District Development Committee, Chitwan

DISTRICT CLIMATE AND ENERGY PLAN

Chitwan District

Technical Support by Alternative Energy Promotion Center (AEPC)

December 2014

Submitted by :	
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PREFACE

This plan "District Climate and Energy Plan of Chitwan District**"** was prepared between on May 2014 to December 2014 period. The activities related to the study on information collection were initiated, guided, funded and monitored by Alternative Energy Promotion Centre and District Development Committee Chitwan Jointly.

A dedicated team comprising of Environmental Engineers, Renewable Energy Experts, Environmental / Social Scientist having expertise in the climate change and energy were directly involved in information collection, analysis and interpretation.

The report provides comprehensive information on the state of Energy and climate change situation in district. The report is organized in such a way that can provide background information on Energy and climate change situation in the district. It suggests aspects of and future prospects with Energy and climate change, providing a five year plan.

It is important to note here that this report is compiled within short span of time with limited resources. Therefore, there may be possible to identify some deviations particularly in the figures presented in the report. However, it is expected that the report in present form will serve a basis for future endeavors on the subject.

Acknowledgement

CIAS -Green Jv would like to extend its sincere gratitude to Alternative Energy Promotion Centre and District Development Committee, Chitwan for relying and providing an opportunity for such a gracious work. We are great full to Pr. Dr. Govinda Pokhrel (former Executive Director, AEPC) and Ram Prasad Dhital (Executive Director, AEPC). We like to acknowledge Mr. Raju Laudari, Mr. Rudra Prasad Khanal, Mr. Prem Pokhrel, Mr. Krishna Chandra poudel, Ms. Nigma Tamrakar, Mr. Rajan Rijal, Mr. Laxman Punjali and Mr. Bibek Raj Kandel of AECP for their guidance and inspiration throughout the study period. Their valuable comments and insights in general have helped in improving the document quality.

We would also like to thank Bishal Lamichane, EEO Chitwan for regular support and assistance for preparation of DCEP. We are also very grateful to DEEU for providing district information, organizing site visits and meetings with the stakeholders in the district and arranging enumerators for data collection. We are thankful to all enumerators involved in data collection for their restless effort even during monsoon.

We are thankful to many people whose assistance and cooperation has made preparation of Chitwan's District Climate and Energy Plan possible. First and foremost, we are thankful to all the task force members. We are very grateful for their interest and the openness with which they shared their experiences. We would also like to thank the district stakeholders in renewable energy and more importantly members of the DEEU and DDC for availing themselves during the course of this assignment.

Dinesh Prasad Bhatt

Team Leader for DCEP

CIAS- Green jv

Acronyms and Abbreviations

AEPC	Alternative Energy Promotion Centre
BAU	Business as Usual
BSP	Biogas Support Program
BSP-N	Biogas Sector Partnership Nepal
CBOs	Community Based Organizations
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
CFUG	Community Forest Users Group
CRT	Centre for Rural Technology
DDC	District Development Committee
DEEU	District Energy and Environment Unit
DEMI	Decentralized Energy Management Initiatives
DEPP	District Energy Perspective Plan
DFO	District Forest Office
ESAP	Energy Sector Assistance Programme
FDG	Focal Group Discussion
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHI	Global Horizontal Irradiance
GJ	Giga Joule
GSI	Gender and Social Inclusion
GoN	Government of Nepal
GWh	Giga Watt hour
Ha.	Hector
HDI	Human Development Index
HH	Household
ISRC	Intensive Study Research Centre
ICS	Improved Cooking Stove
INGO	International Non Governmental Organization

IWM	Improved Watermill
Kg.	Kilogram
KII	Key Informant Interview
Km.	Kilometre
kW	Kilo Watt
kWh	Kilo Watt hour
LCC	Life Cycle Cost
LEAP	Long range Energy Alternative Planning
LPG	Liquefied Petroleum Gas
m	Meter
MAS	Medium Adaptation Scenario
MHP	Micro Hydro Project
MJ	Mega Joule
MT	Metric Ton
NAPA	National Adaptation Programme of Action
NEA	Nepal Electricity Authority
NGO	Non Governmental Organization
NPC	National Planning Commission
NTFP	Non Timber Forest Products
NPR	Nepalese Rupees
REDP	Rural Energy Development Program
RET	Renewable Energy Technology
SHS	Solar Home System
sq. km	Square Kilometer
SHS Solar	Home System
SWERA	Solar and Wind Energy Resource Assessment
SWOT	Strength Weakness Opportunity Threat
UNDP	United Nation Development Program
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
Wp	Watt Peak

Executive Summary

This District Climate and Energy Plan (DCEP) for Chitwan District is prepared by District Development Committee (DDC), Chitwan with technical support from the National Rural and Renewable Energy Programme (NRREP) under Alternative Energy Promotion Center (AEPC). The main goal of the District Climate and Energy Plan (DCEP) is to create a planning process for accelerating the dissemination of renewable energy technologies at district level, contributing to development goals at national and local level. In addition to energy development, DCEP addresses climate change impacts on energy planning and ensures that women and social excluded and marginalized groups are addressed throughout the planning and implementation processes.

The methodology for preparing DCEP is based on DCEP Preparation Guidelines prepared by AEPC. Methodology for assignment was developed by dividing the works into three phases and nine stages as per ToR. Primary data were collected by social mobilizers through checklist provided to them. Similarly stakeholder/expert consultation has been the basis for collection of information on energy and climate vulnerabilities and impact and gender and social inclusion issues. The collated data was further used to compile climate, gender and social inclusion, technology and institutional assessments. Secondary data were taken from various sources like CBS 2011, DESR report, District Profiles, data from Department of Hydrology and Meteorology (DHM) etc. LEAP software is used for different assessment. Assessments have done for 3 different scenarios- Business as usual, Medium Adaptation and Climate Resilient Scenario for urban and rural settings of the district. The study is more focused on residential sector energy consumption compared to industrial or commercial energy needs as this is the major demand in the district. Limitations to the study include a general lack of recent disaggregated data of Chitwan on GSI especially those relating to renewable energy, which reflects in the study as weakness and needed to be strengthened in coming days. There is also very limited reliable climate data for Chitwan.

Administratively, the district comprises 2 Municipalities and 36 Village Development Committees (VDCs), 13 Ilakas and five electoral constituencies. Bharatpur is the district headquarters of Chitwan. Total population of the district is 579,984 with 132,462 households (CBS 2011) and projected to be 629,978 in 2015. Though verities of Caste and Ethnic groups reside in Chitwan, the Brahmin Hill (28.56%), Chhetree (11.36%) and Tharu (10.92%) are the dominant groups.

As per NAPA ranking for climate change vulnerability, Chitwan district lies in High vulnerability zone with vulnerability index from 0.061 to 0.786. According to the study by Practical Action in the Jugedi watershed region in Chitwan District, the summers are becoming hotter and the winters are becoming colder. Similarly the number and quality of water resources have fallen. Monsoon rainfall has increased whilst winter rainfall has become scarcer and periods of drought have become longer. Similarly, as per the study by Shambhu Chamakar (2010) submitted to NAPA, overall temperature and precipitation of the Chitwan is increasing.

The residential energy demand was found high in the district. The people inhabiting the rural Chitwan are predominantly peasant farmers. They mainly use traditional source of energy (fire wood, agricultural straw and husk, and animal dung), improved cooking stove (ICS), bio-gas, kerosene, LPG gas, coal and electricity for cooking. In rural area, more than half (51.4%) households use traditional stoves, about 24% use LPG gas, 13% bio-gas, 5.3% use ICS, 2.6% kerosene, 1.7% electricity and 1.5% use coal for cooking. Majority of Dalits (60.2%) use traditional stove for cooking and about 24% Dalits use LPG gas for cooking. Only 3.4% dalits have installed bio-gas stoves in rural Chitwan. Similarly, main source of energy for cooking for Janajatis are traditional stoves (47.4%) and LPG gas (28.1%). About 15.1% Janajati households have used bio-gas for cooking. More than half (57.1%) Madhesi households use traditional stoves, 17.5% use LPG gas, 11.8% use ICS, 7.5% use bio-gas and 4.8% use kerosene for cooking. Almost half (49.6%) religious minority households use traditional stoves, 25.2% use LPG gas, 12% bio-gas and 5.8% use ICS for cooking. Similarly, 43.3% Brahmin/Chhetri/Thakuri households use traditional stove, 28.6% use LPG stove, 20.5% use bio-gas, 2.5% ICS and 2.2% use electricity for cooking.

In urban Chitwan, all most equal number of households uses traditional stoves (36.7%) and LPG stoves (36.5%). Similarly, 11.3% households use ICS and 10.7% use bio-gas. Only 4.6% households use kerosene and 0.1% households use coal stove for cooking. Most of Dalit households (41.3%) use traditional stoves, 31.8% households use LPG gas, 19.9% use ICS and 4.2% use bio-gas for cooking in urban Chitwan. Surprisingly, 65% Janajati households use LPG gas, 14.9% use ICS and 12% households use traditional stoves for cooking. Same way, 48.6% Madhesi households use LPG gas for cooking. About 18% households use kerosene, 17.3% use traditional stove, 13.4% use ICS and 2.5% bio-gas for cooking.

Major energy source for lighting in rural Chitwan include electricity / national grid (69.4%), solar home system (17.4%), kerosene (10.7%), bio-gas (1.4%), LPG light (1%) and micro-hydro (0.2%). Most of Dalit households (69%) use electricity/national grid for lighting, 14.7% use kerosene lamp and 13.4% use solar light. About 65% Janajati households use national grid, 19% use solar light, 12% kerosene and 2.3% LPG light. About 80% Madhesi households use national grid, 9.2% kerosene lamp and 8.7% solar light. Almost 68% religious minority households use national grid, 20.5% households use solar light and 11.3% households use kerosene lamp for light. Similarly, 65.4% Brahmin/Chhetri/Thakuri households use national grid for light. About 25% households use solar light, 6.7% kerosene lamp and 2% bio-gas light.

Energy source of lighting in urban Chitwan include national grid (64.1%), bio-gas (19.2%), solar light (14%) and LPG light (2,7%). About 58% Dalit households use national grid for light, 34.6% households use solar light, 6.1% use LPG light and 3.6% households use bio-gas for light. Solar light being the second most energy source of light for Janajati households (30.6%) after national grid (55.7%). Considerable numbers of Janajati households (28.6%) are being attracted to bio-gas source for lighting and 5.6% households depend on LPG light. Being under privileged group, most of the religious minority households (89%) are dependent to national grid for light, and only 11.1% households are using bio-gas for lighting in urban

Chitwan. Being privileged groups, 35.8% Brahmin / Chhetri / Thakuri households are using bio-gas for light after electricity/national grid (58.8%).

The residential sector is the largest consumer of energy in the district with a demand of 27850, 28860, 29900, 30980, 32110 and 33270 GJ in 2014, 2015, 2016, 2017, 2018 and 2019, respectively. Cooking makes up the biggest share of energy consumption in the residential sector. In terms of fuel consumption, biomass has the largest share for cooking making up over 85% of fuel uses. For lighting, the main sources of energy is electricity (if the HH has access to the NEA or an off grid electricity connection) and kerosene (mainly in rural areas). The main consumers in the commercial sector of Chitwan are restaurants, hotels, hospitals, schools etc. The energy demand in the district in 2014 is estimated about 100 GJ and no significant change in energy demand is noted up to 2019. The industrial sector is primarily based on the industries like rice mills, saw mills, workshops, and other factories. The energy demand was calculated 100, 200, 300, 400, 500, 600 GJ in the year 2014-2019, respectively. The energy demand for agricultural sector from 2014-2019 are estimated to be 268247 GJ per year but no significant change in energy demand is noted.

For energy share, different technologies viz. traditional cooking stove, improved cooking stove, kerosene stove, biogas, LPG Stove and Electric stove have been assessed for cooking purpose. For lightning, technologies like kerosene lamp, solar home system, grid electricity, micro hydroelectricity, Biogas light, and LPG light have been assessed. Assessment of energy technologies has been made with relation to their existing use share, cost, resource availability, vulnerability to climate change, potential to adaptation, potential to mitigation, gender friendly in use, promote social inclusion and contribution in poverty reduction. LPG stove is found to be gender friendly whereas Biogas is found to be climate change friendly for cooking purpose. In case of lightning, gird electricity is gender as well as climate change friendly.

For cooking purpose, it is observed that LPG Stove is gaining popularity and spreading rapidly. In case of lightning, it is assumed that all the households will be connected to national grid within this plan period.

In this study, three types of scenarios - Business as Usual Scenario, Medium Adaptation Scenario and Climate Resilient Scenario have been used for residential cooking purpose. For projection, household growth rate have been considered to be 3.62%. The share of different technologies for different scenario for cooking purpose is taken as follow.

Share of Technologies for different scenarios

		Share of Technologies					
	Scenarios	**TCS**	**ICS**	**Biogas**	**Kerosene**	**LPG**	**Electricity**
Rural	BAU	51.4	5.3	12.8	2.6	23.8	1.7
	Purposed MAS	20	28	20	2	25	5
	Purposed CRS	10	30	30	0	20	10
Urban	BAU	36.7	11.3	10.7	4.6	36.5	0
	Purposed MAS	15	20	17	3	40	5
	Purposed CRS	5	25	20	0	35	15

The Business as Usual Scenario (BAU) is based on current status, increment trends and population growth rates. This scenario does not give emphasis on social and gender inclusions. In this scenario, the total energy demand is found to be 12.52 million GJ in the base year, which has been increased to 16.56 million GJ at the end of 2019. The increments in residential, transportation and industrial are found to be 9.88, 6.41 and 0.0000063 million GJ from 8.27, 3.98 and 0.0000015 million GJ, respectively during the year 2014-2019 whereas no increment is noted for commercial and agricultural sectors.

Medium Adaptation Scenario has taken into account the development of livelihoods by providing inclusive access to energy sources. It also takes into account cost of the technology along with adaptive measures to potential vulnerabilities of resources and technologies. In this scenario, emphasis is given to use of cheap and clean energy in the place of traditional inefficient energy sources and technologies. In this scenario, the total energy demand for urban sector is forecasted to decrease from 0.36 million GJ to 0.16 million GJ. The consumption of fuel wood is decreased whereas the use of electricity and biogas are increased. Regarding energy demand for rural sector, the total demand is found to be decreased from 7.91 million GJ to 3.87 million GJ. The demand of fuel wood will be decreased whereas the demand of electricity, biogas, and solar are predicted to be increased.

Climate Resilient Scenario has emphasized the use of clean and environment-friendly energy. Meeting energy demand through promotion of the maximum possible clean energy technology, security of supply, achieving, energy saving leading to the reduced climate change vulnerabilities are the main rational of this scenario. The total energy demand is predicted to decrease from 0.36 million GJ to 0.18 GJ at the end of 2019 in urban sector. Similarly, the total residential energy consumption is predicted to decrease from 7.91 million GJ to 1.90 million GJ at the end of year 2019 under CR scenario for rural sector.

It is estimated that by shifting from BAU Scenario to MA Scenario, emission of 213.56 thousand metric tonnes of CO_2 Equivalent GHGs will be reduced up to 2019 whereas by shifting from BAU Scenario to CR Scenario, emission of 246.95 thousand metric tonnes of CO_2 Equivalent GHGs will be reduced.

The implementation plan has focused on planning for rural as well as urban residential sector as the residential sector is the highest energy consuming sector of Chitwan. The level of intervention and budget requirements has also been analyzed for different scenarios. The district level offices have to take lead on technology assessment and institutional assessments for implementing DCEP. The DCEP should be the rolling document to be mainstreaming into usual annual and periodic development planning of the district, the DDC and line agencies in particular by adopting the current DDC planning process.

The detailed intervention of different technologies required for cooking in MAS is presented below:

Residential Energy demand for cooking in urban sector under MA scenario

	Households					
Fuels/Technology	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity (Rice	3547	3680	3819	3962	4112	4266

cooker, Micro-oven)						
LPG stove	38216	33300	27977	22226	16021	9338
Biogas	1186	1860	2582	3354	4179	5058

Residential Energy demand for cooking in rural sector under MA scenario

	Households					
Fuels/Technology	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity (Rice Cooker, Micro-oven)	4146	4301	4461	4627	4800	4979
LPG stove	32823	30124	27187	23998	20542	16804
Fuel wood (ICS-Mud or Metal type)	273,400	249,219	222,928	194,408	163,531	130,164
Solar	14780	15315	15870	16444	17040	17657
Kerosene	0	110	229	355	491	636

The detailed intervention of different technologies required for cooking in CR scenario is presented below:

Residential Energy demand in urban sector under CR scenario

	Households					
Fuels/Technology	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity (Rice Cooker, Micro-oven)	3547	3681	3821	3965	4116	4272
LPG stove	38216	33660	28723	23385	17623	11413
Biogas	1186	2036	2946	3919	4960	6070

Residential Energy demand in rural sector under CR scenario

	Households					
Fuels/ Technology	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity (Rice Cooker, Micro-oven)	4146	4302	4464	4631	4805	4986
LPG Stove	32823	30448	27858	25041	21983	18672
Fuel wood (ICS-Mud or Metal Type)	273400	236724	197035	154162	107927	58142
Kerosene	0	98	203	316	436	565
Solar	14780	15315	15870	16444	17040	17657

In case of lightning, though DDC is assured that 100% of the households will be connected to National Grid within this planning period.

