun,
125	Sun Khola	Koban	Khalakyu, Chhaktan, Sauru
126	Chhaktan Khola	Koban	
127	Tangchahara	Koban	
128	Tamo Khola	Koban	
129	Sirkun Khola	Koban	
130	Seti Khola	Lete	Kokhethati, Lhakyor, Dhampu, Thakkholagau,
131	Lete Khola	Lete	Kalapani, Lete, Pari Letekholagau, Misi,
132	Pari Lete Khola	Lete	Ghumaune, Dhaiku, Ghasa, Thaplyan
133	Dhaiku Khola	Lete	
134	Thaplyan Khola	Lete	
135	Panpu Khola	Kunjo	Titi, Khoko, Kunjo, Panpu, Deurali (Jhirpa),
136	Tantun Khola	Kunjo	Polche, Mindi, Chhyo, Chyachu, Sari,
137	Simrankhun Khola	Kunjo	Nauli Ghyan, Pairothapla, Kopchepani
138	Kali Gandaki Nadi	all VDCs	

Annex 3: Details of Lake and Ponds in Mustang district

S.N	Name of Lake/pond	Beneficiary VDCs	Surface area (m2)
1	Lake 1, Agarchhu	Chhonhup	7,500
2	Lake2, Agarchhu	Chhonhup	12,500
3	Damodar Kund	Surkhan	35,000
4	Dhegau pond	Surkhan	2,500
5	Lake 1	Lomanthan	47,500
6	Lake 2	Lomanthan	5,000
7	Lake 3	Lomanthan	5,000
8	Lake 4	Lomanthan	10,000
9	Lake 5	Lomanthan	30,000
10	Lake 6	Lomanthan	2,500
11	Ghyaka Tal	Lomanthan	20,000
12	Kekyap Tal	Lomanthan/Charan	200,000
13	Tallo Kekyap Tal	Lomanthan/Charan	330,000
14	Lake 1	Charan	157,500
15	Lake 2	Charan	30,000
16	Lake 3	Charan	1,050
17	Lake 4	Charan	10,000
18	Dhau Dhundhun Tal	Charan	27,500
19	Lake 5	Charan	35,000
20	Lake 6	Charan	6,500
21	Lake 7	Charan	2,500
22	Lake 8	Charan	4,000
23	Lake 9	Charan	1,250
24	Lake 10	Charan	22,500
25	Lake 11	Charan	3,250
26	Lake 12	Charan	30,000
27	Lake 13	Charan	1,250
28	Lake 14	Charan	3,750
29	Lake 15	Charan	1,750
30	Lake 16	Charan	5,000
31	Lake 17	Charan	63,000
32	Lake 18	Charan	1,250
33	Lake 19	Charan	750
34	Lake 20	Charan	875
35	Lake 21	Charan	1,500
36	Lake 22	Charan	15,000
37	Naktan Tal	Charan	52,500
38	Lake 23	Charan	625
39	Lake 24	Charan	1,250
40	Lake 25	Charan	500
41	Lake 26	Charan	375
42	Lake 27	Charan	625
43	Lake 28	Charan	500
44	Lake 29	Charan	875
45	Lake 30	Charan	500
46	Lake 31	Charan	15,000
47	Lake 32	Charan	5,000
48	Lake 33	Charan	30,000
49	Lake 34	Charan	7,500
50	Lake 35	Charan	11,400

