GOVERNMENT OF NEPAL
WATER AND ENERGY COMMISSION SECRETARIAT
SINGHA DURBAR, KATHMANDU
NEPAL

CONSULTING SERVICES FOR

PREPARATION OF LONG TERM VISION OF NEPAL'S WATER RESOURCES AND ENERGY SECTORS

NEPAL`S ENERGY SECTOR VISION 2050 A.D.

FINAL REPORT

NOVEMBER 2013

CMS CONSOLIDATED MANAGEMENT SERVICES NEPAL (P.)LTD.
126 GREEN HOUSE, BHADRABINAYAK MARG, THAPAGAON, NAYA BANESHWOR
GPO BOX 10872, KATHMANDU-10, NEPAL

TABLE OF CONTENTS

ABBREVIATIONS .....
EXECUTIVE SUMMARY x
CHAPTER 1.....1
INTRODUCTION.....1
1.1 Rationale for Long Term Vision for Water Resources & Energy Sectors 1
1.2 Long Term Vision Formulation Approach..... 2
1.3 Long Term Vision Formulation and Attainment Process 2
1.5 Basis of the Vision 2050 2
1.4 Structure of the Vision Document 3
CHAPTER 2.....5
GLOBAL SCENARIO 5
2.1 Current Global Scenario 5
2.1.1 Traditional (Biomass) Energy..... 5
2.1.2 Commercial Energy 5
2.1.3 Renewable Energy 6
2.2 Current Regional Scenario..... 8
2.2.1 Traditional (Biomass) Energy Sector in South Asia 8
2.2.2 Commercial Energy Sector in South Asia..... 9
2.2.3 Renewable Energy Sector in South Asia..... 10
2.3 Current Major Trend in Development and Management..... 13
2.3.1 Traditional (Biomass) Energy..... 13
2.3.2 Commercial Energy 14
2.3.3 Renewable Energy 14
CHAPTER 3.....16
HISTORIC PERSPECTIVE OF DEVELOPMENT IN NEPAL: PAST TREND AND FUTURE PROSPECTS.....16
3.1 Historic Perspective..... 16
3.1.1 Planned development during First Plan (2056-2060): Initiation of Planned Development 16
3.1.2 Planned Development during Panchayat Regime (1962-1990): Period of Controlled Planning 16
3.1.3 Plan Holiday Period (1990-1992): Transition from Controlled to Liberalized Planning 16
3.1.4 Planned Development during Constitutiional Monarchy Regime (1992-07): Liberalized Planning.. 17
3.1.5 Planned Development during Republican Regime (2007/08-2012/13): Inclusive Planning 17
3.2 Past Trend in Economic Growth of Nepal 20
3.3 Future Macro-Economic Prospects of Nepal..... 20
3.4 Historical Development of Hydropower..... 21
3.5 Historical Development of Rural Electrification 22
CHAPTER 4.....26
CURRENT SCENARIO OF ENERGY RESOURCES IN NEPAL 26
4.1 Traditional (Biomass) Energy Resources..... 26

CHAPTER 5 37
CURRENT STATUS OF ENERGY RESOURCES CONSUMPTION IN NEPAL 37
5.1 Current Status of Energy Consumption 37
5.1.1 Traditional Energy Consumption by Sector 38
5.1.2 Commercial Energy Consumption by Sector 39
5.2 Current Status of Energy Supply 41
5.2.1 Traditional (Biomass) Energy Supply 41
5.2.2 Commercial Energy Supply 41
5.2.3 Renewable Energy Supply 41
CHAPTER 6 43
POLICY AND LEGISLATIVE FRAMEWORK IN ENERGY SECTOR 43
6.1 Evolution of Legislative Framework in Energy Sector 43
6.1.1 Legislative Frameworks 43
6.2 Major International Laws and Conventions on Energy Resources that have implications on Nepal 43
6.3 Current Status of Policy and Legislative Framework related to Energy Sector in Nepal 44
CHAPTER 7 46
INSTITUTIONAL FRAMEWORK IN ENERGY SECTOR 46
7.1 Institutional Framework in Energy Sub-Sectors 46
7.1.1 Institutional Framework in Traditional (Biomass) Energy Sub-Sector 46
7.1.2 Institutional Framework in Commercial Energy Sub-Sector 467
7.1.3 Institutional Framework in Renewable Energy Sub-Sector 468
CHAPTER 8 51
MAJOR GAPS BETWEEN POTENTIALS OR DEMANDS AND SUPPLY 51
8.1 Major Gaps in Energy Demand and Supply 51
8.1.1 Traditional energy 51
8.1.2 Commercial energy 53
8.1.3 Renewable Energy 54
CHAPTER 9 56
MAJOR ISSUES IN ENERGY SECTORS 56
9.1 Major Issues in Energy Sectors 56
9.1.1 Policy 56
9.1.2 Legislative Framework 57
9.1.3 Traditional (Biomass) Energy 57
9.1.4 Commercial Energy 63
9.1.5 Renewable Energy 70
CHAPTER 10 74
METHODOLOGICAL APPROACH FOR FUTURE ENERGY SCENARIOS 74
10.1 Methodological Approach: Bottom-up Modelling Using MAED-2 74
10.2 Supply policy analysis by optimization approach MARKAL 78
CHAPTER 11 83
DIFFERENT FUTURE ENERGY SCENARIOS 83
11.1 Low Economic Growth scenario 83

11.2 Medium Economic Growth scenario 836
11.3 High Economic Growth scenario 91
CHAPTER 12 103
VISION FOR 2050 AD 103
12.1 Vision for Energy Sector and its Sub-Sectors for 2050 AD 103
12.1.1 Traditional (Biomass) Energy 103
12.1.2 Commercial Energy 103
12.1.3 Renewable Energy 104
CHAPTER 13 105
MISSION FOR 2050 AD 105
13.1 Mission for Energy Sector and its Sub-Sectors in 2050 AD 105
13.1.1 Traditional Energy 105
13.1.2 Commercial Energy 105
13.1.3 Renewable Energy 106
CHAPTER 14 107
OBJECTIVES AND GOALS OF THE VISIONS 107
14.1 Energy Resources Sector and its Sub-Sectors 107
14.1.1 Traditional (Biomass) Energy 107
14.1.2 Commercial Energy 107
14.1.3 Renewable Energy 109
CHAPTER 15 110
STRATEGY FOR MATERIALIZING THE VISIONS 110
15.1 Strategy for Formulation of Energy Policy and Legislative Framework 110
15.2 Legislative and Regulatory Framework 110
15.3 Specific Targets 111
15.4 Institutional Strategic Programs 112
CHAPTER 16 114
PLANS/PROGRAMS/PROJECTS 114
16.1 Plans/Programs/Project of Traditional (Biomass) Energy 114
16.2 Plans/Programs/Project of Commercial Energy 114
16.3 Plans/Programs/Project of Renewable Energy 1147
CHAPTER 17 118
ACTIVITIES 118
17.1 Traditional (Biomass) Energy 118
17.2 Commercial Energy 118
17.2.1 Hydropower 118
17.2.2 Other commercial Energy 122
17.3 Renewable Energy 123
CHAPTER 18 124
POTENTIAL THREATS AND MITIGATION MEASURES/PLANS 124
18.1 Climate Change 124
18.2 Political Change 124

18.3 Global Economy and International Market 125
CHAPTER 19 126
STRATEGIES AND MEASURES TO DEAL WITH THE THREATS 126
REFERENCES: 127

LIST OF TABLES:

Table 2-1: Share of Woody Biomass Sources in Primary Bio-energy Mix in the World 5
Table 2-2: Wood fuel Consumption in South Asia, 1990-2009 (in million m3) 8
Table 3-1: Projected Capital Investment Requirements for Water and Energy Sectors under long Term Vision of 2050 at 2010/11 Prices 20
Table 4-1: Forest and Scrubland area by Development Region 26
Table 4-2: Area of Reachable and Non-reachable Forest by Development Region 27
Table 4-3: Annual Rates of Change in Forest Cover (1990/91-2000/01) by District Excluding Protected Forest Areas 27
Table 4-4: CF Area by Development Region and Physiographic Region (2010) (Unit in 000 ha) 28
Table 4-5: Production Potential of Animal Dung in 2008/09 (in '000MT) 29
Table 4-6: Production Potential of Agricultural Residue in 2008/09 30
Table 4-7: Waste Generation in Five Municipalities of the Kathmandu Valley (tons per day) 30
Table 4-8: Theoretical Hydropower Potential of Nepal 31
Table 4-9: Economic Hydropower Potential 31
Table 4-10: Status of solar PV in Nepal 33
Table 4-11: Status of Micro-hydro in Nepal 34
Table 4-12: Status of MH in Nepal 34
Table 4-13: Yearly Installation of Biogas Plant by Capacity Size 36
Table 4-14: Waste Generation in Five Municipalities (tons/day) 36
Table 5-1: Energy Balance of Nepal in 2010 in TJ 37
Table 5-2: Summary of installed RET's in Nepal till mid July 2011 (AEPC, 2011) 42
Table 8-1: Traditional Energy Consumption by Different Sources (carriers) in Short, Medium and Long Term (at 5.5% GDP growth rate and in TJ measurement unit) 51
Table 8-2: Project Amount of Different Energy Sources (carriers in total consumption in short, medium and long term (in TJ) 51
Table 8-3: Projected Share of Different Energy Sources (carriers) in Total Consumption in 2020, 2030 and 2050 52
Table 8-4: Potential of Renewable Energy 54
Table 10-1:Final energy consumption by different energy forms and by economic sectors in 2010 76
Table 11-1: Fuel Consumption inLow Economic Growth scenario 84
Table 11-2: Sectoral consumption at Low Economic Growth scenario 86
Table 11-3: Peak Power Plant Capacity at Low Economic Growth scenario 86
Table 11-4: Fuel Consumptions at Medium Economic growth rate 87
Table 11-5: Sectoral Energy Consumption (TJ) at Medium Economic growth rate 89
Table 11-6: Power Plant Capacity at Medium Economic growth rate 90
Table 11-7: Energy Indicators in Medium Economic growth rate 90
Table 11-8: Fuel Consumption at High Economic growth rate 91
Table 11-9: Energy Mix by sector (TJ) in High Economic growth rate 93
Table 11-10: Power Plant Capacity High Economic growth rate 94
Table 11-11: Fuel Consumption in Combined Policy Scenario 96
Table 11-12: Sectoral Energy Consumption in TJ in Combined Policy Scenario 98
Table 11-13: Power plant Capacity in Combined Policy Scenario 99
Table 11-14: Energy Indicators in Combined Policy Scenario 99

LIST OF FIGURES:

Figure 1-1: Vision Formulation and attainment Process 2
Figure 4-1: Sales of Major Petroleum Products from 1995 to 2010 in MT(toe) ((NOC, 2011)....32
Figure 4-2: Number of SHS installed annually 33
Figure 4-3: Yearly ICS Installation 35
Figure 5-1: Fuel-wood Consumption by Sector in 2008-09....38
Figure 5-2: Petroleum Consumption by Sector 2008/09 (WECS, 2010) 40
Figure 5-3: Energy Mix by Fuel type in 2010 (MOF, 2012; WECS, 2010)....41
Figure 8-1: Projected Amount of Energy Components by Different Sources by 2050 52
Figure 8-2: Import of Petroleum Products against Commodity Exports in 2012(Source: MOF, 2012; NOC, 2011) 53
Figure 8-3: Differences between Peak Demand and Installed Capacity of Power Plants (MW) (NEA, 2012)....54
Figure 10-1: Structure of MAED-2 Model for Energy Demand Projection 75
Figure 10-2: Different Sectors and Sub-sectors in MAED Model 77
Figure 10-3: Classification of Energy Sector Models 78
Figure 10-4: Classification of Energy Sector Models 80
Figure 10-5:MARKAL Modelling Framework....80
Figure 11-1 Fuel Consumption Trend at Low Economic Growth scenario 84
Figure 11-2: Fuel mix at Low Economic Growth scenario in 2020 85
Figure 11-3: Fuel mix at Low Economic Growth scenario in 2030 85
Figure 11-4: Fuel mix at Low Economic Growth scenario in 2050 85
Figure 11-5: Peak Power Plant Capacity at Low Economic Growth scenario 86
Figure 11-6: Fuel Consumption Trend at Medium Economic growth rate 87
Figure 11-7: Fuel mix in Medium Economic growth rate in 2020 88
Figure 11-8: Fuel mix in Medium Economic growth rate in 2030 88
Figure11-9: Fuel mix in Medium Economic growth rate in 2050 89
Figure 11-10: Power Plant Capacity at Medium Economic growth rate 90
Figure 11-11: Fuel Consumption Trend in High Economic growth rate....92
Figure 11-12: Fuel mix in High Economic growth rate in 2020....92
Figure 11-13: Fuel mix in High Economic growth rate in 2030....93
Figure 11-14: Fuel mix in High Economic Growth Rate in 2050 93
Figure 11-15: Power Plant Capacity and High Economic Growth Rate 94
Figure 11-16: Fuel Consumption in Combined Policy Scenario....96
Figure 11-17: Fuel mix in Combined Policy Scenario in 2020....97
Figure 11-18: Fuel mix in Combined Policy Scenario in 2030....97
Figure 11-19: Fuel Mix in Combined Policy Scenario in 2050....98
Figure 11-20: Power Plant capacity in Combined Policy Scenario 98
Figure 11-21: Per Capita Energy Consumption 100
Figure 11-22: Growth Trend of Per Capita Electricity Consumptions....100
Figure 11-23: Household Electricity Consumption Per Capita 100
Figure 11-24: Falling Trend Energy Intensity 101
Figure 11-25: Share of Non Carbon Energy in Total Final Energy....101
Figure 11-26: Per capita CO2 Emissions....102
Figure 11-27: Net Imports of energy commodity to the Total Energy Consumptions....102

ABBREVIATIONS

ADB	Asian Development Bank
ADBN	Agriculture Development Bank Nepal
AEPDB	Alternative Energy Promotion Development Board
AEPC	Alternative Energy Promotion Center
BCFUGC	Buffer Zone Community Forest Users Group
BISEP-ST	Biodiversity Sector Programme for Siwalik and Terai
BSP	Biogas Support Programme
BSP-N	Biogas Sector Partnership-Nepal
CBOs	Community Based Organizations
CDM	Clean Development Mechanism
CERs	Certified Emission reduction
CES	Center for Energy Studies
CMS	Consolidated Management Services Nepal
CREF	Central Renewable Energy Fund
CRT	Center for Rural Technology
CTEVT	Council for Technical education and Vocational Training
CSP	Concentrating Solar Power
CF	Community Forest
CFM	Collaborative Forest Management
CFUG	Community Forest Users Group
DANIDA	Danish International development Association
DCS	Development and Consulting Services
DoED	Department of Energy Development
DFO	District Forest Office
DoF	Department of Forest
DoFRS	Department of Forest Research and Survey
EC	European Commission
ESAP	Energy Section Assistance Programme
ET	Emission Trading
EU	European Union
EUROSTAT	European Statistic
EA	International Energy Agency
FAO	Food and Agriculture Organization of the United Nations
FRA	Forest Resources Assessment
FUGC	Community Forest Users Group Committee
GHG	Green House Gases
GEF	Global Environment Facility
GGC	Gobar Gas and Agricultural Equipment Development Company
GJ	Giga Joules
GoN	Government of Nepal
HLFFDP	Hills Leasehold Forestry and Forage Development Project
IAEA	International Atomic Energy Agency

ICS	Improved Cooking Stove
IEA	International Energy Agency
IPCC	International Panel on Climate Change
IOE	Institute of Engineering
ISPS	Institutional Solar PV System
ITDG	Intermediate Technology Development Group
JI	Joint Implementation
JNNSM	Jawaharlal Nehru National Solar Mission
JREC	Johannesburg Renewable Energy Coalition
KfW	Kreditanstalt fur Wiederaufbau
KVIC	Khadi and Village Industries Commission
LF	Leasehold Forest
LFLP	Leasehold Forestry and Livelihood Programme
LFP	Livelihood Forestry Project
MAED	Model for Analysis of Energy Demand
MARKAL	Market Analysis
MDG	Millennium Development Goal
MJ	Mega Joules
MFIs	Micro Finance Institution
MoAD	Ministry of Agricultural Development
MoEnv	Ministry of Science, Technology and Environment
MOU	Memorandum of Understanding
MOF	Ministry of Finance
MoLRM	Ministry of Land Reform and Management
MoFSC	Ministry of Forest and Soil Conservation
MoSTE	Ministry of Science, Technology and Environment
MPFRS	Master Plan for Forestry Sector
Mtoe	Million ton of oil equivalent
MW	Megawatt
NAST	Nepal Academy of Science and Technology
NARC	Nepal Agricultural Research Center
NBL	Nepal Bank Limited
NGOs	Non-Government Organization
NOC	Nepal Oil Corporation
NPC	National Planning Commission
NRB	Nepal Rastra Bank
NRREP	National Rural and Renewable Energy Programme
NFI	National Forest Inventory
NWP	National Water Plan
PPPs	Public Private Partnership
PSEP	Pulimarang Solar Village Electrification Project
PV	Photovoltaic
PVPS	Solar PV Pumping System
R & D	Research and Development

REDP	Rural Energy Development Programme
RET	Renewable Energy Technology
RETS	Renewable Energy Test Station
RRE	Rahimafrooz Renewable Energy Pty Ltd
SEAM-N	Strengthening of Environmental Administration and Management Nepal
SAARC	South Asian Association for Regional Cooperation
SC	Solar Cookers
SD	Solar Dryers
SELF	Solar Electric Light Fund
SHS	Solar Home System
SNV/N	The Netherlands Development Organization of Nepal
SWERA	Solar & Wind Energy Resource Assessment
SWH	Solar Water Heater
TOR	Terms of Reference
TCN	Timber Corporation of Nepal
TOF	Tree outside Forest
TPES	Total Primary Energy Supply
UMN	United Mission to Nepal
UNEP	United Nations Children Fund
UNFCCC	United Nations Framework Convention on Climate Change
UBET	Unified Bioenergy Terminology
UNDP	United Nations Development Programme
WEC	World Energy Council
WB	World Bank
WECS	Water and Energy Commission Secretariat
WLED	White Light Emitting Diode
WUPAP	Western Upland Poverty Alleviation Programme
YSD	Yashoda Sustainable Development (P) Ltd.

EXECUTIVE SUMMARY

In the year 2010, the total final energy consumption was 410,000 TJ (MOF, 2012; WECS, 2010), out of which traditional Biomass resources supplied 85 percent in the total energy consumption, whereas commercial energy such as fossil fuels and electricity were 14 percent. Modern biomass such as biogas and briquettes and renewable energy sources supplied about 1 percent only. Among the commercial energy sources, all the petroleum products are being imported from Indian Territory. The electricity has been generated by hydropower plants and partially about 121.44 MW of electricity is being imported from India as well.(NEA, 2012) In recent years, subsidized fuels for cooking such as Liquefied Petroleum gas (LPG) are being widely used not only in urban but also in rural areas. But due to price rises in the international oil markets, fossil fuels have become economically inefficient for cooking if their costs were compared in 1990s and in 2013.

The major renewable energy supplied in Nepal is electricity which contributes only 2% of the total energy demand (SREP, 2010). At present Nepal has a total installed capacity of 762.029 MW. Of the total installed capacity of the hydropower, 477.930 MW is contributed by NEA hydro including the only storage type Kulekhani power plant with an installed capacity of 60 MW, 5.341 MW by NEA thermal, 0.100 MW by solar and 230.589 MW-all Run-off-the River (ROR) by IPP hydro. Hydropower supplies about 92.98% of the total electricity generated. Energy demand of INPS in fiscal year 2012/13 is estimated at 5,446.285 GWh, out of which only 4,218.135 GWh (77.45%) could be supplied. There is big gap between energy demand and supply and due to increasing trend in gap between the supply and demand, Nepal is facing acute energy crisis with almost 16 hours of power cuts a day in the dry season.

Against this backdrop of current status of energy sector, Nepal energy sector vision 2050 is formulated on the basis of the various scenarios developed in the total energy systems of Nepal with the base year taken as 2010 and the final year 2050. The scenarios are obtained from the analysis of the outputs from the MARKAL energy systems modeling framework. The main energy drivers taken into consideration in the modeling framework are the economic growth rate of the country and the population growth rate as envisaged by the macroeconomic analysis and the population census in 2011 respectively. The macroeconomic analysis has shown three growth paths of the national economy of Nepal (a) low economic growth scenario, (b) medium economic growth scenario, and (c) high economic growth scenario. In order to address aspirations shown by the participants in the development of the energy sector in the five regional workshops, the main objectives of the UN's sustainable energy for all program (SE4ALL), the judgments formed during several rounds of discussions among the sub-sectoral consultants in the energy sector and inputs from the national workshops , a combined policy scenario is also developed at the medium economic growth scenario.

All these energy development pathways are further macro-economically analyzed to look into their economic sustainability. The analysis indicated that even the combined energy development pathway requiring huge investments in the energy sector does not crowd out investments in other essential sectors. Nepal energy sector vision 2050 is developed on the foundation of the combined energy policy scenario.

Vision Statement

"Discover, explore, develop and manage sustainably all the available potential energy resources in the country, to meet the national demand for all the forms of energy, to substitute the imported energy and to contribute maximum to the national economy through the export of indigenously produced energy".

Mission Statement

Energy sector for socio-economic development, environmental sustainability and energy security

Key Elements of the Energy Sector Vision 2050 AD

The following are the key elements of the energy sector vision 2050 based on the sub-sectoral vision reports:

1. Hydro-power is the "lead" energy sector long term demand for energy of all sectors to meet the short as well as long term energy needs of the country.
2. A high powered umbrella organization (within PMO) will be created for implementing the one window policy. Programs to enhance rural electrification will be improved and implemented.
3. Environment for incremental domestic capital market and foreign capital for hydropower development will be created.
4. Water rights of power projects will be ensured and people will be made aware of water rights and obligations.
5. National Energy Regulation Commission (NERC) will be created and PPA will be brought under it.
6. Hydropower development will be maximized for cent percent electrification including its uses for energy-intensive industries and export of power providing substantial benefits to the country
7. Complete electrification in water pumping and enhanced electrification in farm machinery in agriculture sector
8. Total electrification in end-uses in commercial sector
9. Higher penetration of electrification in freight, inter-city and intra-city transport
10. Sizable Penetration of electric cars in private transport by 2050
11. Complete electrification in boilers in industrial sector
12. Complete cooking in electricity in urban households by 2030 onwards
13. Enhanced share of electricity in cooking in rural households and total penetration of ICS in cooking with solid biomass remaining in the rural households
14. Total electrification in lighting from 2030 onwards
15. Traditional fuelwood stoves in rural areas will be completely replaced by ICS by 2030
16. Fuelwood consumption will be sustainable by 2020 onwards
17. Connection of off-grid micro-hydro to grid;
18. Connection of solar PV power to grid;
19. Connection wind power plant to grid
20. Extension and promotion of use of bio-diesel and gasifier
21. Continuous improvement/implementation of policies and regulations in energy sector
22. Preparation of an Integrated Energy Sector Policy
23. A comprehensive legal framework will be required for the development and management of energy resource.
24. The draft legislation for the development and management of electricity needs to provide for appropriate frameworks to implement the 2001 Hydropower Development Policy. The planned large scale development of generation will attract a significant number of private investors for its development and in turn requires an independent and strong regulatory body. The draft Electricity Bill 2065 could not be enacted following sudden dissolution of the Legislature Parliament in 2068. Priority should be given to revise the Bill taking into consideration, as required, the 142 amendments tabled in the Parliament.
25. Enact a separate law for establishing an independent regulatory body. The energy sector requires regulatory oversight to balance consumer and producer interests, to ensure efficiency and to create a level playing field. Natural monopolies need regulation to ensure open access to all so that competitive efficiency is realized. The draft Electricity Regulatory Commission Bill 2065 also could not be enacted due to dissolution of the Legislature Parliament in 2068. The process will be faster if the same Bill is revised incorporating, as necessary, the 31 amendments already tabled.
26. Enact a separate law for regulation of petroleum products. Besides the supply and distribution aspects of petroleum products, the law should make mandatory provisions for developing, promoting and blending indigenous biofuels such as biodiesel and ethanol with incentives and tax concessions for biofuel producers, retailers and users.
27. An enabling institutional framework is essential. An appropriate institutional framework shall be created and or strengthened for integrated development of the energy sector. The institutional framework for development of other renewable and non-conventional energy sources shall be strengthened.

28. The vertically integrated NEA shall be restructured and unbundled to allow healthy competition and a level playing field for commercial operation of power sector. An independent regulatory authority shall be created for a sound tariff setting system enabling the power sector to operate in a commercial manner.
29. An appropriate legal framework shall be developed for an integrated policy formulation, development and coordination in the energy sector.
30. WEC/WECS should be the lead agency for integrated energy planning. All the sub sectoral institutions in energy will integrate the sub-sectoral energy plan with the integrated energy plan to be prepared by the WEC/WECS. The WEC should be the apex body for national energy security and integrated planning.
31. Institutional reform of the existing institutions to eliminate the monopoly. Monopoly of (i) NEA in hydropower transmission, distribution and (ii) NOC in import, storage, transfer and distribution of petroleum product. This will make them competitive improving the service delivery. The syndicate system in renewable energy for example in biogas and solar lighting should be eliminated.

The Core Principles

The energy sector vision 2050 is developed on the premises of the following core principles:

- To make consumption of biomass energy resources sustainable. The current consumption of solid biomass energy, especially fuelwood, is not sustainable. It is causing deforestation, landslides, soil erosion and creating indoor air pollution which consequently is the main reason for untimely death and health hazards of women and children.
- To make hydropower resources as the main energy resources. Nepal has huge hydropower resources and its harnessing is dismally poor in the country creating energy crisis of which the scale is in the increasing trend. Strong, coordinated focus and removing barriers for the development of hydropower resources should be the prime objective of the governmental development efforts.
- To reduce dependence on imported fossil fuels. Nepal is increasingly becoming dependent on imported fossil fuels in meeting its energy demand which is detrimental from the point of sustainable development and energy security and hence, Nepal should try to develop indigenous hydropower resources and renewable energy. There is ample scope of economic viability for the substitution of fossil fuels from indigenous energy resources.
- To provide an adequate supply of energy throughout Nepal at reasonable and affordable price. Access to modern energy is a prerequisite for achieving the millennium development goals (MDGs) and as a consequence, UN has come up with sustainable energy for all (SE4ALL) program with the main objectives of (a) access to modern energy to every household by 2030, (b) doubling the improvement rate of energy efficiency by 2030, and (c) doubling the share of renewable energy in the total energy by 2030. In order to achieve these goals Nepal should develop its indigenous hydropower resources and renewable energy in the provision of reliable, affordable and accessible energy to every household.
- To develop alternative energy technologies such as biogas, solar, wind and etc. Nepal has ample abundance of renewable energy such as solar energy, biogas, micro hydro, wind and etc. These renewable energy resources have to be develop in order to enhance energy security and environmental sustainability.
- To encourage efficient use of energy and to minimize detrimental environmental effects resulting from energy supply and use. Usage of energy is poor in efficiency in Nepal and demand side management in the energy efficiency in household, commercial, industrial and transport sectors will reduce unnecessary investments in the supply side and reduce unwanted environmental hazards.

Different Scenarios Analysis for the Development of Energy Sector

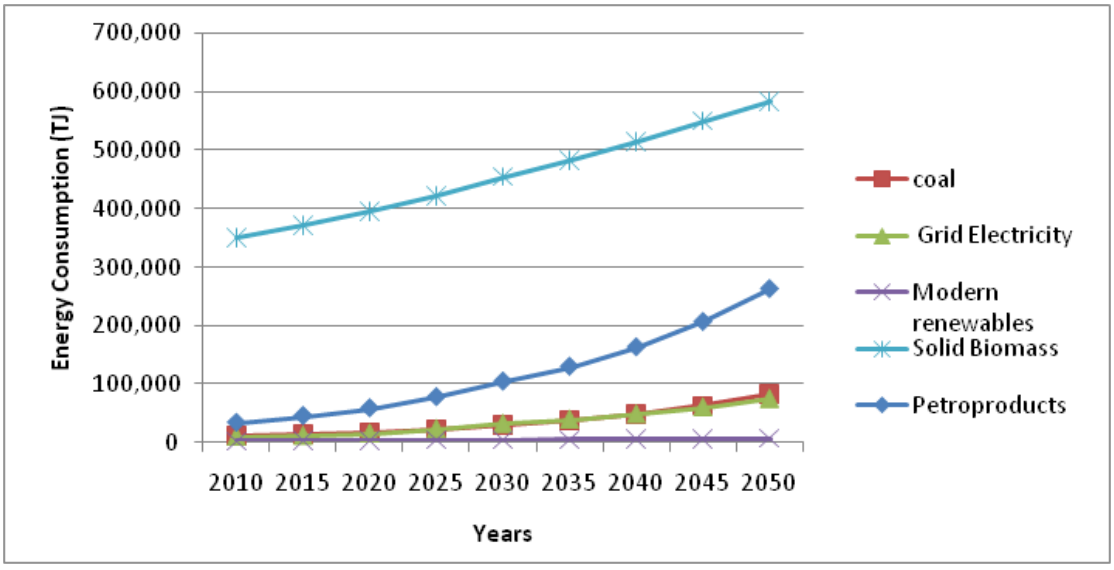
Forests resources are denuded due to unsustainable consumption of fuelwood creating soil erosion, landslides and other natural disasters. Nepal has abundance in hydropower resources and other renewable energy but unfortunately, their harnessing is dismally poor. On the other hand, she is increasing becoming dependent on the

imported fossil fuels for meeting its energy demand jeopardizing sustainable development process and energy security. Import of petroleum products shot up to 126% of export earnings in 2012 which was just 27% in 2001. With the soaring oil prices in the international markets, current household fuel economics reveals that it has become economically efficient to cook on electricity rather than on kerosene and LPG which are widely used for cooking in urban domestic and commercial sectors. Against this backdrop, Nepal has to undertake energy development pathways for socio-economic development, energy security and environmental sustainability.