Residential Energy demand for Lightning

	2014	2015	2016	2017	2018	2019
Annual Grid Electricity requirement, kWh	9253943	9588935	9936055	10295740	10668446	11054643

Cost required without subsidy for different technologies under different scenario up to 2019 is given below

Cost Calculation

Location	**Scenario**	**Technology**	**Cost Required (NRs)**
Rural	MAS	ICS	222375025
		Biogas	190560072
	CRS	ICS	168956616
		Biogas	279035316
Urban	MAS	Biogas	188206140
	CRS	Biogas	237371380

Monitoring and Evaluation Plan has been formulated for checking and verifying the achievement of the proposed plan.

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Chapter One

Introduction

The Agreement between Alternative Energy Promotion Center (AEPC), Khumaltaar Heights, Lalitpur Sub Metropolitan City, Nepal (hereinafter referred to as the “Client”) and Joint Venture of Civil Informatics and Solutions P. Ltd. (CIAS) and Green Consult (P) Ltd. (Green) (hereinafter referred to as the term "Consultant") for **“Preparation of District Climate and Energy Plans (DCEPs) in Selected Districts of Cluster 2”** (hereinafter referred to as the "Project") was officially signed on 23 April 2014. Cluster 2 includes Dolakha, Ramechhap, Mohattorai, Chitwan and Nuwakot Districts. This report, as required in the letter of agreement, contains a detail District Climate and Energy Plan for Chitwan District.

1.1. Background

This District Climate and Energy Plan (DCEP) for Chitwan District is prepared by District Development Committee (DDC), Chitwan with technical support from the National Rural and Renewable Energy Programme (NRREP) under Alternative Energy Promotion Center (AEPC). NRREP is a single programme modality (where there are no other AEPC executed Development Partner supported renewable energy programmes or projects funded outside the NRREP) for removing remove inefficiencies, duplication, lack of co-ordination, supply led projects and fragmentation of aid to the rural and renewable energy sector in Nepal. For the effective coordination of different actors at the local and district levels, AEPC has been supporting the DDCs to establish District Environment Energy and Climate Change Section (DEECCS). The energy planning and implementation have been started in the DDC by preparing District Energy Situation Reports (DESR), establishing District Energy Funds and Community Energy Fund in different districts.

For long term visionary plan for renewable energy to mainstream gender and social inclusion, and response climate change issue at district level, DCEPs are being prepared. DCEPs for three districts (Mustang, Ilam and Makwanpur) have already been prepared during the first phase and are under implementation. In this phase, DCEPs are being prepared for 25 districts under 5 clusters. Gradually, DCEPs will be prepared for all the districts.

The main goal of the DCEP is to create a planning process to increase the dissemination of renewable energy technologies at district level, contributing to Nepal’s national and local development plans. DCEPs will act as a systematic roadmap, which serves as a periodic rolling plan of the district in the sector of renewable energy development and climate change preparation. Strategies for development and dissemination of the RETs in the district will be mapped out and climate adaptation and mitigation and gender and social inclusion linkages identified.”

1.2. Rationale

Planning is a process and not an event. It is the framework that helps us identify our starting point ("Where are we now"), our objective ("Where do we want to be in the future"), the way to reach our objective ("How are we going to get there") and finally how do we measure our progress. The performance of a plan in meeting its objectives must be evaluated and taken forward as a major input into further planning cycles. The objective should be to ensure sustainable improvements to service coverage and standards.

Effective, country oriented and district specific plans are necessary for addressing issues related with climate change and energy. Appropriate Planning offers the opportunity to deliver sustainable improvements in adopting and mitigation climate change, combat energy crisis and incorporating GESI issues.

Planning and strategies are necessary to ensure that AEPC and DDC services keep pace with demand, are appropriate to needs, contribute to a sound environment, are cost-effective and build continuously on existing and new opportunities offered.

DCEP provides a framework for decentralized energy planning that is customized to local contexts and needs. At the district level, DCEP can align with other sectorial plans and programs, as well as broader development planning to promote a more consistent and comprehensive strategy. DCEP can also be placed within a broader framework that encapsulates national plans, moving Nepal towards a low-carbon emission, socio-economic development pathway. DCEPs will play an important role in providing inputs to national renewable energy planning, following a bottom-up approach.

DCEP ensures in adoption of RETs at local level with controlled GHG emission for combating climate change. In fact, widespread application of RETs offers some of the best prospects for achieving deep reductions in greenhouse gas emissions at the global level, while satisfying some of the increased demand for commercial energy. Similarly DCEP will be aligned towards addressing gender and social inclusion (GSI) issues.

1.3 Objectives of DCEP

The main objective of this assignment is to develop District Climate and Energy Plan (DCEP) for Chitwan District. These plans need to be adaptive and de-centralized and should contain detailed implementation plan that can contribute in developing climate change adaptation and mitigation technologies and also addresses the mainstreaming of Gender Equality and Social Inclusion.

The specific objectives of the study are:

- To outline energy needs of Chitwan district
- To carry out the assessment of available resource, technology and institutions working in climate change and renewable energy/energy sector.

- To carry out situational assessments of climate change, gender equality and social inclusion in the Chitwan district.
- To assess the institutional arrangements of the Chitwan district, identify the gap and recommend for necessary improvements.
- To conduct capacity need assessment and identify the actions to implement the proposed District Climate and Energy Plan (DCEPs)
- To outline implementation of the plan with identification of roles and responsibilities of different stakeholders
- To recommend interventions of appropriate renewable energy technologies incorporating the influencing factors of climate change and GESI that contribute to climate change adaptation and mitigation and GESI mainstreaming

1.4 Scope of DCEP

The detailed DCEPs will provide the basis for adapting and mitigating climate change along with mainstreaming GESI through RETs and other energy related programs. The scopes of the assignment are as follows:

- Review and assess climate change policy and program
- Review and assess the available District Energy Situation reports, district plans, annual reports, district overview documents from respective districts
- Define the methodology; finalize scope (activities) and basis for subsequent work.
- Conduct desk study to review the relevant document, program, policies etc.
- Prepare and present all findings of the desk study at the inception workshop. Prepare Inception report incorporating all comments received from inception workshop.
- Assess and analyze energy supply and consumption patterns in the selected district based on technology with GESI perspective – identify weaknesses and limitations.
- Analyze vulnerable groups in the context of climate and GESI
- Identify the potential of all alternative energy resources e.g. micro hydro, solar, improved water mills, peltric sets, wind, biomass/biogas, etc. Targets and recommendations for identifying appropriate technology based on climatic condition, geographical variations and GESI perspectives.
- Prepare a broad climate change assessment of the district – (based on existing data)
- Identify all current and potential stakeholders in the RE (and interlinking) sectors, analyze strengths and weaknesses in terms of ability to implement RE strategy.

- Prepare integrated rural/renewable energy development and management plan including divisions of responsibility and specific activities of stakeholders.
- Integrate a district climate and energy strategy addressing potential for mitigation and adaptation activities.
- Provide tentative financial requirements for identified/proposed RETs and suggest funding mechanisms and possible sources of funding (subsidies through AEPC, DDCs/VDCs commitments, Contribution from users, other sources of funds like: micro finance, other distribute agencies in the districts)
- Ensure that gender equality and social inclusion is incorporated in planning and processes are mainstreamed into the DCEP.
- Recommend appropriate strategies to implement GESI responsive DCEP implementation.
- Provide a monitoring and evaluation plan, mechanism for disaggregated data base for the implementation of DCEPs.

1.5 Limitation of the study

Major limitations for the assessment are as follows:

- Energy demand at individual level has been calculated through generalization bases rather than actual assessment
- As this study was not a user focused assessment it has not been possible to explicitly assess the particular needs of women and social groups
- Hydro-meteorological data could not be obtained at local level and hence reference has been made from available station of DHM (i.e Rampur Station).
- The information available, from implementing partners of RET interventions in the district are based on the total number of installations carried out. There is no such information on whether a particular HH has installed the same technology twice and no such information on the number of functioning technologies. Therefore the study makes some assumption on the lifespan of the technology and subsequently the operation number of technologies.

1.6 District Overview

1.6.1 Geographic profile

Chitwan District is located in south western part of Narayani Zone, Central Development Region of Nepal between longitudes 83°54' 45’’to 84°48’15’’E and latitudes 27°21'45’’ to 27°52' 30’’N. The district boundaries are marked by Nawalparasi District in the west along the Narayani River and the Makwanpur District in the east and the Parsa District and Bihar,

India in the south. It has the Tanahun, Gorkha and Dhading Districts to the north. It occupies 2,218 sq.km area which is 1.5% of total area of Nepal.

Most part of Chitwan district lies on Siwalik region (86.5%) followed by Mid-mountain region (12.7%) and Terai region (0.8%). Elevation of the district ranges from 244m to 1945m.

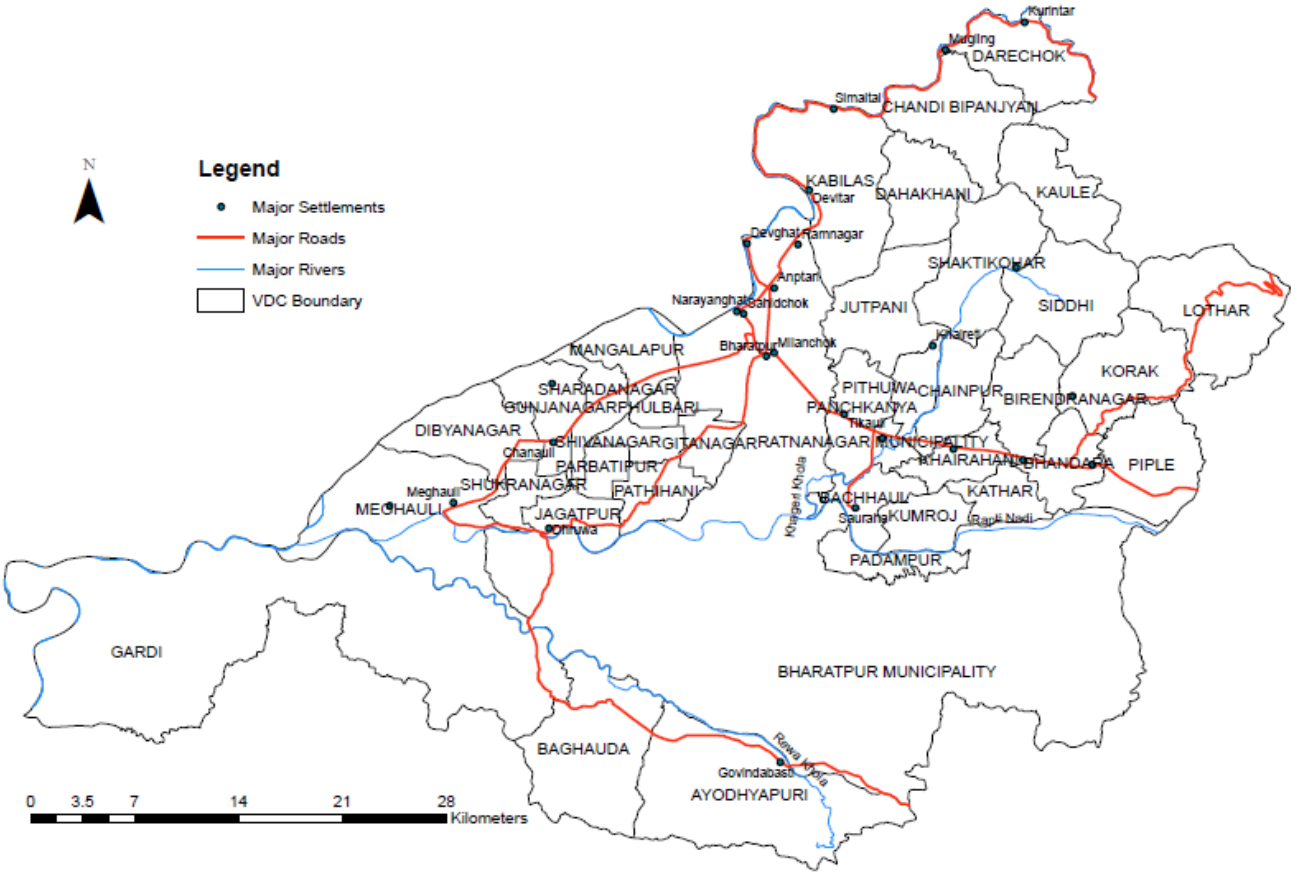

Figure 1: District Map of Chitwan

Administratively, the district comprises 2 Municipalities and 36 Village Development Committees (VDCs), 13 Ilakas and five electoral constituencies. Bharatpur is the district headquarters of Chitwan.

Narayani River is the major river and flows from north to east separating the District's western boundary. Most of the catchment water drains to this river. Manahari from eastern side drains to Lothar which again drains to Rapti River. Kayar khola, Ladar khola and Riukho River also drain to Rapti River and finally Rapti drains to Narayani River. Marsyangdi, Trisuli and Seti Rivers drain to Narayani River from northern side. Kaligandaki River drains to Narayani from Northern western side. Kiran Khola, Arun Khola and Bina Khola drain to Narayani from western side. The district has many lakes like Nanda-Bhausu lake, Kasara lake, Gaduwa lake, Tamoreghaila lake, Baikuntha Kunda etc.

1.6.2 Demographic Structure

a. Population

The following table shows the population status of Chitwan. According to the Census 2011 (CBS) the total population of Chitwan was 579,984 with an annual population growth 2.06% and having 51.88% population of female. The projected population of Chitwan is likely to reach around 629,978 in 2015.

Table 1: Demographic figure of Chitwan District

Population	**1991 census**	**2001 census**	**2011 census**	**2015 Projection***
Total Population	354,488	472,048	579,984	629,978
Male	175,656	235,084	279,087 (48.12%)	298,914
Female	178,832	236,964	300,897 (51.88%)	331,064
Total Households	65,147	92,863	132,462	152,683
Average Household size	5.4	5.08	4.38	4.13
Literacy Rate of 5 years and above	55.7	70.76	77	79.62
Population density per sq. Km	159.8	213	261.49	283.94

Source: ISRC 2014/15

b. Caste Ethnic Composition, Language and Religion

Though verities of Caste and Ethnic groups reside in Chitwan, the Brahmin Hill (28.56%), Chhetree (11.36%) and Tharu (10.92%) are the dominant groups. Similarly Tamang, Gurung, Newar, Chepang/Praja, Kami and Magar do also have remarkable presence within the district. The population distribution of Chitwan district on the basis of Caste and ethnic group is given in Table below.

In terms of religion, the majority of people (81.4%) in Chitwan are Hindu followed by Buddha (13.02%), Christian (3.39%) and smaller shares of Islam, Kirat, Sikh, Jain and of other religions.

Language wise 70.14% of total population speak Nepali, similarly 10.16% of people speak Tharu. Tamang is spoken by 4.92% followed by Chepang language with 3.71%, Gurung 2.83%, Bhojpuri 1.67%, Magar 1.61%, Newari 1.58% and Darai 1.14%. Along with these languages there are also various languages having users less than 1%.

Table 2: Caste/Ethnic Composition of Chitwan District

Caste	**Census 2011**	**%**	**Caste**	**Census 2011**	**%**	**Caste**	**Census 2011**	**%**
Brahman Hill	165652	28.56	Danuwar	1110	0.19	Kayastha	237	0.04
Chhetree	65894	11.36	Yadav	1099	0.19	Bangali	217	0.04
Tharu	63359	10.92	Kanu	1062	0.18	Hyolmo	213	0.04
Tamang	46198	7.97	Koiri/Kushwaha	922	0.16	Undefined	212	0.04

						Others		
Gurung	39155	6.75	Badi	840	0.14	Rajput	183	0.03
Newar	30256	5.22	Sunuwar	748	0.13	Brahmu/Baramo	156	0.03
Chepang/Praja	28989	5.00	Hajam/Thakur	613	0.11	Sherpa	144	0.02
Kami	28318	4.88	Majhi	594	0.10	Dhanuk	141	0.02
Magar	27985	4.83	Haluwai	558	0.10	Losar	138	0.02
Damai/Dholi	12101	2.09	Mallaha	549	0.09	Sudhi	130	0.02
Kumal	9302	1.60	Dura	549	0.09	Mali	129	0.02
Darai	8011	1.38	Terai Others	494	0.09	Nuriya	128	0.02
Sarki	7218	1.24	Gaine	469	0.08	Bhote	125	0.02
Musalman	6780	1.17	Marwadi	467	0.08	Foreigner	125	0.02
Gharti/Bhujel	4430	0.76	Kurmi	466	0.08	Dhobi	113	0.02
Rai	3962	0.68	Musahar	428	0.07	Tatma/Tatwa	92	0.02
Sanyasi/Dashnami	3716	0.64	Limbu	372	0.06	Baraee	84	0.01
Thakuri	3488	0.60	Dalit Others	365	0.06	Kumhar	79	0.01
Bote	3094	0.53	Dusadh/Pasawan/Pasi	359	0.06	Thami	72	0.01
Teli	1551	0.27	Brahman-Tarai	296	0.05	Bin	72	0.01
Kathbaniyan	1420	0.24	Chamar/Harijan/Ram	283	0.05	Badhaee	51	0.01
Ghale	1254	0.22	Thakali	283	0.05	Others	558	0.10
Kalwar	1252	0.22	Sonar	274	0.05			

c. Educational Status

As per Census report 2011, 77% of populations aged above five are literate and can read and write. Only 83.87% of boys and men aged five and above and 70.68% of women and girls in Chitwan can read and write. 1.93% of men aged above five can read only whereas the similar percentage for women is 2.01. 12.62% of total populations have passed School Leaving Certificate. Following figure shows completed level of education of Chitwan District as of 2011 census data.