S.N	Name of Lake/pond	Beneficiary VDCs	Surface area (m2)
51	Lake 36	Charan	5,000
52	Lake 37	Charan	2,500
53	Lake 1	Ghami	625
54	Lake 2	Ghami	400
55	Lake 3	Ghami	500
56	Lake 4	Ghami	625
57	Lake 5	Ghami	350
58	Lake 6	Ghami	3,750
59	Lake 7	Ghami	4,000
60	Lake 8	Ghami	22,500
61	Dhuya Tal	Ghami	150,000
62	Lake 9	Ghami	10,000
63	Lake 10	Ghami	25,000
64	Lake 11	Ghami	7,500
65	Lake 12	Ghami	6,000
66	Lake 13	Ghami	35,000
67	Lake 1	Chhusan	20,000
68	Lake 2	Chhusan	5,000
69	Lake 3	Chhusan	22,500
70	Lake 4	Chhusan	30,000
71	Lake 5	Chhusan	1,225
72	Lake 6	Chhusan	1,000
73	Lake 7	Chhusan	6,500
74	Tawa Lake 8	Chhusan	14,400
75	Purkun Lake 9	Chhusan	33,000
76	Lake 10	Chhusan	2,500
77	Lake 11	Chhusan	2,500
78	Lake 12	Chhusan	5,000
79	Lake 13	Chhusan	15,000
80	Lake 14	Chhusan	20,000
81	Lake 15	Chhusan	20,000
82	Lake 16	Chhusan	10,000
83	Lake 17	Chhusan	7,500
84	Lake 18	Chhusan	7,500
85	Lake 19	Chhusan	22,500
86	Lake 20	Chhusan	6,500
87	Lake 1	Kagbeni	20,000
88	Lake 2	Kagbeni	1,600
89	Lake 3	Kagbeni	1,600
90	Lake 4	Kagbeni	1,800
91	Lake 5	Kagbeni	1,800
92	Lake 6	Kagbeni	5,000
93	Lake 7	Kagbeni	5,000
94	Lake 8	Kagbeni	1,500
95	Lake 9	Kagbeni	400
96	Lake 10	Kagbeni	5,000
97	Lake 11	Kagbeni	150
98	Lake 12, Muli Tal	Kagbeni	150,000
99	Lake 13, Tin Tal	Kagbeni	5,000
100	Lake 14, Tin Tal	Kagbeni	2,025
101	Lake 1	Jomsom	6,000
102	Lake 1, Dhumba Tal	Marpha	7,500
103	Lake 1	Koban	2,500
104	Lake 1, Titi Tal	Kunjo	2,500

Annex 4: List of participants during the District Task Force meeting

S.N.	Name	Organisation
1.	Mr. Mani Kumar Gyanwali	Local Development Officer, Mustang
2.	Mr. Nabin Ruwali	District Energy and Environment Officer, Mustang
3.	Mr. Ranjan Parajuli	Alternative Energy Promotion Center, Lalitpur
4.	Mr. Hridaya Shrestha	Soil Conservation Officers
5.	Mr. B Krishna CHaudhary	Mustang Development Service Agency
6.	Mr. Rajendra Man Shrestha	LGCDP
7.	Mr. Krishna P Panthi	Planning Officer, District Development Office, Mustang
8.	Mr. Om Prasad Pandey	Acting CDO, Mustang District
9.	Mr. Birendra Thakali	
10.	Mr. Madhukar Upadhya	CEPAD
11.	Mr. Anil Pokhrel	CEPAD
12.	Mr. Anand Pradhan	CEPAD
13.	Mr. Bibek Raj Kandel	CEPAD

Annex 5: Mustang DCEP Stakeholder Consultation Workshop Schedule

Venue: AEPC Meeting Hall, AEPC Office, Khumaltar, Lalitpur

Date: 18 March 2011 (2067 Chaitra 4), Friday

Time: 09:00 – 17:00 Hours

Time	Agenda	Facilitator
0900 – 0915	Welcome and Introduction	AEPC & CEPAD
0915 – 0930	District Climate and Energy Plan • Background • Objective • Rationale	JS & RP
0930 – 1000	Why is Mustang unique? Proposed framework to address this unique setting of Mustang.	MU
1000 – 1030	Energy Demand Supply Scenario of the district • Energy assessment • Resource assessment • Institution assessment • Technology assessment	BK & APR
1030 – 1045	**Tea Break**	
1045 – 1115	Climate Assessment	AP
1115 – 1130	GSI Assessment	MU
1130 – 1200	Interactive Session	Plenary
1200 – 1300	**Lunch**	
1300 - 1400	System Approach - Interplaying Systems and their role in sustainable energy plan design • Core System • Support System • Institution System	MU
	Key Actors and Organizations at system level	
1400 – 1430	Energy Scenarios development with linkage to Climate and GSI	BK & AP
1430 – 1530	Group feedback on energy scenarios	Plenary
1530 – 1545	**Tea Break**	
1545 – 1600	Monitoring, Evaluation and Financing Plan – Discussion only	MU
1600 – 16:50	Exercise to Evaluate Energy options, Climate, GSI and Cost	Plenary
16:50-1700	Closing	

(JS: Jeremy Stone, RP: Ranjan Parajuli, MU: Madhukar Upadhya, APR: Anand Pradhan, AP: Anil Pokhrel, BK: Bibek Kandel Mr. Anand Pradhan will serve as the Master of Ceremony.)