In order to develop energy vision 2050, it is very essential to develop different energy development scenarios based on the main energy drivers (a) economic growth rate of the country (GDP growth rates), and (b) demographic growth rate. Scenarios are developed for three GDP growth rates (a) low economic growth scenario (b) medium economic growth scenario and (c) high economic growth scenario. These scenario are observed without any technology and new policy intervention. A scenario analysis is also conducted for medium economic growth scenario with the technological policy intervention based on the UN's Sustainable energy for all (SE4ALL) program and the aspirations as expressed by the participants in the stakeholders' workshops at different regional development centers. A combined policy scenario is further honed by several rounds of discussions among the concerned consultant experts.

Low economic growth scenario

This scenario is based on the low economic growth and population growth rate as per the population census in 2011. The share of demand technology is assumed to be the same as in the base year 2010 in other periods of analysis.

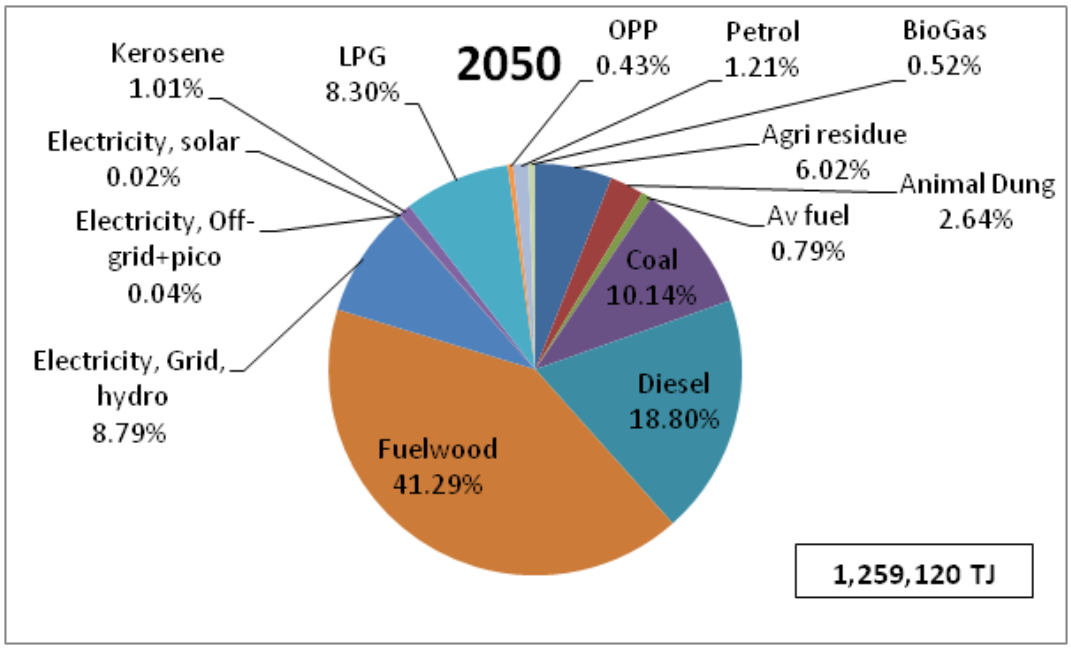


Energy Consumption for Various Energy Carriers in the low economic growth scenario

The total energy consumption will be 492,000 TJ, 626,000 TJ and 1,011,000 TJ in 2020, 2030 and 2050 respectively. Figure reveals that Nepal will need heavy quantity of solid biomass for its energy demand in coming years, followed by rising demand for petroleum products. The share of residential sector will decline to 53% in 2050 from 88% in 2010. Industrial and commercial sectors will occupy shares of 19% and 11% in 2050. The installed capacity of power plant needed in 2020, 2030 and 2050 will be 1,900 MW, 3,650 MW and 7,500 MW respectively. Electricity consumption per capita will reach 145 kWh, 260 kWh and 450 kWh in 2020, 2030 and 2050 respectively.

Medium Economic Growth Scenario

In this scenario, economic growth is commensurate with the government's projected GDP growth rate and the population growth as per the current census in 2011. The technology mix in energy demand end - uses will remain as in other periods as in the base year.



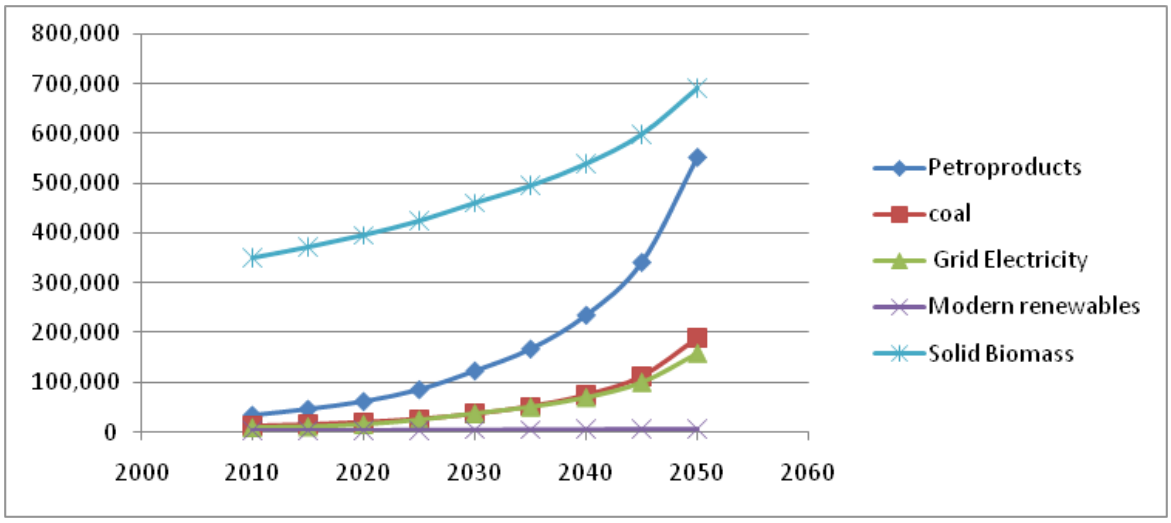
Fuel Consumption in 2050 at Medium Economic Growth Scenario

The share of solid biomass will decline to 50% and that of petroleum products will shoot up to 31% in 2050 in this scenario. The share of electricity will be 9% in 2050. The energy consumption will be 494,000 TJ, 642,000 TJ and 1.26 million TJ in 2020, 2030 And 2050 respectively. Regarding energy consumption in economic sectors, residential sector will have a share of 42%, industrial sector 23%, transportation sector 19%, commercial sector 14% in 2050 respectively. The share of energy consumption in agriculture will remain at 1.2% in 2050.

The installed power capacity should be 1,900 MW, 3,900 MW and 11,000 MW in 2020, 2030 and 2050 respectively to meet the demand for electricity. Per capita electricity consumption will increase to 145 kWh, 277 kWh, and 662 kWh in 2020, 2030 and 2050 respectively in this scenario.

High economic growth scenario

In this scenario is envisaged a high economic growth path and the population growth is based on the census in 2011. The technology mix in the energy end-uses is presumed to remain the same as in the base year. The energy consumption will increase to 497,000 TJ, 663,000 TJ and 1.6 million TJ in 2020, 2030 and 2050 respectively.



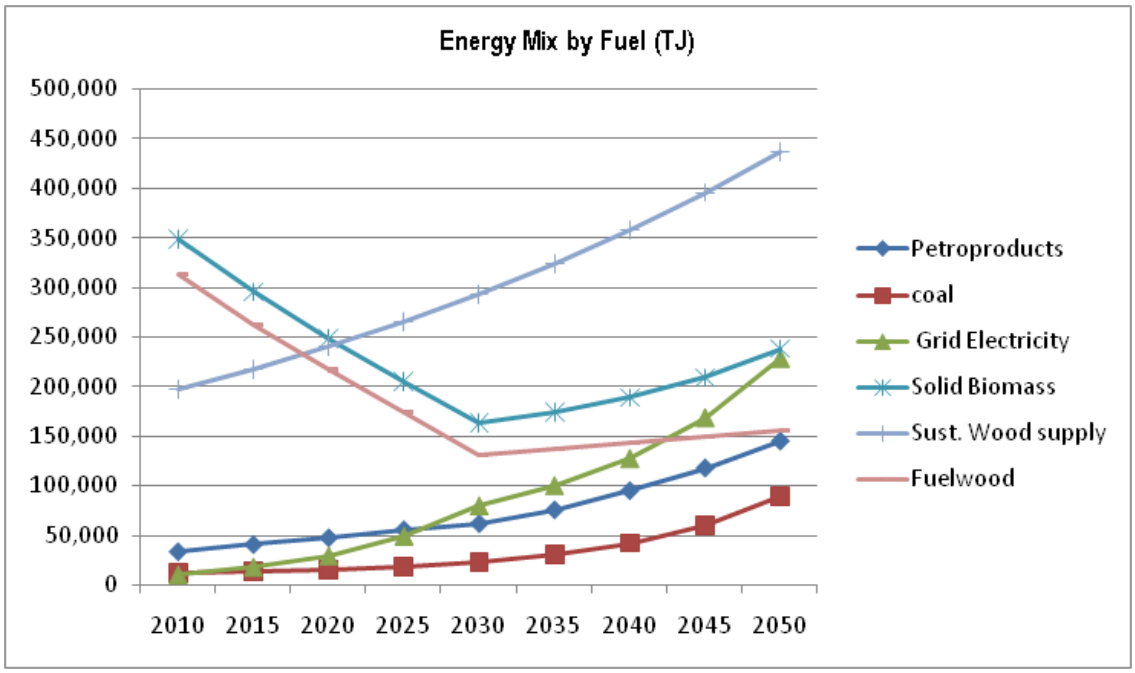
Consumption of energy at high economic growth scenario

Figure indicates that the consumption of petroleum products will exponentially to meet the energy demand in the country. The share of fuelwood will come down to 35% in 2050 and that of petroleum products will soar up to 35% in 2050. Electricity will have a share of 10% in 2050. In the context sectoral energy consumption, share of residential sector will decline to 33%, shares of industrial sector, transportation and commercial sector will shoot up to 27%, 22% and 16.5% respectively in 2050.

To meet the rising demand for electricity, the country must have installed power plant capacity of 2,000 MW, 4,250 MW, and 16,000 MW in 2020, 2030 and 2050 respectively. Per capita electricity will need to increase to 150 kWh, 305 kWh and 955 kWh in 2020, 2030 and 2050 respectively.

Combined Policy Scenario at Medium Economic Growth

A scenario analysis is also conducted for medium economic growth scenario with the technological policy intervention based on the UN's Sustainable energy for all (SE4ALL) program and the aspirations as expressed by the participants in the stakeholders' workshops at different regional development centers. A combined policy scenario is further honed by several rounds of discussions among the concerned consultant experts. Some of the key policy options undertaken in this scenario are 100% electrification in commercial sector by 2030 and onwards, 100% electrification in water pumping by 2030 and onwards and 50% electrification on farm mechanization by 2050. Energy efficiency measures are taken into consideration in the industrial sector such as total electrification in boilers and motive power by2050 and efficiency improvement in process heat. In the residential sector, cooking in urban areas will be done on electricity 100% by 2030 and onwards, and in rural areas the share of electricity, fuelwood and LPG will be 40%, 50% and 10% respectively by 2030. Cooking on fuelwood will be done 100% on ICS by 2030 and onwards. There will be 100% lighting in electricity with fuel efficient bulbs like CFLs by 2030 and onwards. It is presumed that 30% freight transport and 30% passenger inter-city transport will be running on electric train by 2050, electric cars will occupy 20% share in 2050, and penetration of ethanol and biodiesel will achieve 10% and 5% of total share of gasoline and diesel respectively by 2050.



Trends of Consumption of Different Energy Carriers in the Combined Policy Scenario

Figure reveals various prominent policy features in the energy sector. Consumption of fuelwood will become sustainable around 2020 and onwards, electricity consumption will surpass fuelwood consumption by 2045, and consumption of petroleum products will be almost equivalent to the consumption of fuelwood. The total energy requirement will be 343,000 TJ, 330,000 TJ and 709,000 TJ in 2020, 2030 and 2050 respectively, which are 66%, 50% and 44% respectively from the corresponding consumptions in the medium economic growth scenario. This

drastic change in energy consumption indicates that with the policy intervention in technology, improvement in demand side management especially in energy efficiency in household, industrial, commercial and fuel substitution in transport sectors and the use of modern clean energy, overall energy consumption can be reduced. Nepal is currently consuming energy, especially solid biomass in huge volume, which is replaced by mostly modern energy in this scenario.

In the context of energy consumption pattern in economic sectors, consumption in industrial sector surpasses consumption in residential sector and stands at 35% in 2050, whereas in household sector it is 30% only. Transport sector will be achieving a consumption of 21%, and commercial sector 14% respectively in 2050.

This scenario reveals that Nepal needs installed power capacity of 4,100 MW, 11,500 MW and 31,000 MW by 2020, 2030 and 2050 respectively to meet the objectives of SE4ALL and the aspirations as expressed by the participants for domestic consumption. This consists of 60 MW, 220 MW and around 1,200 MW from off-grid renewable energy technology such as micro-hydro and solar home systems (SHS) by 2020, 2030 and 2050 respectively. Besides, there will be 2,100 MW of solar PV power plants from 2030 onwards. The electricity consumption per capita will achieve 265 kWh, 630 kWh, and 1,500 kWh by 2020, 2030 and 2050 respectively.

Energy Indicators at the Combined Policy Scenario

S.N.	Indicators	Units	2010	2020	2030	2050
1	Final energy consumption/capita	GJ/capita	15	11	9	16
2	Final electricity consumption	kWh/capita	104	263	628	1464
3	Final energy consumption	GJ/1000$	0.0231	0.0131	0.0078	0.0048
4	Final Electricity Consumption	kWh/1000$	0.1570	0.3074	0.5233	0.4299
5	Electricity power utilized	per cent	3.0%	9.5%	26.9%	71.3%
6	Total Energy Consumption/ value added in industrial sector	GJ/1000$ value added	0.0172	0.0177	0.0218	0.0250
7	commercial energy / value added	GJ/ Bill Nrs	12	16	23	23
8	Total Energy Used/household	GJ/HH	66	41	25	23
9	Transport Energy Utilization	GJ/M T-km	1.23	1.19	1.07	0.72
	Transport Energy Utilization	GJ/M P-km	0.313	0.354	0.330	0.314
10	share of non-carbon energy in primary supply	per cent	2.4%	8.5%	24.1%	32.2%
11	Share of renewable energy in final total energy consumption	per cent	3.1%	8.9%	24.6%	33.3%
12	the ratio of net import to total primary energy supply	per cent	10.1%	16.9%	24.0%	32.3%
13	GHG emission for every ton of energy production and use	GHG in Kg/capi	139	160	184	421

The table reveals various energy related indicators for Nepal in 2010, 2020, 2030 and 2050. Per capita energy consumption during the various periods remain constant as energy carriers are substituted to modern energy from solid biomass energy sources, and energy efficiency is improved in demand side management and strong focus is concentrated on harnessing indigenous energy resources and renewable energy. Energy efficiency (GJ/US$1000 GDP) is improved by 500%, electricity consumption (kWh/US41,000 GDP) by 300%, and power development in the range of 71% of the economic potential of hydropower resources in the country during the study horizon. Share of renewable energy will jump to 33% of the total energy consumption with the exception of solid biomass. Per capita GHG emission will be reduced by 25%, 56%, and 48% in 2020, 2030, and 2050 respectively from their corresponding values in the medium economic growth scenario.

A further analysis by AHP, a multi-criteria decision analysis (MCDA) process, indicates that the combined policy scenario can meet the main objectives of UN's SE4ALL program, expectations of the participants from the 5 regional workshops, and judgment based series of discussions among the consultants experts on the foundation of several decision criteria, though the total energy systems costs will increase in this scenario compared to other scenarios. The long term energy sector vision 2050 is based on the combined policy scenario.

With the implementation of technological strategic targets/activities in solid biomass (traditional), commercial and renewable energy sub-sectors and with enactments of proper policy, legislations, and proper functioning of institutional set-ups as envisaged in the report, Nepal can achieve the required level of energy consumption in the South Asia and meet the requirements of objectives such as the UN's Sustainable Energy for All (SE4ALL) program.

Macroeconomic Implications of Capital Investments in the Energy Sector

Both volume and share of capital investment on energy sub-sector will be expected to increase optimistically during the projected period. The GDP share of energy sub-sector will, in an average, be 2.42 percent. The GDP shares of energy sector by 2050 in will be 2.42 percent, 2.53 percent and 2.73 percent in low economic, moderate economic and high economic growth scenarios respectively. In case of combined energy policy under moderate growth scenario, the average GDP share of capital investment on energy will reach to 5.38 percent, which may not be proved as an unreasonable investment by the global experiences.

Capital Investment in Energy Sector in Various Periods

Sector	2011-2020	2021-2030	2031-2040	2041-2050	2012-2050
In Million Rs.					
Lower Growth Scenario					
Energy	252,651	608,065	1,007,921	1,329,766	3,185,594
Moderate Growth Scenario					
Energy	259,690	672,274	1,212,230	2,018,412	4,149,797
Higher Growth Scenario					
Energy	269,419	755,064	1,443,279	3,024,064	5,479,017
Combined Energy Policy in Moderate Growth Scenario					
Energy	690,488	1,909,649	2,233,966	4,106,565	8,927,859
As % of GDP at producers' prices					
Lower Growth Scenario					
Energy	1.59	2.59	2.79	2.32	2.42
Moderate Growth Scenario					
Energy	1.61	2.67	2.82	2.49	2.53
Higher Growth Scenario					
Energy	1.64	2.76	2.82	2.82	2.73
Combined Energy Policy in Moderate Growth Scenario					
Energy	4.27	7.47	5.12	5.01	5.38

The implication of capital investment for energy sector development as proposed in the long term vision will have positive impacts on economic growth and level of employment. Resources balance will also be positive if the faster rising remittance can be diverted towards the investment in productive sectors from spending on consumption items and real estate development. Besides, current account balance, government fiscal balance and resources gap of present and future are not found worse in the baseline as well as in other alternative scenarios. This indicates that the macroeconomic stability of the country has not yet been spoilt and will not worsen in future. That's why; the

volume and trend of proposed investment on energy sector will not have adverse effects to the rest of other sectors of the economy and rather it will have positive impacts on the development of other sectors of the economy as well as the national economic development of the country as a whole. Thus, the required volume of investments for energy sector development will be guaranteed by the economy without distorting the macroeconomic stability of the country in future, if the peace and political stability will be improved in future and all economic forces will work properly.

Major Strategies for the Energy Sector Vision 2050

In order to achieve the energy sector vision 2050, Government of Nepal should without delay take the following strategies.

- Hydropower development is the national priority and hydropower will be taken as the lead energy resource. It is to be optimally developed to cover the maximum need of all the sectors of the economy and contributing the economy by exporting the indigenously produced hydro-electricity.
- Capabilities of existing physical infrastructure such as road access and transmission lines are strengthened and new ones are added
- By the end of 2050 mechanisms will be in place whereby adequate legislative frameworks are functioning and adapting to changing circumstances
- Integrated Energy Sector Policy is approved
- Electricity Act and Regulations are amended
- The legal instruments will be reviewed regularly and adaptive measures taken so that they remain compatible with the changing circumstances
- Legal frameworks in Renewable Energy, Feed in Tariff and Feed in Law, Regulatory Authority enacted
- Reform policies to attract private sector with incentives such as soft loan and others
- Environment for incremental domestic capital market and foreign capital for hydropower development is improved
- Promotion of electricity operated small appliances, machines, with a target of complete electrification in selected possible sectoral end-uses.
- Promotion of use of energy efficient technologies in all sectors
- Introduction of bio-fuels (ethanol and Bio-diesel) and electric cars and promotion of mass transportation
- Creation of awareness amongst broader public about renewable energy technology (RET)
- Formulation of appropriate legislative tools to enable implementation of plans and policies
- Expansion of appropriate RET installations at every level based on geographical feasibility;
- Ensure implementation and monitoring of RET plans and policies.
- Upliftment of national economy through grid connection of renewable energy plants.

CHAPTER 1
INTRODUCTION

Since the beginning of the planned development in the 1950's, water resources sector has received due importance in it planning and development process. However, the pace of developmental progress and the benefits accrued from those investments have been dismal compared to their targets and the needs of her people.

Recognizing the need for an accelerated development of its water resources, the Nepal Government has formulated a 25-Year Water Resources Strategy in 2002 AD. This strategy document adopted the national goal of water resources development as to "significantly improve the living condition of Nepali people in a sustainable manner". Following the adoption of the water resources strategy, the National Water Plan (NWP) was prepared and approved in 2005. This is an action plan for implementing the Water Resources Strategy. However, subsequent translation of these strategy and plan documents into real action has remained below satisfaction because the concerned government line agencies continued to operate in their conventional manner in the absence of supporting institutional, regulatory, policy, operational and financial frameworks, and the political instability and lack of commitment which were essential for implementing the plan.

Needless to over-emphasize, water and energy sectors are closely interconnected and interdependent with each other in many ways, and both together has immense impacts, directly and indirectly, on the lives and livelihoods and the social and economic welfare of the Nepalese people. This fact cannot be truer in Nepal more than elsewhere because water resources, which is one of the Nepal's principal natural resources, has the potential of becoming the main source of energy and water supply for poverty reduction and economic transformation. Without proper harnessing its indigenous water resources, Nepal cannot resolve her water and energy sector problems and address the larger issues of poverty reduction, equity and overall economic development of the country. An integrated strategic policy and planning are essential for facing those problems and issues.

In this context, the Water and Energy Commission Secretariat (WECS) of the Government of Nepal deemed it necessary to prepare a national vision on Water Resources and Energy Sectors of Nepal for 2050 AD. The present study is funded by Government of Nepal, and its Executing Agency is the Water & Energy Commission Secretariat (WECS).

1.1 Rationale for Long Term Vision for Water Resources & Energy Sectors

Water is fundamental to life, livelihood and food security. It is also essential for every other economic development activities and hence for national economic development. Water and energy consumption have direct relationship with social and economic advancement of a country. World experience shows that without proper management of natural resources particularly the water resources, economic growth has a high social and environmental cost in the long term. While Nepal is suffering presently from underutilization of its water resources, integrated development, proper utilization and management of the available water resources are the emerging issues which are crucial for sustainable future of Nepal. Water resource utilization has many dimensions, and so have the energy sources and their utilization mechanisms. Both offers the opportunities as well as the challenges for the wellbeing and prosperity of the Nepalese people.

The rationale behind long term vision formulation is to define the nation's purposes of developing water and energy sectors in a vision statement which could powerfully communicate the nation's intentions and motivations to realize an attractive and inspiring common future. The essence is to chart the path to growth in the water and energy sectors in order to realize the hopes and aspirations of the Nepalese people from utilization of available water and energy resources in the country.

1.2 Long Term Vision Formulation Approach

The key to vision formulation process has been the nationwide consultation with the stakeholders in the related sectors. In the process, the following stepwise approach and methodology has been adopted:

- Review and analysis of plans and policies including the legal and institutional provisions in the water and energy sectors;
- Review and analysis of water and energy sector development;
- Extensive consultations with the stakeholders at regional and national level;
- Identification of major issues and gaps in different aspects of all water resources and energy sectors like policy, legal, institutional, social, environmental, economic and political;
- Analysis of the future growth scenario options;
- Formulation of vision and mission of water resources and energy sectors; and
- Formulation of strategic goals and actions for the realization of the long term vision.

1.3 Long Term Vision Formulation and Attainment Process

The process of Vision formulation is divided into five phases that are interactive (Figure 1-1).

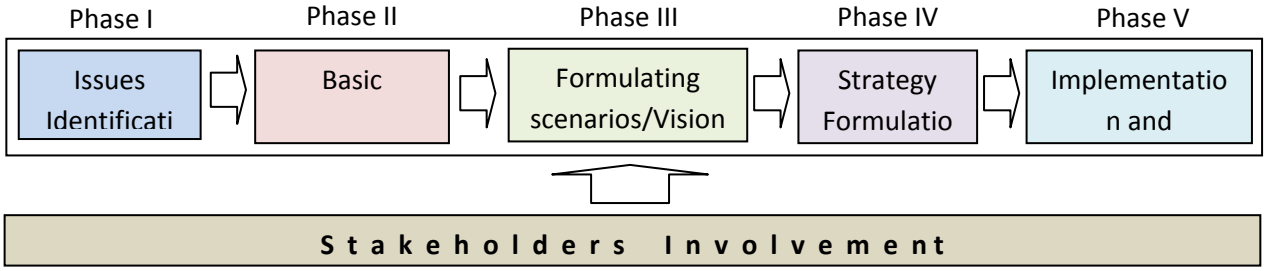


Figure 1-1: Vision Formulation and Attainment Process

Phase I is about identifying the hopes and aspirations of the people and grouping these into themes and issues that may need detailed understanding and action.

Phase II provided the knowledge base for the design and implementation of the national development strategy.

Phase III involved constructing scenarios about the future.

Phase IV was concerned with strategy formulation.

Phase V was the development of short term, medium term and long term plans/programs/activities to achieve the Vision.

1.5 Basis of the Vision 2050

The Vision 2050 on Water Resources and Energy Sectors draws heavily on the views and aspirations of the stakeholders, civil societies, professionals and political party representatives expressed during the national and regional level stakeholders' workshops. The concept dissemination workshop was organized at the national level in Kathmandu, and regional stakeholders' consultative workshops were organized in Biratnagar, Chitwan, Pokhara, Nepalgunj and Dhangadhi where stakeholders from all districts in the respective development regions were invited. Over 450 men and women were consulted during this process when they shared their views on their people's needs and aspirations, the major issues and the possible ways and means to deal with those issues. Individual questionnaire survey and group discussions methods were used to collect their views and suggestions. The vision statement has been formulated to best capture and reflect the sentiments of the participants in these workshops.

The water resources and energy sector visions, based on the current realities and the potential opportunities, is focused on:

- Defining a pragmatic vision for the development of different sub-sectors of water and energy in an integrated manner, so as to meet the needs and aspirations of the people and the changes in the social, economic, technological, ecological and political contexts.
- Developing realistic projections of water and energy sector development needs consistent with the likely and possible economic growth scenarios and thus contribute to transformation of the national economy with positive social and economic impacts at the grass roots and national level.
- Assessing the value, relevance and incentives created by the existing institutional arrangements for water sector development and identifying the gaps and changes required in the institutional frameworks to support the perspective vision of water and energy sector development.
- Defining the activities that are required in water and energy sectors in order to achieve the stated vision.

The Nepal`s Water Resources and Energy Sectors Vision aspires to be an inspiration to Nepalese men and women from every geographic region and every social composition to meet their present and future generations' water and energy needs for leading a life with dignity and pursue to their social and economic prosperity. It is also an inspiration to overcome the obstacles and achieve fundamental changes. Its message is for everyone, particularly for the leaders and the professionals who have the power and the knowledge to help people turn their vision into reality. It provokes all the stakeholders to initiate action and to call on their leaders to bring about fundamental changes in the way water and energy sectors are developed and managed and to lead the country towards sustainable development for a better living condition for all the Nepalese people.

1.4 Structure of the Vision Document

There are two main Vision Documents; one on water resources sector vision 2050 and the other on energy sector vision 2050. The water resources vision document deals with all water use sub-sectors, namely (i) Water supply and sanitation, (ii) Irrigation, (iii) Hydropower, and (iv) all other economic uses of water such as (a) Fishery and aquaculture use, (b) Industrial use, (c) Recreation and tourism, (d) Religious and cultural uses, and (e) Water Transport and its (v) Policy and legislative frameworks, and (vi) Institutional framework .There are separate sub-sector vision documents for water supply and sanitation (Annex I), irrigation (Annex II), and hydropower (Annex III) sub-sectors, and for practical reasons, the vision for all other economic uses of water has been presented in only one document (Annex IV). Though not mandated by contractual Terms of Reference, the Study Team has prepared one separate vision document for Aquatic Environment and Water Induced Disaster Risk Management (Annex V) because of the colossal importance they carry in the management and development of water and energy resources in the country. Two more vision documents have also been prepared – one on Policy and Legislative Framework (Annex VI), and the other on Institutional Framework (Annex VII) for water resources sector.