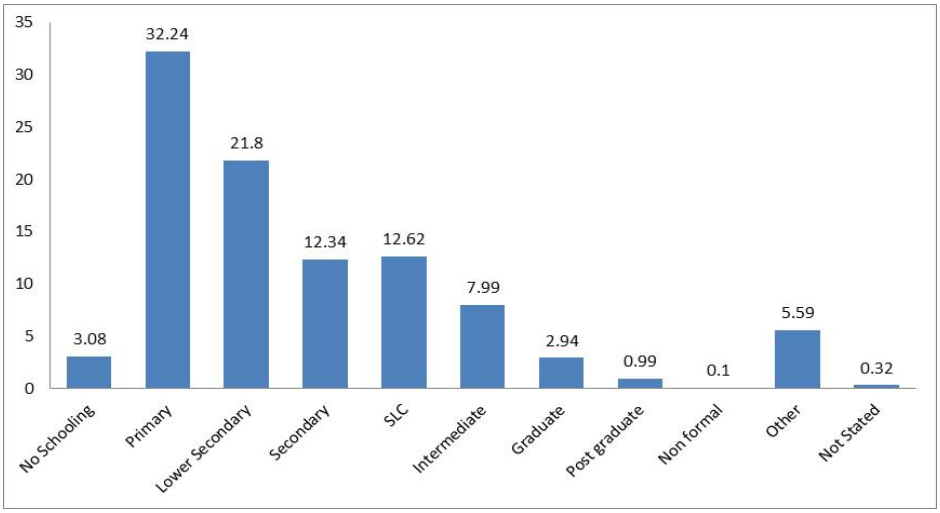

Figure 2: Completed level of education percentage

As per ISRC 2014/15, there were 680 ECD/Pre-primary centers, 521 primary, 289 Lower Secondary, 197 Secondary and 80 higher secondary schools in Chitwan in 2012. There are 2 constituent campuses under TU and more than 20 affiliated campuses/colleges under TU.

d. Health

According to ISRC 2014/15, there are 2 governmental hospitals, 28 institutions, 4 PHCC/HC, 5 HP, 31 SHP, 106 PHC Outreach Clinic, 226 EPI Clinic and 456 FCHV in 2011/12. 11 NGO/INGOs were found to be involved in Health sector.

Chitwan district is also known as the medical city of Nepal. There are many top rated medical institutions in the district, although most of them are situated in and around Bharatpur Municipality. People from all over Nepal and also from North India come here for treatment. After Kathmandu and Pokhara, it is the third most medically developed district.

Impetigo/Boils/Furunculosis, URTI, ARI/LRTI, Fall/Injury, ASOM, PUO, Gastritis, Headache, Fungal Infection, and Tonsilitis are the top 10 diseases of the district.

e. Economic Status

As per CBS 2011, 470927 people in Chitwan are 10 years and above and are considered for economic analysis. It is noticed that in Chitwan district, 53.8% of people are economically active. 48% of population are usually active and employed, however 0.8% of population are usually active but unemployed.

Agriculture is the main economic activities of Chitwan District; around 30.79% of the population has their own agriculture business. 18.59% of the population are involved in wage/salary earning. 10.09% of population are involved in own non-agricultural business, 8.15% in extended economic and 29.65% in household chores. 3% of population are seeking job, 30.51% are involved in study and 10.75% are involved in none of activity.

Now a days the trained of Foreign migration as worker is also rising. Remittance from foreign employment is also one of the sources of income. Especially the skill workers migrate to Gulf Countries for certain years. Similarly the non-skilled workers of southern part seasonally migrate to India.

f. Road Network

Average road density of the district is 11km/1000km^2. East West Highway also known as Mahendra Highway passes through heart of Chitwan. Most of the part of Chitwan is connected with its District Headquarters via road network. There are 139.75 kms blacktop road, 56.50 kms gravel road and 37 km of earthen road. There are 2 airports in this district.

g. Land Use pattern and Forest Distribution

Among total land of Chitwan 59.7% of land is occupied by forest and 34.7%of land is used for Agriculture and grass land. Similarly, only 2.8% of land is shrub. 1.7% of total land is barren land and 1.1% water bodies (Enviornmental Statistics 2008, 202013).

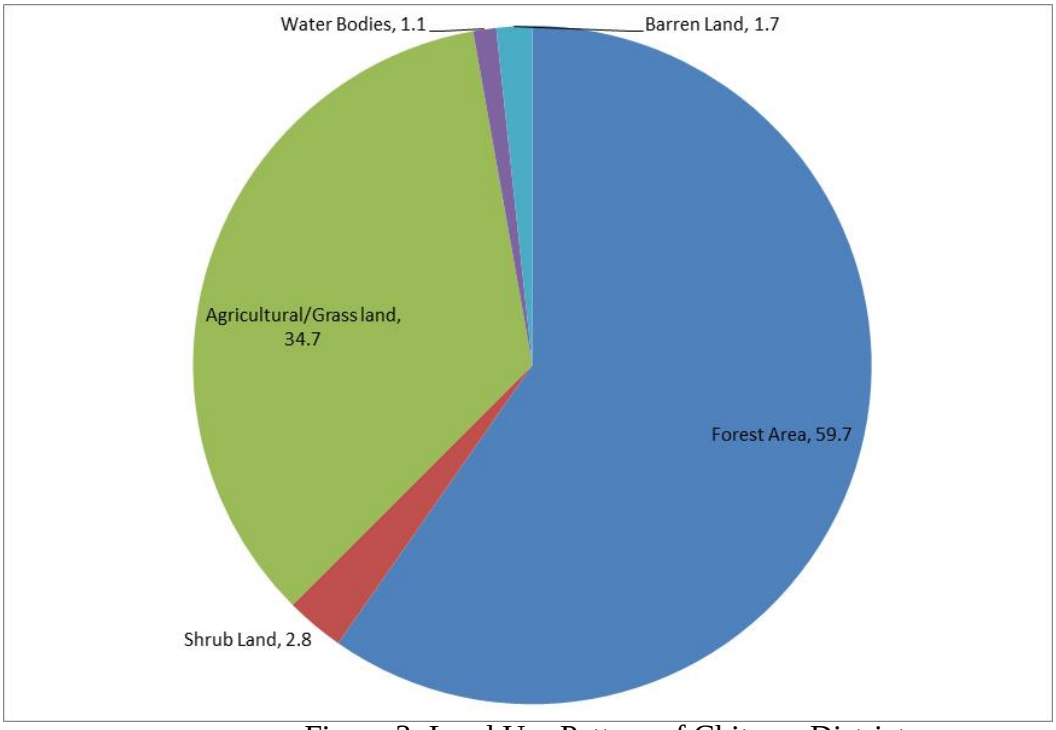

Figure 3: Land Use Pattern of Chitwan District

Drinking Water and Sanitation

According to National report of census 2011, 34.98% of total household are using tap /Piped, 49.26% of total household use Tubewell/hand pump, 13.45% of total household use well/kuwa, 0.48% of total household use spout water, 0.37% of use stream and river similarly 1.07% of total household use other source of water for drinking purpose.

Regarding the Sanitary facilities 5.91% of total household do not have toilet, 73.82% have modern toilet and 19.86% have ordinary toilet.

Energy

According to National report of Census 2011, 49.06% of total household use firewood, 0.75% of total household use kerosene, 39.70% of total household use LPG, 0.16% of total household use cow dung, 9.25% of total household use biogas, 0.08% of total household use Electricity whereas 0.51% of total household use other source of energy for cooking purpose.

For the lighting purpose 85.93% of total household use Electricity, 5.45% of total household use Kerosene, 0.25% of total household use Bio-gas, 5.64% of total household use Solar, 2.32% of total household use other source of energy.

Chapter Two

DCEP Preparation Process

2.1 DCEP Preparation Concept

The methodology for preparing DCEP is based on DCEP Preparation Guidelines prepared by AEPC. Methodology for assignment was developed by dividing the works into three phases and various stages as per ToR. Figure below shows the concept of the consultant for approach and methodology.

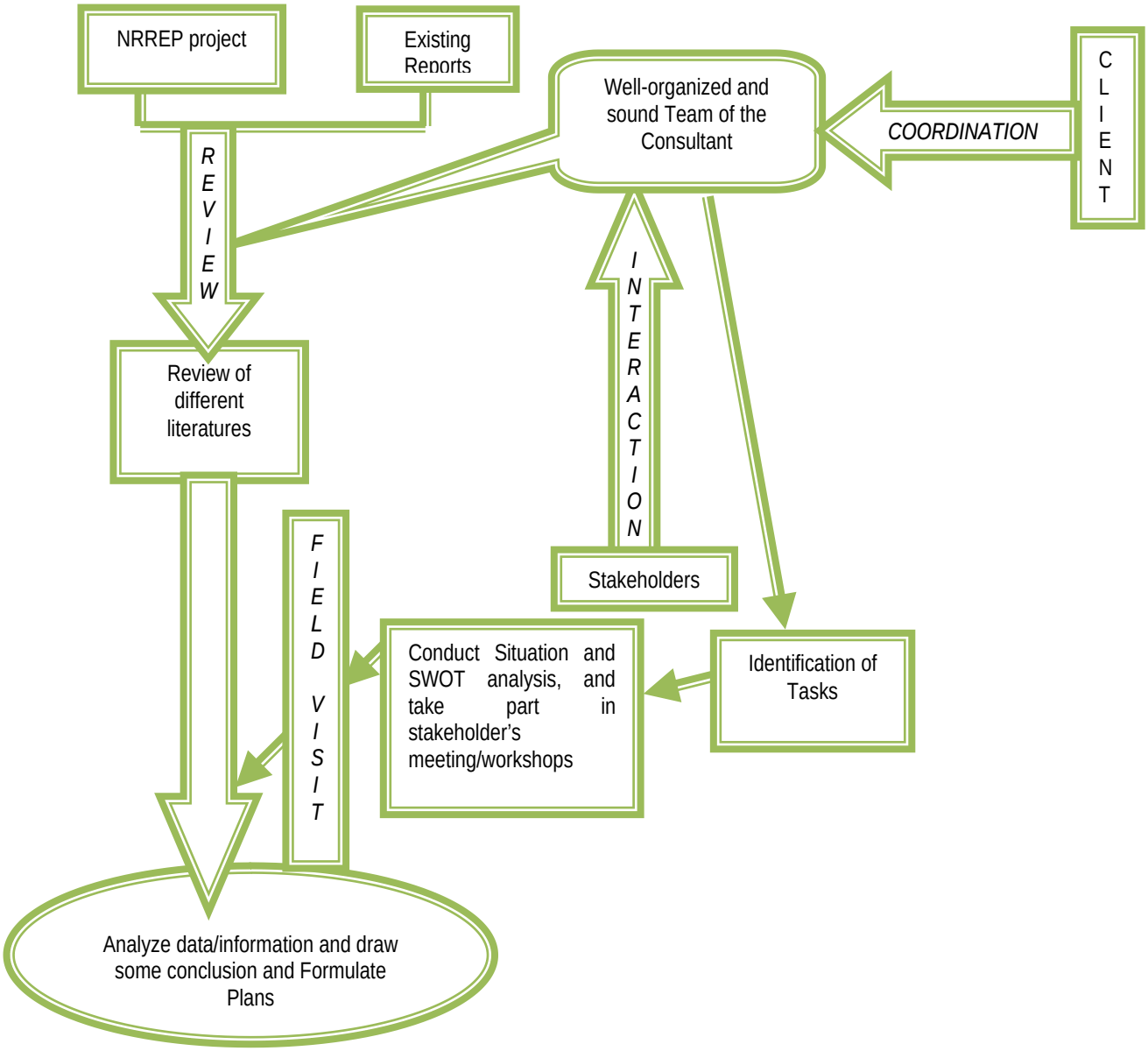

Figure 4: Approach to Conducting study for preparation of DCEPs

2.2 Steps involved in DCEP Preparation

The consultant has followed the nine stages of the DCEP preparation process as mentioned in the DCEP guidelines. Following figure outlines the DCEP preparation steps in brief

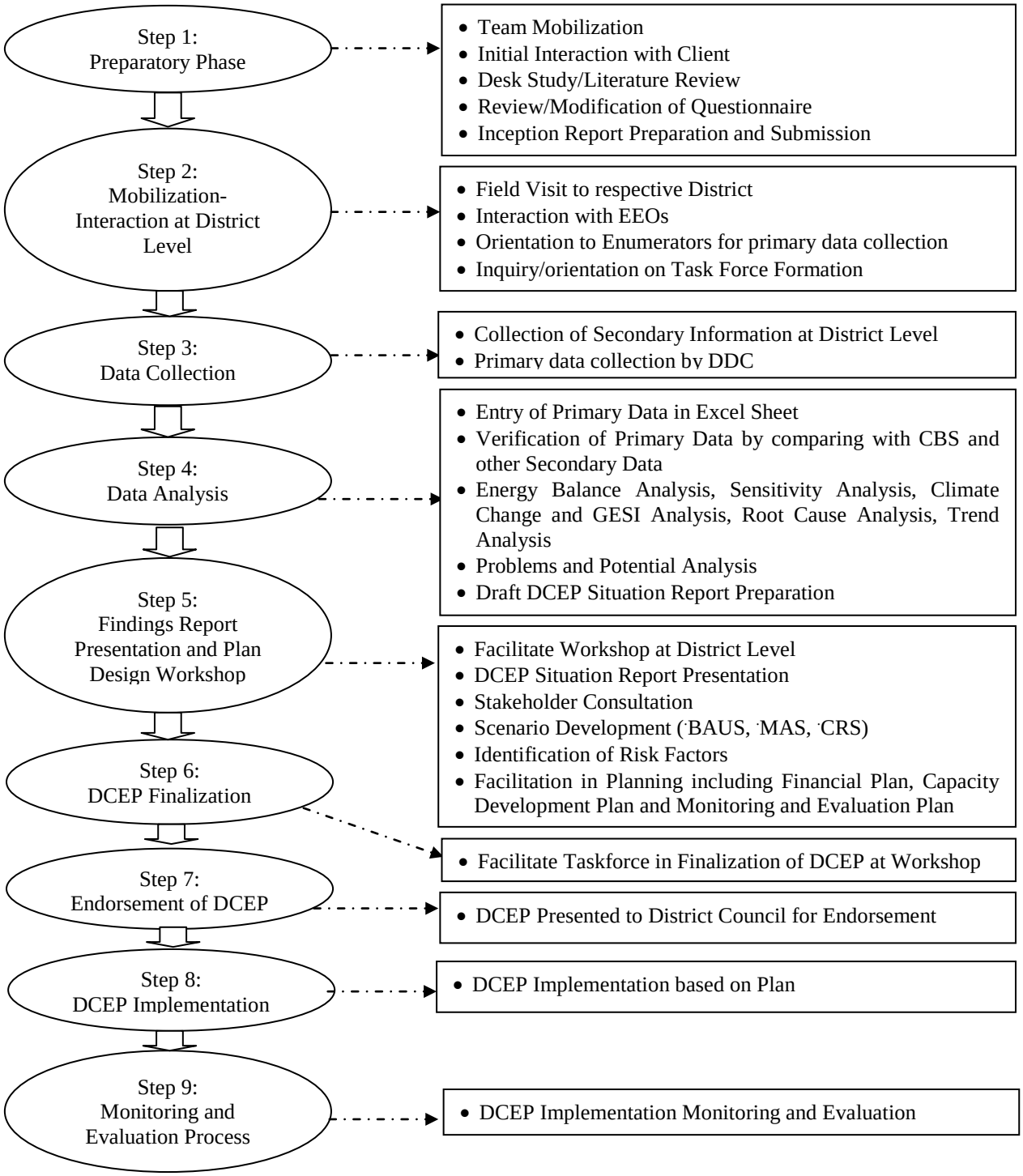

Figure 5: DCEP Preparation Steps

The final DCEP document has incorporated the relevant and appropriate feedback from related stakeholders and been approved by the DCEP task force (including DDC) and national level stakeholders.

2.3 Methodology for preparing DCEP

2.3.1 Data Collection

For preparation of DCEP, both primary and secondary data have been used. Primary data were collected by social mobilizers through checklist provided to them (Annex1). Orientation to social mobilizers for collecting data was given on 1st week of Jesth. Relevant participatory rural appraisal (PRA) tools including focus group discussions (FGDs), key informant interview (KII) and stakeholder/experts consultation also formed the basis for collection of information on energy and climate vulnerabilities and impact and gender and social inclusion issues. The collated data was further used to compile climate, gender and social inclusion, technology and institutional assessments.