Annex 6: VDC wise Energy Consumption in Base Year 2010

Region	VDC	No. of HHs	Total Population	HH Size	Energy Source - Cooking						Energy Source - Electricity					Overall Energy Consumption
					Firewood	Dung Cake	Agri Residue	Kerosene	LPG	Total Energy	SPV	SPV	MHP	MHP	Total Energy	
		#	#	#	GJ	GJ	GJ	GJ	GJ	GJ	kWh	GJ	kWh	GJ	GJ	GJ
Northern	Chonnup	189	1201	6.35	325.41	8,823.09	20.64	16.46	219.72	9,405.32	4,415.04	15.89	22,245.16	80.08	95.98	9,501.29
	Lomanthan	140	688	4.91	241.04	6,535.62	15.29	12.19	162.75	6,966.90	3,270.40	11.77	16,477.90	59.32	71.09	7,038.00
	Chhoser	170	827	4.86	292.70	7,936.11	18.56	14.81	197.63	8,459.80	3,971.20	14.30	20,008.88	72.03	86.33	8,546.13
	Surkhang	126	666	5.29	216.94	5,882.06	13.76	10.98	146.48	6,270.21	2,943.36	10.60	14,830.11	53.39	63.98	6,334.19
	Chharang	138	780	5.65	237.60	6,781.32	15.07	12.02	160.43	7,206.44	4,029.60	14.51	16,242.50	58.47	72.98	7,279.42
	Ghami	135	830	6.15	232.43	6,302.21	14.74	11.76	156.94	6,718.08	3,153.60	11.35	15,889.40	57.20	68.55	6,786.63
	Chhusang	172	1068	6.21	296.14	8,029.48	18.78	14.98	199.95	8,559.33	4,017.92	14.46	20,244.28	72.88	87.34	8,646.67
Total		1070	6060		1,842.26	50,289.88	116.84	93.20	1,243.90	53,586.08	25,801.12	92.88	125,938.22	453.38	546.26	54,132.34
Central	Kagbeni	216	1224	5.67	4,665.60	5,837.83	23.59	480.82	1,126.20	12,134.04	9,720.00	34.99	184,680.00	664.85	699.84	12,833.88
	Jhon	91	584	6.42	1,965.60	2,459.46	9.94	202.57	474.47	5,112.03	4,095.00	14.74	77,805.00	280.10	294.84	5,406.87
	Muktinath	161	1089	6.76	3,477.60	4,351.35	17.58	358.39	839.44	9,044.35	7,245.00	26.08	137,655.00	495.56	521.64	9,565.99
	Jomsom	253	1174	4.64	5,464.80	6,837.83	27.63	563.18	1,319.12	14,212.56	11,385.00	40.99	216,315.00	778.73	819.72	15,032.28
	Marpha	216	986	4.56	4,665.60	5,837.83	23.59	480.82	1,126.20	12,134.04	9,720.00	34.99	184,680.00	664.85	699.84	12,833.88
Total		937	5057		20,239.20	25,324.30	102.33	2,085.76	4,885.43	52,637.02	42,165.00	151.79	801,135.00	2,884.09	3,035.88	55,672.90
Southern	Tukeche	131	541	4.13	5,659.20	643.73	14.30	58.32	105.08	6,480.64	0.00	0.00	112,005.00	403.22	403.22	6,883.85
	Kobang	152	679	4.47	6,566.40	746.93	16.60	67.67	121.93	7,519.52	0.00	0.00	129,960.00	467.86	467.86	7,987.38
	Kunjo	138	716	5.19	5,961.60	678.13	15.07	61.44	110.70	6,826.93	0.00	0.00	117,990.00	424.76	424.76	7,251.70
	Lete	153	798	5.22	6,609.60	751.84	16.71	68.12	122.73	7,569.00	0.00	0.00	130,815.00	470.93	470.93	8,039.93
Total		574	2734		24,796.80	2,820.64	62.68	255.54	460.43	28,396.09	0.00	0.00	490,770.00	1,766.77	1,766.77	30,162.86
Grand Total		2581	13851		46,878.26	78,434.81	281.85	2,434.51	6,589.76	134,619.19	67,966.12	244.68	1,417,843.22	5,104.24	5,348.91	139,968.10

Annex 7: Energy Demand in Different Scenarios (Northern Region)