Likewise in energy sector, the vision document encompasses (i) Traditional energy, (ii) Commercial energy and (iii) Renewable energy, the (iv) Policy and legislative framework, and (iv) Institutional framework. Separate sub-sector vision documents have been prepared for each of these energy sub-sector (Annex VIII – Annex X), policy and legislative framework (Annex XI) and institutional framework (Annex XII). The main vision document on energy sector comprises the main findings in all the three sub-sectors and its policy, legislative and institutional frameworks.

The report on macro-economic analysis of long term vision of water and energy sector development is given in Annex XIII.

Structure of the Present Report

The present document on Energy Sector Vision 2050 has been structured as below:

Chapter 2 provides a review of current global energy scenario and trends in energy sector in the world and in South Asia and Nepal. A historic perspective of development process in Nepal is described in chapter 3 and the energy resource base of Nepal is presented in chapter 4.

Chapter 5 highlights the current status of energy consumptions energy carriers. Chapters 6 and 7 provide an overall overview of policy, legislations and institutional frameworks prevalent currently in Nepal respectively. The major gaps and major issues in water resources sector are dealt in chapter 8 and chapter 9.

Chapter 10 explains the methodological approach used for the development of energy systems modelling framework for creating future scenarios based on the workshops and experts' consultations. Different future energy scenarios are described in chapter 11. The visions and missions for energy sectors and its sub-sectors are given in chapter 12 and the missions for short term (2020), medium term (2030) and long term periods (2050) are provided in chapter 13, which is followed by objectives, goals and the targets for short-, medium- and long term periods in chapter 14.

The major strategies for realizing vision goals are explained in Chapter 15. The chapter 16 deals on plans and programs, and chapter 17 on activities for achieving vision targets. Lastly, potential threats and the strategies to deal with them are given in chapters 18 and 19 respectively.

CHAPTER 2
GLOBAL SCENARIO

Energy is a crucial enabler. Every advanced economy has required secure access to modern sources of energy to underpin its development and growing prosperity. Modern energy services are crucial to human well-beings and to a country's economic development. While many developed countries may be focused on domestic energy security or decarbonising energy fuel mix, many other developing countries are still seeking to secure enough energy to meet basic human needs. Access to reliable and affordable energy services is fundamental to reducing poverty and improving health, increasing productivity, enhancing competitiveness and promoting economic growth. Currently, 1.3 billion people do not have access to electricity, which is around 20% of total global population; almost 2.7 billion people relied on traditional use of biomass for cooking which is around 40%of total global population (IEA, 2011).

2.1 Current Global Scenario

2.1.1 Traditional (Biomass) Energy

Globally, the common traditional (biomass) energy (TE) source has been fuelwood, produced either from forests or from non-forest lands, as well as other woody and non-woody residues of agriculture and animals. These sources have been used either in their primary form to generate energy through direct combustion or through their conversion into secondary and tertiary forms, through thermo-chemical or bio-chemical conversion (i.e. charcoal and liquid bio-fuels) or by using these sources for generating heat and electric power.

IEA was also of the view that still there were about 40% of the population until 2010 who did not have access to clean cooking facilities and they had to rely solely on traditional biomass fuels. In World Energy Outlook 2012, IEA categorically stated that nearly 1.3 billion people still remained without access to electricity and 2.6 billion without access to clean cooking facilities. The World Energy Council (WEC) stated that, based on the Data from Energy Survey 2004, it showed the share fuel wood as much as 50% of the IEA's classification of energy that was placed under combustible Renewable. It also presented the share of different woody biomass in primary energy bio-energy mix using the information provided in International Panel on Climate Change (IPCC), 2007. This statistics showed a highest 67% share for Fuel-wood, followed by other sources as shown in Table 2-1.

Table 2-1: Share of Woody Biomass Sources in Primary Bio-energy Mix in the World

Biomass Source	Share
Fuelwood	67%
Charcoal	7%
Forest Residues	1%
Wood Industry Residues	5%
Black Liquor	1%
Recovered Wood	6%
Agriculture (Animal by-products 3%; Agricultural by-products 4%; Energy crops 3%)	10%
Municipal Solid Waste & Landfill Gas	3%

(Source: IPCC, 2007 in WEC, 2010, pp359-407)[1]

2.1.2 Commercial Energy

Globally, fossil fuels have remained the dominant source of energy, accounting for 81 percent of the overall energy share in 2010 with oil remaining single largest fuel in primary mix and coal coming in second (IEA, 2012). As a result, their share of world demand edges up from 80 percent to 81 percent. The total electricity supplied was 21,431

[1] http://www.worldenergy.org/documents/ser_2010_report_1.pdf

TWh, of which nearly 65% is generated by thermal power plant, while hydro and nuclear comprise 16 and 13 percent. For the first time since 1982 the global demand for energy actually decreased in 2009, especially significant within the OECD countries. Oil demand is estimated to have decreased by 3 % compared to 2008. Coal demand decreased heavily in Europe and North America, but increased globally with around 2 % mainly due to a large increase in China. But the trend is still increasing ever since.

2.1.3 Renewable Energy

In 2011, global investment in the renewable energy (RE) sub-sector hit another record, up 17% to $257 billion. This was a six fold increase on 2004 figure and 93% higher than the total in 2007, the year before the world financial crisis. There may be multiple reasons driving this renewable investment, from strengthening regulatory frameworks to decreasing costs - whatever the drivers, the strong and sustained growth of the sector is a major factor that is assisting many countries towards a transitional to a low-carbon, resource Green Economy.

The pace of development of renewable energy sources and clean technologies will have significant impact on world energy supply and demand and consequently on global climate change Nehzad, H. (2009). Table 2-1 (a): 2012 Selected Indicators given below followed by a brief explanation on different alternative energies provide an overview of the current global trend of alternative energy sources and technologies:

Table 2-1 (a): 2012 Selected Indicators

	Unit	2009	2010	2011
Investment in new renewable capacity (annual)[2]	Billion USD	161	220	257
Renewable power capacity (total, not including hydro)	GW	250	315	390
Renewable power capacity (total, including hydro)	GW	1170	1260	1360
Hydropower capacity (total)	GW	915	945	970
Solar PV capacity (total)	GW	23	40	70
Concentrating solar thermal power (total)	GW	0.7	1.3	1.8
Wind power capacity (total)	GW	159	198	238
Solar hot water/heat capacity (total)[3]	GW th	153	182	232
Ethanol production (annual)	Billion litres	73.1	86.5	86.1
Biodiesel production (annual)	Billion litres	17.8	18.5	21.4
Country with policy targets	#	89	109	118

Note: Numbers are rounded. Renewable power capacity (including and not including hydropower) is rounded to nearest 10 GW; renewable capacity not including hydropower and hydropower capacity data are rounded to nearest 5 GW; other capacity numbers are rounded to nearest.

(Source: Renewables 2012 – Global Status Report)

Wind Power

Total world installed wind power capacity has grown tremendously in the last decade reaching to approximately 238 GW by the end of 2011. This accounts to 40% of the total renewable capacity globally. The latest capacity additions have been in the developing countries and emerging markets than in OECD countries.

[2]Investment data are from Bloomberg New Energy Finance and include all biomass, geothermal, and wind power projects of more than 1 MW, all hydropower projects between 1 MW and 50 MW, all solar projects, with those less than 1 MW estimated separately and referred to as small scale projects, or small distributed capacity, all ocean energy projects, and all biofuel projects with a capacity of 1 million litres or more per year.

[3] Solar heat data include glazed capacity but not capacity of unglazed systems for swimming pool heating.

Solar Energy

Solar energy can be used to produce electricity either directly using Photovoltaic (PV) cells, or indirectly by producing steam for a steam turbine using Concentrated Solar Power (CSP). Solar energy could also be used as solar thermal heating and cooling.

Currently, the total global capacity of solar PV is almost 70 GW which accounts to 30% of the total renewable capacity worldwide. Continuation of the trend towards very large-scale ground-mounted systems is observed in the global market, while rooftop and small-scale systems continue to play an important role.

More than 450 megawatts (MW) of CSP was installed in 2011, bringing global capacity to almost 1,760 MW. Spain accounted for the vast majority of capacity additions, while several developing countries launched their first CSP plants and industry activity expanded its attention from Spain and the United States to new regions.

In 2011, solar heating capacity increased worldwide by an estimated 27% to reach approximately 232 GWh. This figure excludes unglazed swimming pool heating. Currently, China is dominant globally in both solar thermal installations and solar heating industry (manufacturing). Europe takes the second lead in solar thermal installations after China.

Biomass[4]

Currently, biomass provides 72 GW of the world's energy needs. More than 2.5 billion people in the developing countries rely on biomass for heating and cooking. According to IEA report (ETP 2008), bioenergy has the highest technical potential of all renewable energy sources and its contribution to global energy needs could quadruple in 2050. The IEA report indicates that about half of the primary bioenergy would be used for the production of liquid biofuels, and the other half would be used for power generation, heating and industrial feedstock. Ethanol and biodiesel are the primary renewable fuels in the transport sector. Several airlines in international arena began to operate commercial flights using various biofuels blends.

Hydropower

Currently, hydropower accounts for more than 70 of all renewable power generation globally accounting to approximately 970 GW. Hydropower is increasingly providing balancing services, including through expansion of pumped storage capacity, in part to accommodate the increased use of variable solar and wind resources. Pumped storage is the most popular storage technology today. Pumped storage facilities pump water into elevated reservoirs during periods of excess electricity production or low demand, and release it to generate electricity during periods of high-demand and low variable renewable generation. They account for about 99% of global energy storage capacity.

Geothermal Energy

Geothermal energy provided an estimated 205 TWh (736 PJ) in 2011, one-third in the form of electricity (with an estimated 11.2 GW of capacity) and the remaining two-thirds in the form of heat. Regardless of the high risk inherent in the development of new resources and lack of awareness which are hampering the geothermal power industry, at least 78 countries used direct geothermal energy in 2011. Most of the growth in direct use was associated with ground-source heat pumps (GHP), which can provide heating and cooling and have experienced growth rates averaging 20% annually.

Ocean Energy

Almost all ocean energy power generation is based on harnessing tidal energy. Recently, there has been a lot of progress in wave energy which caused the global ocean power capacity to almost double in 2011 as compared to past several years. But capacity worldwide still very small with a need to reduce the cost and improve the reliability.

[4] The paper states that – Biomass is the most important global renewable energy source today and well into the future. Although biomass, when used releases CO2, there is no net increase in carbon dioxide emissions to the atmosphere.

The launch of a 254 MW tidal power plant in South Korea and a 0.3 MW wave energy plant in Spain brought total global capacity to 527 MW. A number of additional projects—small pilot-scale and utility-scale—were under development in 2011, designed to test and demonstrate various technologies for full commercial applications in the near future.

Nuclear power

Currently the nuclear power use globally has slowed down and even declined in some countries. In 2007, there were 438 operating nuclear power plants in 30 countries with a total installed capacity of 372 GW (IAEA, 2008). About half of these units were installed in three industrialized countries – U.S, France and Japan. However, in the last three decades, the Three Mile Island and Chernobyl accidents caused a considerable slowdown in nuclear power expansion. Most recently, in response to the Fukushima Daiichi nuclear disaster that took place in Japan in March 2011 due to Tohoku earthquake and tsunami, almost 80% of the public supported the phase-out of nuclear power by March 2012 and other forms of renewable energy is now widely viewed as the critical source of future energy needs.

2.2 Current Regional Scenario

2.2.1 Traditional (Biomass) Energy Sector in South Asia

In many countries the dependence on wood as energy source was extremely high, as much as 78 percent of total energy consumption in Nepal (in 2004/2005); 59 percent in Bhutan (in 2005 and all if that was harvested from natural forests); and in Sri Lanka its share was 48 percent. In India too, fuelwood provided as much as 50 percent of rural energy demand in 2002.

The fuelwood consumption data for South Asian countries between 1990 and 2009 is shown below in Table2-2.

Table 2-2: Wood fuel Consumption in South Asia, 1990-2009 (in million m^3)[5]

Country	1990	2000	2009
Bangladesh	28.0	28.0	27.0
Bhutan	4.0	4.0	5.0
India	276.0	297.0	309.0
Maldives	0.0103	0.0132	0.0152
Nepal	12.0	13.0	13.0
Pakistan	21.0	31.0	29.0
Sri Lanka	6.0	6.0	6.0
South Asia total [6]	348.0	379.0	388.0

(Source: FAOSTAT-ForestSTAT, in FAO, 2012)

The above table showed increased consumption of wood fuel in the sub-region since 1990. Most of the increased fuelwood was consumed in India and Pakistan. While presenting the present data, FAO also warned that the reported level of consumption might not truly reflect the actual level of consumption since unreported harvesting in many countries could not be taken into account in the statistics provided by concerned government forestry department of respective member countries. Therefore, the actual amount of fuelwood consumption in the sub-region could be much higher than the figure reported by these agencies.

[5]Conversion factor: 1m^3 of dried woodfuel (30% moisture content) would be equivalent to 0.725 tons, or in net calorific value term 13.8MJ/kg, according to the Unified Bioenergy Terminology of FAO (2004)

[6]Consumption figure rounded up to nearest unit, so the total may not reflect to true value.

2.2.2 Commercial Energy Sector in South Asia

Nepal:

The Integrated Nepal Power System (INPS) has a total installed capacity of 706 MW of which 652 MW (92%) is generated from hydro resources. The annual electricity generation on the grid system in 2009–2010 was about 3690 GW h, of which power plants owned by the Nepal Electricity Authority (NEA), 26% by IPPs, generated about 57% and the remaining 17% was imported from the Indian grid. (IEEN, 2012) As in case of petroleum products, the country has no indigenous resources and thus imports all fossil fuels which constitute nearly 8 percent of total primary energy consumption.

Pakistan:

Pakistan Atomic Energy Commission (PAEC) is currently operating three nuclear power plants i.e. Karachi Nuclear Power Plant (KANUPP) and Chashma Nuclear Power Plant Unit-1 and 2 (C-1 and C-2). The construction of two more units C-3 and C-4 of being 340 MW each is in progress.(GoP, 2012). About 70 % of that energy supply is from oil and gas and 15% from electricity. Pakistan has vast potential indigenous energy resources, much of which has remained untapped. Only about 2% of coal, 3% of oil, 16% of gas, and 16% of hydropower resources have so far been proven.

Bhutan:

Bhutan Power Corporation (BPC), responsible for domestic power supply, and Druk Green Power Company (DGPC), responsible for operating the export-oriented hydropower projects. Bhutan has committed to an ambitious agenda of developing over 10,000 MW (MW) of hydropower capacity by 2020 with assistance from the Government of India, and achieving 100% electrification by 2013 (ADB, 2010).Only 60% of the total population has access to electricity (IRENA,2012) . At the same time, the country has one of the higher energy consumption rates in South Asia at 36 GJ per capita in 2005(DoE, 2009). The country has significant energy resources with an estimated hydropower potential of 30,000 MW but has no known reserves of petroleum resources, nor there are any refineries set up for crude oil import. Thus entire petroleum products are imported from India, coal is mined in south eastern part of the country which is estimated at about 1.96 tons. (DoE, 2009)

Sri Lanka:

While Sri Lanka's energy supply is dominated by biomass, petroleum and hydropower constitute the only other two primary energy sources. Sri Lanka has total identified major hydro power potential of 2006 MW out of which 1207 MW is harnessed as at present. The mini hydro potential is identified as 200 MW out of which 110 MW has already been developed in Sri Lanka (Ariyadasa, L., 2011). Further; the end-use energy demand in Sri Lanka consists of three main sources: electricity, petroleum which includes liquefied petroleum gas (LPG) and biomass. On average the demand for energy has increased over the past 25 years at a rate of 2.2% a year.

Maldives:

Geographically, Maldives is one of the most vulnerable nations to the effects of climate change impacts such as sea level rise. The Energy Authority of Maldives has announced the inception of $138 million renewable energy project which would generate 26 MW of electricity in Maldives.(IRIB, 2013). Maldives has no hydrocarbon resources or hydropower potential and is entirely dependent on imports for its energy needs. Rural areas and poor households use biomass for most of their energy needs though, in recent years, there has been greater use of kerosene and LPG for cooking.

India:

Currently, India is one of the world's fastest-growing economies. The rapid increase in economic activity has been accompanied by rising energy consumption. During the period of 2006 and 2010, India's primary energy consumption increased at 8.3% from 15.96 million GJ to 21.95 million GJ. Coal, oil and natural gas are major

sources of primary energy of India, accounting for 52.9%, 29.6% and 10.6%, respectively, of the primary energy consumption. (FICCI, 2011) India has ample indigenous energy resources including: As on 31.03.12 the estimated reserves of coal was around 293.5 billion tones and the estimated reserves of crude oil in India as on 31.03.2012 stood at 759.59 MT. Economic hydropower potential of 84,044 MW experience with nuclear power; and is a leading proponent of renewable energy with over 2,000 MW of installed wind power capacity. The total potential for renewable power generation in the country as on 31.03.12 is estimated at 89774 MW. This includes wind power potential of 49130 MW (54.73%), SHP (small-hydro power) potential of 15399 MW (17.15%), Biomass power potential of 17,538 MW (19.54%) and 5000 MW (5.57%) from bagasse-based cogeneration in sugar mills. (CSO, 2013)

Bangladesh:

Bangladesh has one of the lowest per capita energy consumption rates in the world of about 8.77 GJ per capita[7]. About 88 per cent of the country's power is currently generated from gas and about 50 per cent of the consumed commercial energy is used for power generation while hydroelectricity provides another 2.7%.(GED, 2010) Over three-quarters of urban and one-quarter of rural households have access to electricity. Accordingly, Bangladesh's economic development future is inextricably linked to its management and usage of natural gas.

Afghanistan:

Afghanistan has one of the lowest rates of per capita energy consumption in the world, at 3.77GJ[8] per capita in 2010. Although no reliable data is found from within the country, it is estimated that traditional fuels meet over 85 % of energy needs and the remainder is met by commercial sources of oil, gas, coal, and hydropower, much of which is imported. According to estimate of US geological survey ,the evaluation made is indicative of 444 billion cubic meters of natural gas reserves, 219 million tons of petroleum, and 75 ml tons of condensation. (ANDS ,2008)

2.2.2.1 Hydropower potential in South-Asia

Nepal with huge untapped hydropower potential of about 83,000 MW, stands on the second place in South Asia (Pokharel, 2010). It has 3% of world's hydro energy and 46% of South Asia's. India has the highest economically exploitable hydropower potential of about 84 GW, Pakistan 59 GW and Nepal 43 GW. According to a study conducted by the Nepal Electricity Authority (NEA), Nepal with the harnessing of only 1.53 percent of the total hydro electricity potential has harnessed the least commercially feasible hydropower potential among the six South Asian countries. The average power harnessing in the six countries (Nepal, Pakistan, India, Bhutan, Sri-Lanka and Bangladesh) is 23.15 percent of the total available potential.

Sri Lanka is the highest in utilization 54.93 percent of its potential, followed by India with 46.48 percent, Bangladesh 30.46 percent, Pakistan 11.11 percent, Bhutan 6.20 percent and Nepal 1.53 percent.

2.2.3 Renewable Energy Sector in South Asia

South Asia Region (SAR) comprises of eight countries, namely, Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Currently, total population of SAR exceeds 1.5 billion half of which live under the poverty level. Most of countries in the region are energy deficit and depend largely on non-conventional sources of energy. Regardless of lack of uniformity in the distribution of energy resources potentials in the region, there is huge potential of renewable energy development in general throughout the South Asia region. Sky rocketing prices of crude oil, scarcity of available energy resources and growing demand of electricity for socio-economic development have created enormous opportunity to explore the window of renewable energy technologies and its application. Current regional scenario of renewable energy in South Asia is briefly provided below:

[7] http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE

[8] http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=44&pid=45&aid=2&cid=regions&syid=2007&eyid=2011&unit=QBTU

Wind Resources

Afghanistan:

According to the 2009 report on IEPSA: Vision 2020, there is a lack of reliable wind data and maps in Afghanistan. In 2005, a pilot hybrid wind and solar system was installed in Afghanistan under the technical assistance of ADB. Four wind monitoring towers in different central mountain parts in Afghanistan, a 1000-watt wind solar hybrid system in a tomb of local area in Panjsher province, installation of a number of small scale wind turbine throughout the country, wind resource assessment and development of wind maps based on topography.

Bangladesh:

There is no reliable wind map in Bangladesh. Bangladesh has not been able to explore even 1% of its estimated total wind power potential of around 2000 MW. According to 2009 SAARC Energy Report, some of the wind energy installations in Bangladesh through different projects include – pilot project with two plants of total 2 MW capacity; 7 wind and diesel hybrid plants in different cyclone centers; 1 wind and solar hybrid system and 10 wind energy installations in the coastal area of the country.

India:

According to the Government of India, the total onshore wind capacity potential of India is 48GW. Industry associations believe that this potential could be much greater ranging from 65 GW to 242 GW considering the hub heights of greater than 50m and improving the conversion efficiencies from technology advancements and aggressive policy actions. As of March 2010, India has installed the wind capacity of almost 12GW. India ranked third in 2011 in the list of countries that added annual wind power capacity. (NREL, 2010).

Nepal:

Except for identifying some favorable locations for harvesting wind energy, there has been no development of wind map for the country. A couple of wind mills have been installed at certain locations with the objective of research and development. According to 2008 report on Solar and Wind Energy Assessment by AEPC, the potential of wind energy is 3000 MW in Nepal with consideration of 10% of area with more than 300 W/m2 WPD (AEPC, 2008).

Pakistan:

Pakistan has huge potential of wind power, ideally estimated by the Alternative Energy Development Board (a government entity) to be 50,000 MW. Five wind turbines of 1.2 MW capacities each were completed by October 2008 in Jhimpir. Several wind farms have been developed at various locations with around 50 MW capacities each.

Pakistan Government has plans to achieve electric power up to 2500 MW from wind energy by the end of 2015 for which the government has been putting constant effort.

Sri Lanka:

According to IEA Data source 2009, Sri Lanka produces 3GWh wind energy.

Solar Resources

Afghanistan:

With more than 80% of sunny days in a year, the total potential of solar energy in Afghanistan is anticipated to be up to 5 KWh/m2/day. However, actual exploitation will largely depend on the acceptance and acceptance and affordability of the technology.

Bangladesh:

Bangladesh has solar potential of an estimated 2 – 6.5 KWH/m^2/day. Various government and non-government organizations including private sectors are observed to have been actively involved in installing solar photovoltaic system (PV) throughout the country.

India:

India's cumulative installed capacity of solar PV marked 15.2 MW (12.3 MW grid-connected and 2.9MW off-grid) in June 2010. The recent Jawaharlal Nehru National Solar Mission (JNNSM) aims to increase installed PV through attractive feed-in tariffs and a clear application and administration process. (NREL, 2010) India has approximately 3.5 million m^2 of installed SWH collector area out of an estimated potential of 40 million m2. Several programs are in place to accelerate deployment of SWH, including the provision of low-interest loans and incorporation of SWH into the building code.

Maldives:

National Renewable Energy Laboratory estimated in 2008 that the solar potential in Sri-Lanka is 793MWh/year (NREL, 2008) .

Nepal:

The estimated total potential of solar PV in Nepal is 62.5 x 10^3MWp. According to Solar and Wind Energy Resource Assessment project 2008 report prepared by Alternative Energy Promotion Center, the commercial potential of solar power for grid connection is 2100 MW (AEPC, 2008). With the subsidy scheme provided by the government, there has been installation of solar capacity (including SHS, ISPS and PVPS) of about 14.5 MW so far.

Sri Lanka:

National Renewable Energy Laboratory estimated in 2008 that the solar potential in Sri-Lanka is 189,451,980 MWh/year (NREL, 2008). According to IEA Data source[9], solar PV accounted to 16GWh capacity in Sri Lanka in 2009.

Biogas/Biomass Resources:

Afghanistan:

According to SEA/2002 Annual Report, there has been no estimation of biomass resources available for sustainable energy generation in Afghanistan yet. However, the contribution of fuel wood, agricultural residues and animal dung is considered to be around 18-27 million tones. The biomass stock in forest as on 2005 is estimated to be 14 million tons (FAO, 2011)

Bangladesh:

Estimated biomass resources of Bangladesh is around 26.60 MT. As of 2009, Bangladesh had about 25, 000 plus biogas plants (aim was to install 60,000 households by 2009). Few of these plants also produce electric resources. The biomass stock in forest as on 2005 is estimated to be 70 million tons (FAO, 2011)

India:

The Government has estimated a potential of 12 million animal manure supported household biogas plants of which 4 million have already been installed with an additional 4000 community biogas plants. In addition to household plants, currently India has 48 industrial waste water supported larger-scale biogas plants used to produce electricity with an aggregate installed capacity of 70 MW. The estimated potential capacity for industrial biogas is 1.3 GW. India has targets to realize its biogas potential for which national and state programs are supporting expansion of

[9] http://www.iea.org/stats/renewdata.asp?COUNTRY_CODE=LK

biogas through technical capacity building, financial incentives, and demonstration projects, with additional deployment supported through the Clean Development Mechanism (CDM) (NREL, 2010). The biomass stock in forest as on 2005 is estimated to be 5,748 million tons (FAO, 2011)

Nepal:

According to 2008/09 estimates of WECS, 40% of the country's energy requirement could be met by utilization of dung alone of which has been estimated to be 14.9 million tons of dung (Refer to Table 4-5). Under the assumption that 80% of the dung is available for biogas production, there would be a potential of 1.02 million biogas plants. The actual installation of the biogas plants until 2011 has been 260,899 plants so far(BSP, 2012). The biomass stock in forest as on 2005 is estimated to be 1,114 million tons (FAO, 2011)

Sri Lanka[10]:

Due to its favorable conditions for plant growth, biomass technology is one of the suitable renewable energy resources in Sri Lanka. According to 2009 report, based on the data available from this cultivation research, a company established 1 MW electricity generation plant, to which Government committed to provide support through substantial subsidy until the industry would perfect the technology themselves. The biomass stock in forest as on 2005 is estimated to be 88 million tons (FAO, 2011)

2.3 Current Major Trend in Development and Management

2.3.1 Traditional (Biomass) Energy

FAO (2010) presented two distinct wood energy subsystems that currently prevailed in the Asia-Pacific region.

a) Traditional' wood energy subsystem

b) Industrial wood-sourced bioenergy subsystem

The first subsystem focused on households and small industry, especially in rural areas of developing countries. And the second subsystem dealt with emerging potential to substitute for fossil fuels. It was of the view that each of the above subsystems possessed unique characteristics, in terms of end-users, end-uses, production and processing. Traditional household fuel use largely focused on cooking and space heating. It accounted for most fuelwood use in developing and emerging economies. Efficiency improvement was a key thrust in past efforts to enhance fuelwood security, with considerable attention being given to development and popularization of improved cook-stoves (ICS). However, there were indications of change, especially due to increasing awareness of health implications of inhaling smoke from traditional stoves, encouraging the use of improved stoves.

Recently, with climate change and energy security concerns, FAO presented the view that wood energy has entered into a new phase of high importance and visibility. It has been considered as a climate neutral and socially viable source of renewable energy, but only when wood arising from sustainably managed resources (forests, trees outside forests, etc.); appropriate fuel parameters (water content, calorific value, shape, etc); and, efficient incineration or gasification minimizing indoor and outdoor emissions.

It has been envisioned that energy and climate change policies under the green economy scenario will significantly boost demand for wood as a source of energy, partially replacing non-renewables. However, present slow pace of application of known energy-efficient technologies and the development of new economically feasible technologies (i.e. cellulosic biofuel production, small-scale bio-gasifiers, etc.) is expected to considerably reduce the overall demand and bring other benefits such as reduced indoor pollution from burning wood and other dried biomass fuels.

[10]https://www.saarcenergy.org/PDF%20Files/srilanka_EP.pdf

2.3.2 Commercial Energy

Energy is a crucial enabler. Every advanced economy has required secure access to modern sources of energy to underpin its development and growing prosperity. While many developed countries may be focused on domestic energy security or decarbonising energy fuel mix, many other developing countries are still seeking to secure enough energy to meet basic human needs. International concern for energy access is growing. While international Millennium Development Goals (MDGs) do not include specific targets regarding access to electricity for cooking, UN has declared 2012 as "International Year of Sustainable Energy for All". Strategic platforms to discuss energy access include the "Energy for All Conference" in Oslo, Norway in October 2011 and COP17 in Durban, South Africa in December 2011, UN Conference on Sustainable Development in Rio de Janeiro, Brazil in 2012.