Secondary data were taken from various sources like CBS 2011, DESR report, District Profiles, data from Department of Hydrology and Meteorology (DHM) etc. Primary data and secondary data were compared for verification. After that, data collected were entered in excel sheet for further analysis.

2.3.2 Energy Assessment

The necessity of energy in the district was assessed by collecting information from different documents including district and VDC profiles as well as primary data. The data for residential, commercial, agricultural and industrial sectors have been collected. The residential energy demand was found high in the district.

For energy assessment, the total energy requirement for each end-use has been calculated by multiplying the minimum energy amount with the average efficiencies for each device as indicated by EPS (2010) used by DCEP for Ilam and Makwanpur.

Table 3: Device efficiencies of technologies

TCS	ICS	Charcoal	Biogas stove	LPG stove	Kerosene stove	Electric Kettle
10%	20%	20%	60%	65%	50%	80%

Source: EPS, 2010

Table 4: Minimum energy requirements in cooking activities for different devices (GJ/household/year)

Fuelwood		Charcoal	Biogas	LPG	Kerosene	Electricity
TCS	ICS	Charcoal stove	Biogas stove	LPG stove	Kerosene stove	Electric Kettle
55.0	27.5	27.5	9.2	8.5	11.0	6.1

Source: EPS, 2010

Table 5: Minimum energy requirements in lighting for different devices (kWh/household/year)

Electric Devices					Kerosene Devices		
CFL (7 W)	Fluorescent Lamps	Incandescent Lamps	SHS (7 W)	SSHS (0.03 W)	Kerosene Tuki	Lantern (50 lm)	Gas Lamp

	(40 W)	(40W)			(5 lm)		(1000 lm)
35.8	44.2	143.1	35.8	38.2	2.6	8.6	26.1

Source: EPS, 2010

The level of the activities/ household shares and the intensity of energy for the device provide energy demand.

Energy Demand= Energy Intensity*Activity Level

Energy intensity is the amount of energy used per household and concerning activity level is the number of Households in case of residential sector. Energy demand changes with the change in energy intensity or activity level or both. Energy intensity changes with the technology use pattern of people which can be fairly estimated judging from the probable changes in the affinity of the people towards several available technologies.

The updated secondary data from various organizations including AEPC, BSP, WECS, CRT and EPS were used. In addition, specific energy consumption of different devices have been computed by multiplying the average annual household energy consumption (GJ/household) with their corresponding device shares.

2.3.3 Energy Resource Assessment

Forests, water and agriculture resources are treated as major energy sources in the district. The energy resource potential is taken from sources including Energy Poverty Study (EPS) 2010 and primary sources. The information on application for licenses and issues licenses on survey for generation was noted from the Department of Electricity in the district. In fact, it is a major source to get hydropower potential. Similarly, in order to find solar and wind potential, the reports-The Solar and Wind Energy Resources Assessment (SWERA)- have been referred. The potential of biogas was noted from the study of BSP on Technical and Market Potential of Biogas in Nepal. Furthermore, for the purpose of finding resource vulnerability, the report of the National Adaptation Programme of Action (NAPA), other supporting reports of climate change impacts and local perception of climate change impacts collected through focus group sessions were used in order to get resources vulnerable to the impacts of climate change in the district. The scenarios have been prepared using LEAP and considerations of communities, stakeholders and experts.

2.3.4 Technology Assessment

The technology assessment was done with the help of both the primary and secondary data. The analysis for the status and trend of specific technologies have been performed with the data about obtained from the respective well-known monitoring/ implementing organizations. That is: Biomass, solar home systems, watermills and bio fuel from AEPC; Biogas from BSP-Nepal; Micro Hydro from the REDP; and Improved water mills from CRT/N. They have further been verified through focus group discussions. This section further analyzes issues related with energy costs which are based on market prices regarding costs of fuel as well the installation costs from REDP as well as triangulation with the implementing organizations in the districts and the principal organizations. Comparative analyses have been

performed in order to prioritize the energy technologies based on financial estimates as well as from the environment perspectives.

For financial assessment, comparisons were done using following financial tools:

Payback Period

Net present value

Internal rate of return

Cost benefit analysis

Energy cost

From the environment perspective, comparisons were performed as:

Comparative emission rates of each of the technologies

Carbon emission abatement cost

Potential contribution to climate change adaptation

Vulnerability of the technology due to climatic variation and extreme events (through FGD)

These analyses have been carried out to prioritize different renewable energy technologies, considering prevailing values in the district to assess required costs to abate GHG emissions for different incremental investment for each technology.

The findings on technology prioritization are presented in Chapter 4.

2.3.5 Financial Assessment

For financial assessment, following terminologies were estimated.

Payback Period

Payback Period = Initial Cost / Uniform annual benefit = (Investment cost-Subsidy)/(Annual Income-Annual Expenditure)

The payback period should be used as a screening method only. It reflects liquidity, not the profitability of project.

Discounted payback period

It considers discounted cash flows (time value of money). The general formula for discounting is

PV = FV/[(1+m)n]

Net Present Value (NPV)

Present worth is an equivalence method of analysis in which a project's cash flows are discounted to a single present value.

NPV/NPW = A0/(1+i)0 + A1/(1+i)1+ …..+ AN/(1+i)N

NPV>0 : Accept

NPV<0: Reject

NPV=0: Remain indifferent

Net Future Worth

It is used to determine a project's value at commercialization (a future date), not its value when we begin investing (the present).

FW (i) = PW (i) (F/P, I, N)

Capitalized Equivalent

It is a constant annual net cash flow. In the project with lengthy service lives, it is recommended to apply.

CE (i) = A/i

Annual equivalent criterion

AE (i) = PW (i) (A/P, I, N)

Benefit/Cost Ratio

The total discounted income or revenue divided by total discounted cost will give benefit/cost ratio of the project. A cost-benefit analysis has been used, providing a systematic evaluation of the economic advantages (benefits) and disadvantages (costs) of a set of investment alternatives. Typically, a "Base Case" is compared to one or more Alternatives (which have some significant improvement compared to the Base Case). The analysis evaluates incremental differences between the Base Case and the Alternative(s). In other words, a benefit-cost analysis tries to answer the question: What additional benefits will result if this Alternative is undertaken, and what additional costs are needed to bring it about? It translates the effects of an investment into monetary terms and to account for the fact that benefits generally accrue over a long period of time while capital costs are incurred primarily in the initial years. The primary energy-related elements that can be monetized are investment costs, technology operating costs, ongoing maintenance costs, and remaining capital value (a combination of capital expenditure and salvage value). The computation is based on the discounted values of all costs and benefits.

2.3.6 Climate Change Assessment

For climate change assessment, precipitation and temperature data from Environmental Statistics of Nepal have been taken along with NAPA document and other secondary sources.

Similarly community and stakeholder's perception on changing climate and its consequences were documented and analyzed for further assessment. Trend in land use change and forest cover were also taken into consideration.

Impact of climate change in energy resources including possible impacts in upcoming years were estimated through trend analysis. Reductions on GHG emissions by switching from

traditional energy towards eco-friendly alternative energy have been estimated as per IPCC guideline.

2.3.7 Institutional Assessment

Institutional 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.

2.3.8 GESI Assessment

The disaggregate data available from field survey in terms of household heads and ownership of technologies as per ethnicity and gender has formed the basis for GSI assessment. The available data was analyzed considering the access and technologies with highest potential to address GSI issues to prioritize for scenario development. The upcoming FGDs will also provide the basis for a brief overview of the utilization of various technologies, ownership, acceptance of various RET technologies and the livelihood benefit it has been providing to various groups.

2.3.9 Scenario Development and LEAP Projection

Both primary and secondary data were analyzed to draw conclusions and make appropriate recommendations. Required data on both energy supply and demand were collected and entered into the Long Range Energy Alternatives Planning System (LEAP) software to estimate the current energy demand of Chitwan and the energy demand and supply figures of the district were compared and further analyzed under different scenario in the software.

Three scenarios were developed taking important aspects such as climate change, gender and social inclusion into account. Three scenarios were developed as Business As Usual (BAU), Medium Adaptation (MA) and Climate Resilient (CR) Scenario with base year as 2010 and were subjected to projection by using LEAP for 5 years up to 2019. The penetration of technologies in different stratum of society were analyzed and quantified with the vulnerability analysis of different technologies. Other relevant software such as Microsoft excel has also been used for data analysis.

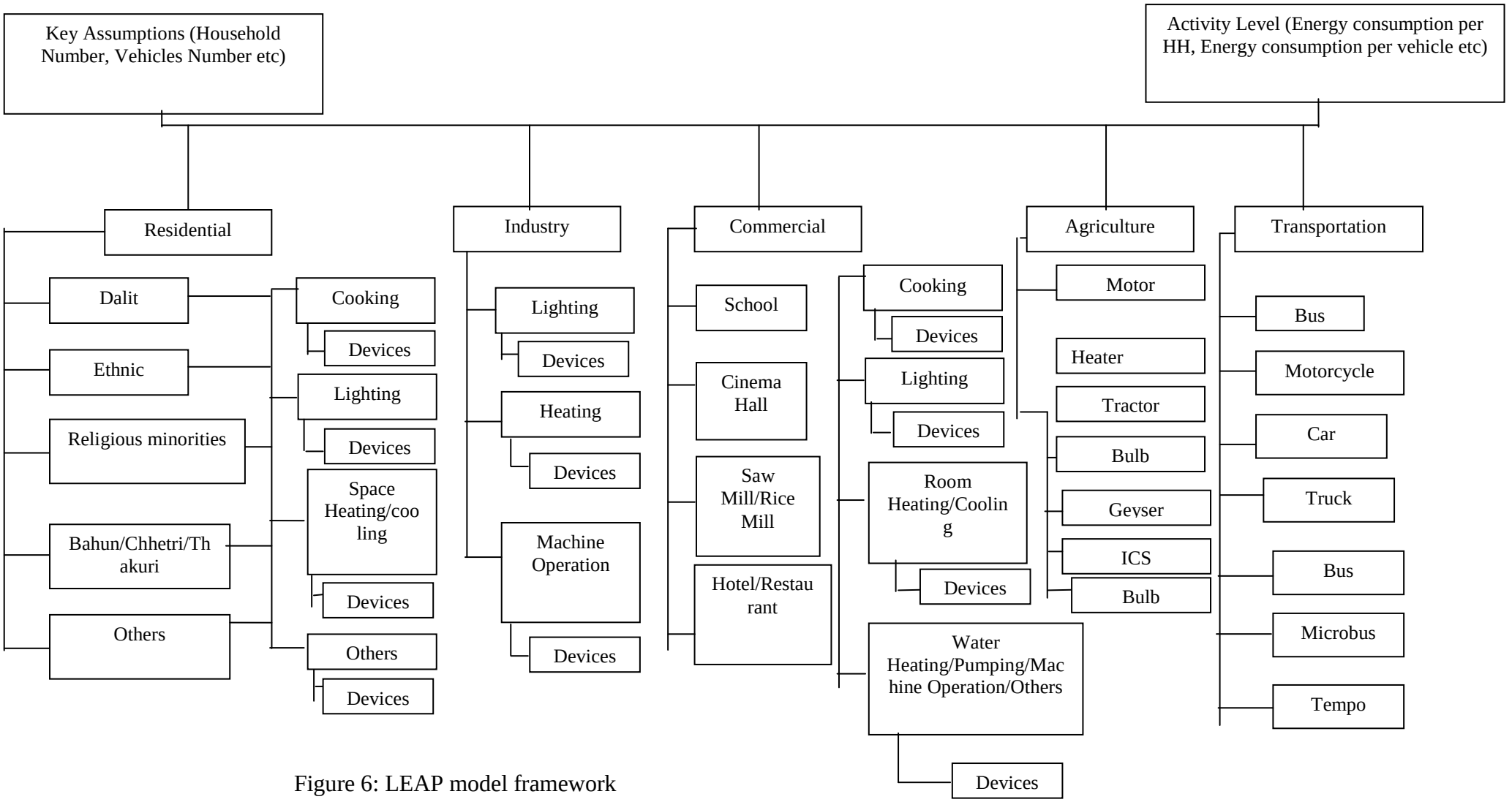

Figure 6: LEAP model framework

2.3.10 Workshop Facilitation and Preparation of DCEP

After preparation of draft report, it was sent to DDC for review. For detail interaction and collection of view from different stakeholders, district level workshop was organized by DEEU and consultant facilitated the workshop. Suggestions from the workshop have been incorporated and final DCEP report has been prepared.

2.3.11 Framework Development for Monitoring and Evaluation

Framework for monitoring the progress and achievement of the plan has been developed and presented in chapter 5. It includes parameters to be monitored, method and frequency of monitoring and responsible institution for monitoring. Software has also been developed so as to evaluate the achievement of the plan.

2.3.12 Software Development

Simple software has been developed by using Microsoft Excel to facilitate the concerned users to visualize the changes in the energy pattern with the implementation of appropriate energy and climate interventions. User can enter the basic parameters like population, household number, industry and commercial GDP etc. along with energy demand pattern of the region and they can observe the change in energy consumption pattern with the policy interventions to optimize the energy situation of the region.

Chapter Three

District Climate Change and Energy Situation of Chitwan

3.1 Climate Change Assessment

As per NAPA ranking for climate change vulnerability, Chitwan district lies in High vulnerability zone with vulnerability index from 0.601 to 0.786.

Table 6: Climate Change Vulnerability Indices

Sub-Indices		Rank	Index Range
Sensitivity	Human	Low	0-0.033
	Ecological	Very High	0.62-1
	Combined	High	0.302-0.573
Climate Risk/Exposure	Temperature and Rainfall	Very High	0.580-1
	Ecological	Very Low	0.000-0.081
	Landslide	Very Low	0.000-0.072
	Flood	High	0.545-0.765
	Drought	Low	0.106-0.223
	GLOF	Moderate	0.251-0.500
	Combined	Very High	0.682-1.000
Adaptive Capacity	Socio-economic	High	0.119-0.395
	Technology	Very High	0.000-0.030
	Infrastructure	Very High	0.000-0.063
	Combined	High	0.064-0.166
Vulnerability	Temperature and Rainfall	Very High	0.641-1.000
	Ecological	Low	0.079-0.192
	Landslide	Very Low	0
	Flood	High	0.534-0.787
	Drought	Low	0.181-0.331
	GLOF	Low	0.001-0.597
	Combined	High	0.601-0.786

Source: NAPA, Climate Change Vulnerability Mapping for Nepal, 2010.

According to the study by Practical Action in the Jugedi watershed region in Chitwan District, the summers are becoming hotter and the winters are becoming colder. Similarly the number and quality of water resources have fallen. Monsoon rainfall has increased whilst winter rainfall has become scarcer and periods of drought have become longer. Higher levels of sediment have altered the course of rivers, liver disease has been observed in cattle and cereal crop production has fallen. The effect on livelihoods has been seen through an increase in alcohol production to offset the failure of agriculture, whilst paddies have been converted to maize, millet and gram fields as the agricultural conditions change.

Similarly, as per the study by Shambhu Chamakar (2010) submitted to NAPA, MOE, overall temperature and precipitation of the Chitwan is increasing.

3.1.1 Precipitation

Precipitation data of Rampur Station is given in tables below

Table 7: Annual Precipitation of Chitwan District (Rampur Station)

Year	1995	1996	1997	1998	1999	2000
Annual Precipitation (mm)	1962	1784	2141	2645	2542	2050
Year	2001	2002	2003	2004	2005	2006
Annual Precipitation (mm)	2340	2644	2694	2042	1732	1997
Year	2007	2008	2009	2010	2011	2012
Annual Precipitation (mm)	2743	1786	1909	2400	1184	1636

Source: Environmental Statistics of Nepal 2013

Table 8: Mean annual and seasonal Precipitation of Chitwan District (Rampur Station)

1971-2000				
Annual	Monsoon	Winter	Pre-Monsoon	Post-Monsoon
1995.8	1634.5	48.1	221.1	92.1

Source: Environmental Statistics of Nepal 2013

As per the study by Shambhu Chamakar (2010), the overall rainfall in the district has increased in last 21 years. But, the seasonal analysis showed that rainfall in Chitwan had increased in all seasons except winter. According to the study, post-monsoon rainfall was high whereas annual, monsoon and winter rainfall was low and rest of the season received high in Chitwan than average rainfall of last 16 years (1988-2003).