Business as Usual Scenario											
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Fuelwood	1,842.26	1,860.68	1,914.64	1,970.17	2,027.30	2,086.09	2,146.59	2,208.84	2,272.90	2,338.81	2,406.64
Animal Waste	50,289.88	50,792.77	52,265.77	53,781.47	55,341.14	56,946.03	58,597.46	60,296.79	62,045.40	63,844.71	65,696.21
Agriculture Residue	116.84	118.01	121.43	124.95	128.58	132.30	136.14	140.09	144.15	148.33	152.63
Biomass - Total	**52,248.98**	**52,771.47**	**54,301.84**	**55,876.59**	**57,497.01**	**59,164.43**	**60,880.20**	**62,645.72**	**64,462.45**	**66,331.86**	**68,255.48**
LPG	1,243.90	1,256.34	1,292.77	1,330.26	1,368.84	1,408.54	1,449.38	1,491.41	1,534.67	1,579.17	1,624.97
Kerosene	93.20	94.13	96.86	99.67	102.56	105.54	108.60	111.75	114.99	118.32	121.75
Fossil Fuel - Total	**1,337.10**	**1,350.47**	**1,389.63**	**1,429.93**	**1,471.40**	**1,514.07**	**1,557.98**	**1,603.16**	**1,649.65**	**1,697.49**	**1,746.72**
Hydropower	453.38	457.91	471.19	484.86	498.92	513.38	528.27	543.59	559.36	575.58	592.27
Solar Home System	92.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewabale Energy - Total	**546.26**	**457.91**	**471.19**	**484.86**	**498.92**	**513.38**	**528.27**	**543.59**	**559.36**	**575.58**	**592.27**
Total	**54,132.34**	**54,579.85**	**56,162.66**	**57,791.38**	**59,467.33**	**61,191.88**	**62,966.45**	**64,792.48**	**66,671.46**	**68,604.93**	**70,594.47**
Medium Adaptation Scenario											
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Fuelwood	1,842.26	1,860.68	1,879.29	1,898.08	1,917.06	1,936.23	1,916.87	1,897.70	1,878.73	1,859.94	1,841.34
Animal Waste	50,289.88	50,792.77	51,300.70	51,813.71	52,331.85	52,855.17	52,326.61	51,803.35	51,285.31	50,772.46	50,264.74
Agriculture Residue	116.84	118.01	119.19	120.38	121.58	122.80	121.57	120.36	119.15	117.96	116.78
Biomass - Total	**52,248.98**	**52,771.47**	**53,299.18**	**53,832.17**	**54,370.49**	**54,914.20**	**54,365.06**	**53,821.41**	**53,283.19**	**52,750.36**	**52,222.86**
LPG	1,243.90	1,256.34	1,268.90	1,281.59	1,294.41	1,307.35	1,294.28	1,281.33	1,268.52	1,255.83	1,243.28
Kerosene	93.20	94.13	95.08	96.03	96.99	97.96	96.98	96.01	95.05	94.10	93.16
Fossil Fuel - Total	**1,337.10**	**1,350.47**	**1,363.98**	**1,377.62**	**1,391.39**	**1,405.31**	**1,391.25**	**1,377.34**	**1,363.57**	**1,349.93**	**1,336.43**
Hydropower	453.38	634.73	888.62	1,244.07	1,741.70	2,438.37	3,413.72	4,779.21	6,690.90	9,367.26	13,114.16
Solar Home System	92.88	130.04	182.05	254.87	356.82	499.55	699.37	979.12	1,370.77	1,919.08	2,686.71
Renewabale Energy - Total	**546.26**	**764.77**	**1,070.67**	**1,498.94**	**2,098.52**	**2,937.93**	**4,113.10**	**5,758.34**	**8,061.67**	**11,286.34**	**15,800.87**
Total	**54,132.34**	**54,886.70**	**55,733.83**	**56,708.73**	**57,860.41**	**59,257.43**	**59,869.41**	**60,957.08**	**62,708.43**	**65,386.63**	**69,360.16**
Climate Resilient Scenario											
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Fuelwood	1,842.26	1,713.30	1,593.37	1,481.84	1,378.11	1,281.64	1,191.92	1,108.49	1,030.90	958.73	891.62
Animal Waste	50,289.88	46,769.58	43,495.71	40,451.01	37,619.44	34,986.08	32,537.06	30,259.46	28,141.30	26,171.41	24,339.41
Agriculture Residue	116.84	108.66	101.05	93.98	87.40	81.28	75.59	70.30	65.38	60.80	56.55
Biomass - Total	**52,248.98**	**48,591.55**	**45,190.14**	**42,026.83**	**39,084.95**	**36,349.01**	**33,804.58**	**31,438.25**	**29,237.58**	**27,190.95**	**25,287.58**
LPG	1,243.90	646.83	336.35	174.90	90.95	47.29	24.59	12.79	6.65	3.46	1.80
Kerosene	93.20	48.46	25.20	13.10	6.81	3.54	1.84	0.96	0.50	0.26	0.13
Fossil Fuel - Total	**1,337.10**	**695.29**	**361.55**	**188.01**	**97.76**	**50.84**	**26.44**	**13.75**	**7.15**	**3.72**	**1.93**
Hydropower	453.38	665.47	976.77	1,433.71	2,104.40	3,088.83	4,533.79	6,654.70	9,767.76	14,337.12	21,044.03
Solar Home System	92.88	136.34	200.11	293.73	431.13	632.81	928.84	1,363.36	2,001.13	2,937.26	4,311.32
Renewabale Energy - Total	**546.26**	**801.80**	**1,176.89**	**1,727.43**	**2,535.53**	**3,721.65**	**5,462.63**	**8,018.05**	**11,768.90**	**17,274.39**	**25,355.35**
Total	**54,132.34**	**50,088.64**	**46,728.58**	**43,942.27**	**41,718.24**	**40,121.49**	**39,293.64**	**39,470.05**	**41,013.62**	**44,469.05**	**50,644.86**