IEA analysis shows that the global primary energy demand is projected to grow by 51 percent higher from 2009 value to 18,302 Mtoe (766 million GJ) in year 2035, at the rate of 1.6 percent per year. Fossil fuels remain dominant source of energy, but the share decreases to 80% in 2035 from current status of 81% share of total energy mix. The coal is expected to have greater share than oil in year 2035 due to higher oil prices. However, the average growth rate of other renewables is highest at 6.3% per year.

Hydropower continues to be one of the most cost-effective renewable energy generation sources. Typical costs are in the range of 2–13 U.S. cents per kilowatt-hour for existing grid-connected hydropower plants and 5–10 cents per kilowatt-hour for new plants. This is also one of the reasons why global consumption and installed capacity of hydropower increased steadily since 2003, though its growth in 2011 was little slower *(www.worldwatch.org).* Global installed capacity of hydropower reached 970 Gigawatts (GW).

China is clearly driving the development of the resource. But Europe and North America, despite their existing levels of hydropower deployment, are continuing to develop substantial new hydropower capacity. The North American region, for example, has more than 19GW of development under planning, of which some 11GW is identified in Canada. Current deployment of hydropower is already high in much of the developed world, but is still growing in order to satisfy growing energy demand (IHA, 2011).

The electricity sector will be the pioneer of renewable energy utilization. By 2050, around 77% of electricity will be produced from renewable energy sources generating 28,600 TWh (Sustainable global energy outlook, 2008). As per, the BLUE Map scenario in the Energy Technology Perspectives 2010, hydropower can provide 5749 TWh in 2050. Hydropower share in the global electricity production will increase slightly to 17.3% in 2030 but then reduce to 14.1% by 2050 as other power generation technologies grow at faster rates. Most of the growth in hydroelectricity generation will come from large projects in emerging economies and developing countries (IEA, 2012).

2.3.3 Renewable Energy

Renewable energy sector is most encouraging sector these times. The global new investment in renewable energy in 2011 was highest being $257 billion ($89 billion in developed countries and $168 billion in developing countries). (UNEP, 2012) The top countries for investment in 2011 were China, Germany, the United States, Italy, and Brazil. According to 'Managing the risk in renewable energy, The Economic Intelligence Unit Limited, 2011', the global investment in new renewable energy projects exceeded investment in new fossil fuel-fired plants for the first time in 2010. The major driving forces for this increase in renewable energy investment are considered to be both the incentives in RET sector and the political pressure to invest on less emission-intensive energy production.

Based upon different stages of commercialization, the International Energy Agency (IEA) has defined the development of three generations of renewable energy technologies reaching back over 100 years:

First-generation technologies which are quite widely used emerged from the industrial revolution at the end of the 19th century, and include hydropower, biomass, combustion, geothermal power and heat.(IEA, 2007) ·

Second-generation technologies are the ones which are entering market currently as a result of R&D and demonstration investments since the 1980s, and include solar heating and cooling, wind power, modern forms of

bio-energy and solar PVs. Initial investment on these second generation technologies was prompted by energy security concerns linked to the oil crises of the 1970s. However, the enduring appeal of these technologies is also due to the environmental benefits. Many of the technologies reflect significant advancements in materials (IEA, 2007).

Third-generation technologies are still under development and include advanced biomass gasification, bio-refinery technologies, concentrating solar thermal power, hot-dry rock geothermal power, and ocean energy.

CHAPTER 3
HISTORIC PERSPECTIVE OF DEVELOPMENT IN NEPAL: PAST TREND AND FUTURE PROSPECTS

3.1 Historic Perspective

Nepal remained isolated from other countries of the world in its social and economic development due to various political and geographic reasons till the democratic movement of 1951-52. Some limited development activities in some sub-sectors such as development of power and drinking water facilities in Kathmandu, health programmes in few districts, some schools, and colleges, commercial bank, few roads and some small-scale irrigation works were undertaken before 1951.

Since 1956 A.D., the National Planning Commission has already implemented 10 periodic plans that includes 9 five year plans and one three year plan (second plan), and two Three Year Interim Plans. Currently, the Twelfth Three Year Interim Plan is running at the end of its last year. The 57 years of planned development in Nepal has passed across three types of politico-economic systems: (a) centralized and controlled planning during the Panchayat regime (up to the 7th plan), (b) liberalized planning during the constitutional monarchy regime (the 8th to 10th plan) and (c) inclusive planning during federal republic regime (11th and 12th Three Year Interim Plans). Priorities of development in these periods have been different from each other.

3.1.1 Planned development during First Plan (2056-2060): Initiation of Planned Development

The First Five Years Plan for Nepal aimed and prioritized to generate and develop the statistical data through survey, studies and researches required for planning purposes as well as for day-to-day operations of the economy. The plan had also aimed at complete overhauling of the administrative structure and procedures of government offices to carry out many-sided programmes of national development with fast and timely decision. There was little progress in road, power, and industrial development, but the Plan did stimulate public interest in support of planning.

3.1.2 Planned Development during Panchayat Regime (1962-1990): Period of Controlled Planning

The Second Plan emphasized on collecting data on economic conditions, organizational reform, and the development of economic infrastructure. Priority was given to survey and statistical activities, agricultural reform, organizational improvement and training as well as to the development of transport and communications, power, agricultural extension work and irrigation. During the second plan period, a leather and shoe factory was established in the public sector. The major road construction programmes were the Raxaul-Bhainse and the Kathmandu-Kodari roads. Construction work of East-West Highway and the Sunauli-Pokhara road was started. 7,600 KW. of new electricity was generated from Trisuli and Hetauda. A considerable progress in the field of education and health sectors was made. Malaria eradication program was completed in the central zone of Nepal and started in the eastern zone. Smallpox and leprosy control programmes were started. Efforts were made to diversify trade.

The primary objective of the Third Plan was to develop the prerequisite for rapid economic growth. During this plan it was realized that modern agricultural technologies should be made available and the benefits of increased production should be accrued to the cultivators. The Land Reform programme was designed to accomplish the latter goal. It was also realized that production loans, cottage industry development, cooperative credit, marketing, and resettlement programmes were needed in order to uplift the economic conditions of the cultivators. In the light of these considerations, the highest priority was given to agricultural development followed by transport, power and industry in descending order of priority.

Basic objectives of the Fourth Plan were to maximize output, establish the base for sustained and long-term economic growth (viz. Transport, Communications, Power etc.), expand and diversity international trade, secure accelerated pace of development with maximum economic stability by controlling price level, make effective use of manpower resources and control population growth, and create conditions conducive to the emergence of a society free from exploitation. In order to meet above objectives, priority was given to the development of basic sectors like

transport and communication. Second priority was provided to agriculture sector, as this sector was the major sources of livelihood (including food and employment) of the mass people, and raw materials for various industries. Industry was placed at third priority after transport and agriculture.

The objective of the Fifth Plan was not only to maximize output, but also to make such outputs consistent with the minimum felt-needs of the people. The people-oriented production and the maximum utilization of man-power were the twin objectives of the Fifth Plan. The regional development was another major objective of the Plan, and the country was divided into four development regions. Besides, the Plan also focused on specialization in livestock improvement in the northern region, horticultural development in the central hills and food-grains and cash crops production in the southern plains of the country. Unlike the previous periodic Plans which accorded high priority to Transport and Communication sector, the Fifth Plan gave priority to agricultural sector for securing increased production because the past experiences had shown that extension of transportation facilities without complimentary production activities had not only added maintenance liability but also became a means of dramatizing inherent disparity.

The objectives of the Sixth Plan were to attain higher growth rate in production, increase productive employment opportunity, fulfill minimum basic needs *of* the people (like food grains, fuel (firewood), drinking water, basic health services, primary, vacationland adult education, and basic transport facilities), and the priority was given to the development of the agriculture sector, cottage and small scale industries, export trade and tourism. The topmost priority was given to the full utilization of the already created infrastructure and to control population growth rate.

Fulfilling minimum basic needs of the People was the new objective in the history of development. Looking at country's economic conditions and realities, the objectives laid down in the Sixth Plan were felt of equal relevance and significance even for the Seventh Plan. The same objectives were therefore set forth as the objectives of the Seventh Plan also. They were: to increase production at a higher rate; to increase opportunities for productive employments; and to fulfill the minimum basic needs of the people.

During the three decades of Panchayat regime, some attractive fundamental reform programmes were implemented. Land reform program was introduced in the beginning of Panchayat regime. A 'Back to the Village' national campaign was initiated with a view to providing a village oriented philosophical base to the Panchayat regime. But, this campaign later became a means/system of political evaluation of Panchayat workers instead utilizing in development programmes. Concept of balanced regional development through the development regions based on north-south growth axis or development corridors was introduced. The construction of East-West Highway, initiated in the Panchayat regime, could not be completed even within the stretch of thirty years. A new education plan was introduced which centralized the whole education system, but it became an unsustainable burden on national coffer and reduced people's participation in education development. Many projects were implemented under the integrated rural development with international assistance for rural development. The 'basic needs program', the principal slogan and priority of the Seventh Plan, aimed to fulfill the basic minimum needs such as food grains, clothing, housing, health, education and public security among others and raise the economic condition of the people to the Asian standard by 2000. But most of these efforts could not produce desired results to the economy.

3.1.3 Plan Holiday Period (1990-1992): Transition from Controlled to Liberalized Planning

The main responsibility of the interim government formed after the restoration of the multi-party system was: to formulate constitution compatible with multiparty system and to hold general elections in accordance with the constitution. Therefore, formulation of a new periodic plan was postponed. During 1990/91 and 1991/92, development programmes were executed under annual plan.

3.1.4 Planned Development during Constitutional Monarchy Regime (1992-2007): Liberalized Planning

The Eighth Plan set the objectives of attaining sustainable economic growth, alleviating poverty and reducing regional disparity. In order to achieve these objectives, economic policies based on competitive liberal market-oriented economy, power decentralization to the local bodies, regional development through rural development,

confined role of the public sector mainly in physical infrastructure development and render basic social services in the rural areas by mobilizing private sector were adopted. The major attempts during the Eighth Plan were , introduction of value -added tax (VAT); initiation of the privatization of public enterprises; determination of exchange rate by the market forces; encouragement to establish commercial banks and financial institutions; adaptation of a policy of inter-weaving the concept of regional development with village development and decentralization policy; preparation of an Agriculture Perspective Plan (APP); implementation of land reform to put an end to dual land-ownership; identification of potential areas for the development of irrigation and energy; and initiation of new and special programmes to uplift the deprived and the downtrodden class. During the plan, the role of NGOs and INGOs were increased. The power sector did not record expectant progress due to the failure of taking off of Arun III Project.

The objectives of the Ninth Plan were poverty alleviation and increase employment opportunities,. Since, agriculture sector has been taken as a lead sector and implemented the Agricultural Perspective Plan (APP) in a national economy to reduce poverty in rural areas and to increase the employment opportunities. The plan had the target to drop the proportion of population living under absolute poverty to 32.5 percent at the end of the plan period, and had a 20-year objective to reduce the absolutely poverty to 10 percent. There were three main strategic development policies within the framework of liberal and market-oriented economy adopted in the Ninth Plan. They were: achievement of sustainable and wider economic growth rate, development of social sectors and rural infrastructures, and targeted group programs for deprived areas and communities.

The Ninth Plan period was severely disturbed by deteriorating law and order situation in the county, which not only hindered the implementation of development programs but also forced the government to divert development fund into security sectors. The global recession as a result of terrorist activities also adversely affected Nepal's major economic sectors like industry, tourism, foreign trade etc., and thereby the macro economic conditions. As a result, the GDP growth rate in the fifth year of the Plan was negative by -0.5, which brought home unhealthy stress on poverty alleviation and employment generation. The growth rate of all sectors except the social sector got setback compared to targets on this plan period. Important economic sectors such as industries and commerce, hotel and restaurant witnessed low progress.

In the Tenth Plan, expected and normal projections of economic growth rate were made, considering the existing situation. The normal economic growth rate for the Plan period was 6.2 percent with 4.1 percent growth rate in the agriculture sector and 7.5 percent growth rate in the non-agriculture sector. In the same way, if the internal security situation would improve only at a later stage of the Plan, the economic growth rate was expected to increase at about 4.3 percent with 2.8 percent growth rate for agriculture and about 5.2 percent for non-agriculture sector. The achieved growth rate was 3.4 percent on an average during the Plan period having 2.7 percent growth rate in the agriculture sector, and 3.8 percent in the non-agricultural sector. On the whole, agricultural production was not encouraging during the Plan period due to unfavorable weather condition. Because of the persistent conflict and unfavorable international situation, production of most of the sub-sectors of the non-agriculture sectors was negatively affected and hence reduced the production growth. The overall poverty and human development indices improved significantly during the past years in spite of achieving lower growth rate. In the fiscal year 2003/04, the people living below the absolute poverty line had fallen to 31 percent from 42 percent. The reasons were: increased wage rate in both the agricultural and non-agricultural sectors, increasing urbanization, increased proportion of active human resources in the population and inflow of huge amount of remittances.

3.1.5 Planned Development during Republican Regime (2007/08-2012/13): Inclusive Planning

The political movements in the past had exposed the discriminating structural attitudes that existed in economic, social, cultural and geographical terms. The latest movement in 2005/06 had directed the country towards a new vision in order to enhance inclusive social and economic development that covers women, *Dalits*, *AdibasiJanajatis*, *Madhesis*, Muslims and the people with disabilities.

With a long term vision of building prosperous, modern and justice Nepal, the objectives set in the Eleventh Three Year Interim Plan (2007/08 -2009/10) were to achieve poverty alleviation oriented broad economic growth; to enhance good governance and increase effectiveness in services delivery; to increase in investment on physical infrastructures development; to emphasize on social development; to operate inclusive development and targeted programmes. The priority areas of the Plan were: reconstruction and rehabilitation of physical infrastructure: development through the inclusion of excluded groups, areas and gender in all mechanisms, spheres and processes of development; expansion of physical infrastructures including hydropower, roads, irrigation and communication for supporting agriculture, tourism and industries; and development of Social sectors such as: education, health, water supply and sanitation sectors for the development of human resources.

During the past three years percentage of people below poverty line had reduced to 25.4 percent from 31 percent. The reasons behind this poverty reduction were: increased wage rate in both the agricultural and non-agricultural sectors, increased urbanization, increased proportion of active human resources in the population and inflow of huge amount of remittance income. However, though the poverty level had fallen, inequality in income distribution had gone up.

The vision of the 12th Three Year Plan (2010/11-2012/13) was to build prosperous, peaceful and just Nepal by transforming the country from least developed to developing nation within two decade. It was expected that the existing legal, social, linguistic, cultural, religious, economic, ethnic, gender, physical, regional discrimination and differences in the country will end in future. The main goal was to reduce the percentage of people below the poverty line to 21 percent by creating result-oriented employment opportunity, reducing economic inequality, achieving regional balance, improving the living condition of all Nepalese people, eliminating all social exclusions, and sustainable growth based on targets fixed in least developed countries upliftment strategy and Millennium Development Goals by 2015. The targeted economic growth rate in the running Three Year Plan was 5.5 percent with 3.9 percent agricultural growth rate and 6.4 percent non-agriculture growth rate. But the review of the 12thThree Year Plan shows that the achieved economic growth rate during the plan period was only 4.0 percent with 3.6 percent agriculture growth rate and 4.2 percent non-agriculture growth rate. The Plan succeeded in reducing the percentage of population below the poverty line to 23.8 percent. The actual growth rate of employment achieved during the plan period was 2.9 percent against the target of 3.6 percent. Thus, this plan cannot be considered as a successful plan.

The approach paper of 13thThree Year Plan (2013/14-2015/16) had already been submitted to the Development Council at end of June, 2013. This approach paper was developed with a long term vision of upgrading the country to the group of developing countries from the group of least developed countries by 2022. Accordingly the objective of the plan has been set to make feel the direct change in living standard of common people by reducing the economic and human poverty level. Major target of the plan is to reduce the percentage of people living below the poverty line to 18 percent. With a view to achieve this goal and objective, it is targeted to achieve 6.0 annual economic growth rate with 4.5 percent agriculture annual growth rate and 6.7 percent non-agriculture annual growth rate. Priorities are given to water resources and energy development; increase in agriculture productivity, and its diversification and commercialization; and development of basic education and health, drinking water and sanitation in descending order.

But the development process of the past two years of this plan has shown the possibility of failure in achieving its goals, objectives and targets. However, the performance of the last year of the plan, the current running year, is yet to be reviewed. It has publicly been realized that the government after the people's movement of 2006 has not been able to give the clear cut economic development policy to lead the country since there were/are always political scuffle among the political parties for power as a result of which no single sector is left unaffected by the present system of power and benefit sharing among the political parties.

3.2 Past Trend in Economic Growth of Nepal

The economy of Nepal can be classified into three major sectors namely, agriculture, industry and services. After the restoration of democracy in 1990, Nepal liberalized its economic policy following the globalization of world economy. Private sector was encouraged to involve in economic activities and thus reducing the government involvements. Following the privatization policy, the public enterprises were privatized. Consequently, economic activities were expanded and thus, relatively higher economic growth rate (4.7%) was achieved during the last decade of the twentieth century. The first decade of twenty-first century was found discouraging in terms of the economic activities because of the Maoist insurgency and political instability in the country. Political instability still continues and it is still difficult to predict when it will be stabilized. As a result of all these, the annual growth rate of GDP at factor cost was reduced to 3.9 percent during this decade. The growth rate of agriculture sector was slightly improved to 3.1 percent from 2.6 percent due to the favorable climate during this decade. But the industry and services sectors both were badly affected by the strikes, *Nepal Bandh* and political conflicts caused by Maoist insurgency and political instability. The growth rate of industrial value added and services value added dropped down to 2.0 percent and 5.1 percent from 6.5 percent and 6.3 percent respectively. The growth rate of electricity, gas and water sector had drastically dropped down to 0.4 percent from 14.7 percent due to low investment and absence of working environment caused by political conflicts. Many industries and organizations were forced to shut down their operations. Prolonged power outage was another major cause for slowing down of the economic activities in the country. This problem is still unsolved and it is still difficult to predict when it will be resolved.

3.3 Future Macro-Economic Prospects of Nepal

If the present gloomy political and economic situation continues for a long time, in the coming forty years, the economy will get further worse(the baseline scenario). The annual growth rates of GDP at factor cost and GDP at producer's price is predicted to remain at 4.3 percent respectively during the forecasted period (2012-2050). Annual GDP growth rates of all sectors will fall down badly and industry, among others, will get further worse. The services sector may be expected to be relatively less affected by the hang-over of the political instability; therefore, its annual growth rate will remain at 5.7 percent. The annual GDP growth rates of agriculture, industry and services sectors for projected period (2012-2050) will be 1.4 percent, 1.3 percent and 5.7 percent respectively.

The structure of the economy will drastically shift to services led economy which will encourage faster rate in the urbanization process. The contributing share of agriculture sector to GDP at factor cost, which was 38.3 percent during the period (2001-2010), will reduce to 13.7 percent during the last decade (2041-2050) of the projected period. Similarly, the contributing share of industry sector to GDP at factor cost will come down to 5.9 percent during the last decade (2041-2050) from 15.9 percent during the last decade of historical period. But that of services sector will climb up to 80.5 percent during last decade of the projected period from 45.8 percent during the last decade of historical period. The GDP share of electricity, gas and water sector will be less than unity in the last decade of forecasting period, which depicts the gloomy picture of this sector.

As economic growth is the driver for higher consumption of water resources and energy carriers, three scenarios - (a) low economic growth scenario with average GDP growth rate 4.4%, (b) moderate economic growth rate scenario with average GDP growth rate of 5.6%, and (c) high economic growth rate scenario with average GDP growth rate of 6.5% - are looked into in the macroeconomic analysis to observe whether or not the capital investments requirements in these sectors will have dire impacts on other macro-economic parameters.

Table 3-1: Projected Capital Investment Requirements for Water and Energy Sectors under long Term Vision of 2050 at 2010/11 Prices

Sector	2011-2020	2021-2030	2031-2040	2041-2050	2012-2050
In Million Rs.					
Lower Growth Scenario (Scenario_1)					
Water supply	113,021	111,206	112,687	115,183	445,119
Irrigation	96,949	119,894	147,430	180,805	536,530
Energy	252,651	608,065	1,007,921	1,329,766	3,185,594
Moderate Growth Scenario (Scenario_2)					
Water supply	119,159	139,754	203,354	278,170	733,459
Irrigation	119,751	192,112	250,734	327,382	881,429
Energy	259,690	672,274	1,212,230	2,018,412	4,149,797
Higher Growth Scenario (Scenario_3)					
Water supply	138,127	199,138	253,810	371,925	956,023
Irrigation	137,679	237,501	349,676	518,206	1,234,513
Energy	269,419	755,064	1,443,279	3,024,064	5,479,017
Combined Energy Policy in Moderate Growth Scenario (Scenario_4)					
Energy	690,488	1,909,649	2,233,966	4,106,565	8,927,859
As % of GDP at producers' prices					
Lower Growth Scenario (Scenario_1)					
Water supply	0.71	0.47	0.31	0.20	0.34
Irrigation	0.61	0.51	0.41	0.32	0.41
Energy	1.59	2.59	2.79	2.32	2.42
Moderate Growth Scenario (Scenario_2)					
Water supply	0.74	0.55	0.47	0.34	0.45
Irrigation	0.74	0.76	0.58	0.40	0.54
Energy	1.61	2.67	2.82	2.49	2.53
Higher Growth Scenario (Scenario_3)					
Water supply	0.84	0.73	0.50	0.35	0.48
Irrigation	0.84	0.87	0.68	0.48	0.62
Energy	1.64	2.76	2.82	2.82	2.73
Combined Energy Policy in Moderate Growth Scenario (Scenario_4)					
Energy	4.27	7.47	5.12	5.01	5.38

Since 1995 onward, the share of capital investment on water and energy sub- sectors to the GDP at producer's prices has been fallen and product supplies of these sub-sectors are lagging behind the increasing demand for these products as per need of faster structure changes in production and consumption patterns due to speedy urbanization and modernization of livelihood of the citizens of the country. Keeping these facts in mind, capital investments on water supply, irrigation and electricity are required to be increased remarkably since these sub sectors have multiplier effects on the socio-economic development of the country. Their forward and backward linkages with rest of the sectors of the economy are significantly high.

In the lower growth scenario, amounts of capital investments on both water supply and irrigation sub-sectors are expected to increase in absolute terms but their shares to GDP at producer's prices will fall drastically and average shares of these sub-sectors during the projected period (2012-2050) will be 0.34 percent and 0.41 percent respectively. No doubt, the case of water supply will further worse in the future in the absence of intervention. Both volume and share of capital investment on energy sub-sector may be expected to increase optimistically during the projected period. The GDP share of energy sub-sector will, in an average, be 2.42 percent. In moderate growth

scenario, the GDP shares of these sub-sectors will be 0.45 percent, 0.54 percent and 2.53 percent respectively and similarly, they will be 0.48 percent, 0.62 percent and 2.73 percent respectively in higher growth scenario. In case of combined energy policy under moderate growth scenario, the average GDP share of capital investment on energy will reach to 5.38 percent, which may not prove to be unreasonable investment by the global experiences.

The implication of capital investment for water and energy sectors development as proposed in the long term vision will have positive impacts on economic growth and level of employment. Resources balance will also be positive if the faster rising remittance can be diverted towards the investment in productive sectors from spending on consumption items and real estate development. Besides, current account balance, government fiscal balance and resources gap of present and future are not found to be worse in the baseline as well as in other alternative scenarios. This indicates that the macroeconomic stability of the country has not yet been spoiled and will not worsen in future. Therefore, the volume and trend of proposed investment on water and energy sectors will not have adverse effects to the rest of other sectors of the economy and economy as a whole; rather, it will have positive impacts on the development of other sectors of the economy as well as the national economic development of the country on the whole. Thus, the required volume of investment for water and energy sectors development can be guaranteed by the economy without distorting the macroeconomic stability of the country in future, if the peace and political stability is improved in near future and all economic forces gets to work properly.

3.4 Historical Development of Hydropower

The history of hydropower development and with this the evolution of electricity supply in Nepal is as old as more than a century. It began with the development of 500 kW Pharping power plant in May 1911 *(Bisht, K. B., 2010).* It took more than another two decades till the second hydropower plant was established in 1934 with an installed capacity of 900 kW at Sundarijal. This power plant is still in operation and producing 640 kW. The third hydropower plant with a capacity of 1600 kW was constructed by Morang Hydro electric Company, a private sector, in 1942 at Chisang Khola (Morang district). It was later damaged by several landslides *(Pradhan, 2006).* Until that time hardly any big importance was given to the development of hydropower. It was only when Nepal started with the systematic five year development plan in 1955, that hydropower was given proper importance in planning and execution (*Bisht, K. B., 2010).*

Until 1990, hydropower development was under the domain of government utility, Nepal Electricity Authority (NEA), only. However, with the enactment of new Hydropower Development Policy 1992, the sector was opened to the private sector also.

In 2002, Nepal's largest hydropower plant KaligandakiA 144 MW was commissioned. It has an output of 791 GWh.. The 3 MW Piluwa-Khola hydropower and 7.5 MW Indrawati III hydroelectric project were also commissioned *(Lako, Eder, Noord, Reisinger, 2003).*

3.5 Historical Development of Rural Electrification

Rural electrification had figured prominently in all Nepal's national development planning since the mid-1970s and it continued with ever greater emphasis up to the Tenth Five Year Plan (2003-2008). In 2001, a new Hydropower Policy highlighted rural electrification, specifically calling for the creation of a central rural electrification fund to support development of rural electric supply. This idea is incorporated into the Tenth Plan (2003-2008), which makes rural electrification one of government's highest development priorities. It specifically called for creation of a central entity with the mandate of developing rural electricity supply. As a result in 2003/04 GoN adopted a policy that created the Community Electrification Program to accelerate the electrification process.

Solar Energy

Solar energy has been used traditionally for drying such things as crops, clothes, fuel wood, and crop residues. Currently there are two types of solar energy technology in the country: solar thermal systems and solar photovoltaic (PV) systems. Solar dryers and water heaters are the two main types of solar thermal devices.

A few manufacturers and NGOs have attempted to promote a few designs of solar dryers in the country. A modified rack type solar dryer developed by RECAST is also used for drying fruits and vegetables. The government has been trying to encourage the use of solar dryers by providing subsidies. A 50% subsidy on the cost of solar dryer was announced by AEPC in 1998.Development of solar cookers in Nepal started in 1997 with the parabolic cooker brought in by RECAST. Later on RECAST developed box type solar cookers locally.

Solar cookers were introduced by the Research Centre for Applied Science and Technology (RECAST) in 1977 as parboiling cookers. The Centre for Rural Technology, Nepal (CRT/N) took further initiative to promote Solar Cookers since early 1990's with the government subsidy channeled through Alternative Energy promotion Centre (AEPC). Because of their high cost, this technology has not become popular in the rural areas. Although various types of solar cookers have been developed to reduce cost, efforts to improve the efficiency of solar cookers have yet to be undertaken.

The use of solar water heaters were mainly in the urban centers and in the trekking route. Till 2005, there are around 61,000 solar heaters installed in the country. The technological intervention in extraction of solar energy started only in the early sixties with installation of first PV system in Bhadrapur. Since then PV systems were extensively used by telecommunications sector. NTC had become one of the significant users of solar electricity amounting to more than 1000 kWp generating about 47000 kWh/day of electrical energy at more than 3000 locations by 1990. Seventy five percent of all the Public Call Offices (PCO) in NTC was being powered by PV. Similarly Nepal Electricity Authority also started generating small amount of electricity from PV system in remote areas of country.

The government formulated comprehensive Renewable Energy Subsidy Policy and Renewable energy delivery Mechanism in the year 2000. The use of solar photovoltaic is increasing rapidly in the country after the provision of subsidy by the Government of Nepal. There were around 30 registered solar PV companies operating for the dissemination of SHS with hundreds of branch offices in the various district and rural areas of Nepal. Till 57,875 PV home systems are installed in the country by the end of 2004 and 90,172 units of SHS have been installed in the country by 2005.

Biomass and Biogas

Nepal has a history of over 50 years of biogas technology development. Biogas in Nepal has had a long, eventful history. Started in the 1980s as a technological research project with a limited number of test models, it was expanded during the 1990s by the Biogas Support Program into a very successful market development program with the active involvement of the business community. Over the last 13 years, more than 140,000 biogas installations have been built. Due to the consolidated efforts of various actors (organizations and individuals) involved in the promotion and development of biogas sector in Nepal, 186,073 family sized bio-digesters have been installed by July 16, 2007 covering 67 districts in all five development regions of the country. As of June 2009, some 2800 village development committees (VDCs) of the total 3913 in Nepal have biogas plants. The installation of biogas plants of varying capacities (4, 6, 8, 10, 15 and 20m3, along with 300 institutional biogas plants) shows an increasing trend because of the technical and financial supports from the Biogas Support Program (BSP) of the Netherlands Development Organization-Nepal (SNV/N).Presently, the Biogas Support Program (BSP) is the second largest to improved cooking stoves (ICS) program for alternative rural energy program in Nepal.