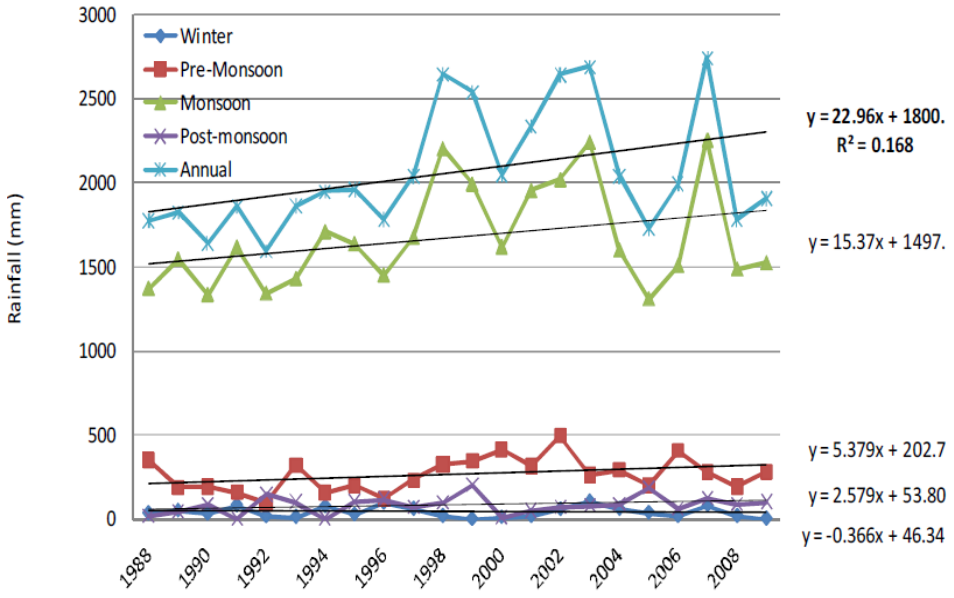

Figure 7: Annual and Seasonal Rainfall in Chitwan

3.1.2 Temperature

Temperature data of Rampur Station is given in table below

Table 9: Mean Temperature of Chitwan District (Rampur Station)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mean Temperature	24.6	24.7	24.4	24.5	24.7	24.9	24.5	24.3	24.8	24.8	NA	22.2

As per the study by Shambhu Chamakar (2010), the mean annual temperature for the last 21 years increased by 0.026 degree Celsius in Chitwan. Though the average maximum temperature didn't increase in Chitwan, minimum temperature was found to be increasing.

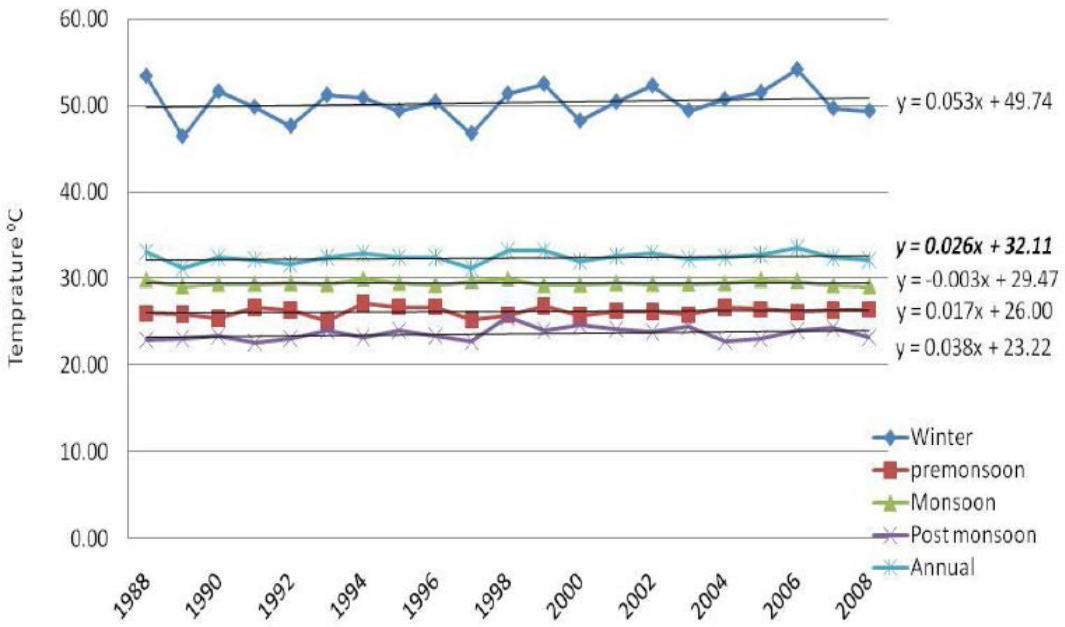

Figure 8: Average seasonal and annual temperature in Chitwan

3.1.3 Climate Change and Associated Disasters

During the workshop, major disasters due to climate change as reported by the participants are as follows.

- Increase in landslides and landslide induced flood disasters
- The district is facing uneven precipitation pattern and there is impact in vegetation too. This may be due to climate change.

3.2 GESI Assessment

Chitwan is densely populated district with rapid population growth. Females are more than male in Chitwan. According to field survey 2014, about 52% populations were female and 48% were male out of total population (570,498).

Table 10: Population Distribution by Sex in Chitwan

Sex	Number	Parentage Share (%)
Male	274853	48.2
Female	295645	51.8
Total	570498	100.0

Source: Field Survey 2014

Chitwan is the home land of Tharu people, who are renowned for their historic art and religious drawing. In Chitwan there are 18 highly excluded groups, which are Tamang, Chepang/Praja, Kami, Damai/Dholi, Sarki, Majhi, Mallah, Gaine, Mushar, Chamar/Harijan/Ram, Nuniya, Dhobi, Tamata, Thami, Pahari, Lodh, Dom, Bantar/Sardar[1].

Dalit, Janajati, Madheshi, Religious Minorities, Brahmin, Chetri and Thakuri are major ethnic or caste groups in Chitwan.

Table 11: Population by Ethnicity in Chitwan

Ethnicity	**Population**	**Percentage Share (%)**
Dalit	34800	8.2
Janajati	137100	32.4
Madhesi	8467	2.0
Religious Minorities	1732	0.4
Brahmin/Chhetri/ Thakuri	240607	56.8
Others	874	0.2
Total	423580	100.0

Source: Field Survey 2014

According to field survey, about 57% were Brahmin/Chetri/Thakuri, more than 32% Janajati, 8% Dalits, 2% Madhesi and 0.2% Religious Minorities.

Table 12: Population by Ethnicity and Location in Chitwan

Ethnicity	**Total**	**%**	**Rural**	**%**	**Urban**	**%**
Dalit	34800	8.2	26881	11.5	7919	4.2
Janajati	137100	32.4	90797	38.9	46303	24.3
Madhesi	8467	2.0	1816	0.8	6651	3.5
Religious Minorities	1732	0.4	1411	0.6	321	0.2
Brahmin/Chhetri/ Thakuri	240607	56.8	111852	47.9	128755	67.7
Others	874	0.2	630	0.3	244	0.1
Total	423580	100.0	233387	100	190193	100.0

Source: Field Survey 2014

Rural population of Chitwan is larger than urban population. Dalits are more in rural area (11.5%) than in urban area (4.2%). About 39% Janajatis live in rural area whereas only

24.3% live in urban area. In contrary, 68% Brahmin/Chhetri/Thakuri groups live in urban areas and only 48% live in rural Chitwan.

Table 13: Number of Households by Head of Family in Chitwan

Head of Family	Number of Households	Parentage Share (%)
Male	108792	83.1
Female	22094	16.9
Total	130886	100.0

Source: Field Survey 2014

Only about 17% households were headed by women and 83% households headed by male in Chitwan.

Table 14: Percentage of Households by Ethnicity and Location in Chitwan

Ethnicity	Rural Households %	Urban Households %	Total
Dalit	77.1	22.9	100
Janajati	66.2	33.8	100
Madhesi	21.4	78.6	100
Religious Minorities	81	19	100
Brahmin/Chhetri/ Thakuri	46.5	53.5	100
Others	72.1	27.9	100
Average	60.7	39.3	100

Source: Field Survey 2014

About 61% households were living in rural area and about 39% households live in urban Chitwan.

3.2.1 Energy Source for Cooking

The people inhabiting the rural Chitwan are predominantly peasant farmers. They mainly use traditional source of energy (fire wood, agricultural straw and husk, and animal dung), improved cooking stove (ICS), bio-gas, kerosene, LPG gas, coal and electricity for cooking.

Table 15: Energy Sources for Cooking by Ethnicity in Rural Chitwan

Ethnic group	Traditional stoves users (%)	ICS (%)	Biogas Stove (%)	Kerosene Stove (%)	LPG Stove (%)	Coal Stove (%)	Electric Stove / Grid (%)	Total (%)
Dalit	60.2	3.4	9.5	2.3	20.2	2.1	2.2	100
Janajati	47.4	4	15.1	1.6	28.1	1.6	2.3	100
Madhesi	57.1	11.8	7.5	4.8	17.5	0.9	0.3	100
Religious Minorities	49.6	5.8	12	3.2	25.2	2.2	2.1	100
Brahmin/Chhetri / Thakuri	43.3	2.5	20.5	1.6	28.6	1.3	2.2	100

Average	51.4	5.3	12.8	2.6	23.8	1.5	1.7	100

Source: Field Survey 2014

In rural area, more than half (51.4%) households use traditional stoves, about 24% use LPG gas, 13% bio-gas, 5.3% use ICS, 2.6% kerosene, 1.7% electricity and 1.5% use coal for cooking.

Majority of Dalits (60.2%) use traditional stove for cooking and about 24% Dalits use LPG gas for cooking. Only 3.4% dalits have installed bio-gas stoves in rural Chitwan. Similary, main source of energy for cooking for Janajatis are traditional stoves (47.4%) and LPG gas (28.1%). About 15.1% Janajati households have used bio-gas for cooking. More than half (57.1%) Madhesi households use traditional stoves, 17.5% use LPG gas, 11.8% use ICS, 7.5% use bio-gas and 4.8% use kerosene for cooking. Almost half (49.6%) religious minority households use traditional stoves, 25.2% use LPG gas, 12% bio-gas and 5.8% use ICS for cooking. Similarly, 43.3% Brahmin/Chhetri/Thakuri households use traditional stove, 28.6% use LPG stove, 20.5% use bio-gas, 2.5% ICS and 2.2% use electricity for cooking.

Table 16: Energy Sources for Cooking by Ethnicity in Urban Chitwan

Ethnicity	**Traditional stoves (%)**	**ICS (%)**	**Biogas Stove (%)**	**Kerosene Stove (%)**	**LPG Stove (%)**	**Coal Stove (%)**	**Total (%)**
Dalit	41.3	19.9	4.2	2.6	31.8	0.2	100
Janajati	12.1	14.9	5.5	2.2	65	0.3	100
Madhesi	17.3	13.4	2.8	18	48.6	0.0	100
Religious Minorities	62.9	1.6	19.4	0.0	16.1	0.0	100
Brahmin/Chhetri/ Thakuri	49.7	6.7	21.4	0.3	21.9	0.0	100
Average	36.7	11.3	10.7	4.6	36.5	0.1	100

Source: Field Survey 2014

In urban Chitwan, all most equal number of households uses traditional stoves (36.7%) and LPG stoves (36.5%). Similarly, 11.3% households use ICS and 10.7% use bio-gas. Only 4.6% households use kerosene and 0.1% households use coal stove for cooking.

Most of Dalit households (41.3%) use traditional stoves, 31.8% households use LPG gas, 19.9% use ICS and 4.2% use bio-gas for cooking in urban Chitwan. Surprisingly, 65% Janajati households use LPG gas, 14.9% use ICS and 12% households use traditional stoves for cooking. Same way, 48.6% Madhesi households use LPG gas for cooking. About 18% households use kerosene, 17.3% use traditional stove, 13.4% use ICS and 2.5% bio-gas for cooking.

3.2.2 Energy Source for Lighting

Table 17: Percentage use of Energy Source for Lighting by Ethnicity in Rural Chitwan

Ethnicity	**Kerosene lamp (%)**	**LPG Light (%)**	**Biogas Light (%)**	**Solar Light (%)**	**National Grid (%)**	**Micro-hydro (%)**	**Total (%)**
Dalit	14.7	1.4	1.1	13.4	69.0	0.3	100
Janajati	11.6	2.3	1.6	19.3	64.7	0.6	100
Madhesi	9.2	0.3	2.0	8.7	79.8	0.0	100
Religious Minorities	11.3	0.0	0.3	20.5	67.9	0.0	100
Brahmin/ Chhetri/ Thakuri	6.7	0.7	2.0	25.1	65.4	0.0	100
Average	10.7	1.0	1.4	17.4	69.4	0.2	100

Source: Field Survey 2014

Major energy source for lighting in rural Chitwan include electricity / national grid (69.4%), solar home system (17.4%), kerosene (10.7%), bio-gas (1.4%), LPG light (1%) and micro-hydro (0.2%). Most of Dalit households (69%) use electricity/national grid for lighting, 14.7% use kerosene lamp and 13.4% use solar light. About 65% Janajati households use national grid, 19% use solar light, 12% kerosene and 2.3% LPG light. About 80% Madhesi households use national grid, 9.2% kerosene lamp and 8.7% solar light. Almost 68% religious minority households use national grid, 20.5% households use solar light and 11.3% households use kerosene lamp for light. Similarly, 65.4% Brahmin/Chhetri/Thakuri households use national grid for light. About 25% households use solar light, 6.7% kerosene lamp and 2% bio-gas light.

Table 18: Percentage use of Energy Source for Lighting by Ethnicity in Urban Chitwan

Ethnicity	LPG Light (%)	Biogas Light (%)	Solar Light (%)	National Grid (%)	Total (%)
Dalit	6.1	3.6	34.6	55.7	100
Janajati	5.6	28.6	30.6	35.2	100
Madhesi	0.0	16.7	1.3	82.0	100
Religious Minorities	0.0	11.1	0.0	88.9	100
Brahmin/Chhetri/ Thakuri	2.0	35.8	3.4	58.8	100
Average	2.7	19.2	14.0	64.1	100

Source: Field Survey 2014

Energy source of lighting in urban Chitwan include national grid (64.1%), bio-gas (19.2%), solar light (14%) and LPG light (2,7%). About 58% Dalit households use national grid for light, 34.6% households use solar light, 6.1% use LPG light and 3.6% households use bio-gas

for light. Solar light being the second most energy source of light for Janajati households (30.6%) after national grid (55.7%). Considerable numbers of Janajati households (28.6%) are being attracted to bio-gas source for lighting and 5.6% households depend on LPG light. Being under privileged group, most of the religious minority households (89%) are dependent to national grid for light, and only 11.1% households are using bio-gas for lighting in urban Chitwan. Being privileged groups, 35.8% Brahmin / Chhetri / Thakuri households are using bio-gas for light after electricity/national grid (58.8%).

3.3 Energy Demand Assessment

An assessment of the energy demand of different sectors including residential, industrial, commercial, agriculture and transportation in Chitwan is based on the minimum energy required for these activities. It is found using Energy Demand= Energy Intensity*Activity Level. Energy intensity which is the amount of energy used per household and concerning activity level which is the number of Households in case of residential sector. Energy demand changes with the change in energy intensity or activity level or both. Energy intensity changes with the technology use pattern of people which can be fairly estimated judging from the probable changes in the affinity of the people towards several available technologies. Table shows energy demand for different sectors from 2014 to 2019. The energy demand is calculated 12523, 13220, 13969, 14772, 15636 and 16564 GJ from 2014-2019, respectively.

Table 19: Energy demand for different sectors (‘000 GJ)

Sector	2014	2015	2016	2017	2018	2019
Residential	8,271.7013	8,571.1368	8,881.4120	9,202.9191	9,536.0648	9,881.2703
Transportation	3,983.1427	4,381.4569	4,819.6026	5,301.5629	5,831.7192	6,414.8911
Industrial	0.0015	0.0020	0.0026	0.0035	0.0047	0.0063
Commercial	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076
Agricultural	268.2469	268.2469	268.2469	268.2469	268.2469	268.2469
Total	12,523.1000	13,220.8503	13,969.2719	14,772.7401	15,636.0433	16,564.4223

3.3.1 Residential

The residential sector is the largest consumer of energy in the district with a demand of 8271, 8571, 8881, 9202, 9536 and 9881 GJ in 2014, 2015, 2016, 2017, 2018 and 2019, respectively. Cooking makes up the biggest share of energy consumption in the residential sector. In terms of fuel consumption, biomass has the largest share for cooking making up over 85% of fuel uses. For lighting, the main sources of energy is electricity (if the HH has access to the NEA or an off grid electricity connection) and kerosene (mainly in rural areas).

3.3.2 Commercial

The main consumers in the commercial sector of Chitwan are restaurants, hotels, hospitals, schools etc. The energy demand in the district in 2014 is estimated about 76 GJ and no significant change in energy demand is noted up to 2019.

3.3.3 Industrial

The industrial sector is primarily based on the following industries: rice mills, saw mills, workshops, and other factories. The energy demand was calculated 100, 200, 300, 400, 500, 600 GJ in the year 2014-2019, respectively.

3.3.4 Agricultural

The energy demand for agricultural sector from 2014-2019 are estimated to be 268247 GJ per year but no significant change in energy demand is noted.

3.3.5 Implication of climate change on energy supply and consumption

General climatic phenomenon for the district is described in section 3.1. Impacts from weather phenomena associated with climate change pose risks of economic costs to energy suppliers and users. Increases in average temperatures and temperature extremes will lead to increase demand for energy for cooling and heating. Expected reductions in precipitation in the form of snowfall in the northern part of the country will reduce hydropower production. Similarly expected seasonal water scarcity represent risks of electricity supply disruptions (load shedding). Climate change can impact on biodiversity resulting in less productivity of forest and hence impact in supply of fire woods. Impacts of climate change are risks to many oil and gas supply activities resulting in increased cost of petroleum products. However both climate change and rising concentrations of atmospheric carbon dioxide will affect bioenergy production potentials hence creating favorable condition for biogas production.