Annex 8: Energy Demand in Different Scenarios (Central Region)

Business as Usual Scenario											
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Fuelwood	20,239.20	20,441.59	21,034.40	21,644.40	22,272.08	22,917.97	23,582.59	24,266.49	24,970.22	25,694.35	26,439.49
Animal Waste	25,324.30	25,577.54	26,319.29	27,082.55	27,867.94	28,676.11	29,507.72	30,363.45	31,243.99	32,150.06	33,082.41
Agriculture Residue	102.33	103.35	106.35	109.43	112.61	115.87	119.23	122.69	126.25	129.91	133.68
Biomass - Total	**45,665.83**	**46,122.49**	**47,460.04**	**48,836.38**	**50,252.64**	**51,709.96**	**53,209.55**	**54,752.63**	**56,340.45**	**57,974.33**	**59,655.58**
LPG	4,885.43	4,934.29	5,077.38	5,224.63	5,376.14	5,532.05	5,692.48	5,857.56	6,027.43	6,202.22	6,382.09
Kerosene	2,085.76	2,106.62	2,167.71	2,230.58	2,295.26	2,361.82	2,430.32	2,500.80	2,573.32	2,647.95	2,724.74
Fossil Fuel - Total	**6,971.20**	**7,040.91**	**7,245.09**	**7,455.20**	**7,671.40**	**7,893.87**	**8,122.80**	**8,358.36**	**8,600.75**	**8,850.17**	**9,106.83**
Hydropower	2,884.09	2,912.93	2,997.40	3,084.33	3,173.77	3,265.81	3,360.52	3,457.97	3,558.26	3,661.45	3,767.63
Solar Home System	151.79	153.31	157.76	162.33	167.04	171.88	176.87	182.00	187.28	192.71	198.30
Renewabale Energy - Total	**3,035.88**	**3,066.24**	**3,155.16**	**3,246.66**	**3,340.81**	**3,437.70**	**3,537.39**	**3,639.97**	**3,745.53**	**3,854.15**	**3,965.92**
Total	**55,672.90**	**56,229.63**	**57,860.29**	**59,538.24**	**61,264.85**	**63,041.53**	**64,869.74**	**66,750.96**	**68,686.74**	**70,678.65**	**72,728.33**
Medium Adaptation Scenario											
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Fuelwood	20,239.20	20,441.59	20,646.01	20,852.47	21,060.99	21,271.60	21,058.89	20,848.30	20,639.81	20,433.42	20,229.08
Animal Waste	25,324.30	25,577.54	25,833.32	26,091.65	26,352.57	26,616.09	26,349.93	26,086.43	25,825.57	25,567.31	25,311.64
Agriculture Residue	102.33	103.35	104.39	105.43	106.49	107.55	106.47	105.41	104.36	103.31	102.28
Biomass - Total	**45,665.83**	**46,122.49**	**46,583.71**	**47,049.55**	**47,520.04**	**47,995.25**	**47,515.29**	**47,040.14**	**46,569.74**	**46,104.04**	**45,643.00**
LPG	4,885.43	4,934.29	4,983.63	5,033.47	5,083.80	5,134.64	5,083.29	5,032.46	4,982.14	4,932.31	4,882.99