Biomass Briquetting

In Nepal Bio-Briquette's history is not so old. Only one decade ago it was commonly adopted in Nepali society. Most of the Community Forest User Group (CFUG) are producing Bio-briquette as a source of income. In 1982, two different briquetting technologies were introduced in Nepal, namely pyrolysing and extrusion technology. Nearly 20 enterprises registered with the Ministry of Industry for the installation of briquetting plants. High initial investment, increase price of raw material and frequent repair of extruder are problems associated with it. Due to which, about 65% of them had not started operating simultaneously due to poor profitability and marketing problems, as well as shortage of rice husk. Only one manufacturer had continued to produce rice husk briquettes in Nepal.

Improved cooking stoves (ICS)

With the support of community Forestry Development Project (CFDP), assisted by FAO in1981, RECAST carried out research works for the development of designing of improved cooking stoves suitable for Nepal. This is the first undertaking in the country with specified commitments for the development and dissemination of improved cooking stoves in a large scale. As a result of the project activities, there has been a notable advance in the identification of suitable stove design and also in the dissemination of the improved types to the field in a sizable number. The government of Nepal accorded high priority to increase ICS installation in the country in the 9th plan. The national ICS programme (2002 – 2006) funded by Energy Sector Assistance Programme (ESAP) of DANIDA and executed by AEPC has disseminated about 300,000 ICS till June 2008, in 44 mid-hill districts by more than 2500 trained promoters out of which 50% are women. There are more than 90 local NGOs involved in the program and about 50,000 ICS is being disseminated every year. This has been perceived as a strong platform for the commercialization of ICS in the rural household of Nepal. Within the 10th plan period (2002-2007), the government of Nepal disseminated additional 250,000 numbers of ICS in the rural areas of the country.

Petroleum Products

The first four wheel vehicle was brought in to Kathmandu valley in early 1930s for the personal use by the then Ranas rulers was possibly when need of petroleum products first felt in Nepal. After construction of Tribhuvan Highway in 1956, which gave Kathmandu a road connection to India, the consumption of petroleum products has been ever increasing. Private entrepreneurs used to be dealers of Indian companies such as ESSO, Burmah-Shell, Caltex etc in the 50's & 60's for Nepal and started marketing their petroleum products such as, Petrol, Diesel, LDO, engine oil, Kerosene oil etc.

Nepal Oil Corporation (NOC) was established in January 1971 by the Government of Nepal under the "Company Act, 2021 (1964)" as a state-owned trading company to deal with the import, transportation, storage and distribution of various petroleum products in the country. The government owns 98.36% of its share and rest is contributed by four other state owned enterprises. NOC, headquartered in Kathmandu, has Five Regional Offices and also Branch Offices, Fuel Depots and Aviation Fuel Depots with total storage capacity of 71,558 Kilolitres (KL) and around 600 employees.

All the petroleum products consumed in Nepal are procured and imported from Government of India (GOI) undertaking national oil company, i.e. Indian Oil Corporation Ltd (IOC) under a 5 years' Contract Agreement signed on 31st March 2007. NOC uplifts petroleum products as per its requirement from IOC's 6 nearest refineries and depots situated in eastern and northern part of India. The transportation from IOC locations to NOC depots and to retail outlets is done by Tank Trucks. To meet the increasing demand, a MOU between IOC and NOC for construction of cross border Petroleum Product Pipeline from IOC's depot (Raxaul) to NOC's depot (Amlekhgunj) has been signed. The Detailed Feasibility Report (DFR) of the proposed pipeline has also been prepared and the construction/investment modalities are under discussion between the companies.

The government had earlier announced that it would now allow the private sector to import and process petroleum products ending the monopoly of NOC. So far, five private firms have applied for permission for transaction of fuel products. The government has fixed paid-up capital of Rs 20 billion for refinery, Rs 10 billion for companies importing fuel products and Rs 5 billion for firms importing LPG.

Wind Power

In the Northern belt (region) of Nepal wind energy is available, but the exact potential is yet to be estimated due to lack of technical personnel. It is reported that the potential it's to generate wind energy in Mustang is reported at about 200 MW. (Rajbhandari et.al). The Kagbeni wind power project was one of the biggest projects with installed capacity of 20kW built in 1987 under the support of the Danish Government. Unfortunately, the wind power project could not sustain itself due to the lack of maintenance. The establishment of wind-solar hybrid systems of 400W with 150W solar power projects in six rural communities has been completed. More than 48 households and two

secondary schools have directly benefitted from these micro-projects. Although the government declared a plan to generate 20MW electricity by wind energy in the Three Year Interim Plan (2007/08–2009/10), the lack of sufficient research data, and complicated geographical landscape of the country hindered its successful implementation. Also, the areas are very site specific without infrastructure and limited human settlement.

CHAPTER 4
CURRENT SCENARIO OF ENERGY RESOURCES IN NEPAL

4.1 Traditional (Biomass) Energy Resources

The major source of traditional energy is of course the forest resources. The legal definition of forest un Nepal, according to MFSC-DOF(1999) comprised of all fully or partly covered areas by trees, including land use types such as forest, shrub-land and grassland, non-cultivated inclusions and all other lands except the cultivated lands registered under private or institutional ownership were also embraced under the legal definition of National forest.

And the National forests have been classified into:

- *Government Managed Forest* (government owned and managed)
- *Protected Forest* (government owned and declared protected forest, for environmental conservation and protection of scientific and cultural values)
- *Community Forest* (government owned, management responsibility entrusted to identified historical users group for conservation, use and benefit sharing)
- *Leasehold Forest* (government owned, management and use right entrusted to identified individual who is below the poverty line or to specified registered institution such as forest-based industries or communities, for specific task and fixed period of time)
- *Buffer Zone Community Forest* (government owned forest situated around a national park or wildlife reserve, management right handed over to local buffer zone user committee, for conservation of biodiversity as well as fulfillment of forest products needs of the local community)
- *Religious Forest* (ownership and management responsibility entrusted to specified religious body, group or community for protection and established historical use).

The area of existing National forest and Shrub land in different Development Regions of the country according to DFRS (1999) is provided in Table 4-1.

Table 4-1: Forest and Scrubland area by Development Region

Region	Total land (area in ha)	Total Forest* (area in ha)	Forest as percent of total land (%)	Total Shrubland (area in ha)	Shrubland as percent of total land (%)	Total percent of Forest and shrubland (%)
FWDR	1,953,900	687,400	35.2	263,9000	13.5	48.7
MWDR	4,234,800	1,192,400	28.2	442,000	10.4	38.6
WDR	2,939,800	734,300	25.0	256,900	8.7	33.7
CDR	2,741,000	918,600	33.5	233,800	8.5	42.0
EDR	2,845,600	736,100	25.9	362,600	12.7	38.6
Total	14,718,100	4,268,800	29.0	1,559,200	10.6	39.6

** Forest area includes all government owned forest including handed over CF to local community for sustainable management*
Source: FRISP (in DOFRS, 1999)

The current area of reachable and non-reachable forest by development region according to FRISP/DFRS (1999) is provided in Table 4-2.

Table 4-2: Area of Reachable and Non-reachable Forest by Development Region

Region	Reachable forest (ha)	Non-reachable forest (ha)	Total forest ('000 ha)	Reachable forest area (%)[11]
FWDR	358,800	328,600	687,400	52.2
MWDR	454,400	738,000	1,192,400	38.1
WDR	262,100	472,200	734,300	35.7
CDR	527,700	390,900	918,600	57.4
EDR	576,300	159,800	736,100	78.3
Total	2,179,300	2,089,500	4,268,800	51.5

Source: Derived from DOFRS (1999)

Due to this change in concept, reachable forest area has now increased from 43% in 1978 to 51% in 1999, and the area of reachable shrub land decreased from 64% to 52% during the same period of time (DFRS1999).

A recent report, DOF (2005) provided the changed forest cover in 20 Terai districts between the period 1990/91 and 2000/01.These districts bordered India in the south and embraced both plain and hilly parts corresponding to their respective administrative division. Its findings have been published in a report entitled: Forest Cover Change Analysis of the Terai Districts (1990/91-2000/01). However, it did not distinguish the forest from shrub land areas. Instead, both areas have been grouped together as forest. And it also excluded the areas set aside for protection (i.e. national parks, wildlife reserves, etc.) under the National Park and Wildlife Conservation Act 1973.

These 20 districts were spread over from Jhapa in the east to Kanchanpur in the west. The district wise forest area change in these districts has been shown in Table 4-3.

Table 4-3: Annual Rates of Change in Forest Cover (1990/91-2000/01) by District Excluding Protected Forest Areas

District	Forest cover 1990/91 (area in ha)		Forest cover 2000/01 (area in ha)		Change in forest cover (area in ha)		Rate of change (%)		Total Forest Cover in 2000/01
	Hill	Plain	Hill	Plain	Hill	Plain	Hill	Plain	
Kanchanpur	17,671	36,875	17,003	34,930	-668	-1,945	-0.38	-0.54	51,933
Kailali	119,165	91,248	121,529	84,410	2,364	-6,838	0.20	-0.78	205,939
Bardiya	4,050	31,441	4,261	29,458	211	-1,983	0.51	-0.65	33,719
Banke	48,858	64,216	48,255	62,565	-603	-1,651	-0.12	-0.26	110,820
Dang	168,007	23,193	170,712	23,550	2,705	357	0.16	0.15	194,262
Kapilbastu	18,586	45,993	18,661	43,550	75	-2,443	0.04	-0.54	62,211
Rupendehi	16,944	10,361	16,850	9,674	-94	-687	-0.06	-0.68	26,524
Nawalparasi	65,633	25,393	67,743	25,428	2,110	35	0.32	0.01	93,171
Chitwan	43,695	17,982	43,899	19,687	204	1,705	0.05	0.91	63,586
Parsa	3,079	15,825	2,561	16,083	-518	258	-1.82	0.16	18,644
Bara	14,938	34,694	14,731	34,426	-207	-268	-0.14	-0.08	49,157
Rautahat	7,767	21,705	7,721	21,838	-46	133	-0.06	0.06	29,559
Sarlahi	16,198	13,839	16,059	14,469	-139	630	-0.09	0.45	30,528
Mahottari	13,367	10,220	13,438	10,753	61	533	0.05	0.51	24,181
Dhanusa	27,364	1,512	26,661	1,662	-703	150	0.26	0.95	28,323

[11] DOFRS (1999) did not provide specific information regarding the proportion of reachable shrublands in different Development Regions. WECS, 2005 by applying the same reachability factor assumed a decreased proportion of reachable shrublands, from 64% in LRMP/WECS, 1987 to now only 52% at the national level.

District	Forest cover 1990/91 (area in ha)		Forest cover 2000/01 (area in ha)		Change in forest cover (area in ha)		Rate of change (%)		Total Forest Cover in 2000/01
	Hill	Plain	Hill	Plain	Hill	Plain	Hill	Plain	
Siraha	16,717	2,304	16,324	1,954	-393	-350	-0.24	-1.63	18,278
Saptari	18,377	2,677	18,421	2,689	44	12	0.02	0.04	21,110
Sunsari	7,194	14,465	7,019	14,346	-175	-119	-0.25	-0.08	21,365
Morang	21,832	23,886	21,848	23,336	16	-550	0.01	-0.23	45,184
Jhapa	2,446	18,828	2,429	18,571	-17	-257	-0.07	-0.14	21,000
Total/Average	651,888	506,657	656,115	493,379	4,227	-13,278	0.06	-0.27	1,149,494

Source: DoF, 2005.

DoF (2005) showed a negative 0.06% change in the forest area between 1990/91 and 2000/01 in its study findings from the above 20 districts. However, for the whole country, no new data has been published after the 1999 Forest Resources Assessment by DFRS.

Moreover, this follow up survey in the Terai districts did not take into account the continuing process of forest growing stock depletion due to illegal tree felling and smuggling of wood and fuelwood for commercial gains. However, a second Forest Resources Assessment (FRA) project was under implementation currently, under the financial assistance of the Governments of Finland. So, the current total area of both forest and shrubland remained unchanged from the data of 1999, which means 5.83 million ha (or slightly over 39%) of the country's total land area. And it had been observed that both forest and shrubland had decreased at the rate of 1.7% and 0.5 %, respectively from 1978/79 to 1994.

Besides, the Government of Nepal (GON) now considering to maintaining at least 40% of the country's land area under forest and shrubland. And based on this new thinking, the Tenth Five Year Plan document has categorically recommended for not converting or handing over any part of the remaining forest land for other uses. But, this target seemed difficult to achieve, because forest and shrub land in the country have been continuously decreasing over time. It has decreased from 39.6% in 1999 to now less than 37%. The GoN reported to FAO only 38% forest and shrub land cover for Global Forest Resource Assessment (GFRA) of 2000 and 37.6% for GFRA 2005. This clearly indicated about 1.24% loss of forest cover during the last 10 years.

Fuel-wood Resources

Since the last four decades, community forest has become one of the priority programs of forestry development. Numerous bilateral donors and multi-lateral agency such as World Bank were involved in its development. It is reported that about 35% of the total development budget allocated to MFSC is spent on CF development program. So far, about 1.45 million households or 35 percent of the population of Nepal is involved in community forestry management program. To date, 17,685 Community Forestry User Groups (CFUGs) have been formed. And a total of 1,652,654 hectares of National forest have been handed over as CF in which 2,177,858 households have benefited. The area of National forest handed over as CF by Physiographic Zone and Development Region is provided in Table 4-4.

Table 4-4: CF Area by Development Region and Physiographic Region (2010) (Unit in 000 ha)

Development Region	Terai	Hills	Mountain	Total
FWDR	15.3	104.3	64.0	183.6
MWDR	82.1	139.7	44.7	266.6
WDR	12.2	165.3	6.7	184.2
CDR	24.4	181.9	56.1	262.4
EDR	35.6	240.5	56.8	332.9
Grand Total	169.5	831.7	228.4	1,229.7

Source: WECS, 2010 (initial source FECOFUN 2010)

Very recently, DoF has also put into practice a new strategy of Collaborative forest management (CFM) in the remaining degraded National forest areas of the Terai, Inner-Terai and Siwalik that have not yet been handed over as CF or LF.

Besides the directly derived fuelwoods from forests and non-forest lands, other indirect supply sources of fuelwoods in the country include residues from logging and wood processing industries, recycled wood from construction activities, used packing crates, pallets, driftwood, abandoned furniture, recovered wood from old construction, etc. As a matter of fact, the share of direct fuelwoods generally would be only up to 50% of annual log-harvest in a managed forest, but the share could vary considerable depending on local conditions. According to FAO's statistics, the share of fuelwood in total roundwood production in Nepal was very high, over90%even up to 2009.The logging/harvesting residue would comprise of stumps, main trunks, and lops and tops.

Currently, more than 19% of the land cover has already been classified as Protection forest, conservation of biodiversity and representative wildlife habitats in the form of National Parks, Wildlife Reserves, Conservation Areas, and Buffer Zones. Besides, the Tenth Five Years Plan of Nepal has envisioned to expand the forest covered area in the country to 40%.

Animal Residues

Where both woody and herbaceous biomass supply sources are scarce, not sufficient to meet the traditional energy needs of the local people, historically animal excreta, mostly *gobar (*cow dung) either in a dried cake form of different shape and size, or in the form of sticklike object made from *gobar* mixed with different herbaceous biomass like cattle shade refuses, twigs, rice straw, etc. has served as important complementary biomass energy supply source to compensate the scarcity of fuelwood. These types of fuels have commonly been used in Western, Central and Eastern Terai districts. The estimated annual supply potential of animal dung in different physiographical zones of the five Development Regions is shown in Table 4-5.

Table 4-5: Production Potential of Animal Dung in 2008/09 (in '000MT)

Development Region	Physiographic Zone			
	Mountain	Hills	Terai	Total
EDR	466	1384	1918	3769
EDR	371	1731	1414	3516
WDR	12	2178	970	3160
MWDR	285	1317	950	2552
FWDR	441	780	696	1917
Total	1575	7390	5948	14913

Source: WECS, 2010

Dung has been the second largest energy source in terms of total primary energy consumption. Although dung cake is the poorest form of energy and it is regarded as the energy of the poor. The availability factor of animal dung in Mountain, Hills and Terai region was estimated by WECS as 50%, 75% and 100% respectively.

Agricultural Residues

Where fuelwood supply does not meet the energy needs of the local people, field and processing residues of agricultural crops such as *paddy, maize, what, millets, oil seeds, grain legumes, jute* etc, in dried form become the important alternative biomass fuel sources. The estimated annual supply potential of agricultural residues in different physiographic zones of the five Development Regions is shown in Table 4-6.

Table 4-6: Production Potential of Agricultural Residue in 2008/09

(in '000 tons)

Development Region	Physiographic Zone			
	Mountain	Hills	Terai	Total
EDR	362	1437	3179	4978
CDR	357	1663	3940	5960
WDR	10	2448	2069	4528
MWDR	109	952	1374	2435
FWDR	141	297	1073	1511
Total	980	6797	11635	19412

Source: WECS (2010)

Agricultural residues have remained as the third largest indigenous biomass energy source (WECS, 2010). At both times, during crop harvest at the field and during processing of agricultural products, considerable amount of residues are generated. And these biomass residues play an important role in complementing biomass energy supply to rural households. The Residue-to-Product-Ratio (RPR) values have been used with care while assessing the resource potential of some important crops. Actual value of RPR could vary widely depending on local conditions, crop species and moisture content.

Other Biomass Waste and Residues

Other biomass waste and residues that possessed of energy potential included municipal solid waste and forest- and agro-industry wastes. ADB/ICIMOD (2006) reported that there were 58 municipalities of varying sizes in the country that generated over 1,350 tons of solid waste every day. And among the municipalities, Kathmandu Municipality was the largest that produced 383 tons of solid waste on a daily basis. It constituted slightly less than one-third of the total municipal waste generated in the country. In the Municipal solid waste, household waste comprised of about 75 percent. The per capita solid waste production potential per day varied from 0.11 to 0.93 kg (average 0.34 kg) per person. The households on the outskirts of smaller towns were rural in nature and used most of the waste for feeding domestic animals. The municipal solid waste comprised of:

- Organic material 66 percent by weight (with a range of about 39 to 95 percent (between municipalities) ;
- Metal, glass paper, and plastic combined, 20 percent by weight (range 5 to 50 percent), plastic alone constitutes 7.6 percent (range 1.6 to 21 percent);
- Inert material 9.6 percent (range 0 to 37 percent); and
- "Other", including medical waste (about 5%).

Recently estimated generation of solid waste in five municipalities of the Kathmandu Valley is provided in Table 4-7.

Table 4-7: Waste Generation in Five Municipalities of the Kathmandu Valley (tons per day)

Municipality	Generation in 2004	Collection in 2004	Projected Generation 2015
Kathmandu	308	250	548
Lalitpur	75	52	135
Bhaktapur	25	19	46
MadhyapurThimi	143	5	28
Kirtipur	12	4	18
Total	435	330	775

Source: Nippon Koei 2005 (in ICIMOD/MoWST/UNEP, 2007)

It was also reported that currently, management of these wastes has been a major burden to the five municipalities. And they are forced to spend between 20-25% of their total expenditure on solid waste management. There were 58

municipalities of varying sizes in the country, and the estimated waste generation by them was over 1,350 tons of solid waste every day at that time.

4.2 Commercial Energy Resources

Hydro Energy Resources

Hydroelectricity, petroleum, natural gas and coal are the major commercial energy sources in use in the country. Among all commercial energy sources for power generation, hydroelectricity has the major share and also this is the most important in the context of the country considering the potential for hydroelectricity generation.

Table 4-8: Theoretical Hydropower Potential of Nepal

River Basin	Potential in MW		Total Potential in MW
	Major river courses having catchments areas above 1000 km^2	Small river courses having catchments areas 300-1000 km^2	
Sapta Koshi	18,750	3,600	22,350
Sapta Gandaki	17,950	2,700	20,650
Karnali and Mahakali	32,680	3,500	36,180
Southern Rivers	3,070	1040	4,110
Country Total	72,450	10,840	83,290

Table 4-9: Economic Hydropower Potential

River Basin	Number of Project Sites	Economic Potential Capacity in MW
Sapta Koshi	40	10,860
Sapta Gandaki	12	5,270
Karnali	7	24,000
Mahakali	2	1,125
Southern Rivers	5	878
Country Total	66	42,133

Source: WECS, 2010

In Nepal, the theoretical and economic hydropower potential has been estimated at about 83,000 MW and 42,000 MW, respectively. A summary of the theoretical hydropower & economically feasible potential of the major river systems of the country is presented in Tables 4-8 & 4-9 respectively. Among the major river basins, Karnali and Sapta Koshi basins have the most potential and economically viable hydropower resources.

Fossil Fuel Resources and their consumption

Nepal does not have proven fossil fuel reserves. All the petroleum products consumed in Nepal are imported from India or overseas in the refined form for direct consumption. The import and distribution of petroleum products in the country is handled by Nepal Oil Corporation (NOC) solely. The NOC has current storage facilities of 72,000 KL for all the essential petroleum fuels, except for LPG (NOC, 2011) which is bottled and distributed by private companies. As per NOC, a new trend has surfaced since 2008. A sizable quantity of petroleum products such as diesel, gasoline and kerosene are used in the isolated generation of electricity by households, service sector and manufacturing industries.

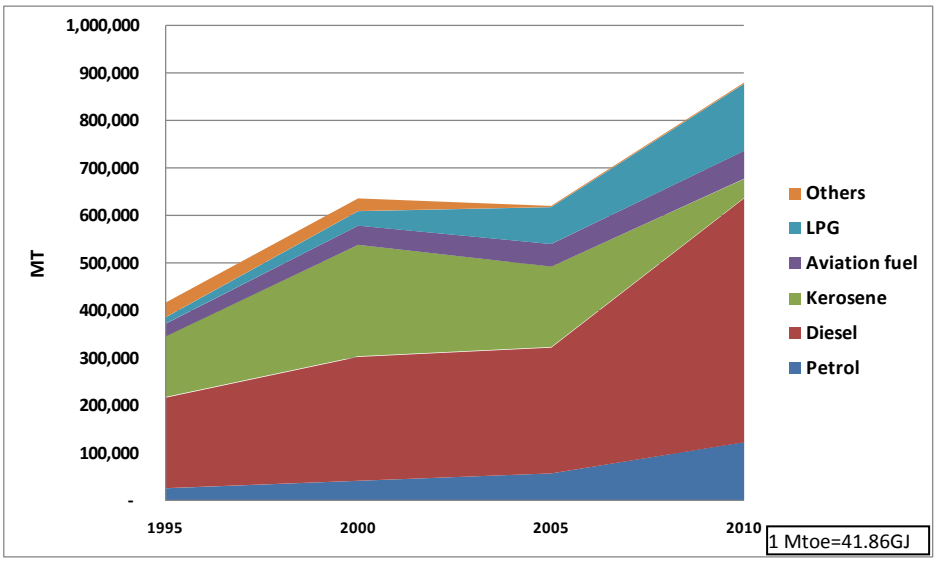


Figure 4-1: Sales of Major Petroleum Products from 1995 to 2010 in MT(toe) ((NOC, 2011)

Figure 4-1 indicates that consumption of petroleum products was virtually stagnant during the period from 2000 to 2008 due to political insurgency in the country. Especially consumption of diesel has doubled from 2008 to 2010, whereas consumption of heating oil such as kerosene has plummeted since 2003, as Nepal Oil Corporation (NOC) made the domestic prices of diesel and kerosene equalized for controlling rampant adulteration. Due to this reason, consumption of LPG are growing at double digits as it is the mostly available and cheaper energy carrier for cooking and other household purposes.

There are some small occurrence of coal and lignite in Nepal, which are not commercially attractive. The occurrences of coal can be classified into four major categories – Quaternary lignite of Kathmandu Valley, Coal from Dang (Eocene coal from Mid-Western Nepal), Siwalik coal and Gondwana coal. There are some open pit mining practices in the Dang area for the extraction of lignitic coal. The primary production of this coal is about ten thousand tonnes, which are mainly used in brick manufacturing industries. Also Nepal imports from India through private organizations under agreement with Coal India Limited. In the year 2004/05, Nepal imported about 260 thousand tonnes of coal from India. Kathmandu alone consumes about 40% of imported coal. It is mainly used in the industrial sector like cement, lime, and brick industries in Nepal.

4.3 Renewable Energy Resources

Renewable energy resources are those resources which can be used to produce energy without depletion. The available sources of renewable energy development in Nepal are water, sun, wind, biomass, hot spring and so on. These renewable energy sources are un-interruptible and infinitely available due to their widespread complementary technologies, and hence can accommodate the country's need of diverse supply. Besides, these energy sources are eco-friendly as they have insignificant to no adverse impact on the environment. For instance - the use of renewable energy resources help avoid green house gas (GHG) emission which further mitigates the climate change. Moreover, there is opportunity to earn from carbon trading as per CDM as developed by UNFCCC.

The potential renewable energy technologies which can generate power by exploiting the locally available energy resources are: pico-hydro and micro-hydro power, biomass related biogas, briquettes, gasifier, liquid bio-fuel, improved cooking stove, solar photovoltaic (PV), solar thermal and wind powered plants. Of these technologies, micro-hydro, biogas, improved cooking stove, solar PV home systems and solar water heaters are popular and are at various stages of commercialization. On the other hand, technologies such as solar cooker, solar dryer, briquettes, wind and geothermal are only in demonstration stage.

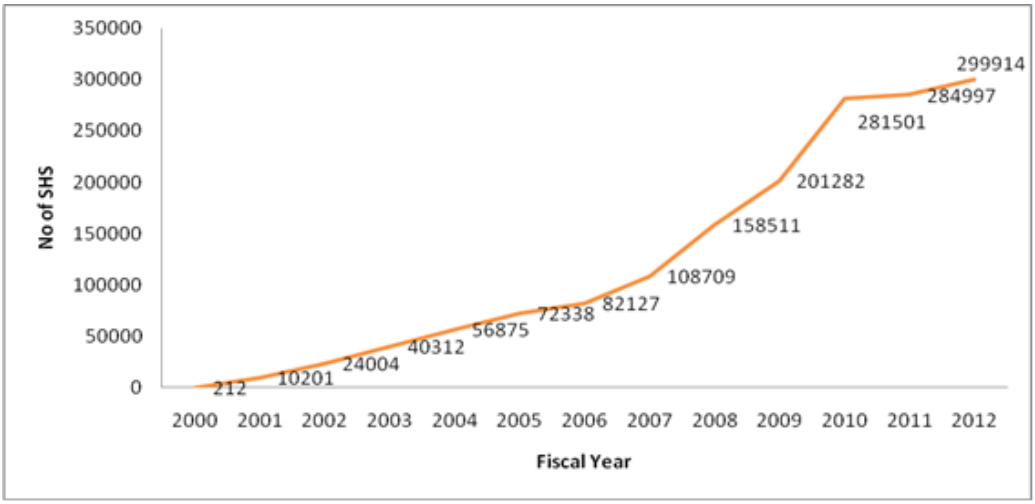
Status of Solar Energy

Total number of solar PV systems disseminated so far along with the total installed capacity is presented in Table below. Installed capacity of solar home systems (SHS) and small solar home systems are viz 10.7 MW and 0.8 MW respectively and installed capacity of ISPS and PVPS is 2.9 MW. The total installed capacity is about 14.5 MW as shown in Table 4-10.

Table 4-10: Status of solar PV in Nepal

System	Number	Installed Capacity (kWp)
Solar Home System		
Solar Home Systems (SHS) installed under government subsidy since 2000 to July 2012.	299,914	7490.014
Solar home systems installed under government subsidy since 1995 to 1999*	96673	2900.190
Disseminated through various organization without government subsidy*	8149	276.493
Installed in urban area without government subsidy*	2210	119.280
Sub total		10785.9
Small Solar Home System		
Small Solar Home System (SSHS) under government subsidy	22,605	113.025
Disseminated through various organization without government subsidy*	82799	401.036
Karnali Ujyalo Program*	60000	300.000
Sub total		814.061
Solar PV in Communication Sector*	943 sites	1243.894
Institutional solar PV system (ISPS)*	402	217.789
Solar PV Pumping system (PVPS)*	76	135.969
Institutional System under REP support (ISPS,PVPS)	933 sites	1023.000
Solar PV in government related offices*	17 sites	361.367
Subtotal other than SHS and SSHS		2982.019
Grand Total		14581.98

*Source: * Status of Solar PV Sector in Nepal 2010 and for others: AEPC/ESAP, 2012*



Source: AEPC/ESAP, 2012

Figure 4-2: Number of SHS installed annually

In twelve years from 2000, nearly 300,000 solar home systems have been disseminated. The Figure below shows a cumulative number of SHS disseminated. In early years, rate of dissemination was slow but between 2006 and 2010 there was rapid increase in dissemination. In 2006, a total of 82,127 systems were installed and in 2010 the number of systems installed reached 281,501.