Increase in temperature will lead to energy demand for cooling. No much energy requirement for space heating is noticed for the district. Current trend in unavailability of adequate water for irrigation is leading in energy requirement for pumping.

3.4 Energy Resource Assessment

3.4.1 Biomass

Biomass is used by a large proportion of the population for cooking; cattle feed preparation, commercial and agro processing. Almost all rural households are depending on biomass (fuel wood, agri-residue, animal dung, charcoal) to meet their energy needs. More than 90% of energy required for cooking activities in rural areas is fulfilled by biomass.

Fuel wood: Fuel wood is the major energy resource in the district for all the activities in residential, commercial and agricultural uses. In total the district has 18,055 ha of community forest land whereas 672.88 ha area for Hill Leasehold Forestry and Forage Development Project, and 456.04 ha area for Leasehold Forestry and Livestock Programme.

Agricultural residue: Another traditional source of energy in the district is agricultural residue and animal dung. The main sources of agri-residue in Chitwan are rice, paddy, maize, and wheat; other sources provide much smaller quantities of energy.

Animal dung: With many rural households owning cattle and other domestic animals, animal dung is often used as a fuel source. The dung is being used for biogas production as well as traditional uses including organic fertilizer and guitha. In the district, there are 32,824 households with land and cattle and so technical potential of biogas plants from cattle dung is 32,824.

3.4.2 Fossil fuels

As in other parts of Nepal, Chitwan also use fossil fuels which are imported from foreign countries. Furthermore, settlements neighboring India are also importing fossil fuels such as LPG and Kerosene in an illegal way. It is very difficult to get exact data of fossil fuels import and usage in district. However, some of the major areas where different types of fossil fuels are consumed is summarized in the Table 8 below.

Table 20: Commercial fuel type and use practices

Fossil Fuels	Major Applications
Diesel	Transportation, Industries, Generators, Boilers, Water pumps
Kerosene	Cooking, Lighting
LPG	Cooking
Coal	Industry
Gasolene	Transportation, Small Generators

3.4.3 Renewable energy

Hydropower: Chitwan does not have good hydro power resources. Residential, commercial and industrial communities rely on grid electricity to meet their energy demands.

Pico Hydro and IWM: There is some potential for pico-hydro and IWM in the district. In the district the pico-hydro of 9 kW (Thado khola:1.5kW, Devitar: 5 kW and Jogini khola: 2.5 kW) has been installed. The installed three picohydro plants are serving to 157 households at Chandibhanjyang, Lothar and Korak villages. There are 19 IWMs in the district, benefiting 672 households.

Solar: Solar energy is an important source of lighting in the district. There is good sunshine and there is great potential for solar energy. It is noteworthy that Chitwan has one of the best solar resources in the country (in average more than 5.1 kWh/m2/day). In total there are 724 solar home systems (SHS) with a total capacity of 21839 Wp; 3001 small SHS with 15005 Wp and 36 solar dryers and cookers.

Table 21: Solar home system installation in Chitwan

Year	Number of installations	Capacity (Wp)
Up to 2009/10	422	12869
2010/11	302	8970
Total	724	21839

Source: Renewable Energy Data Book, 2011

Table 22: Small Solar home system installation in Chitwan

Year	Number of installations	Capacity (Wp)
Up to 2009/10	2653	13265
2010/11	348	1740
Total	3001	15005

Source: Renewable Energy Data Book, 2011

Table 23: Solar dryers and cookers

Upto 2006	In 2007	In 2008	In 2009	In 2010	In 2011	Total
9	8	6	9	4	0	36

Wind: Regular wind flow has been observed in many places in the district, it is not noted any feasible site for installation of wind turbine.

Biogas: Biogas plants mix animal dung and water to produce a combustible gas known as Gobar gas which can be used for lighting and cooking purposes. There are currently 16,485 biogas plants installed in Chitwan (Source: Renewable Energy Data Book, AEPC, 2011)

Table 24: Number of biogas installation in Chitwan

Before BSP	1992/93-2008/09	2009/10	2010/11	Grand Total
1077	13465	1105	838	16485

Source: Renewable Energy Data Book, 2011

Improved cooking stove: Improved cook stoves represent a simple and cost effective solution to improve the efficiency of cooking stoves. The number of ICS installed in the district is not mentioned in Renewable Energy Data Book. However, according to survey, there has already been installed a large number of ICS in Chitwan.

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

As the energy is an important player in climate change and its mitigation and adaptation, unmanaged resources and use is likely to generate adverse feedback implications. Existing trends of land use seems to dominant over the climate variability in the district as there is less verifiable information on climate variability and change. However, climate compatible management of resources will enable both communities and energy resources to cope with uncertainties associated with climate change in the district.

Energy resources that are dependent on water are impacted through climate induced disasters are the most vulnerable to stresses of climate change. Decreasing levels of water availability has a direct impact on hydropower production. It also results in a decrease in forest cover, decrease in agriculture production and livestock rearing which impact availability of energy resources like firewood, agriculture waste and animal dung. Increase spells of droughts result in forest fires which also adversely impact forest resources and availability of fuel wood; while climate induced disasters either eradicate the source or limit access to such resources.

Weather induced hazards such as landslides can disrupt the supply of fuel and electricity to some extent when infrastructure like roads and transmission lines get damaged.

Forests:

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

Forests are under deforestations and land use change into agriculture and settlement although some improvements can be seen due to community participation in the forest management. Erratic pattern of rainfall and increased temperature both are likely to have adverse impacts on forest growth as intensive but squeezed rainfall to shorter periods lessens the ground water recharge. Together with increased evaporation and transpiration due to increased temperature moisture content is lessened leading to drought situations and to the consequences of fire hazard.

Local communities and district level stakeholders have reported a shift of vegetation zone which was regarded as having both positive and adverse effects on energy resources. Positive effects are attributed to opportunity to grow new crops and adverse effects are attributed to depletion of indigenous species to which community livelihoods are associated with. Adaptive management is necessary to reduce the vulnerability of forest resources to the undergoing impact of climate change and socio-economic factors.

Solar and Wind

Vulnerability of solar and wind in the district is yet to be understood. There are a number of passes where community members reported regular wind flow. However the change in the wind is not assessed in detail such that the trend could be identified. Communities were not able to provide reliable indicators of change in wind pattern over the period they have been in the area. So, this is also a potential area for future studies.

Agriculture/Crop residue resource

Traditional agriculture products including cereal crops are vulnerable to climate change impacts and weather variability as they are heavily dependent on natural rainfall and seasons. Farmers have switched to different crops over the past. This reveals the vulnerability of agriculture and energy resource despite their positive impact on farmers' income. Since farmers have switched increasingly to cash crops, available biomass for fuel from the agriculture sectors is reducing, posing increased pressure in the forests. However, access to electricity and LPG has helped withstanding shortage.

Transportation and access to resources

Weather induced hazards including landslides have disrupted the supply of fuel and electricity. However, communities and stakeholders have overcome these situations utilizing existing storage facilities. However increasing hazards could aggravate this situation and the district could consider a transportation management system. Generally forests are formally and informally under community based management whilst agriculture is normally under private management and water resources are utilized under different regimes. In order to utilize natural resources, it is important to maintain diversity and sustainability. Objective oriented management considers the balance between supply and demand and should be priority in land, water and forest management. Fire prevention and sustainable extraction should be a major focus of forest management, whilst promotion of regeneration considering extension of species with respect to the impacts of changing climate, and socioeconomic factors could be a new approach to afforestation, agro-forestry and natural restoration.

3.5 Technology Assessment

Different technologies available within the districts and potential for the districts have been assessed. Suitability of the technology in contest of resource availability, installation and operation cost, different aspects of climate change, different aspects of GESI etc. have been done and presented in tables below.

Table 25: Technology assessment for cooking purpose

Technologies	Existing Use Share		Cost Analysis		Resource Availability	Vulnerability to CC Impacts	Potential to Adaptation	Potential to Mitigation	Gender Friendly in use	Promote Social Inclusion	Contribute poverty Reduction
	Rural	Urban	Installation (NRs)	Monthly Operation							
Traditional Cooking Stove	51.4	36.7	150	600	Available within the district (forest resources)	Climate change can effect forest and trees so highly vulnerable	No any potential to adaptation	Adversely affect as it produces GHGs	Difficult in fire wood collection	Does not promote because socially excluded groups do not have own forest land for fire wood collection.	No, rather it consumes productive time for firewood collection or need to spend money to buy firewood.
Improved Cooking Stove	5.3	11.3	Mud type 300 and metal type 7000	480	Available within the district (forest resources)	Climate change can effect forest and trees so highly vulnerable	As it requires less fuel wood is more adaptive that TCS	Adversely affect as it produces GHGs	Difficult in fire wood collection	It helps to promote social inclusion if equal access provided to community forest	Contribute poverty reduction in some extent as less firewood is needed and if subsidy provided for installation.
Kerosene Stove	2.6	4.6	1000	750	Imported	Not Vulnerable	No any potential to adaptation	Adversely affect as it produces GHGs	Difficult for pumping stove and kerosene smell	Save time for work, but it is expensive and imported item, depend on others.	In some extent if subsidy provided for poor and save time for work
Biogas	12.8	10.7	40,000	0	Available in houses with livestocks	Climate change causes increase in temperature favorable for	Favorable for climate change so highly	Potential to mitigation as it reduces methane	Difficult in feeding and mixing	Not in general, but yes, if installed in	Promote poverty reduction as it promotes

						biogas production	adaptable	release in atmosphere	dung slurry for biogas	public level.	livestock rearing
LPG Stove	23.8	36.5	3,000	750	Imported	Not Vulnerable	No any potential to adaptation	Adversely affected as it produces GHGs	Gender Friendly in use	No, it is expensive and hard to transport in rural areas. It is imported energy source.	No, it is expensive and increase poverty.
Electric Stove	1.7		3,500	850	National grid (not within the district)	Water resources are affected by climate change so vulnerable	No any potential to adaptation	Potential to mitigation as it does not emit GHGs	Gender friendly use but risk of electric socks	No	No

Table 26: Technology assessment for lightning purpose

Technologies	**Existing Use Share**		**Cost Analysis**		**Resource Availability**	**Vulnerability to CC Impacts**	**Potential to Adaptation**	**Potential to Mitigation**	**Gender Friendly in use**	**Promote Social Inclusion**	**Contribute poverty Reduction**
	Rural	**Urban**	**Installation**	**Monthly Operation**							
Kerosene lamp	10.7	0.0	400	300	Imported	Not Vulnerable	No any potential to adaptation	Adversely affect as it produces GHGs	Risk of contamination, smell and fire	Access and control to larger community and can be transported in remote areas also	Cheaper than electricity, so save money, but is is imported resource and available in the country.
Solar Home System	17.4	14.0	20,000	250 (Battery replacement)	Freely available	Not Vulnerable	Resource freely available and not	Potential to mitigation as it does not emit	Gender Friendly in use	Yes, if subsidy provided	Yes, save time for work

							vulnerable to CC so potential to adaptation	GHGs			
Grid Electricity	69.4	64.1	10,000	350	National grid (not within the district)	Water resources are affected by climate change so vulnerable	No any potential to adaptation	Potential to mitigation as it does not emit GHGs	Gender Friendly in use but risk of electric socks	Yes, helps in study at night also, but need to provide subsidy and distribute equally in rural area	Yes, if provided subsidy
Micro Hydro Electricity	0.2	0.0	Too expensive for single household	250	Within district	Water resources are affected by climate change so vulnerable	No any potential to adaptation	Potential to mitigation as it does not emit GHGs	Gender Friendly in use	Yes, locally available with subsidy	Yes, save time & energy for micro Enterprise development, ghatta/ mills/processing cottage industries.
Biogas Light	1.4	19.2	1000	90	Available in houses with livestocks	Climate change causes increase in temperature favorable for biogas production	Favorable for climate change so highly adaptable	Potential to mitigation as it reduces methane release in atmosphere	Difficult in feeding and mixing dung slurry for biogas	Yes, if installed publicly	Promote poverty reduction as promotes livestock rearing
LPG Light	1.0	2.7	3,000	400	Imported	Not vulnerable	No any potential to adaptation	Adversely affected as it produces GHGs	Gender Friendly in use	No	No

Table 27: Technology assessment for lightning bulbs

Bulb Use Pattern	Cost		Health Hazard	Life time (hrs)
	Installation	Monthly Operation		
Fillament	50	540	Risk to Eye Damage	600
Tubelight	1,000	360	Contains mercury, toxic metal	1500
CFL	350	81	Risk to Eye damage but less than filament	3000
LED	400	81	Health Friendly	3500

3.6 Institutional Arrangements

The institutional assessment was carried out through stakeholder identification, consultations, capacity assessment and SWOT analysis tools to create a detailed implementation plan in order to implement the DCEP in Chitwan district.

Institutional analyses of some of the organizations are as follows:

District Environment and Energy Unit (DEEU) in DDC: The environment and energy unit (DEEU) plans and implement rural energy programmes in Chitwan under technical and financial supports from APEC and DDC of Chitwan. Most of the funds required to implement the rural energy programme comes from AEPC, while DDC also allocates significant funds to disseminate rural energy activities including biogas and ICS promotion and awareness activities. The DDC of Chitwan seemed to fully recognize the DEEU which a required condition for implementation of plans like DCEP. Similarly, the DEEU also seemed to have a good relationship with non-government organizations functional in the district. Hence, DEEU have good opportunity to mobilize qualified NGOs. Currently, the DEEU of Chitwan has full time staffs, but not sufficient in term of numbers and knowledge they acquire. Human resource in the DEEU is not currently sufficient to deliver the DCEP as implementation requires increase in activities including: monitoring and evaluation, subsidy disbursement and promotion and awareness activities. Therefore, the current human resources are unlikely to handle such an increase in activities.

District Forest Office (DFO): Conserving forest resources and its sustainable use within the district is the main objective of District Forest Office. Fuel wood production, plantation & seedling production, community forest management, leasehold forestry development program, nursery vegetation, forest management, timber production, training, awareness campaign are its regular programs related to climate change. Forests are closely related both with energy and climate change. Hence their sustainable use and conservation is crucial. District Forest Office, Chitwan has been lunching different programs like Community Forest Development Programme, National Forest Development and Management Programme, Vegetation improvement, Plantation and Private Forest Programme, REDD-Reduced Emission from Deforestation and Forest Degradation Programme, etc. Annual budget allocation for such program is as per the government budget decision/red-book. Major strengths of this organization are: Forest conservation and management plays direct role in

climatic balance and climate change impact reduction, this organization has trained human resources, has sector and subject related laws, and has grass root level users group in forest sectors (Community Forest Users Group). Major weakness of the organization are: Lower staffs of the organization like forest helpers are not up to date, there is lack of physical infrastructures like building, there is lack of enough budget to address all the district level issues, lack of energy and climate change focused program. Major opportunities of this organization are: livelihood related resources availability at local level, possibility of coordination with DDC and VDCs, possibility of funding from donor agencies for current issues like climate change, REDD, carbon trade, etc. Duplication of prevailing laws and rules, exploitation of natural resources, haphazard construction of infrastructures mainly roads destroying forests, forest encroachment and forest fires, illegal wildlife hunting poaching, etc. are major threats to the organization.

FECOFUN: Although FECOFUN do not deal directly with RETs, they operate in the field of climate change, with a core strategy to conserve Nepal's forests to reduce landslides and desertification. The organization does not have adequate skills to deal with issues in the district, although premises and access to information are present. There are no systems in place to measure the satisfaction of the operations of FECOFUN locally although they have significant contact with policy makers and external stakeholders. Gender and social issues are said dealt with adequately by the organisation, the capacity to pick up and deal with issues, and a specific gender policy of the organization in place. They deal less well with social inclusion issues, and it was not perceived that the staffing policy deals sufficiently with the issue. FECOFUN do target minority groups in their projects, and they have a specific social inclusion policy.

Besides, there are various donors, government line agencies, NGOs, INGOs, private sector, finance institutions and local organizations with aim of improving energy status and contributing in the field of climate change. However all these organizations are working disintegrated without coordination among each other. The taskforce formed for the preparation of this DCEP is expected to remove all these shortcomings and help to work in unified way.