Kerosene	2,085.76	2,106.62	2,127.69	2,148.96	2,170.45	2,192.16	2,170.24	2,148.53	2,127.05	2,105.78	2,084.72
Fossil Fuel - Total	**6,971.20**	**7,040.91**	**7,111.32**	**7,182.43**	**7,254.25**	**7,326.80**	**7,253.53**	**7,180.99**	**7,109.18**	**7,038.09**	**6,967.71**
Hydropower	2,884.09	3,432.06	4,084.15	4,860.14	5,783.57	6,882.45	8,190.11	9,746.24	11,598.02	13,801.65	16,423.96
Solar Home System	151.79	182.15	218.58	262.30	314.76	377.71	453.25	543.91	652.69	783.22	939.87
Renewabale Energy - Total	**3,035.88**	**3,614.22**	**4,302.74**	**5,122.44**	**6,098.33**	**7,260.16**	**8,643.37**	**10,290.14**	**12,250.71**	**14,584.87**	**17,363.83**
Total	**55,672.90**	**56,777.61**	**57,997.77**	**59,354.42**	**60,872.63**	**62,582.20**	**63,412.19**	**64,511.27**	**65,929.63**	**67,727.00**	**69,974.54**
Climate Resilient Scenario											
Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Fuelwood	20,239.20	18,822.46	17,504.88	16,279.54	15,139.97	14,080.18	13,094.56	12,177.94	11,325.49	10,532.70	9,795.41
Animal Waste	25,324.30	23,551.60	21,902.99	20,369.78	18,943.89	17,617.82	16,384.57	15,237.65	14,171.02	13,179.05	12,256.51
Agriculture Residue	102.33	95.17	88.51	82.31	76.55	71.19	66.21	61.57	57.26	53.25	49.53
Biomass - Total	**45,665.83**	**42,469.22**	**39,496.38**	**36,731.63**	**34,160.42**	**31,769.19**	**29,545.34**	**27,477.17**	**25,553.77**	**23,765.00**	**22,101.45**
LPG	4,885.43	2,442.72	1,221.36	610.68	305.34	152.67	76.33	38.17	19.08	9.54	4.77
Kerosene	2,085.76	1,042.88	521.44	260.72	130.36	65.18	32.59	16.30	8.15	4.07	2.04
Fossil Fuel - Total	**6,971.20**	**3,485.60**	**1,742.80**	**871.40**	**435.70**	**217.85**	**108.92**	**54.46**	**27.23**	**13.62**	**6.81**
Hydropower	2,884.09	3,518.58	4,292.67	5,237.06	6,389.22	7,794.84	9,509.71	11,601.84	14,154.25	17,268.18	21,067.19
Solar Home System	151.79	185.19	225.93	275.63	336.27	410.25	500.51	610.62	744.96	908.85	1,108.80
Renewabale Energy - Total	**3,035.88**	**3,703.77**	**4,518.60**	**5,512.70**	**6,725.49**	**8,205.10**	**10,010.22**	**12,212.47**	**14,899.21**	**18,177.04**	**22,175.98**
Total	**55,672.90**	**49,658.59**	**45,757.78**	**43,115.73**	**41,321.60**	**40,192.13**	**39,664.49**	**39,744.10**	**40,480.21**	**41,955.66**	**44,284.25**

Annex 9: Energy Demand in Different Scenarios (Southern Region)