There is a huge potential for solar thermal devices such as Solar Water Heaters (SWH), Solar Dryers (SD), Solar Cookers (SC) as well. Presently SWH have been fully commercialized and till 2009 more than 185,000 SWH have been installed in the country. Similarly some 1400 solar cookers and dryers have been installed in different parts of the country.

Status of Micro Hydro Power

Micro-hydro technology has been disseminated and power has been generated so far in about 60 hilly and mountainous districts of Nepal. The installed capacity of the existing micro hydro projects is about 31 MW including 15.2 MW mechanical power. In addition to these, some 1000 projects of cumulative installed capacity of 24,062 kW are in different stages of project cycle. Table 4-11 below highlights the annual installation of micro hydro projects.

Table 4-11: Status of Micro-hydro in Nepal

Fiscal Year	District	Water Mills		Electricity Plant		Total	
		Capacity	Numbers	Capacity	Numbers	Capacity	Numbers
Up to 2057/58	47	7064.9	799	5999	1157	13063.9	1956
2058/59	36	154	77	550.6	90	704.6	167
2059/60	39	118	59	955.7	129	1073.7	188
2060/61	33	582.6	420	526.62	103	1109.22	523
2061/62	44	1253	835	830.8	115	2083.8	950
2062/63	40	1317	878	993.9	88	2310.9	966
2063/64	41	1007	671	2081.3	168	3088.3	839
2064/65	23	2019	1346	795.1	58	2814.1	1404
2065/66	22	1752	1168	1193.56	69	2945.56	1237
Total		15267.5	6253	13926.6	1977	29194.1	8230

Source AEPC 2012

As of July 2012, a total of 16.03 MW electricity has been generated benefiting 164463 households since 1996. Status of micro hydro projects supported under two main programs namely REDP and ESAP are shown in table.

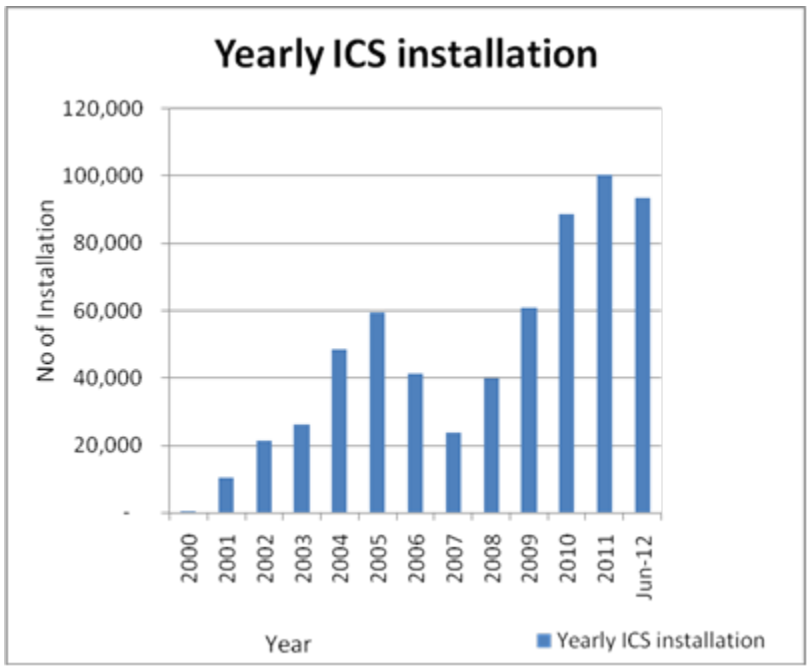
Table 4-12: Status of MH in Nepal

Particulars	No	kW	Household Benefitted
REDP/REL supported			
Pico Hydro	52	171	2027
Micro Hydro	323	7287.2	73362
Sub Total	375	7458.2	75389
ESAP supported			
Pico Hydro	410	1245.3	16066
Micro Hydro	303	7327.3	73008
Sub Total	713	8572.6	89074
Grand Total	1088	16030.8	164463

Source: AEPC/ESAP, 2012 and RERL 2012

Status of Improved Cooking Stoves

As the country relies heavily on traditional biomass for cooking and space heating in hills and mountains, there is a huge prospect for ICS in Nepal. More than 600,000 ICS including some 8000 metallic ICSs have been installed so far through various government and non-government organizations. Yearly installations of Improved cooking stoves are shown in the following table and graph (Figure 4-3).



Year	Yearly ICS installation
2000	476
2001	10,455
2002	21,180
2003	26,213
2004	48,461
2005	59,367
2006	41,203
2007	23,831
2008	39,893
2009	60,931
2010	88,719
2011	100,566
Jun-12	93,591
Total	614,886

Figure 4-3: Yearly ICS Installation

Status of Wind Technology

Not much work has been done in wind energy generation. A pilot project for demonstrations and dissemination is being carried out by various organizations like AEPC, Intermediate Technology Development Group (ITDG). ITDG has installed five 200-watt wind turbines at various locations like Kavre, Tansen, Palpa, Makwanpur, Chisapani (Karnali), and Udayapur for the stand-alone system whereas AEPC has installed one 400-watt wind turbine at Nagarkot and a 11 kW solar wind hybrid project in Nawalparasi for demonstration purposes.

Geothermal Resources

In connection to geothermal energy resources, 32 hot water spring sites are situated at various parts of the country, with a water temperature up to 50° Centigrade (CES, 2000). Currently, they are used for the therapeutic purposes. There is a need to undertake a study to investigate the possible end uses of the hot water spring resources.[12]

Status of Biogas

program has been fully internalized in AEPC and external development partners including the World Bank (WB) has been supporting AEPC in wide scale dissemination of the technology.

[12] National Energy Strategy Report WECS, 2010

Table 4-13: Yearly Installation of Biogas Plant by Capacity Size

Fiscal year	District Coverage	Capacity (CuM)							*Source: BSP/N 2012*
		2	4	6	8	10	15	20	Total
2051/2052	47		62	652	1,451	2,633	279	38	5,115
2052/2053	58		123	1,190	2,460	3,097	249	38	7,157
2053/2054	57		304	2,004	3,201	2,686	175	17	8,387
2054/2055	56		265	2,861	4,234	2,303	180	26	9,869
2055/2056	56		494	4,268	4,717	1,451	109	13	11,052
2056/2057	58		1,771	7,850	3,001	643			13,265
2057/2058	59		3,225	11,629	2,616	387			17,857
2058/2059	57		2,779	10,597	1,864	287			15,527
2059/2060	57		3,391	11,105	1,622	222			16,340
2060/2061	58		1,859	8,072	1,191	137			11,259
2061/2062	56		2,467	13,352	1,804	180			17,803
2062/2063	55		2,058	12,184	1,686	190			16,118
2063/2064	60		2,463	13,486	1,550	164			17,663
2064/2065	62		2,224	11,558	1,099	3			14,884
2065/2066	69		3,420	14,997	1,062				19,479
2066/2067	69	1,085	4,978	14,266	829				21,158
2067/2068	65	1,006	5,770	12,175	710				19,661
2068/2069	62	440	5,904	12,039	596				18,979
Total		2,531	43,557	164,285	35,693	14,383	992	132	261,573

Due to the concerted efforts of various stakeholders, a total of 261573 biogas plants have been installed in the country till July 2012 covering all 75 districts. The yearly installation and trend are shown in Table 4-13. It is also noteworthy to quote that more than 90% of these plants are operational.

Biomass Wastes

In addition to agricultural residue mentioned above, there are other biomass wastes like municipal solid waste and forest- and agro-industry wastes which can be used for energy generation. Nepal's 20 years Perspective Plan for renewable energy prepared by FEEDBACK INFRA for AEPC in 2011 reported that 58 municipalities in Nepal generate over 1,350 tons of solid waste every day. The current estimate of municipal solid waste generation in Kathmandu valley is provided in Table 4-14.

Table 4-14: Waste Generation in Five Municipalities (tons/day)

Municipality	Generation in 2004	Collection in 2004	Projected generation 2015
Kathmandu	308.4	250	547.9
Lalitpur	75.1	52	135.4
Bhaktapur	25.5	19	46.2
Madhyapur	14.3	5	27.8
Kirtipur	11.6	4	18.1
Total	434.9	330	775.4

As reflected in the table above, 435 tons of solid waste was generated in 2004. Most of these wastes contained biodegradable organic waste, which comprised of energy potentials but the energy generation potential is yet to be determined.

CHAPTER 5
CURRENT STATUS OF ENERGY RESOURCES CONSUMPTION IN NEPAL

Nepal's energy sector is mostly based on traditional biomass energy resources rather than commercial energy. Table 5-1 shows the energy balance calculated for the year 2010 based on the Energy Sector Synopsis report (WECS, 2010) and the economic survey (MoF, 2012). The total Primary Energy Supply (TPES) in 2010 is calculated to be 417,000 TJ and the final energy consumption is around 410,000 MJ which are elaborately explained subsequently in the Among the commercial energy carriers, 64% of petroleum products are consumed in the transportation sector, almost 100% of coal in the industrial sector. 44% of electricity are used in the industrial sector whereas 39% of it in the residential sector. Almost 99% of traditional biomass energy carrier is used in the residential sector. Modern renewable energy is mostly used in the residential sector only.

One salient feature the energy balance reveals is that a sizable volume of petroleum products in the range of 17% of total primary petroleum products (6,900 TJ) is in the mismatch and hence is used by captive generating sets for electricity production. Calculation indicates that there are in operations many captive generating sets with total installed capacity in the range of 600 MW in the country by 2010

Table 5-1: Energy Balance of Nepal in 2010 in TJ

Particulars	Petroleum products	Coal	Hydro	Electricity	Biomass	Modern renewables	Total
Primary Supply							
Indigenous production			11,031		349,263	2,933	363,227
Imports	40,173	11975		2,205			54,353
Exports				(268)			(268)
Stock changes	230						230
Total Primary Supply	40,403	11,975	11,031	1,937	349,263	2,933	417,312
Transformation							
Inputs	(6,912)		(9,928)				(16,840)
Electricity generation				11,551			11,551
T & D losses				(2,862)			(2,862)
Other losses, own-use etc.			(1,103)				(1,103)
Net supply to consumers	33,491	11,975	(0)	10,626	349,263	2,933	408,058
Final Consumption							
Industry	1,651	11,940		4,581	1,949		20,121
Residential	4,687	35		4,064	345,519	2,933	357,238
Commercial	2,994	-		747	1,794		5,535
Transport	21,289	-		20	-		21,308
Agriculture	2,872	-		184	-		3,056
Others	-	-		800	0		800
Total	33,491	11,975	-	10,396	349,262	2,933	408,058
Statistical error	(0)	-	(0)	230	1	-	0

(Calculated based on WECS, 2010 and MoF, 2012)

5.1 Current Status of Energy Consumption

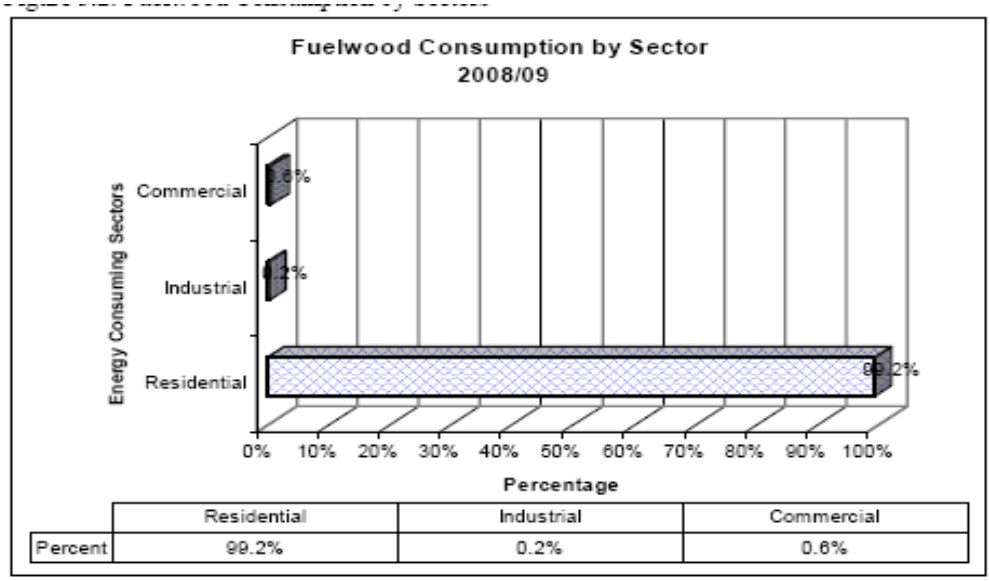
In 2010, residential sector consumed energy the most whereas productive sectors like transport, industrial, commercial and agricultural sectors in total have a lower consumption of 13% of the final energy. Nepal is totally dependent for imports of petroleum products for its energy requirements. The nation spent approximately 126 percent of its commodity exports in 2010/11 on import of petroleum products which was just 27 percent of the exports earnings in 2000/01 (MOF, 2012). But on the other hand, Nepal has huge resources of indigenous energy resources. However, Nepal could just produce 2 percent of its commercially viable resources. Without a proper vision, strategies, and action plans for the sustainable development of energy sector, Nepal's economy seems to be in jeopardy in the coming years.

5.1.1 Traditional Energy Consumption by Sector

Dried biomass materials of different types, particularly fuelwood, animal dung and agricultural residues, constituted the traditional fuel resource that was consumed primarily in the domestic sector. These sources together, contributed as much as 83.4% of the total primary energy supply in country in fiscal year 2010/11. However, its contribution in total energy consumption in various sectors of the economy could not be quantified due to unavailability of data.

Historical data suggest that fuelwood consumption was still increasing but at a decreasing rate during the past one decade. Its average annual growth rate was about 2.5%, nearly equal to the average population growth rate during that decade.

Similarly, the average annual growth rate of both animal dung as well as agricultural residues was also increasing at about 2.3% and to 3.3% respectively, in 2010/11.The sector wise consumption of fuelwood in 2008-09 is provided in Figure 5-1



Source: WECS (2010)

Figure 5-1: Fuel-wood Consumption by Sector in 2008-09

Residential Sector

WECS (2010) stated that over 99% of the traditional energy was consumed solely in the residential sector in financial year 2008/09. Among the traditional fuels, fuelwood alone accounted for around 89% in the total energy consumption for domestic cooking. Similarly, animal dung was consumed mostly in the residential sector. Its contribution in the national energy balance stood high, about 5.5% in fiscal year 2010/11. The annual growth rate of animal dung consumption was also reported high, around 2.3%. Nearly 75% of households in Nepal (i.e., 4.03 million out of 5.42 million households) still use solid biomass. Besides, its consumption as feed stock for biogas generation has increased on average by about 15% in recent years.

Industrial Sector

The industry sector used very little energy up to 2008/09. Its share in total fuelwood consumption was insignificant-only a meager 0.2 percent. It is reported that this sector used about 10% of the total agricultural residues mostly for heating and boiling purposes. Rice husk is one of the major fuels in many industries that require heat for its operation. Currently, rural industries such as ceramic and pottery works, brick baking, limestone burning, bronze, copper and iron works, silver and gold smithy, etc. have been the important users of traditional energy, mostly fuelwood, charcoal and agricultural residues.

Commercial and Service Sector

Commercial establishments such as sweet shops, restaurants, lodges, hotels, etc. also used fuelwood for cooking as well as space and water heating. The other commercial activities that used fuelwood included domestic and small-scale local food and agricultural processing, (i.e. milk processing, ghee and *khuwa* making, paddy and oil seeds roasting, beaten rice (c*hiura)* making, fish, meat and cardamom drying, tobacco and tea leaves curing etc). Besides, local bakeries, confectioneries, breweries, distilleries and sugar mills, at least during initial stage of operation used fuelwood and other dried biomass fuels to meet their energy needs. According to the statistics of WECS (2010) this sector used only about 0.6 percent of total fuelwood consumption in 2008/09.

Agriculture Sector

No data has been floated by concerned agencies showing the share of agriculture sector in total fuelwood production or consumption. Until recently, traditional farming system in Nepal has relied solely on human and animal muscle power for every aspect of crop and tree farming. The use of commercial energy sources in this sector too, primarily in the Terai areas has been growing in recent years. The main activities that are being mechanized include plowing, irrigation, harvesting, thrashing,

Transport Sector

The transport sector of Nepal does not use traditional energy at all. Currently, this sector solely relied on imported petroleum fuels.

5.1.2 Commercial Energy Consumption by Sector

According to the Water and Energy Commission Secretariat (WECS) Nepal's total energy consumption in the year 2008/09 was about 401 million GJ. Hydropower had a share of 2.5% in it. Total of 48% of Nepal's population, which lives mainly in urban areas and 8% of people in rural areas has access to electricity produced from this hydropower and some of other sources of energy.

The total number of consumers at the end of fiscal year 2012/13 grew by 14.34 % and reached 2.59 million at the end of fiscal year 2012/13. Accordingly the power and energy demand also grew by 9.00% and 7.70% respectively. This growth is more significant in residential and industrial sector and a little less in other development sectors (NEA, 2012/13).

Petroleum is the second largest energy fuel after fuelwood which supplies about 8% of the total energy demand. The major petroleum fuels used are gasoline, diesel, LPG aviation fuel and kerosene.

Residential Sector

Residential accounts for the major share of energy consumption 89.1% (WECS, 2010). In terms of composition, the residential sector accounted for 44% (TIM, 2012) of the total consumption of electricity in 2011. Electricity in the residential sector is mainly used for lighting. Out of the 2.32 million total number of consumers accounted in 2012, domestic consumer are 94.94% (NEA, 2012). Private households account for 43.4 % of national electricity consumption. The average daily household consumption is about 2 kWh.

Meanwhile, the residential sector accounts for nearly 16.6% of total 33million GJ of petroleum sources for energy. The major fuel consumption in this sector is due to LPG, accounts for 75.6% while kerosene accounts for rest. These fuels are mainly used for cooking and heating purposes.

Industrial sector

The industrial sector share of energy consumption is about 3.3% (WECS, 2010) of the total energy consumption in Nepal, taking thus the third place after residential sector (89.1%) and transport sector (5.2%). Of the total consumer accounted in 2012, industrial consumer is 1.57%. At present 38% (TIM, 2012) of the total electricity generated in

Nepal is consumed by industrial sector. The main end uses of electricity in this sector are motive power and lighting. The share of electricity used for various purposes are not available.

The share of petroleum consumption by industries is quite low at near 1.4 % only. (WECS, 2010). The major petroleum product s other petroleum products like fuel oil (86.4%)m while diesel and kerosene are used in shares of 11.9% and 1.7 % respectively. The main used of petroleum in industries are for boilers, process heat and motive power.

Transport Sector

The share of energy consumption in the transport sector comes to about 5.2% (WECS, 2010) of the total energy consumption in Nepal. The contribution of electricity in these sectors is very less and comes to about 0.20 % (TIM, 2012) only. It is used mainly to run cable cars, ropeways ad trolley buses, which are very few in the country. This is still less than the contribution of LPG (0.81%), which is being increasingly used in three wheelers and micro- buses. While the use of diesel is quite high at nearly 72%, gasoline usage of about 14 % and ATF at about 13%.

Commercial Sector (Service Sector)

Presently 1.3% of energy consumed in Nepal is through commercial source (WECS, 2010). The share of electricity consumption in this sector is very less i.e. about (TIM, 2012). Consumption of electricity of commercial sector is has increased at 10% from the previous year in 2011 (NEA, 2012).The main use of electricity in commercial sector, is similar to those in residential sectors, e.g. cooking , heating , lighting , water pumping and running other electrical appliances. This sector utilizes around 8.2 % of petroleum products (WECS, 2010). The major petroleum product used by commercial sector is LPG and kerosene with share of around 89% and 11% respectively. There are used for heating and cooking purposes.

Water supply and Agriculture Sector

The share of energy consumption in agriculture sector is about 0.9% (WECS, 2010) of total energy consumption in 2004/2005. Water supply and agriculture consumes about 2% of the total electricity available (SREP, 2011). The only other fuel being used in this sector is high speed diesel (94%). Electricity, in this sector, is used mainly for lift irrigation. This sector majorly uses diesel for water pumping and farming machineries and it accounts for nearly 10.5% share (WECS, 2010).

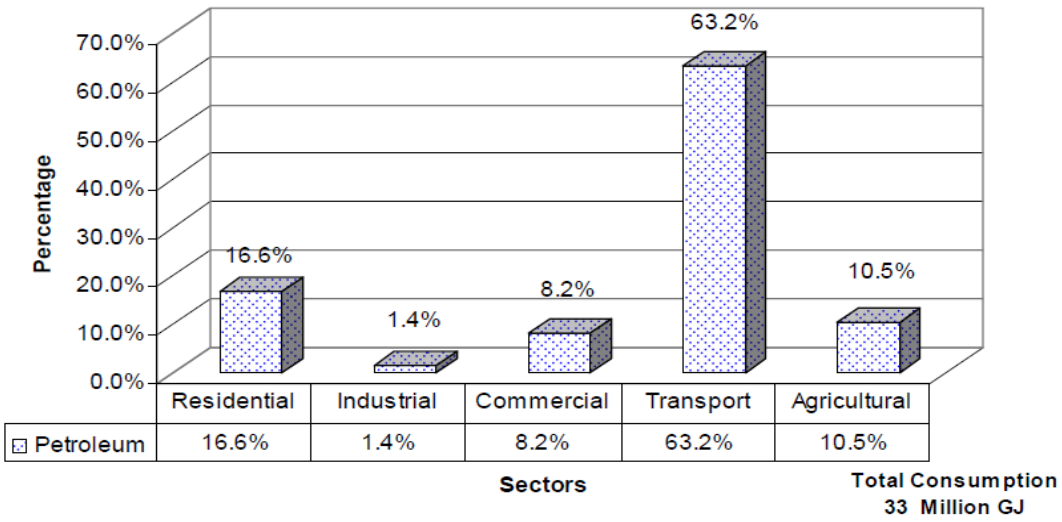


Figure 5-2: Petroleum Consumption by Sector 2008/09 (WECS, 2010)

5.2 Current Status of Energy Supply

5.2.1 Traditional (Biomass) Energy Supply

The recent analyses show that already 40% of the total population depends on CF for forest products, including firewood. Regarding the trends in traditional energy demand, FAO (2009) was of the view that it demand would still be growing, as its consumption had increased by about 2.4% since the last decade. Recently, introduction of briquette technology has also helped in making use of inferior loose biomass residues into a high density, commercially salable biomass fuel. It has also shifted some pressure of firewood collection in the forest. Both woody and non-woody biomass residues are being used to manufacture biomass briquettes, which has been used in urban areas for specific purpose. However, the statistics concerning how much, where and at what cost? In recent years, the use of briquette has become popular particularly in winter months. The expected share of biomass briquette use in Nepal by 2020 is about 25% of total biomass consumption.

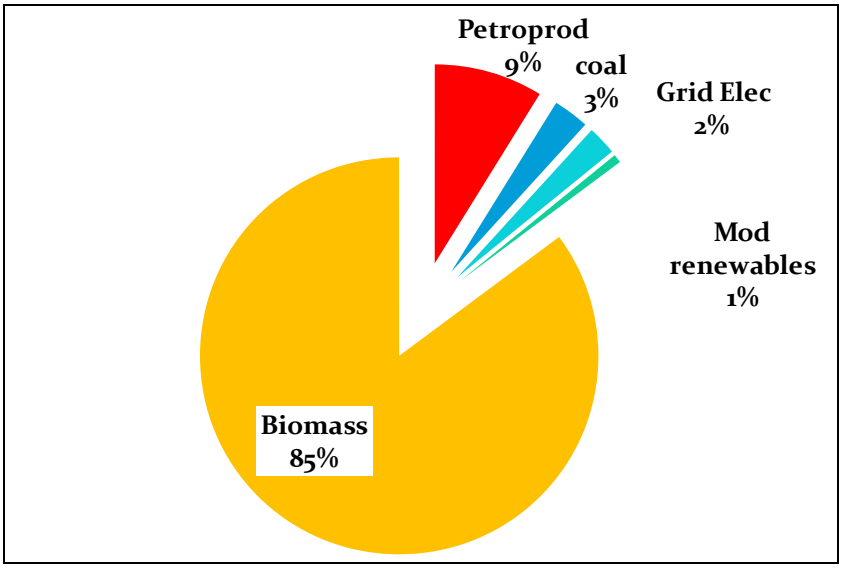


Figure 5-3: Energy Mix by Fuel type in 2010 (MOF, 2012; WECS, 2010)

5.2.2 Commercial Energy Supply

In the year 2010, the total final energy consumption was 410,000 TJ (MOF, 2012; WECS, 2010),out of which traditional Biomass resources supplied 85 percent in the total energy consumption, whereas commercial energy such as fossil fuels and electricity were 14 percent. Modern biomass such as biogas and briquettes and renewable energy sources supplied about 1 percent only (Figure 5-3).

Among the commercial energy sources, all the petroleum products are being imported from Indian Territory. The electricity has been generated by hydropower plants and partially about 121.44 MW of electricity is being imported from India as well (NEA,2012). In recent years, subsidized fuels for cooking such as Liquefied Petroleum gas (LPG) are being widely used not only in urban but also in rural areas. But due to price rises in the international oil markets, fossil fuels have become economically inefficient for cooking if their costs were compared in 1990s and in 2013.

5.2.3 Renewable Energy Supply

The major renewable energy supplied in Nepal is electricity which contributes only 2% of the total energy demand (SREP, 2010). At present Nepal has a total installed capacity of 762.029 MW. Of the total installed capacity of the hydropower, 477.930 MW is contributed by NEA hydro including the only storage type Kulekhani power plant with an installed capacity of 60 MW, 5.341 MW by NEA thermal, 0.100 MW by solar and 230.589 MW-all Run-off-the River (ROR) by IPP hydro. Hydropower supplies about 92.98% of the total electricity generated. Energy demand of INPS in fiscal year 2012/13 is estimated at 5,446.285 GWh, out of which only 4,218.135 GWh (77.45%) could be supplied. The rest 1,228.15 GWh (22.55%) was resorted to load shedding.

Of the total supplied energy volume, 3,467.93 GWh (82.56%) was contributed by domestic generation and 792.52 GWh (17.44%) by import from India. Domestic supply included 1,175.97 GWh (34.00%) from IPPs and the rest 2,291.96 GWh (66.00%) was from NEA owned power stations with a share of 2,273.14 GWh from hydro and 18.82 GWh from thermal.(NEA, 2012/13). The other renewable sources currently installed in Nepal are tabulated below:

Table 5-2: Summary of installed RET's in Nepal till mid July 2011 (AEPC, 2011)

S.N	RETS	Total installation		Unit	District Covered
		No.	Capacity		
1	Hydropower				
	Mini hydro	40	14.95	MW	31
	Micro hydro	999	18.65	MW	59
	Pico hydro	1480	3.18	MW	53
	IWM	7959	.-	.-	46
2	Biogas				
	Household plant	258642	.-	.-	72
	Institutional plant	111	.-	.-	25
	Community Plant	61	.-	.-	20
3	Solar				
	HH Solar PV	284097	7.44	MW	74
	Institutional Solar PV – for computer, FM radio and Vaccain refregirator	299	.-	.-	42
	Solar Pumping	81	.-	.-	22
	Solar cooker/dryer	1920	.-	.-	30
	Small Solar Home System	11687	0.05	MW	49
4	Biomass				
	ICS	619816	.-	.-	52
5	Wind	21	.-	.-	12

CHAPTER 6
POLICY AND LEGISLATIVE FRAMEWORK IN ENERGY SECTOR

6.1 Evolution of Legislative Framework in Energy Sector

Mandates or responsibilities for development and management of energy resources in the public sector have been allocated to several ministries and agencies. At least five ministries are directly related with the production and supply of energy in the country, viz. –

a) Ministry of Energy
b) Ministry of Forest and Soil Conservation
c) Ministry of Commerce and S-supplies
d) Ministry of Science, Technology and Environment
e) Ministry of Agricultural Development

The ministries generally operate within their single sub-sector mandates and there is absence of a comprehensive national energy policy that embraces all energy sources. Various documents and executive orders of the government issued from time to time contain statements that are close to policy statements in the sector e.g., periodic development plans and government orders and notices. They are summarized below.

- Periodic Development Plans
- Hydropower Development Policies 1992 and 2001, Water Resources Act 1992 and Electricity Act 1992
- Water Resources Strategy 2002 and National Water Plan 2005
- National Electricity Crisis Resolution Action Plan 2008
- Procedures for PPA for Projects up to 25 MW (2065 BS)
- Local Self-Governance Act, 1999 (2055 BS)
- Rural Energy Policy 2006
- Forest Sector policies and Forest Act, 1992
- Petroleum, Coal and Natural Gas Sub-sector Policies
- National Transport Policy 2001

6.1.1 Legislative Frameworks

The Water Resources Act (WRA) was promulgated in 1992 which stated that the “ownership of the water resources available throughout the Kingdom of Nepal shall be vested in the Kingdom of Nepal”. It was developed as framework legislation on water resources and anyone wishing to use water resources was required to get a permit from the government. However, the Act said that a system of licensing for production of hydroelectricity would be governed by prevailing law. And, in the same year a separate legislation, the Electricity Act, 2049 was enacted for licensing of survey, production and distribution of hydroelectricity.