Table 28: SWOT Analysis

Organization	Strength	Opportunities	Weakness	Threats
DEEU	Clear Mandate provided; Good Network at district level	INGOs/Donors & other stakeholders are convinced on the need of energy & climate issues	Lack of resource; No full authority (depends on AEPC); no connection in subsidy monitoring; lack of adequate staff; lack of guidelines & procedures	Internalization of DEEU by DDC (DEEU staff)
District Line Agencies	Act, policies, mandate available to work on energy and related field	Basket fund for different sectors (AID effectiveness;	Lack of capacity building of staff (training, exposure); No Compulsion for	Political instability (transition period)

		harmonization)	budget allocation Inter ministerial coordination Gap	
Local Government	Familiar with local conditions and needs	Increasing concern on energy and climate change issues; Network at grassroots level	Low priority to RETs; No long term plan; Lack of resources & human resources	No elected body Restructuring of state (uncertain)
Non Government	Commitment on MDGs and other CC mitigation & adaptation;	Bound by international commitment to get funding (like CO2 saving)	Lack of resources; no long term vision & commitment; Lack of localized MDG goals	Frequent leadership changes
INGOs & donors	Resourceful; International Experience; linkages/relationship with community; familiar with local context	Basket funding (can contribute to International commitment on climate change, MDGs, International Conventions	Lack of coordination; Can't internalize Paris declaration; not localized (not internalizing local context)	Priority country & sector may be changed Preset Conditions
Private Sector	Flexibility; competency	Regarded as a development partner by the Govt.	Low risk baring capacity; low R&D investment; No presence at grass root level	Unfair competition; priority differs in govt. policies; conflict;
Banks	Capable to mobilize fund; Adequate in number	RETs in high demand (new investment opportunities); Foreign investment	Low priority for energy projects; no compulsion to invest on RETs (no policy)	
MFI & cooperatives	Flexible fund; presence at grass-root level; adequate in number	RETs in high Demand Resource Mobilization Possibilities	Lack of adequate policies to invest on energy projects	Dependency on external fund. Insecure ROI Security of fund (investment)
FECOFUN & Networks	Wider network; Flexibility; Good Mobilization capacity	RETs in high Demand which is supported by policies	Lack of accountability / responsiveness; No compulsion to investment on RETs;	High politics (Political motivation); Conflict of interest with national

				policies (forest)
Users	Searching for Utility maximization (ready to invest)	Supported by policy; right based approach – civil engagement (benefit sharing)	Lack of access to adequate information Lack of skills and resources	Conflict (transition phase); lack of elected body (lack of accountable agency)

Chapter Four

District Energy Scenario Development/Demand Projection

4.1 Introduction

A scenario explains how an energy system might evolve for a particular region under a particular policy over time. The energy scenario provides users, implementting agency and policy makers to consider particular type of energy for specific purpose. It also gives idea how such energy will be used over time. In this study, three types of scenarios have been used. They are Business as Usual Scenario, Medium Adaptation Scenario and Climate Resilient Scenario. For projection, household growth rate have been considered to be 3.62%. Similarly share of different technologies for different scenario for cooking purpose is taken as follow.

Table 29: Share of Technologies for different scenarios

		Share of Technologies					
	Scenarios	**TCS**	**ICS**	**Biogas**	**Kerosene**	**LPG**	**Electricity**
Rural	BAU	51.4	5.3	12.8	2.6	23.8	1.7
	Purposed MAS	20	28	20	2	25	5
	Purposed CRS	10	30	30	0	20	10
Urban	BAU	36.7	11.3	10.7	4.6	36.5	0
	Purposed MAS	15	20	17	3	40	5
	Purposed CRS	5	25	20	0	35	15

The results of these scenarios have been compared. The GHG emissions have also been calculated under these scenarios.

4.2 Business as Usual Scenario

The Business as Usual Scenario (BAU) is based on current status, increment trends and population growth rates. The scenario forecasts consumption of different types of energy including fossil fuels, traditional energy, commercial energy and renewable energy as per actual present demand without changing level of energy intensity. This scenario does not give emphasis on social and gender inclusions. Table 30 presents energy demand of the district in different sectors under this scenario from 2014-2019. The total energy demand is found to be 12.52 million GJ in the base year, which has been increased to 16.56 million GJ at the end of 2019. The increments in residential, transportation and industrial are found to be 9.88, 6.41 and 0.0000063 million GJ from 8.27, 3.98 and 0.0000015 million GJ, respectively during the year 2014-2019 whereas no increment is noted for commercial and agricultural sectors.

Table 30: Energy demand under BAU scenario from 2014-2019 ('10^3GJ)

Sectors	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Residential	8,271.7013	8,571.1368	8,881.4120	9,202.9191	9,536.0648	9,881.2703
Transportation	3,983.1427	4,381.4569	4,819.6026	5,301.5629	5,831.7192	6,414.8911

Industrial	0.0015	0.0020	0.0026	0.0035	0.0047	0.0063
Commercial	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076
Agriculture	268.2469	268.2469	268.2469	268.2469	268.2469	268.2469
Total	12,523.1000	13,220.8503	13,969.2719	14,772.7401	15,636.0433	16,564.4223

The residential energy demand for urban sector in the district is presented in Table 31. The total residential energy consumption for the base year 2014 in the urban sector under this scenario is 0.36 million GJ, which is predicted to increase 0.43 million GJ. Regarding residential energy demand in the rural sector, the consumption of energy under this scenario is forecasted to increase 7.91 million GJ to 9.45 million GJ (Table 32).

Table 31: Energy demand for urban sector (residential) under BAU scenario from 2014-2019 ('10^3GJ)

Fuels	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity	21.6347	22.4179	23.2295	24.0704	24.9417	25.8446
LPG	324.8401	336.5993	348.7842	361.4102	374.4932	388.0499
Biogas	10.9073	11.3022	11.7113	12.1353	12.5746	13.0297
Others	1.2908	1.3375	1.3859	1.4361	1.4881	1.5420
Total	358.6729	371.6569	385.1109	399.0519	413.4976	428.4662

Table 32: Energy demand for rural sector (residential) under BAU scenario from 2014-2019 ('10^3GJ)

Fuels	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
LPG	278.9977	289.0974	299.5627	310.4069	321.6436	333.2871
Fuel wood (Traditional Stove)	7,183.8742	7,443.9305	7,713.4008	7,992.6259	8,281.9589	8,581.7659
Fuelwood (Improved cooking stove)	334.6173	346.7304	359.2821	372.2881	385.7649	399.7296
Biogas	47.6687	49.3943	51.1824	53.0352	54.9551	56.9444
Total	7,845.1579	8,129.1527	8,423.4280	8,728.3561	9,044.3226	9,371.7271

4.3 Medium Adaptation Scenario

This scenario has taken into account the development of livelihoods by providing inclusive access to energy sources. It also takes into account cost of the technology along with adaptive measures to potential vulnerabilities of resources and technologies. In this scenario, emphasis is given to use of cheap and clean energy in the place of traditional inefficient energy sources and technologies. The residential energy consumption in the urban sector under this scenario is presented in Table 33. The total energy demand is forecasted to decrease from 0.36 million GJ to 0.16 million GJ. The consumption of fuel wood is decreased whereas the use of electricity and biogas are increased.

Table 33: Energy demand for urban sector (residential) under MA scenario from 2014-2019 ('10^3GJ)

Fuels	2014	2015	2016	2017	2018	2019
Electricity	21.6347	22.4491	23.2941	24.1709	25.0806	26.0245
LPG	324.8401	283.0494	237.8074	188.9189	136.1793	79.3738
Biogas	10.9073	17.1147	23.7572	30.8582	38.4422	46.5348
Others	1.2908	2.0844	2.9337	3.8418	4.8117	5.8469
Total	358.6729	324.6976	287.7924	247.7898	204.5139	157.7801

Regarding energy demand for rural sector, the total demand is found to be decreased from 7.91 million GJ to 3.87 million GJ. The demand of fuel wood will be decreased whereas the demand of electricity, biogas, and solar are predicted to be increased.

Table 34: Energy demand for rural sector (residential) under MA scenario from 2014-2019 ('10^3GJ)

Fuels	2014	2015	2016	2017	2018	2019
Fuelwood (Traditional Stove)	7,183.8742	6,229.3945	5,196.3963	4,080.4458	2,876.8910	1,580.8516
Fuelwood (Improved cooking stove)	334.6173	624.1148	934.1334	1,265.7795	1,620.2127	1,998.6481
Biogas Stove	47.6687	54.0432	60.8167	68.0098	75.6440	83.7418
LPG Stove	278.9977	256.0577	231.0913	203.9817	174.6065	142.8373
Kerosene stove	-	1.2133	2.5144	3.9081	5.3995	6.9937
Electric stove _grid	-	0.0267	0.0553	0.0860	0.1188	0.1539
Total	7,845.1579	7,164.8501	6,425.0074	5,622.2110	4,752.8726	3,813.2264

4.4 Climate Resilient Scenarios

This scenario has emphasized the use of clean and environment-friendly energy. Meeting energy demand through promotion of the maximum possible clean energy technology, security of supply, achieving, energy saving leading to the reduced climate change vulnerabilities are the main rational of this scenario. The residential energy demand under CR scenario from 2014-2019 is presented in Table 35 (urban sector) and Table 36 (rural sector). The total energy demand is predicted to decrease from 0.36 million GJ to 0.18 GJ at the end of 2019 in urban sector.

Table 35: Energy demand for urban sector (residential) under CR scenario from 2014-2019 ('10^3GJ)

Fuels	2014	2015	2016	2017	2018	2019
Fuelwood (Traditional Stove)	7,183.8742	5,955.1444	4,628.0405	3,197.0504	1,656.3918	-
Fuelwood (Improved cooking stove)	334.6173	554.7687	790.4206	1,042.4067	1,311.6008	1,598.9185
Biogas Stove	47.6687	56.9487	66.8382	77.3690	88.5746	100.4902
LPG Stove	278.9977	258.8110	236.7972	212.8505	186.8596	158.7082
Kerosene stove	-	1.0785	2.2350	3.4739	4.7995	6.2166
Electric stove _grid	-	0.0345	0.0716	0.1113	0.1538	0.1992
Total	7,845.1579	6,826.7859	5,724.4031	4,533.2617	3,248.3801	1,864.5326

Table 36: Energy demand for rural sector (residential) under CR scenario from 2014-2019 ('10^3GJ)

Fuels	2014	2015	2016	2017	2018	2019
Electricity	25.2933	26.2435	27.2293	28.2521	29.3132	30.4142
Kerosene	0.0001	1.0786	2.2351	3.4740	4.7996	6.2167
LPG	278.9977	258.8110	236.7972	212.8505	186.8596	158.7082
Wood	7,518.4915	6,509.9131	5,418.4611	4,239.4570	2,967.9925	1,598.9185
Solar	90.1607	93.4245	96.8065	100.3109	103.9421	107.7048
Others	0.0850	0.1016	0.1192	0.1380	0.1580	0.1792
Total	7,913.0283	6,889.5722	5,781.6484	4,584.4824	3,293.0652	1,902.1416

The total residential energy consumption is predicted to decrease from 7.91 million GJ to 1.90 million GJ at the end of year 2019 under CR scenario for rural sector.

4.5 Comparison of the scenarios

Table 37 presents energy scenarios under BAU, MA and CR scenarios in the district from 2014 to 2019. The total energy demand in BAU scenario is determined to be 8.27 million GJ in the base year 2014. The energy demand has been forecasted 9.88 million GJ at the end of year 2019. Due to adaptation of Medium Adaptation Scenario and Climate Resilient Scenario, the consumption of fuels will be lessened to 4.02 and 2.08, respectively at the end of 2019. The reduction in energy consumption means cutback of conventional fuels, mainly fuel wood and consequently saving of forests. It will help to keep our climate.

Table 37: Energy scenarios for different scenarios from 2014-2019 ('10^6GJ)

Scenarios	2014	2015	2016	2017	2018	2019
BAU Scenario	8,271.7013	8,571.1368	8,881.4120	9,202.9191	9,536.0648	9,881.2703
Climate Resilient (CR) Scenario	8,271.7013	7,218.3887	6,077.9767	4,845.5396	3,515.9093	2,083.6639
Medium Adaptation (MA) Scenario	8,271.7013	7,555.2344	6,776.0559	5,930.5641	5,014.9791	4,025.3341

4.7 GHG emission in different scenarios

GHGs emission from energy use of different sectors along with possible emission up to 2019 is given in table below. It is estimated that by shifting from BAU Scenario to MA Scenario, emission of 213.56 thousand metric tonnes of CO_2 Equivalent GHGs will be reduced up to 2019 whereas by shifting from BAU Scenario to CR Scenario, emission of 246.95 thousand metric tonnes of CO_2 Equivalent GHGs will be reduced.

Table 38: Global warming potential in Residential sector under different energy scenarios from 2014-2019 (1000 Metric Tonnes CO_2 Equivalent)

Scenarios	2014	2015	2016	2017	2018	2019	Total
BAU Scenario	95.55601	99.01513	102.59948	106.31358	110.16213	114.15000	627.79634
Climate Resilient (CR) Scenario	95.55601	84.05593	71.59802	58.12801	43.58895	27.92109	380.84802
Medium Adaptation (MA) Scenario	95.55601	86.07828	75.78914	64.64227	52.58904	39.57846	414.23319

Chapter Five

DCEP Plan

5.1 Introduction

This chapter presents a detailed implementation plan for coming 5 years on the MAS and CRS scenarios. The implementation plan has focused on planning for rural as well as urban residential sector as the residential sector is the highest energy consuming sector of Chitwan. The level of intervention and budget requirements has also been analysed for different scenarios. The district level offices have to take lead on technology assessment and institutional assessments for implementing DCEP. The DCEP should be the rolling document to be mainstreaming into usual annual and periodic development planning of the district, the DDC and line agencies in particular by following the current DDC planning process.

5.2 Analysis of existing policies to implement proposed plan

The key strategies under which DDC is functioning reflect strong supports for:

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

In addition to local government commitments, the central government has a national level programme under which the district can benefit as well. Renewable Energy Subsidy arrangements provide for about 50% capital cost subsidy for installing micro and pico hydro. Dissemination of solar home systems, biogas and other renewable energy technologies are also provided with subsidies ranging from 25-40% of the installation costs on average. These policies will have positive implications in implementing DCEP in micro hydro by assisting financing options. Policies at both central and local level also provide technical assistance for capacity building and awareness activities in the field.

5.3 Analysis of intervention required in different scenarios

In line with the scenarios presented in chapter 5, various installation and operation targets have been set for a number of RET technologies. The interventions that are put forward are simply based on required resource mix that is prescribed for a scenario in 2020. The detailed intervention of different technologies required in MAS is presented below:

Table 39: Residential Energy demand for cooking in urban sector under MA scenario

Fuels/Technology	Households					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity (Rice cooker, Micro-oven)	3547	3680	3819	3962	4112	4266
LPG stove	38216	33300	27977	22226	16021	9338
Biogas	1186	1860	2582	3354	4179	5058

Table 40: Residential Energy demand for cooking in rural sector under MA scenario

Fuels/Technology	Households					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
Electric stove grid	0	0.0267	0.0553	0.086	0.1188	0.1539
LPG	278.9977	256.0577	231.0913	203.9817	174.6065	142.8373
Kerosene	0	1.2133	2.5144	3.9081	5.3995	6.9937
Fuelwood (ICS)	334.6173	624.1148	934.1334	1,265.78	1,620.21	1,998.65
Biogas	47.6687	54.0432	60.8167	68.0098	75.644	83.7418
Fuelwood (Traditional Stove)	7,183.87	6,229.39	5,196.40	4,080.45	2,876.89	1,580.85

The detailed intervention of different technologies required in CR scenario is presented below:

Table 41: Residential Energy demand in urban sector under CR scenario

Fuels/Technology	Households					
	2014	**2015**	**2016**	**2017**	**2018**	**2019**
Electricity (Rice Cooker, Micro-oven)	3547	3681	3821	3965	4116	4272
LPG stove	38216	33660	28723	23385	17623	11413
Biogas	1186	2036	2946	3919	4960	6070

Table 42: Residential Energy demand in rural sector under CR scenario

Fuels/ Technology	Households					
	2014	2015	2016	2017	2018	2019
Electricity (Rice cooker, micro-oven)	0	6	12	18	25	33
LPG stove	32823	30448	27858	25041	21983	18672
Fuelwood (ICS)	12168	20173	28743	37906	47695	58142
Biogas	5181	6190	7265	8410	9628	10923
Fuelwood (TCS)	130616	108275	84146	58128	30116	0
Kerosene stove	0	98	203	316	436	565

Electrification:

All the municipality and villages of Chitwan district is electrified with grid connection. During workshop consultation, participants including DDC and NEA officials assured that Chitwan district will achieve about 100% electrification by grid-connection within the planned periods.

Table 43: Energy demand for lightning

	2014	2015	2016	2017	2018	2019
Annual Grid Electricity requirement, kWh	9253943	9588935	9936055	10295740	10668446	11054643

5.4 Financing Plan

This section deals with investment requirement for the next five years to achieve the scale of intervention for the two scenarios MAS and CRS. To carry out the analysis of investment required to implement the intervention in the two scenarios, the inflation factor is not considered. This allows for a more thorough analysis of the cost requirements in the present context. The cost per unit of the technologies is listed in the Table below.

Table 44: Unit cost of technologies

Technology	**Cost (NRs)**	**Remarks**
Improved Cook Stove (Mud Type)	350	
Improved Cook Stove (Metal Type)	7000	
Biogas	48,600	
Micro/Pico Hydro	265,000	Per kW
Small Hydro	150,000	Per kW
Solar Home System	20,000	20 Wp
IWM	15,000	

The subsidy amounts are also considered which is to remain constant throughout the planning years. The current subsidy policy for some of the technologies is presented in the table below.