Business as Usual Scenario

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fuelwood	24,796.80	25,044.77	25,771.07	26,518.43	27,287.46	28,078.80	28,893.08	29,730.98	30,593.18	31,480.38	32,393.31
Animal Waste	2,820.64	2,848.84	2,931.46	3,016.47	3,103.95	3,193.96	3,286.59	3,381.90	3,479.97	3,580.89	3,684.74
Agriculture Residue	62.68	63.31	65.14	67.03	68.98	70.98	73.03	75.15	77.33	79.57	81.88
Biomass - Total	**27,680.12**	**27,956.92**	**28,767.67**	**29,601.93**	**30,460.39**	**31,343.74**	**32,252.71**	**33,188.03**	**34,150.49**	**35,140.85**	**36,159.94**
LPG	460.43	465.03	478.52	492.40	506.68	521.37	536.49	552.05	568.06	584.53	601.48
Kerosene	255.54	258.10	265.59	273.29	281.21	289.37	297.76	306.39	315.28	324.42	333.83
Fossil Fuel - Total	**715.97**	**723.13**	**744.10**	**765.68**	**787.89**	**810.74**	**834.25**	**858.44**	**883.34**	**908.95**	**935.31**
Hydropower	1,766.77	1,784.44	1,836.19	1,889.44	1,944.23	2,000.61	2,058.63	2,118.33	2,179.76	2,242.98	2,308.02
Solar Home System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewabale Energy - Total	**1,766.77**	**1,784.44**	**1,836.19**	**1,889.44**	**1,944.23**	**2,000.61**	**2,058.63**	**2,118.33**	**2,179.76**	**2,242.98**	**2,308.02**
Total	**30,162.86**	**30,464.49**	**31,347.96**	**32,257.05**	**33,192.51**	**34,155.09**	**35,145.59**	**36,164.81**	**37,213.59**	**38,292.78**	**39,403.27**

Medium Adaptation Scenario

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fuelwood	24,796.80	25,044.77	25,295.22	25,548.17	25,803.65	26,061.69	25,801.07	25,543.06	25,287.63	25,034.75	24,784.40
Animal Waste	2,820.64	2,848.84	2,877.33	2,906.10	2,935.17	2,964.52	2,934.87	2,905.52	2,876.47	2,847.70	2,819.23
Agriculture Residue	62.68	63.31	63.94	64.58	65.23	65.88	65.22	64.57	63.92	63.28	62.65
Biomass - Total	**27,680.12**	**27,956.92**	**28,236.49**	**28,518.85**	**28,804.04**	**29,092.08**	**28,801.16**	**28,513.15**	**28,228.02**	**27,945.74**	**27,666.28**
LPG	460.43	465.03	469.68	474.38	479.12	483.91	479.08	474.28	469.54	464.85	460.20
Kerosene	255.54	258.10	260.68	263.29	265.92	268.58	265.89	263.24	260.60	258.00	255.42
Fossil Fuel - Total	**715.97**	**723.13**	**730.36**	**737.67**	**745.04**	**752.49**	**744.97**	**737.52**	**730.15**	**722.84**	**715.62**
Hydropower	1,766.77	2,120.13	2,544.15	3,052.98	3,663.58	4,396.29	5,275.55	6,330.66	7,596.80	9,116.16	10,939.39
Solar Home System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewabale Energy - Total	**1,766.77**	**2,120.13**	**2,544.15**	**3,052.98**	**3,663.58**	**4,396.29**	**5,275.55**	**6,330.66**	**7,596.80**	**9,116.16**	**10,939.39**
Total	**30,162.86**	**30,800.18**	**31,511.00**	**32,309.50**	**33,212.66**	**34,240.87**	**34,821.68**	**35,581.33**	**36,554.96**	**37,784.74**	**39,321.28**

Climate Resilient Scenario

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fuelwood	24,796.80	23,061.02	21,446.75	19,945.48	18,549.30	17,250.85	16,043.29	14,920.26	13,875.84	12,904.53	12,001.21
Animal Waste	2,820.64	2,623.19	2,439.57	2,268.80	2,109.98	1,962.28	1,824.92	1,697.18	1,578.38	1,467.89	1,365.14
Agriculture Residue	62.68	58.29	54.21	50.42	46.89	43.61	40.55	37.71	35.07	32.62	30.34
Biomass - Total	**27,680.12**	**25,742.51**	**23,940.53**	**22,264.70**	**20,706.17**	**19,256.73**	**17,908.76**	**16,655.15**	**15,489.29**	**14,405.04**	**13,396.69**
LPG	460.43	239.42	124.50	64.74	33.66	17.51	9.10	4.73	2.46	1.28	0.67
Kerosene	255.54	132.88	69.10	35.93	18.68	9.72	5.05	2.63	1.37	0.71	0.37
Fossil Fuel - Total	**715.97**	**372.31**	**193.60**	**100.67**	**52.35**	**27.22**	**14.16**	**7.36**	**3.83**	**1.99**	**1.03**
Hydropower	1,766.77	2,164.30	2,651.26	3,247.80	3,978.55	4,873.72	5,970.31	7,313.63	8,959.20	10,975.02	13,444.40
Solar Home System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewabale Energy - Total	**1,766.77**	**2,164.30**	**2,651.26**	**3,247.80**	**3,978.55**	**4,873.72**	**5,970.31**	**7,313.63**	**8,959.20**	**10,975.02**	**13,444.40**
Total	**30,162.86**	**28,279.11**	**26,785.39**	**25,613.16**	**24,737.07**	**24,157.68**	**23,893.23**	**23,976.14**	**24,452.32**	**25,382.05**	**26,842.12**