6.2 Major International Laws and Conventions on Energy Resources that have implications on Nepal

International laws and conventions are increasingly recognized as instruments to facilitate development and achievement of sustainable goals for individual countries through international engagement and cooperation. A brief overview of major international policies/conventions that would have implications in the renewable energy sector in Nepal is given below:

Rio's Agenda 21:

A21 is the Earth Summit's (1992) plan of action included major programme areas, such as promoting transitions to different energy sources, increasing energy efficiency, promoting renewable energy sources, and promoting sustainable transport systems. Though energy did not receive its own specific chapter, energy aspects were included in connection to other topics, especially in chapter 9 with relation to climate change, but also in chapters 14 and 16 in relation to sustainable agriculture and biofuels[13].

Johannesburg Plan of Implementation (WSSD, 2002):

Johannesburg Plan of Implementation was adopted at the World Summit on Sustainable Development. The Plan addresses renewable energy as a tool for poverty eradication and sustainable development to which the governments have agreed to. But there were no time bound targets under the Plan that time. However, Johannesburg Renewable Energy Coalition (JREC) 2006 supports time-bound targets for renewable energy.

United Nations Framework Convention on Climate Change (UNFCCC):

Kyoto Protocol is one of the tools of the Convention which establishes specific and binding greenhouse gas (GHG) reduction targets for all ratifying industrialized countries. Clean Development Mechanism (CDM) and Joint Implementation (JI) are the two project-based mechanisms under the Kyoto protocol by which projects in developing countries and countries with economies in transition (both country groups are exempted from binding GHG reduction commitments) can be undertaken to generate carbon credits (CERs). Emissions trading (ET) is the third mechanism under Kyoto Protocol which facilitates trade in carbon emissions among countries that have reduction commitments. Renewable energy sources, including landfill gas, were responsible for the largest share of CERs to be generated annually from the current global portfolio of CDM projects.

The Global Environment Facility (GEF) was created as a financial mechanism for the UNFCCC, supporting developing countries to meet their obligations under the Convention. GEF has become a major source for renewable energy financing in developing countries.

Millennium Development Goal (MDG) 2000:

MDG aims for poverty alleviation and focuses on access to energy to achieve the goal. Among the eight goals targeted for 2015, MDG 1 (poverty eradication) and MDG 7 (environmental sustainability) are directly related to the renewable energy access and utilization.

6.3 Current Status of Policy and Legislative Framework related to Energy Sector in Nepal

Unlike irrigation use, the National Code of 1910 has no legal provision in respect with non-consumptive use of water such as generation of hydroelectricity. It was only in 1967 AD that the Canal, Electricity and Related Water Resources Act attempted to regulate the use of water resources. A license was required under the Act for using water except for traditional or non-commercial use. Therefore, while a license was mandatory to generate hydroelectricity it was not required for daily personal use such as operating water mill and for irrigation using local resources. However, a license was required even for such uses if existing or future government irrigation or hydroelectricity project would be adversely affected. The Act also empowered the state to acquire private irrigation or hydroelectric infrastructures to make large scale and comprehensive arrangements. This has made the rights of an individual secondary to the rights of the state. An individual has been denied 'prior appropriation' rights as opposed to such a right for irrigation purpose under the National Code.

[13] http://www.ren21.net/Portals/97/documents/Other/International%20RE%20Policy%20Process.pdf – Renewable Energy in the International Policy Process

Electricity

Electricity is a critical infrastructure on which the socio-economic development of the country depends. A study on Water Resources of Nepal in the Context of Climate Change, 2011 done by WECS estimates that the identified 114 economically feasible projects have a total capacity of 45,610 MW. At present, the capacity of hydropower generation is below 700 MW (2012). Currently, the power system planning is being undertaken by the NEA which is based on the current annual demand mainly for domestic need. It does not take into account of energy needs of industries that come with an accelerated development. The NWP has earlier set a target of producing 700 MW by 2007. Similarly, the targets for 2017 and 2027, the final year of WR Strategy 2002 have been set at 2,035 MW and 4,000 MW, respectively. Recognizing that electricity is one of the key drivers for rapid economic growth and poverty alleviation, the study conducted by a task force has set a target of 10,000 MW of power in ten years (Chaitra 2065 or correspondingly March 2009). Similarly, another study of Chaitra 2066 correspondingly April 2010 has come up with a plan to develop 25,000 MW of hydropower in 20 years. The Energy Resource Strategy Formulation (ERSF) study done for the WECS (2009), however, shows that under the combined scenario of different policy measures, the peak installed capacity in 2030 will be over 11,480 MW.

Biomass

The Forest Act 2049 (1993 AD) is basically limited to demarcation of forests, classification of forests into protected, community leasehold, religious and private, organization of user's groups and penal provisions against breach of the regulations. The Act is limited to conservation rather than economic use. Forest fulfills people's basic need of fuel wood and a large percentage of national requirements are met by forests. Forest policies have emphasized the need to satisfy people's basic needs of fuel wood but the forest law is too traditional in its approach. It is silent in its task about developing biomass sources for fulfilling the energy needs of the people. Very little attention has gone towards forestation to meet the energy needs of the country.

Petroleum

Under the Nepal Petroleum Act 2040 (1983 AD), ownership of all petroleum found in the country lies with the government. The Petroleum Rules 2041 has developed detailed procedures for tendering, opening and evaluation of tenders, application for exploration and entering into an agreement with a party for exploration. It has also developed a model agreement for exploration, development and production of petroleum.

Alternative Energy

The Government Adopted in 2006 the Rural Energy Policy. The objective was to "improve the living conditions of the rural population by enhancing their access and affordability to rural energy solutions that are efficient, environment-friendly and that address social justice". Similarly, immediate objective is "regulatory and institutional arrangements are in place, technological solutions are available with quality assurance according to income strata, and credit facilities are available to promote investments". The policy, however, was a statement of government intentions without any concrete target and approach to achieve the policy initiatives. Furthermore, it did not have a backing of legislation and was weak.

Currently 12 percent of population has access to rural energy solutions. Generation capacity of micro-hydro projects has reached 23 MW against the estimated potential of more than 100 MW. Similarly, generation capacity of solar power has reached 14.5 MW against the potential of 2100 MW and 20 KW of wind energy against the potential of 3,000 MW (AEPC Brochure).

The development and promotion of renewable energy technology (RET) suffers from duplication of efforts and lack of coordination among the central level agencies of the government. The 2006 Policy does not cover urban sector. In the absence of legislation, implementation of the Policy has been weak.

CHAPTER 7
INSTITUTIONAL FRAMEWORK IN ENERGY SECTOR

7.1 Institutional Framework in Energy Sub-Sectors

7.1.1 Institutional Framework in Traditional (Biomass) Energy Sub-Sector

Ministry of Forest and Soil Conservation

The Ministry of Forest and Soil Conservation (MoFSC), among others, works for:

- Increase the production of forest-based products such as fuel wood, timber, grass, and industrial raw materials.
- Assist in the production of forest products and their proper utilization.
- Implement the in-service training program required for producing manpower necessary for scientific development of the forest resources.

Timber Corporation of Nepal

The Timber Corporation of Nepal (TCN), a government of Nepal undertaking, is managed by a five-member Board of Directors chaired by a joint secretary of MOFSC. It has mandate to meet the forest products demands of the urban population and it sells sawn wood and fuel wood as appropriate. It acquires round wood from the Department of Forests and produces sawn timber. District Forest Office (DFO) allocates forest products to the district level Forest Products Supply Committee (DFPSC) to satisfy district demands first. Of the remaining stock, each DFO sells 50 percent and provides the remaining 50 percent to the TCN for sale in the open market. In urban centers, the fuel wood marketing is done by the depots of TCN, private depots and dealers. There is significant involvement of private sector in fuel wood business. Department of Forests issues permit to TCN for fuel wood transport. TCN and private sectors are responsible for the transport of fuelwood to urban centers. The area of operation includes 33 Terai, Hills and inner Madhesh districts.

Forests Products Development Board

The Forests Products Development Board, a departmental unit under the MOFSC, is responsible for developing forests products (reforestation management and harvesting of forest resources) to meet the forest products demands. It sells roundwood, fuelwood and poles harvested from plantations. MOFSC and its specialized organizational units have a monopoly over forest products (fuel wood) generation and supply. The works being performed by them are much concentrated on the supply side of the forest resources management.

Ministry of Agricultural Development

Although animal dung and agricultural residues play important role as sources of accessible energy, Ministry of Agricultural Development (MoAD) and its agriculture and livestock departments have not used these energy sources in modernizing country's subsistence farming system and making modern biomass energy accessible to the majority of people who traditionally use fuel wood, animal dung, and agricultural residues. Most of the agricultural residues are reportedly used in very crude form and burnt in ineffective stoves.

There is both challenge and opportunity to promote agricultural residues as modern efficient biomass products. This will require adequate and appropriate institutional mechanism for adoption of right technology; research and development, and raising awareness of efficient modern use of agricultural residues.

7.1.2 Institutional Framework in Commercial Energy Sub-Sector

7.1.2.1 Institutional Framework in Hydro sub-sector

National Water Resources Development Council

The National Water Resources Development Council (NWRDC), chaired by the Prime Minister, is high level water resources policy institution formed in 1993. The Council includes representatives from political parties and people from outside the Government. The Council is mandated to:

- Contribute to creating a congenial environment for national consensus on the development and utilization to suit the development needs of the country.
- Decide on national water resources policy with a view to maximizing the benefits of national interest.
- Determine policy foundations necessary for speedy and sustainable development of water resources.
- Identify the basis for coordination between various sectors and agencies.
- Issue directives to the government for enhancing national and international understanding on water resources development.

Ministry of Energy

The Ministry of Energy was created from splitting up of erstwhile Ministry of Water Resources. It is responsible for the development of policies, plan and implementation for conservation, regulation and utilization of energy; conduct survey, research and feasibility study of energy and its utilization; construction, operation and maintenance and promotion of multipurpose electricity project; development of human resources; promotion of private sector in the development of electric power; and negotiation and making conclusion on bilateral and multilateral agreements on energy and electricity.

Department of Electricity Development

The Department of Electricity Development (DoED), the erstwhile Electricity Development Center, is a policy implementation body of Ministry of Energy. The Department is responsible for assisting the Ministry in implementation of overall government policies related to power/electricity sector. The major functions are to ensure transparency of regulatory framework; accommodate, promote and facilitate private sector's participation in power sector by providing "one window" service and license to power projects.

Nepal Electricity Authority

Nepal Electricity Authority (NEA) established under the Nepal Electricity Authority Act, 1984 is primarily responsible for planning, construction, and operations for electric supply. Its major function comprises electricity generation, transmission and distribution. Several Independent Power Producers, who generate electricity and under the Power Purchase Agreement with NEA, sell the bulk power to NEA. The government executes rural electrification program through NEA. It has started to promote public participation in the distribution arrangement for bringing effectiveness by reducing theft and conducting maintenance and distribution system on community basis. The NEA has monopoly over electricity transmission and distribution from the national grid. The NEA is facing the serious problems of inadequate power supply, low capacity of transmission, and leakage in distribution of power supplied.

7.1.2.2 Institutional Framework in Fossil Fuels

Ministry of Commerce and Supplies

The main government institution responsible for managing fossil fuel is the Ministry of Commerce and Supplies (MoCS). Its major functions are policy formulation; planning and implementation; conduction of study, treaty, agreement, bilateral and multilateral intergovernmental trade negotiation and evaluation activities related to trade; co-operation and co-ordination with agencies related to national, regional, international trade and transit; study,

research, survey, analysis and training on supplies of essential commodities. The ministry approves the pricing policy for petroleum products.

Nepal Coal Limited and Private Sector Coal Importers

Nepal Coal Limited (NCL) established as a public corporation was the only agency engaged in necessary coal supplies through agreement with the Coal India Limited (CIL) till 1992. In 1993, twelve private enterprises were emerged to share hands in coal import businesses that provide the individual private enterprises the right to make own agreement and fix price with Coal India Limited. NCL is not existent today by decision of the government to dissolve it. Currently the private sector is engaged in import and distribution of coal throughout the country.

Nepal Oil Corporation

Nepal Oil Corporation (NOC), established as a state owned trading enterprise by the Government in 1970 operates under the MOCS. The Corporation has a monopoly in import and distribution of petroleum products in the Country. Private dealers and gas companies are involved in distribution of petroleum products in the country in agreement with the NOC in the different parts of the country.

Nepal Oil Corporation (NOC) has storage depots in all the five development regions through which the petroleum products are supplied regularly throughout the nation. However, LPG is distributed by several private enterprises from various stations spread over the country.

Salt Trading Corporation

The Salt Trading Corporation entered an agreement with the Nepal Coal Limited in 2000 since the Salt Trading Corporation facilitates the import of Coal from India to Nepal by Nepali industries.

Ministry of Industry

The major functions of Ministry of Industry (MoI) are formulation of rules relating to mines and mineral exploration; conduction of study, training, exploration and survey related to mines and mineral development; and liaison activities for international and regional industrial institutions.

Department of Mines and Geology

The Department of Mines and Geology (DMG) of MoI administers mining rules and regulations. It carries out petroleum exploration activities and coordinates with petroleum companies that are working in Nepal. It has issued licenses for exploration of coal mines. But so far coal does not appear to be a priority energy source in the country. Private individual industries coordinate with the Salt Trading Corporation for the import of coal.

7.1.3 Institutional Framework in Renewable Energy Sub-Sector

Ministry of Science, Technology and Environment

The Ministry of Science, Technology and Environment, (MOSTE) is responsible for the development of available traditional technology and transfer of appropriate technology for overall development of the country. Its major responsibilities include formulation and implementation of policies, plans and programs pertaining to environment. It promotes sustainable environmental activities and renewable energy development projects in the country, and regulates the environment consideration to be abided by the development projects/ programs coming under the criteria set forth by Environmental Protection Act/Environment Protection Rules (EPA/EPR). MOSTE also acts as the Designated National Authority (DNA) for any Clean Development Mechanism (CDM) activities in Nepal.

Its policy functions relate to pollution control, environmental conservation and balance; exploration and analysis of the achievements made in the field of technology; promotion of alternative energy; liaison and coordination with universities with regard to science and technology.

Government Institutions

National Planning Commission (NPC) is responsible for formulation and monitoring of development plans and policies of the country. NPC also facilitates the implementation of development policies and programs and provides a platform for exchange of ideas, discussion and consultation pertaining to economic development of the country.

Currently there is an existence of separate Ministry of Energy and Department of Energy Development (DoED) in Nepal. However, most of the functions related to renewable energy are undertaken by Alternative Energy Promotion Center (AEPC).

Alternative Energy Promotion Center (AEPC)[14]: AEPC is a semi-autonomous government body established in 1996 and currently operating under the Ministry of Science, Technology and Environment (MoSTE). The major functions of AEPC are to:

- Disseminate and promote renewable energy technology (RET);
- Conduct studies and research on Rural Energy;
- Perform subsidy mobilization;
- Provide technical assistance;
- Select private companies and institutions for implementing RET;
- Co-ordinate with donor agencies;

Private Sector

Private sectors within RET sector are mostly involved in supply of goods and services. The quality control of these private institutions involved is ensured by AEPC the process of pre-qualification and requirement to stick with the technical standards and obligations. AEPC has prequalified[15] a total of 57 installation/construction companies for micro/pico hydro power projects and improved water mills (IWM); 52 consulting companies for survey and design of micro hydro projects; 81 biogas companies; 37 solar companies and another 5 companies for quality control; 32 companies for the manufacture of improved cooking stoves; and 13 companies/institutions in the field of wind technology. (GoN, 2011)

Financial Institutions

Among different types of financial institutions involved in mini and micro energy financing, commercial banks, development banks and finance companies are licensed by Nepal Rastra Bank. Following the relaxation of licensing requirements of micro finance institutions (MFIs) and financial NGOs, some MFIs are licensed by NRB and others, especially co-operatives, are regulated under the Cooperative Act.

Donor Agencies

The major investment on RET sector in Nepal is being made by the international agencies like the World Bank, Government of Denmark (through DANIDA), Government of Norway (through NORAD), Government of Germany (through KfW), Netherlands Development Organization (SNV), United Nations Development Program (UNDP), Asian Development Bank (ADB), European Union (EU) etc.

Industry Association

Some of the industry associations involved in supporting mini and micro energy sectors include Nepal Micro Hydro Development Association, Solar Electrical Manufacturers' Association of Nepal, Nepal Biogas Promotion Association, and Rural Technology Promoters Associations Nepal (RuTPAN).

[14]Scaling-up Renewable Energy Program: Investment Plan for Nepal (Draft), Government of Nepal, September 2011

[15] Renewable Energy Data Book 2009, AEPC updated with current statistics from AEPC

R&D and Human Resource Development Center/Institutions

Various government and non-government institutions are involved in applied research and development and human resources development in the RET sector. These institutions include Nepal Academy of Science and Technology (NAST), Nepal Agricultural Research Center (NARC), RECAST, Center for Energy Studies/Institute of Engineering (CES/IOE), CTEVT etc.

Renewable Energy Testing Station (RETS) under NAST has started to certify the various SHS components for quality assurance. Similarly, IOE has established testing center for Improved Water Mill Turbines in collaboration with Center for Rural Technology (CRT/Nepal). Kathmandu University has also established micro hydro turbine testing laboratory. An independent body like Nepal Bureau of Standard and meteorology, can play a vital role in quality control of the RET components/devices/systems. (CMS, 2009)

The Three Years Interim Plan 2007 - 2009 mentions about the need for capacity development of Alternative Energy Testing Center to undertake testing of alternative energy equipments and technology as per national quality standard for quality assurance.

CHAPTER 8
MAJOR GAPS BETWEEN POTENTIALS OR DEMANDS AND SUPPLY

8.1 Major Gaps in Energy Demand and Supply

An extensive and detailed analysis was made using the least cost computer based Market Analysis (MARKAL) software to analyze the energy system for forecasting the three likely scenarios in short- medium- and long- term using the GDP growth of 4.4% in fiscal year 2010/2011, as business as usual, for projecting the likely scenario after every ten years until year 2050. The second GDP growth rate considered in the MARKAL analysis was 5.6% per annum. This seemed slightly higher than the reference year GDP growth rate, but has been considered not unachievable in coming years. The third GDP growth rate used during this analysis was still higher, a 6.5% growth per annum until 2050.

8.1.1 Traditional energy

The periodic growth in traditional energy consumption by different sources (carriers) at GDP growth rate of 5.5% and with combined policy interventions have been provided in Table 8-1.

Table 8-1: Traditional Energy Consumption by Different Sources (carriers) in Short, Medium and Long Term (at 5.5% GDP growth rate and in TJ measurement unit)

Fuel	Year		
	Short-term 2011-2020	Medium-term 2021-2030	Long-term 2031-2050
Fuelwood	216,944	131,588	155,836
Agriculture residues	16,699	25,565	75,288
Animal dung	15,091	6,501	7,382
Total	248,734	163,654	238,506
Share	73% (in 2020)	50% (in 2030)	34% (in 2050)

Source: derived from MARKAL analysis of 2013

The data generated from MARKAL analysis of 2013 reviled the declining share of traditional fuels in short-, medium- and long-term form the base year share of over 85% in 2010/2011. Its declined share with combined policy interventions in all sectors of the national economy is expected to decrease to 73%, 50% and 34% in 2020, 2030 and 2050 respectively. The complete scenario of projected energy consumption by different sources (carriers) with combined policy interventions in all sectors of the national economy have been shown in Table 8-2.

Table 8-2: Project Amount of Different Energy Sources (carriers in total consumption in short, medium and long term (in TJ)

Energy source (carrier)	Short term 2011-2020	Medium term 2021-2030	Long term 2031-2050
Petroleum products	48,203	63,423	152,582
Coal	15,480	22,699	88,892
Grid electricity	29,001	79,528	227,098
Off grid/isolated	167	215	892
Renewable	870	-	-
Solid Biomass	248,734	163,655	238,506
Total	342,454	329,520	707,972

Source: MARKAL analysis 2013

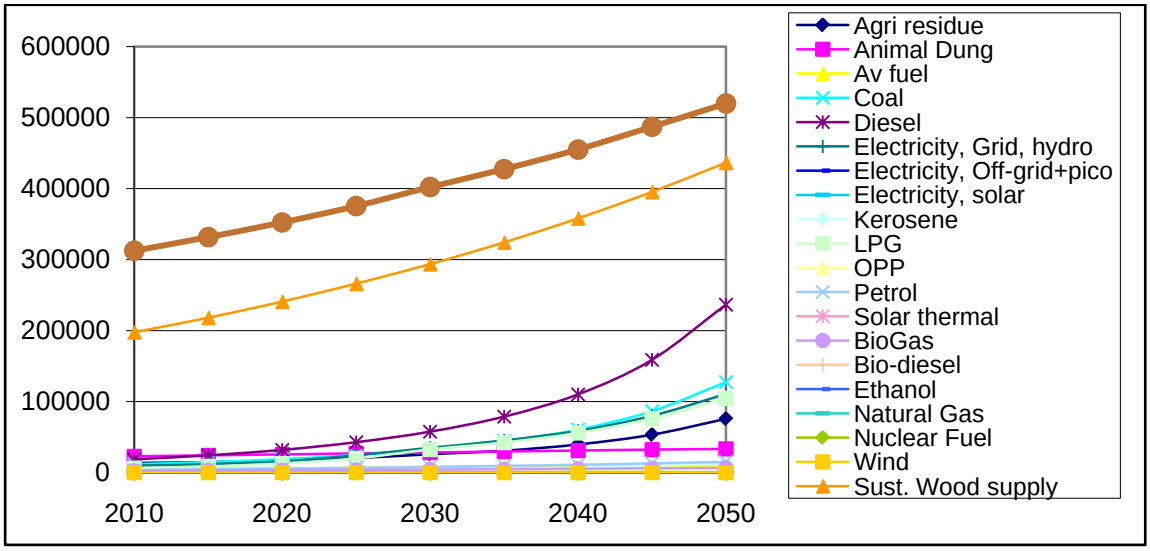
The findings from MARKAL analysis of 2013 revealed that the consumption of solid biomass fuels would decrease from about 85% in the base year of 2010-11 to 73% in 2020, 50% in 2030 and 34% in 2050, Table 8-3.

Table 8-3: Projected Share of Different Energy Sources (carriers) in Total Consumption in 2020, 2030 and 2050

Energy Source (carrier)	Year			
	2010-11	2019-20	2021-30	2049-50
Petro products	9%	14%	19%	22%
Coal	3%	5%	7%	13%
Grid electricity	2%	8%	24%	32%
Off grid/isolated	0.01%	0.05%	0.07%	0.13%
Renewable	0.68%	0.25%	0.15%	0.12%
Solid Biomass	85%	73%	50%	34%
Total	100%	100%	100%	100%

Source: derived from MARKAL generated data of 2013

The emerging trends in traditional energy consumption showed a declining share but increasing amount of fuelwood consumption even up to 2050. Similar trend was observed with the consumption amount of agricultural residues. In the case of solidified animal dung however, both share as well as amount consumed declined in the medium-term. And its consumption amount started to rise slightly again during the long-term. The projected trends in consumption of different energy sources during 2010-2050 have been shown at ten years interval in Figure 8-1.



Source: MARKAL analysis of 2013

Figure 8-1: Projected Amount of Energy Components by Different Sources by 2050

It has been noticed from the energy systems analysis that the demand for wood products would be growing far higher than the sustainable production level of all types of reachable National forests during both short- and medium-term. And the ever growing demand for wood for its diverse uses is expected to create more pressure in the so called government managed National forests. In the medium- and long-term, although the amount of fuelwood consumed for energy would decrease below its consumption level in 2010/11, but the total demand of wood for construction purposes and industrial uses is expected to increase by many folds in the country by 2050.

A massive expansion of the use of ICS in the residential sector is expected to contribute to substantial reduction of annual fuelwood consumption already from the medium-term, after 2020, as the energy efficiency of ICS is expected to be about 15% higher than the traditional stoves.

It has been reported by AEPC that so far about 600,000(6, 21,826 to be specific, as of 30 June 2012)[16] ICS have already been installed in different districts of the country. Its annual report of 2010/11 showed the total number of

[16]As per AEPC press release on16 July 2012, Hotel Himalaya, Kupondol, Lalitpur.

ICS installed was about 89,200 against the target of 100,000 of that year. The number of ICS installed in the Terai that year was about 8,000, in the high hills about 3,000 and the rest in different mid-hill districts.

However, sufficient resources, both financial and human, would be necessary for in country research and development as well as for the import of proven, efficient devices as proto types for local level demonstration, fabrication and dissemination for improving energy efficiency of fuelwood based energy generating devices for use in different sectors for their diverse uses. It is envisaged that the needed financial resources for such type of activities would be incorporated within the action plan of the energy sector.

8.1.2 Commercial energy

8.1.2.1 Conventional Hydro Energy Resources

It is already evident that Nepal has already facing threat of energy security in time being. Nepal has been facing increasing constraints in importing oil to meet the needs due to soaring global oil prices. Nepal is totally dependent for imports of petroleum products for its energy requirement. Figure 8-2 shows that Nepal is dangerously becoming dependent on oil imports to meet its energy requirements. The expenditure on import of petroleum has increased from 27% of the export earnings in 2000/2001 to approximately 126 % (petroleum imports account for NR 94 billion: US$ 1.12 billion) in 2011/2012 which shows that total commodity exports from Nepal are not even sufficient to meet the rising demand of petroleum products (MOF, 2012). It shows rising imports of petroleum products are creating negative impacts on the Balance of Payment (BOP) indicators of the country. In the rural areas biomass continues to be the main source of energy while in the urban areas it is essentially kerosene and LPG meeting the energy needs. With the price of kerosene made equal to that of diesel use of LPG has increased tremendously among the urban dwellers.

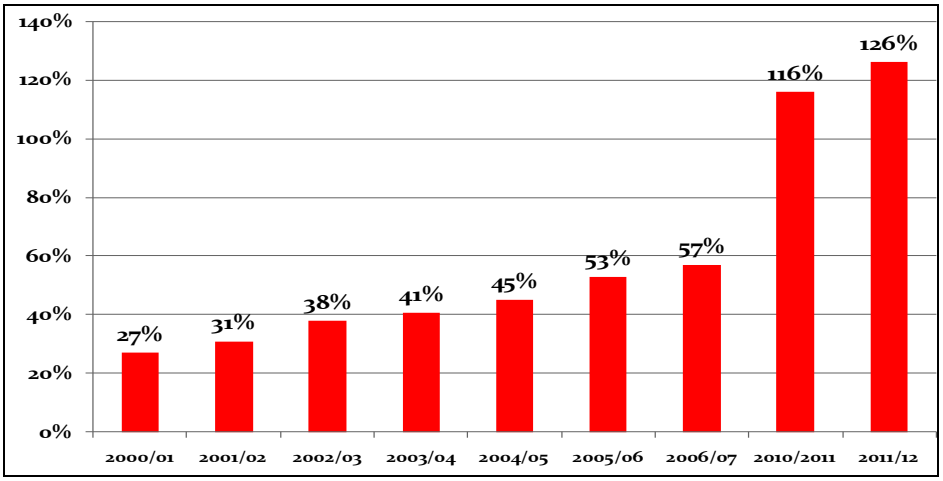


Figure 8-2: Import of Petroleum Products against Commodity Exports in 2012(Source: MOF, 2012; NOC, 2011)

In terms of indigenous energy resource, Nepal's installed electricity generating capacity in 2011 was 719 MW (NEA, 2012), of which around 92 percent was of hydropower generation which is mostly run of the river types and the rest was of thermal generation. The electricity demand reaches its peak in the dry season while the generating capability of run-of-river plant is at the minimum level during this period. Task force report production capacity of 641 MW in wet season would reduce to 321MW in dry season for year 2011 , which accounts for about about 50% power generation loss in that year as well as subsequent years (MoWR, 2009). On the contrary, the generation capacity is highest in summer when demand is low. Figure 8-3 indicates the peak demand of power against the installed capacity of power plants till 2010.

The peak load in January 2012 was 1,026 MW while the supply was only 40 percent. This gap leads to a situation of power outage in managing the distribution- almost 14 hours a day in the dry season and 6 hours a day in the wet season. This has led to a tremendous anomaly in the electricity generation by the domestic as well as commercial and industrial entities. As shown in table 8-3, almost 17% of primary petroleum products are not accounted for in the

final energy petroleum products consumption and are used for generating electricity by captive generating sets of which the installed capacity is expected to be around 600 MW. The capacity utilization is below 20 percent of these installed captive gensets and they are obviously used during the load-shedding periods.