Table 45: Subsidy policy

Resource	**Technology**	**Cost (NPR)**	**Subsidy**
Fuel wood	Improved cook stove (Mud)	250	0
	Metallic stove	7000	2700 for 2 pot 4000 for 3 pot
Biogas	Biogas stoves (2, 4, 6 m^3)	48600	12000 + 700 (2500 for marginalised) (4000 for toilet attached)
Solar	10-18 Wp	1000/Wp	5000
	20 Wp	20000	6000
	Institutional		75% not exceeding 15,000
Micro-Hydro	IWM	15000	12,000 for Grinding (27,000 for other end uses) (6000/HH up to 5kW but no more than 60,000 per KW)
	5 kW	265,000/kW	12000/HH no more than 97,500 per KW
	500 kW to 10 MW	150,000/kW	No subsidy
	5 kW to 500 KW		50% of the installation cost

	(rehabilitation)		subsidy will not be more than NPR 62,500 per kW generated.
	Institutional and community use		97,500 extra
	Transportation		500 per KM per kW, not exceeding 10KM and 30,000 per KW generated
	Productive use		10,000 per KW not exceeding 25,000 per project

Cost calculation

The cost for implementation of different renewable energy technologies are calculated below:

Table 46: Cost estimation (without subsidy) for cooking purpose in urban sector under MA scenario

Year	2015	2016	2017	2018	2019
Biogas	32791265	35089728	37511804	40063304	42750039

Table 47: Cost estimation (without subsidy) for cooking purpose in rural sector under MA scenario

Year	2015	2016	2017	2018	2019
ICS	38687393	41429758	44319979	47365164	50572731
Biogas	33673989	35781750	37998333	40328491	42777509

Table 48: Cost estimation (without subsidy) for cooking purpose in urban sector under CR scenario

Year	2015	2016	2017	2018	2019
Biogas	41320565	44236565	47309459	50547698	53957093

Table 49: Cost estimation (without subsidy) for cooking purpose in rural sector under CR scenario

Year	2015	2016	2017	2018	2019
ICS	29420233	31491663	33674506	35974121	38396093
Biogas	49022609	52242359	55630096	59194800	62945452

5.5 Monitoring and Evaluation Plan

The monitoring and evaluation plan for different RETs promotion and related programs are presented in Tables below. DEEU should bear major role for coordinating and facilitating different agencies assigned for monitoring and evaluation. DCEP task force will directly monitor and evaluate the progress and take major decisions whenever needed to ascertain the implementation of plan. Most of the activities and their outputs shall be monitored on an annual basis. DEEU/ DCEP task force can carry out the monitoring itself or sub contract consultants. DDC, AEPC, VDCs implementing partners, RET companies, NGOs, CBOs and civil society should provide support and assistance to carry out monitoring and evaluation.

Following tables below provides the general monitoring and evaluation plan for DCEP implementation with in district.

Table 50: Monitoring and evaluation plan for Improved Cook Stove

Yearly Target					Activity	Indicators	Tool for verification	Frequency of Monitoring	Institution Responsible for Monitoring	Supporting Organizations
2015	2016	2017	2018	2019						
624	934	1,266	1,620	1,999	ICS Installation	Target number of ICS for each year are installed and are in operation	HH Survey and sample observation/ICS programme annual report	Annually	DCEP task force, DEEU, Consultant	DDC, Implementing partner, NGOs, ICS promoters
					Financial support towards installation of ICS	Finance required is reflected on DDC's annual budget for alternative energy and is spent as per implementation plan.	DDC annual Budget and expenditure	Annually	DCEP task force/ DEEU	DDC, AEPC
					Promotion and awareness of ICS and its benefits	IEC materials should be developed on impact of indoor air pollution on health and and dispersed in all VDCs	Presence of IEC materials in VDCs and HHs	Biannual	DCEP task force, DEEU, Consultant	NGO
1	1	1	1	1	Monitoring	A yearly monitoring report is produced on ICS with user survey, scale of intervention, degree of usage and quality of intervention	Monitoring and Evaluation report	Annually	DCEP task force, Consultant, DEEU	AEPC
1	1	1	1	1	Training for ICS promoters	50 persons are trained on the process of ICS installation each year	Training completion report	Annually	DCEP task force, DEEU, AEPC,	NGO

Table 51: Monitoring and evaluation plan for Biogas

Yearly Target					Activity	Indicators	Tool for verification	Frequency of Monitoring	Institution Responsible for Monitoring	Supporting Organizations
2015	2016	2017	2018	2019						
1914	2643	3422	4255	5142	Biogas plant installation	Target numbers of biogas for each year are installed and are in operation.	HH Survey and sample observation/ BSP programme Annual report	Annually	DCEP task force , DEEU, BSP, Consultant	Biogas companies
					Subsidy provision as per subsidy policy	All biogas plants installed through pre-qualified companies have been provided subsidy as per AEPC's subsidy policy	Subsidy approval document	Annually	DCEP task force , DEEU	AEPC, BSP
					Provide after sales service	At least 95% of biogas installed HHs have access to after sales service and at least 80% are satisfied with the service	Biogas user survey; Monitoring report	Annually	DCEP task force , DEEU, Consultant	BSP
1	1	1	1	1	Monitoring	A yearly monitoring report is produced on Biogas with user survey, scale of intervention, degree of usage and quality of intervention	Monitoring and evaluation report	Annually	DCEP task force , BSP, Consultant, DEEU	AEPC
1	1	1	1	1	Provide operation and maintenance training for biogas users	At least one member of the biogas installed HH has been trained on operation and maintenance of biogas plants	Biogas user survey; End of year monitoring report	Annually	DCEP task force, DEEU, Consultant	BSP

Table 52: Monitoring and evaluation plan for Improved Water Mill

Target					Activity	Indicators	Tool for verification	Frequency of Monitoring	Institution Responsible for Monitoring	Supporting Organizations
2015	2016	2017	2018	2019						
1	1	1	1	1	Installation of IWM	Number of traditional water mills improved	Annual report	Annually	DCEP task force, DEEU	IWM companies
					Subsidy Provision (for grinding)	All systems installed through pre-qualified companies have been provided subsidy as per AEPC's policy	Subsidy approval document	Annually	DCEP task force, DEEU AEPC,	IWM companies
					Provide after sales service	At least 95% of IWM owners have access to after sales service and at least 80% are satisfied with the service	IWM user survey; End of year monitoring report	Annually	DCEP task force, DEEU, Consultant	AEPC
1	1	1	1	1	Monitoring	A yearly monitoring report is produced on IWM with user survey, scale and quality of intervention	Monitoring and evaluation report	Annually	DCEP task force, DEEU, AEPC, Consultant	IWM companies
					Provide resources for IWM rehabilitation and relocation	DDC and or AEPC allocates additional resource as per financing plan for the same purpose for pico hydro as well	DDC annual budget; Subsidy approval sheet	Annually	DCEP task force, DEEU	AEPC
					Promote end use diversification of IWM	Promoted IWM will adopt other end uses beside grinding	IWM user survey; End of year monitoring report; IWM annual report	Annually	DEEU, AEPC, RSC	IWM companies

Table 53: Monitoring and Evaluation Plan for Support Programs

Target					Activity	Indicators	Tool for verification	Frequency of Monitoring	Institution Responsible for Monitoring	Supporting Organizations
2015	2016	2017	2018	2019						
1					Vulnerability assessment of VDCs	A community based vulnerability assessment report is produced	Assessment report for District	Once	DCEP task force, DEEU, AEPC, District line agencies	Consultant
1	1	1	1	1	Monitoring of climate adaptation need for prioritized intervention areas	A report on adaptation needs of technology, resource, community intervention needs etc.	Assessment report for District	Once	DCEP task force, DEEU, AEPC	Consultant
					Awareness of climate change issues through knowledge products including Indigenous knowledge systems	Knowledge products developed on impacts and vulnerability, adaptation and indigenous adaptation methods	Monitoring and evaluation report	Annually	DCEP task force, DEEU, District line agencies	AEPC
1	1	1	1	1	Liaison between government line agencies for hazard preparedness	Increase synergy between DEEU and district line agencies.	Meeting minutes	Annually	DCEP task force, DDC, AEPC	DEEU
1	1	1	1	1	Data collection to collate disaggregated data on RE based on gender and ethnicity	End of project report	End of project report	Annually	DCEP task force, DEEU, Consultant	AEPC

Table 54: Monitoring and evaluation plan for Capacity Building/ Training

Target					Activity	Indicators	Tool for verification	Frequency of Monitoring	Institution Responsible for Monitoring	Supporting Organizations
2015	2016	2017	2018	2019						
					Promote and create access to finance for RETS	Finance institution provide financing for RETs including biogas, micro/pico hydro and SHS	End of year monitoring	Annually	DCEP task force, DEEU	All private companies
1	1	1	1	1	Training of RET stakeholders on climate change related issues	A district wide training is held through which at least 1 person from every VDCs and municipality and every organizations active in these issues	Training completion report	Annually	DCEP task force, DEEU, district line agencies	AEPC, NGO
1	1	1	1	1	Training on business development to RET companies including NGO and CBO	A district wide training is held through which at least 1 person from every VDCs and municipality and every organizations benefitted	Training completion report	Annually	DEEU, district line agencies.	AEPC, NGO
1	1	1	1	1	Provide training on integrated water resource management and forest management to community based organizations	A district wide training is held through which at least 1 person from every VDCs and municipality and every organizations active in rural development activities are imparted knowledge on climate change issues.	Training completion report	Annually	DEEU, district line agencies.	AEPC, NGO

Chapter Six

Recommendations

6.1 Gender and Social Inclusion

- There should be a provision of gender and socially disaggregated data to monitor the progress on GSI issues. Currently not all the data are disaggregated by gender, class, caste and ethnic group wise creating disaggregated data for the whole district in terms of who owns different RETs, who is trained on what RETs etc. Collection and analysis of these data is to be the responsibility of DEEU and DCEP implementing partners with the support from national level organizations like AEPC, SNV and others. There should be a compulsory mechanism to include and institutionalize GSI in all the reporting communication frameworks.
- Data collection surveys need to be designed for disaggregated data. The data collection systems used by organisations including AEPC need to be revised so that they are more users friendly and systematic in order to access GSI specific data. Local experienced NGOs and enumerators or local social mobilizers could be used to collect necessary, reliable and consistent data/information.
- Women, Dalits, Ethnic Group, Religious Minorities, poor and all excluded groups need to be especially targeted for awareness raising and capacity building on Renewable Energy (RE) development.
- Make sure that women and poor have equitable say in decisions making processes in their respective institutions and networks. It is necessary to have at least 33-51% women's representation in all institutional mechanisms created for RETs promotion and development. Likewise, the percentage representation of poor, ethnic groups, Dalit and other caste groups are to be in line with the proportionate share of the population of their respective category.
- Renewable energy (RE) opportunities should be focused to foster equitable development from GSI perspective. Develop strategies for empowering women and excluded groups in planning for DCEP. The GSI friendly Energy Technologies such as Improved Cooking Stove (ICS), Biogas Stove, Electric Stove, LPG Stoves, etc should be promoted for cooking.
- Biogas technology could be promoted also among the households where livestock are not kept through providing subsidy for buying cattle dung from the cattle farm nearby. For subsidy, equal amount may not be appropriate for whole district as the cost of materials and labour vary from location to locations even within the district.
- Awareness raising activities such as door to visits, meetings, Radio, FM, street drama, etc. in rural areas to promote use of smokeless technology and reduce heavy use of fuel woods and cattle dung (gobar-guitha) for cooking that have negative implication on health.

- Local social mobilizers who are already involved in various project / programs like PAF and LGCDP could be utilized for awareness programs. And the DCEP should be implemented through women groups and Nagarik Wada Munch Committees of VDC/Municipalities formed in absence of elected local body.
- A targeted approach for women, poor, ethnic groups and Dalits is required. At present, DDC provides services as per the demand from the households who have access to information and financial resources. Currently poor, marginalized and women headed households have not been able to exploit these benefits. This could be due to lack of both information on the available technologies and financial ability to invest in them.
- There needs to be a mandatory provision to allocate at least 50% of the resources to women's ownership at least for household level energy technologies as women are the primary users and managers of household level energy.
- A more appropriate weighting system needs to be designed that more effectively qualifies the influence of climate change and GSI on energy planning in terms of access, reduced drudgery, increased livelihoods and improved decision making.
- It should be ensured that chosen technologies are accessible and affordable to women, women headed households, poor and other marginalized groups. Since accessibility and affordability of the technologies are the key variables to measure its adoptability, appropriate measures like additional subsidies to these groups of people should be made.
- All technologies introduced should support reducing drudgery and workload of people particularly of women, poor and the marginalised. In context of Smokeless Kitchen by 2017, ICS is going to be one of the popular RETs for women, poor and marginalized, promotion of fast growing fuel wood species in the local community forest and private land could support women, poor, ethnic groups and Dalit to get regular flow of firewood to run their ICSs in collaboration with community forest user groups and district forest office.
- Likewise, promotion of fodder/forage in community forest and also in private land reduces drudgery and workload of people particularly of women.
- Fodder promotion in community forestry will support poor, women and other marginalised groups since these groups of people have limited private land holding to grow fodder in their farm land. Such interventions not only support the running of biogas by providing animal feed but also increase the income of the households by selling livestock and their product which in the long run increases the RET investment capacity of the participating households.
- New energy technologies like "solar heater" should be introduced for cooking.
- Bio-char is also being promoted in some 11 districts by Bio-Energy Project funded by the European Union. This helps to meet the increasing energy demand replacing environmentally hazardous fossil fuels; and it helps to reduce carbon emissions and create additional local employment. Moreover, it will help increase the value of forests, trees, shrubs and other woody perennials as well as it is GSI friendly.

- It needs to be ensured that women, poor and marginalized groups have equitable access to information and skill development in operating and maintaining the chosen technologies. In all cooking related RETs, more than 75% of the training participants should be women. This number might exceed in the case of improved cook stoves as women seem confident to sell their skills after they have received Training of Trainers (ToT). As ICS fixation doesn't require any prior investment (except training) this might be one of the suitable income generation activities for these category of people.
- Central funding sources should be sought to provide financial resources, and subsidies for women, women headed household, poor, ethnic groups, Dalit and other marginalized groups.
- Local level resource should additionally be made available where adequate central funding is not available. Such funding sources can include VDCs, local forest user groups, local saving credit groups and the like.
- For tracking the continued progress and for regular policy feedback there should be a strong GSI inclusive monitoring mechanism which will provide strong evidences and data for the formulation of GSI friendly energy policies at the national level.
- To materialize all the above recommendations, there needs to be a strong service delivery mechanism with strong GSI support at all levels (community, district and national level). There is a need to establish strong GSI focal unit with adequate resources and power delegation at all levels.

6.2 Technology

- There needs to be research, development and implementation of appropriate technology in the district. Utilization of available energy resources at the local level makes the technology sustainable.
- While designing energy system in the district, it is needed to make sure that the supply meets the demand which will naturally increase over time. There is a need to assess and monitor energy systems to ensure systems can adapt to anticipated climate change impacts. Similarly, there is need to implement demand side management as adaptation measure.
- The concern district authority should make conductive environment and encourage private companies, local NGOs, users' group and individuals for development of RETs in Chitwan. Special focus should be made to harness solar, bio-fuel, biogas and pico-hydro resource of the district.
- Research, development and implementation of improved biomass stoves needs to be carried out that so that stoves that use fuel other than wood can also be utilised for water boiling, preparing feed for livestock etc. at greater efficiencies.
- Biogas plants construction should be needed to accelerate. The promotion of this technology in commercial and industrial will be beneficial as well.

- Installation of solar home system, small solar home system, solar pumping, solar cooker and dryer is needed to furthermore accelerate as decentralized system in the district. Use of solar pump for deep irrigation in the agricultural sector provides promotion of agricultural products in the district. In addition, solar thermal heater seems very useful for hotels, restaurants, commercial complexes and individual houses for hot water supply.
- LPG selling points need to be expanded in more places (especially in rural areas) in the future to meet its increasing demand.
- National RET programmes such as MGSP or the IWM programme could look at the vulnerability of RE systems and revise feasibility studies to include analysis of climate vulnerabilities and R&D could be carried out to look at climate proofing technologies.
- With ICS lasting longer and more efficient it would mean less stress on the dwindling forest resource as well as on the scale of interventions required to replace the defunct ICS. Overall it would add efficiency to the natural and financial resources.

6.3 Climate Change

- Climate change is real and underway, so there is a need of impact identification and adoption to cope with vulnerabilities to minimize the impact of climate change in livelihood like change in energy use pattern, agriculture practices etc.
- Representative and scientific climatic stations should be installed and data related to climatic phenomena should be recorded regularly for identifying actual scenario of climate change.
- Detail research on impact of climate change in hydropower and other energy resources is necessary. Catchment area of major river systems should be managed through integrated watershed management approaches.
- Degraded lands can be handed over to community for developing community forests. Appropriate tree species suiting the local ecology and having beneficial impacts in livelihoods should be selected for plantation.
- Proper planning for urbanization of major urban areas is necessary. Waste to energy concept can be developed for management of solid wastes generated in urban area.
- Extraction of sands and gravels from river banks should be monitored strictly and should be extracted only in sustainable manner.
- Biogas installation and use can be associated with CDM mechanism is appropriately flowed UNFCCC Guidelines.

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