Annex 10: Energy Consumption in Different Scenarios

Energy Consumption in BAS, - (2010)

Energy Source	Northern	Central	Southern	Total
Units	**GJ**	**GJ**	**GJ**	**GJ**
Biomass	52,248.98	45,665.83	27,680.12	125,594.92
Fossil Fuel	1,337.10	6,971.20	715.97	9,024.27
Renewable Energy	546.26	3,035.88	1,766.77	5,348.91
Total	54,132.34	55,672.90	30,162.86	139,968.10

Energy Consumption in BAS (2020)

Energy Source	Northern	Central	Southern	Total
Units	**GJ**	**GJ**	**GJ**	**GJ**
Biomass	68,255.48	59,655.58	36,159.94	164,071.00
Fossil Fuel	1,746.72	9,106.83	935.31	11,788.86
Renewable Energy	592.27	3,965.92	2,308.02	6,866.22
Total	70,594.47	72,728.33	39,403.27	182,726.08

Energy Consumption in MAS (2020)

Energy Source	Northern	Central	Southern	Total
Units	**GJ**	**GJ**	**GJ**	**GJ**
Biomass	52,222.86	45,643.00	27,666.28	125,532.14
Fossil Fuel	1,336.43	6,967.71	715.62	9,019.76
Renewable Energy	15,800.87	17,363.83	10,939.39	44,104.09
Total	69,360.16	69,974.54	39,321.28	178,655.98

Energy Consumption in CRS (2020)

Energy Source	Northern	Central	Southern	Total
Units	**GJ**	**GJ**	**GJ**	**GJ**
Biomass	25,287.58	22,101.45	13,396.69	60,785.72
Fossil Fuel	1.93	6.81	1.03	9.78
Renewable Energy	25,355.35	22,175.98	13,444.40	60,975.73
Total	50,644.86	44,284.25	26,842.12	121,771.23

Annex 11: Ethnicity Composition in Mustang

Region	VDC	Gurung	Thakali	Dalit	Magar	Chetri	Lepcha	Bahun	Thakuri	Tamang	Bhote	Newar	Sherpa	Rai	Others	Total
Northern	Chonnup	872	0	0	7	26	0	7	0	0	147	0	0	0	11	1070
	Lomanthan	84	0	15	8	67	634	24	0	0	0	0	0	0	11	843
	Chhoser	750	0	0	0	0	0	20	0	0	0	0	0	0	13	783
	Surkhang	492	0	0	0	0	0	11	0	0	0	5	0	0	7	515
	Chharang	482	0	0	0	134	0	13	0	11	0	0	0	0	21	661
	Ghami	711	0	8	25	14	0	7	37	0	0	0	0	7	41	850
	Chhusang	584	0	25	14	5	0	21	0	0	0	0	0	0	10	659
	Total	3975	0	48	54	246	634	103	37	11	147	5	0	7	114	5381
Central	Kagbeni	825	0	33	15	19	0	14	47	0	0	0	0	0	41	994
	Jhon	425	0	9	0	26	0	12	12	0	0	0	0	0	5	489
	Muktinath	824	0	38	6	15	0	34	68	0	0	0	0	0	7	992
	Jomsom	405	511	177	107	131	0	168	18	25	0	77	23	9	48	1699
	Marpha	193	681	255	104	68	0	74	7	43	0	30	15	16	74	1560
	Total	2672	1192	512	232	259	0	302	152	68	0	107	38	25	175	5734
Southern	Tukeche	26	320	150	84	39	0	44	0	27	0	10	18	13	25	756
	Kobang	24	347	200	127	40	0	20	0	17	0	0	0	0	11	786
	Kunjo	14	205	347	92	19	0	6	0	0	0	0	0	0	34	717
	Lete	39	407	191	289	56	0	82	0	35	0	21	0	0	22	1142
Total		103	1279	888	592	154	0	152	0	79	0	31	18	13	92	3401
Grand Total		6750	2471	1448	878	659	634	557	189	158	147	143	56	45	381	14516