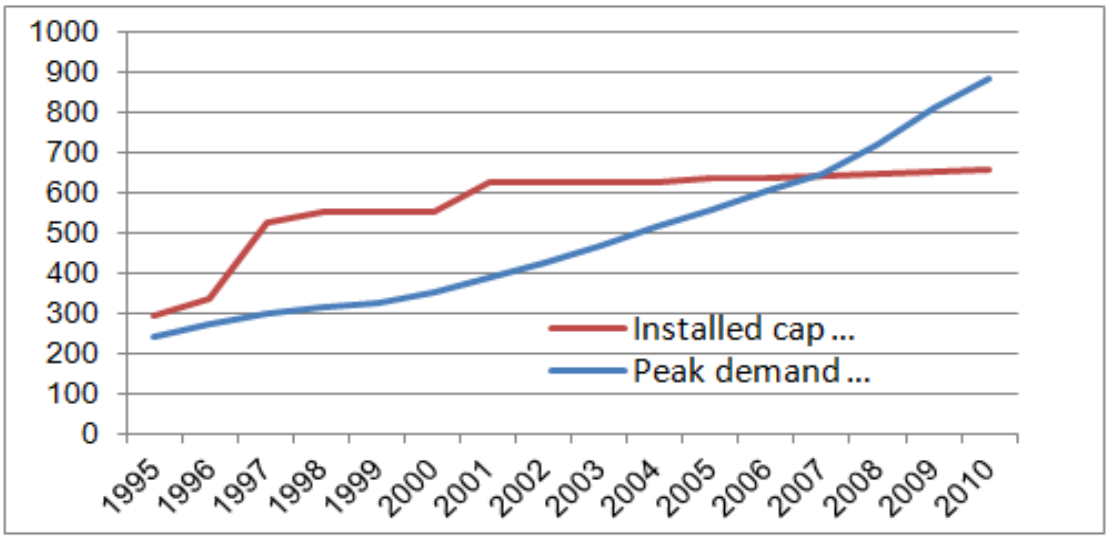


Figure 8-3: Differences between Peak Demand and Installed Capacity of Power Plants (MW) (NEA, 2012)

8.1.3 Renewable Energy

Gap between potential and supply in different sub-sectors of renewable energy sector is summarized in the Table 8-4.

Table 8-4: Potential of Renewable Energy

RE Sub-sector	Estimated Potential	Supply (Installation)
Solar Energy	62.5 x 10^3MWp	14.58MWp
Solar power for grid connection	2,100 MW	
Wind Energy	3,000 MW	600 watt
Micro-Hydro	78.5 MW	16.03 MW
Biogas	1.3 – 2.9 million plants	261,573

In context of Nepal, the potential renewable energy technologies which can generate power by exploiting the locally available energy resources are pico-hydro and micro-hydro power, biomass related biogas, briquettes, gasifier, liquid bio-fuel, improved cooking stove, solar photovoltaic (PV), solar thermal and wind powered plants. Of these technologies, micro-hydro, biogas, improved cooking stove, solar PV home systems and solar water heaters are popular and are at various stages of commercialization. On the other hand technologies such as solar cooker, solar dryer, briquettes, wind and geothermal are only in demonstration stage.

Solar

If the average daily insulation is 4.7 kWh/m2 and the gross available area for potential PV uses would be 75,477 sq.km[17], considering only 1% of this area available for PV, the available areas would be 754 x106 sq.m. Accordingly the potentiality of solar PV would be 62.5 x 103 MWp. As per the report published by AEPC in 2008 under Solar & Wind Energy Resource Assessment (SWERA) project, the commercial potential of solar power for grid connection is 2,100 MW.

[17]The total surface area of Nepal is 147,181 sq.km. Out of this 4000 sq.km is water area. Around 25% is covered with forest and arable land share is around 21%. The available area (147181-4000-147181*25%-147181*21%) for potential PV uses would be 75,477 sq.km. Now considering only 1% of this surface area appropriate for PV, the available area would be 754 *10^6sq.m). Using PV module having 12% conversion efficiency and average sunshine hours of 6.8/day, the potentiality of solar PV would be 62.5 x 10^3MWp

Total number of solar PV systems disseminated so far along with the total installed capacity is presented in Chapter 5. Installed capacity of solar home systems (SHS) and small solar home systems is 11 MW and installed capacity of ISPS and PVPS is 2.9 MW. The total installed capacity is about 14.5 MW.

There is a huge potential for solar thermal devices such as Solar Water Heaters (SWH), Solar Dryers (SD), Solar Cookers (SC) as well. Presently SWH have been fully commercialized and till 2009 more than 185,000 SWH have been installed in the country. Similarly some 1400 solar cookers and dryers have been installed in different parts of the country.

Wind Energy

The study carried out by Dangrid in 1992 shows that 200 MW of wind power can be produced in the 12-km corridor from Kagbeni to Chusang alone. It is estimated that 500 GWh electricity can be generated annually from wind. As per the report prepared by AEPC in 2008 under Solar & Wind Energy Resource Assessment (SWERA) project, the commercial potential of wind power is 3,000 MW in Nepal.

Not much work has been done in wind energy generation. A pilot project for demonstrations and dissemination is being carried out by various organizations like AEPC, Practical action – before known as Intermediate Technology Development Group (ITDG). ITDG has installed five 200-watt wind turbines at various locations like Kavre, Tansen-Palpa, Makawanpur, Chisapani (Karnali), and Udayapur for the stand-alone system whereas AEPC has installed one 400-watt wind turbine at Nagarkot and an 11 kW solar wind hybrid project in Nawalparasi for demonstration purposes.

Micro –Hydro Resources

Micro-hydro technology has been disseminated and power has been generated so far in about 60 hilly and mountainous districts of Nepal. As the study carried out by AEPC, the total estimated economic potential (demand based) is 78.5 MW[18]. The study also identified that 24,062 kW are pipeline projects as of July 2012. The installed capacity of the existing micro hydro projects is about 31 MW including 15.2 MW mechanical powers. In addition to these, some 1000 projects of cumulative installed capacity of 24,062 kW are in different stages of project cycle. As of July 2012, total of 16.03 MW electricity has been generated benefiting 164463 households since 1996.

Biogas

Based upon the estimate that 1 kg cattle dung can produce 0.036 m3 of biogas per day, if 80 percent of the total dung is available for biogas production, the daily gas volume would be 3.5 million m3 which indicate a potential of 2.6 million biogas plants in Nepal (biogas plant capacity 4m3 and gas volume is 1.333 m3). This does not include the poultry droppings and pigs, goats and human excreta. If all these are added in the potential calculation then the biogas production potential will be greatly enhanced in the country. Different studies have tried to assess the biogas potential in Nepal. In 1992, Wim J. van Neses (in BSP-Nepal, 2005) calculated the potential of establishing 1.3 million plants. CMS and SNV/BSP (in BSP-Nepal, 2005) assume a technical potential ranging between 1.3-2.9 million plants. Due to the concerted efforts of various stakeholders, a total of 261573 biogas plants have been installed in the country till July 2012 covering all 75 districts.

Renewable energy technologies other than the above have not yet been commercially developed in Nepal. The analysis of reasons for the gap between demand or potential and the supply leads to various issues in the renewable energy sector which will be discussed in detail in Chapter 9.

[18]Mapping of the Micro Hydropower and Preparation of District Electrification Master Plan, 2010/11, AEPC, Nepal. As per the preliminary findings of the study, conducted in May 2011 in 54 districts, is 78,521 kW, out of which 18,556 kW is already installed.

CHAPTER 9
MAJOR ISSUES IN ENERGY SECTORS

9.1 Major Issues in Energy Sector

Major issues relating to policy and legislative aspect in the energy sector that were identified during the concept dissemination workshop held in Kathmandu, regional workshops and consultation with other stakeholders are presented in the paragraphs below.

9.1.1 Policy

Lack of a Coordinated Approach for Development and Management of Energy Sector

Although there are at least five ministries that are directly related with development and management of energy and related services, meanwhile some sub-sectors such as in hydropower and rural energy sub-sectors have policies for development and management of energy services, others lack specific policy provisions for development and management of energy although they have policies developed in their respective sub-sectors. For example, forestry sub-sector has a policy for management and conservation of forests, but it lacks specific provisions for supply and management of bio-energy. Similarly, the agricultural policy is silent on its role as one of the important supplier of energy from agricultural and animal residues. Likewise, the Ministry of Commerce and Supplies and the Nepal Oil Corporation do not have long or short term plan for development of indigenous sources to replace part of the import of fossil fuels. These ministries and central level agencies are limited within their own sphere of departmental responsibilities without any linkage with other agencies involved in the energy sector.

Absence of an organization for planning and coordination in the centre

There is absence of a central organization that deals with the planning and coordination of the energy sector. Currently, there is absence of a coordination mechanism between the ministries directly related with the development and management of energy. The inputs from the participants in the workshops have highlighted the problem of a coordinated management of energy services. Such a coordinated approach and emphasis on developing indigenous sources of energy would have substituted, in whatever small percentage, of the imports of fossil fuels. The import of oil in the country has reached an unsustainable level. Currently, the country spends more on import of single item oil annually than Nepal's total earnings from export. Inadequate and sometimes conflicting policy provisions in relation to for example subsidy on biogas installation.

Conflict between Competing Sub-Sector Uses

In all five regional workshops the issue of water source rights and conflicts between sub-sector uses such as between hydropower generation and drinking water or irrigation were highlighted with priority.

Lack of institutionalization of the District Water Resources Committee

The issue is related also with lack of institutionalization of the District Water Resources Committee (DWRC) even after two decades of its formation. The important role of DWRC is not correspondingly matched by a provision of necessary facilities of office space, equipments, human and financial resources to fulfill the mandate of a licensing agency and registration of water uses in the district, a vital step in the allocation and re-allocation of the resource for optimum use.

Low Priority in Operation and Efficient Management of Hydropower Stations

The operation of hydropower stations of the NEA is not satisfactory. In terms of efficiency there is much to be desired. All stations are running way below their installed capacity. There may be some room for improvement in operation and raise the capacity. Timely and periodic maintenance can raise their efficiency and generate some more electricity to address the problem of load shedding. A megawatt of power thus generated is equal to producing

equivalent power under a new project. Water administration is accused of being project-oriented. There is not enough priority given to maintenance and operation.

Policy Making Lacks Effective Participation of Stakeholders

Generally participation of the public and stakeholders in policy making is process-oriented. Stakeholder's opinion is taken just to complete the process of participatory policy making. Participants are made witnesses to policy making without an effective role for them.

Lack of a Meaningful Dialogue with India on Energy Trade

Nepal is facing problem of power shortage for some years now. Import of power from India is not working as planned. The reason may be deep and needs to be explored.

Monopoly of NOC in the Import of Petroleum Products

NOC enjoys monopoly in the import of petroleum products. It has also given rise to inefficiency in operation as there are no other trading entities for competition. Consumers are made to pay for the inefficiency of NOC. Trading in petroleum products are not run on commercial principles. Inability of the government to run NOC on commercial principles is partly due to continuing political environment of the country. It has continued for long and there is no reason to be assured of its efficient operation. Regulation of operation of NOC is weak.

Problem of Implementation of Power Projects

It is strange that amidst of a severe power shortage, implementation of ongoing projects have not been smooth. They are delayed for various reasons including demands from local people not connected with the implementation of the project. Delay is accompanied by rising costs. Obstruction is also caused for political reasons.

9.1.2 Legislative Framework

Revision or Consolidation of Electricity Act

The Electricity Act has not been amended to incorporate reform measures and initiatives planned under the 2001 Hydropower Development Policy. Only some changes in the license fees have been introduced using the power of revision of schedules under the Electricity Regulations. A comprehensive new legislation or a consolidated legislation is yet to see the light of the day. Similarly, the proposed legislation on Electricity Regulatory Commission is also pending.

Absence of a Strong Legislative and Regulatory Framework in RE Sector

Absence of a separate law and institution for regulation of the renewable energy sector has affected the smooth operation of the renewable energy sub-sector. Currently the sub-sector activities have been conducted under a policy and few administrative mechanisms on delivery of subsidy.

9.1.3 Traditional (Biomass) Energy

The major issues of traditional energy identified by majority of stakeholders have been grouped under specific categories as shown below:

Technical Issues

The important technical issues in the traditional energy sub-sector include:

Wider Recognition of Present Contribution but Low Development Priority

The overwhelming contribution of solid biomass fuels in total primary energy supply has been widely recognized from its current dominating share in the energy statistics of the country. This is partly because, the annual Economic Survey of MOF and other energy sector related reports categorically points out to the current over two-third share of

TE sources in total primary energy supply. However, from the point of view of resource allocation for sustainable TE utilization, the Red Book of MOF shows a non-proportional financial allocation. Except the ICS dissemination program of AEPC and other multiple objective forestry development activities of MoFSC, there has not been other specific targeted activities or financial allocations for development in the TE subsector.

Low Awareness of Modern Applications

Present TE applications are primitive, inefficient and unsustainable. Its use in traditional forms is therefore, expected to phase out over time with improvement in the national economy. In order to promote the long term use of available/surplus indigenous biomass sources for clean and modern energy, the country must be aware of the technological innovations needed in the TE and the emerging modern bioenergy sub-sector.

Shrinking/Depleting Resources and Growing Consumption of TE sources

Existing reachable forests in the country have been declining as well as depleting year by year. Besides, none of the managed forests of today have aligned their development objectives primarily to fuelwood production.

Unsustainable TE Supply System

The country has not currently pursed any dedicated plantation of energy crops, either annual or perennial crops, grasses or trees solely for the purpose of sustainable biomass supply for energy, neither in the agriculture nor in the forestry sector.

Inadequate/Limited Knowledge of TE Supply System and Complementary Resources

Currently most of the biomass fuels (i.e. fuel-wood, dung and agricultural residues) are derived as residues and byproducts of trees, crops and animals, either at production site during harvesting or at processing sites as residues and by-products of agriculture, livestock and forest-based management/production systems. And this knowledge is generally lacking.

Lack of Data and Reliable Information

Information regarding current level of biomass residue and by-product production, uses and the surplus amount by types, from the forestry, livestock, agriculture, industry and municipal sectors is not yet available for assessing the modern bio-energy generation potentials of these sources in the country.

Competing Land Use and Growing Challenge of Food Security

Unregulated/unplanned development of energy crops/trees on productive agriculture and forest lands may lead to food insecurity, loss of biodiversity and accelerated soil and water erosion in fragile landscapes, including localized deforestation in important watershed areas.

Non-Proportional Distribution of Existing Forest Resource

The distribution of existing TE resources, particularly forest, is neither uniform in all physiographical regions, nor proportional to the present distribution of population in different parts of the country, which caused further difficulty in managing the supply of TE sources for different end uses in different districts/regions of the country.

Inadequate Forest Management and Unsustainable Fuelwood Harvest

Ever increasing pressure on remaining forests for collection of fuelwood and other forest products has already been a threat to forest protection and biodiversity conservation. Not all potential TE resources have been adequately identified or put under effective management. In most cases present fuelwood harvest exceeded the sustainable production potential of existing forests in the neighborhood due to lack of management and/or over exploitation.

No Effort on Commercial-Scale Tree Plantation for Energy

There is a lack of effort on establishment of dedicated fuelwood plantations in fuelwood deficit areas, as well as allocation of part of existing forests solely for the purpose of TE production sources under scientific management systems.

Slow Pace of Technological Innovation

Currently, ICS dissemination has been limited in number and confined only to specific sites. Not all potential users seemed aware of the types of ICS being promoted and their intended benefits.

Lack/Limited Awareness of Efficient Modern Bioenergy Technology

The present knowledge about biomass based energy applications remained limited only to traditional energy use in the domestic, commercial and industrial sectors. The knowledge about proven and commercially available improved (modern, clean) technology still remained low.

High Cost of Imported Efficient Bioenergy Technology

Currently, the technology for improved TE application available in commercial markets remained out of reach for a majority of TE users in the domestic and commercial sectors, because of its high cost and/or due to low economic status of the current TE users.

Current effort on the use of non-wood biomass for modern energy generation was confined only to dissemination of different sizes of biogas digesters.

Lack of Area Specific Information and Inadequate Consideration of Local Level TE Supply Problems

Current efforts on energy development prioritize rural electrification for lighting and access to energy supply for initiating energy based economic development entrepreneurships. These efforts would not be sufficient to relieve the energy supply problems of the rural population, nor for reducing drudgery and hardship of fuel-wood collection and use of women and children.

Policy Issues

As part of the energy vision 2050 formulation process, several stakeholder consultation workshops were organized both at the center and at regional levels. While the workshop organized in the center focused its attention on national level issues including the problem of a gap between demand and supply of energy in the country, the regional workshops have highlighted a number of local and implementation level issues.

Lack of Clear Policy on the Use of Biomass

There is a clear lack in policy and law concerning sustainable use of TE sources. Existing Forest Rules do not focus exclusively on fuelwood production. Besides, the other biomass materials of inferior fuel type have not been properly addressed with appropriate policy for their sustainable use as well.

Community Forest User Group Membership and Revenue Allocation

Currently, there is lack of access to the people on CF if they were not members of the handed-over CF. Besides, no CF had exclusive access only to women, poor or the *Dalits,* often the access was restricted to them in many handed-over CFs.

Currently, there has been no mandatory provision for FUGs to allocate certain percent of their annual revenue accrued from CF harvest for technological innovation in priority areas within the forestry sector.

Inconsistency between Policy and Law

Implementation of private and leasehold forestry policy is still at a rudimentary stage. Many policies suffer from lack of implementation because of absence of supportive instruments (including regulations). On the other hand, we suffer from weak implementation of the law.

Low Priority/Weak R&D

There is lack of priority on research and development. There is virtual absence of a policy that promotes research on technology for use of kitchen wastes as a source of energy (through development of appropriate biomass gasifiers).

Inadequate Dissemination of Efficient Technology

Not enough attention is diverted to efficiency in use. Conservation of forest is closely related with efficiency in use of forest resources.

Institutional Issues

Due to absence of a sole central agency responsible for coordination, integrated planning, and monitoring of relevant sector, sub-sector specific activities of energy development, the problem of energy security has remained a crucial problem in every part of the country.

Traditional Energy Production not a Main Objective of directly Related Sector

Public agencies and industries in forestry, agriculture and livestock sectors do not consider energy production as a priority task of management under their specific sector, nor consider for proper utilization of the biomass residues and by-products for energy purposes. There was a lack of a public agency which was responsible for managing different components of traditional energy sub-sector.

Lack of Operational Recognition to and Support for Planning, Monitoring and Facilitation at Local Level

Central level sub-sectoral institutions currently play a dominant role in energy planning. Development of bottom-up planning system needed immediate consideration. Lack of operational recognition of local bodies in energy planning, monitoring and facilitation of energy resources management affected the quality of the projects implementation so far.

Lack of Level Playing Field for the Private Sector in Fuel-wood Production

Monopoly in generation of fuelwood by public utility (such as Timber Corporation Nepal, Forest Products Development Board, etc.) has hindered competitive utilization and conservation of this resource. There is lack of enabling policy and regulatory mechanism for providing a leveled playing field to promote private sector in forestry development.

Lack of Specific Mechanism for Representation of the Weaker Socio-Economic Groups in Energy Planning

Traditional users of local forests have not been classified under specific socio-economic strata such as people currently falling below the poverty line, gender, occupational groups, suppressed or marginalized communities, *Dalits,* etc. There has not been any targeted programme for such marginalized communities under the present CF development programme, except in selected 27 hill districts where Leasehold Forestry and Forage Development project or Livelihoods Development project are in implementation to address the forestry products needs of such marginalized groups, particularly the poor women.

Weak or Lack of Initiative to Integrate Planning, Awareness Raising, Education and Training

Awareness of integrated energy planning and management has been still very low among majority of the present TE users. School level education does not offer curricular activity about importance and role of integrated and sustainable energy development and security in raising quality of life of the general people.

Increased Problem of Skilled Manpower Retention

Due to political instability, lack of incentives and job opportunities there has been low motivation of youth in recent years to join forestry and agricultural training programs. The increasing trend in youth migration from rural to urban areas has caused human resource problem in many areas. Out migration of professionals has also contributed to brain drains in recent years.

Environmental Issues

Unchecked forest encroachment for human settlement and infrastructure development, illegal logging and haphazard collection of fuelwood, fodder and other forest products; regular occurrence of fires, diseases and pests, all have contributed to forest area loss and/or forest depletion in many parts of the country, and as a consequence the environmental issues of following types have been increasing.

Air Pollution

Though biomass is carbon neutral in terms of Green House Gas (GHG), it emits carbon dioxide including other toxic gases such as carbon monoxide due to incomplete combustion in inefficient cooking device.

Soil and Water Erosion

Unsustainable harvesting and over exploitation of reachable natural forests have contributed to forest depletion, soil erosion at the local level. Smoke emission from inefficient TE combustion devices has caused air pollution with potential of global warming.

Loss of Wildlife Habitat and Biodiversity

Currently, most of the energy requirement in the country is met with TE sources, Over dependence on TE has caused loss of wildlife and biodiversity in heavily populated areas.

Social Issues

In the social front the following issues stood prominently.

Allocation of Forest Products

Currently, no proper recognition of the complementary role of the trees outside of forest (TOF) in meeting local TE needs at political and institutional levels. Besides, strict conversationalist approach of forestry management has created some local level confrontations with the historical users of local forest resources.

Low Awareness of Adverse Environmental Impacts (Health and Climate Change)

User groups of traditional energy resources are not aware of environmental degradation and impact on climate change due to excessive burning of fuelwood, animal dung and agricultural residues in traditional inefficient stoves and devices.

Limited Endeavor on Energy Security and Technological Innovation

There is a lack of energy security among rural people for all types of end-uses. Access to energy has been constrained due to their in-affordability, as well as lack of locally available alternatives. Current TE applications are both primitive and unfriendly to human health and environment.

Low Knowledge of Adverse Health Impacts

One of the major problems facing the rural areas is the lack of knowledge and awareness among people, especially the women folk on the risks and adverse health impacts associated with the use of traditional biomass fuels, primarily smoke emission related health impact. Due to depleting energy sources, the need to travel longer distance has been considered dangerous from different point of views.

Increased Workload of Fuel Collection

The necessity to go afar for collecting biomass energy due to scarcity of local resources has added further hardship to the women and children. More specifically, girls have been deprived of the opportunities to go to school. This consequently perpetuates the cycle of female illiteracy.

Lack of Knowledge on Efficient and Clean Use of Biomass Residues for Energy

Nepalese economy is predominantly an agrarian economy and agri-residue constitutes the third largest indigenous biomass source. But its energy use is also affecting the supply of animal fodder due to these competitive uses, and reduced cattle number due to fodder shortage might also affect animal dung production, essential raw material for both farmyard manure and gobar gas production.

Lack of Alternative Employment Opportunities

There is a large population of marginal poor who are entirely dependent on the illegal cutting down and trade of fuel wood to earn their livelihood. Unless alternative employment opportunities are provided, this activity cannot cease.

Lack of Incentive for Promotion and Utilization of TOF Products

The scarcity of traditional biomass energy can be compensated by encouraging the private forest developers. However, lack of policy on development of private forest as an industry is an impasse to the interested groups who want to develop private forest for trade.

Limited Knowledge of Commercially Valuable Tree Species

Due to lack of knowledge on different economically valuable tree species, these are used as fuelwood which could otherwise earn substantial revenue. This ignorance is causing economic loss not only to the users but to the nation as a whole.

Open Animal Grazing, Frequent Fires and Accelerated Forest Encroachment

Lack of awareness and ignorance on stall feeding of cattle is leading to the destruction of young plants and saplings resulting from the practice of open and rampant grazing on non-pasture lands.

Ever Growing Difficulty in Fuel Wood Procurement for Rituals and Cremations

The depleting firewood source is striking hard time on the availability and supply of fuel wood which is a pre-requisite for the rituals and ceremonial fires for the Hindu people representing the majority of the total population.

Economic and Financial Issues

The TE related issues of economic and financial nature have been identified and presented below.

Indiscriminate Use of Commercially Valuable Wood for Fuel

Fuel wood is commonly marketed only in urban areas but in rural areas it is used as free gift of nature for the daily household consumption. Due to such practice, there is not only the problem of deforestation but the valuable timber is also being used as fuel wood with a great loss to the nation.

Lack of Effort on Commercialization of Modern Technology

TE resources are not generally commercialized. Fuel wood is marketed in urban areas only; residue and dung are marketed to some extent in rural areas at negligible price in comparison to its energy content value. Economic price of fuel wood is not considered, and it is taken as free gift of nature.

Limited Scope of Local Level Income Generation

The dearth of biomass energy has brought a halt to a lot of home bound micro enterprises which economically empowers rural women. The inadequacy and ineffectiveness of social mobilization program has restricted the possibility of using some spare time for income generating activities in rural areas.

Prolonged Political Instability

The country has been passing through a long period of political instability which has affected development in all important sectors of the national economy.

9.1.4 Commercial Energy

The commercial encompasses Hydropower and other commercial energy – chiefly petroleum products. The hydropower sub-sector has been emphasized due to its immense potential and viability. The major issues of CE for , two sub-sectors of CE, have been grouped under specific categories as shown below:

9.1.4.1 Hydropower

Technical Issues

Emphasis on indigenous resources

Although the country has huge potential of hydropower energy resources, but harnessing of these resources is dismally poor. Hence, the country has to focus in developing the indigenous renewable energy resources such as hydropower, solar, wind and bio-energy resources rather than depending on imported petroleum products.

Energy transmission and distribution

The transmission infrastructure is of low capacity and is overloaded. It has become the main bottleneck in the development and transmission of reliable and quality electricity. The problem is aggravated by distribution losses. NEA and Infrastructure Leasing and Financial Services (IL & FS) of India have committed to start development of 220 KV transmission line from the fiscal year 2007/08.

Policy Issues

Appropriate policy to encourage the use of domestic resources for development of hydropower is missing. Two major causes for slow rate of progress in implementation planned hydropower projects are weak implementation of one-window policy and lack of consistency or continuity of taxation policy.

Inconsistent policy

The hydropower Policy 1992 and the related acts were very progressive, development targeted and provided excellent incentives to develop hydropower in Nepal. Less than a decade later, in sharp contrast to the progressive nature of the hydropower policy 1992, GoN promulgated a new hydropower policy 2001, which either decreased or totally cancelled the incentives offered by the earlier policy. In 2006, to baffle the hydropower developers, the new ordinance in hydropower policy was created which neglected all previous relevant policy and added a VAT of 13% for project larger than 3MW.

Emphasis on hydropower development

Despite the focus on hydropower development for meeting domestic needs, its implementation has been weak. Although the country is facing severe load shedding even during the wet season, the hydropower development policies have been delayed due to the lack of proper energy planning. Industries have been hit very hard. The whole economy has suffered. Weak implementation of one-window policy and lack of consistency or continuity of taxation policy have been identified as causes for slow rate of progress in implementing planned hydropower projects in the

private sector. There is also an absence of an effective policy for encouraging the use of domestic resources for development of hydropower.

Inapt energy classification

The existing energy sector classification of traditional, commercial and renewable where hydropower is grouped under commercial is not appropriate. In view of Nepal's potential of developing hydropower, and the existence of a certain lobby in the international scene, Nepal should be cautious about such a development.

Energy Efficiency

Energy efficiency from production, supply end user can be the most effective source for reducing the demand-supply gap. But no serious attention has been paid in this direction. Energy efficiency can be achieved through a host of measures such as manufacture and use of energy efficient equipment, reduction of system losses, proper energy planning and management.

Energy sector reform, restructuring and governance

There is lack of effective implementation of power sector restructuring programs. Reforms in this sector include unbundling the power sector, creating an independent regulatory mechanism, and introducing competition in power generation. Progress has been slow partly due to delays in enabling legislation and lack of time bound roadmaps.

Regional Cooperation

Regional cooperation can play a critical role in ensuring energy security in a sustainable manner. Sub-regional power trade can be an effective way of meeting energy demand. By utilizing different peak times of neighboring countries, regional power trade can reduce the need for building new power generation plants in each country.

Government Issues

There is an uncertainty on country's political regime. Political risks are the major threat in hydropower and others are claim on resources due to near future federal system of governance. Hydropower developers need to be ascertained by the deeds of the party and the governance. While on paper, all of the major political parties seem to be like minded on the issue of hydropower, emphasizing support and commitment towards developing hydropower as stated in their political manifesto. This consensus fails apart when it is brought outside the realm of the political manifestos (Manandhar, 2011).

GoN has resulted in a situation whereby licenses are held mostly by individuals with neither the technical understanding nor financial capability of implementing hydropower projects. GoN failed to renew 11 licenses of total 177.6MW capacity. These include Lower Balephi (5MW), Kolpha Khola (2.23MW), Madhkyu Khola(5MW), Upallo Khimti (4.5MW), TamorMewa (101MW) Thapa Khola (2.23MW), Lower Pheme Khola (2.2MW), Small Likhu Khola (1.5 MW), Rasuwa- Bhotekoshi (22.6MW), Khimti-2 (27MW), Daraudi Khola (5MW).

Legal Issues

The important thing is the implementation of what is clear in the law by the government. The law as it is today is okay to an extent, but implementation is more of problematic. It was felt that faithful application of law is lacking. It was reiterated that the commitment made by the government with regard to the incentives should be kept.

In the matters of hydropower projects, Electricity Act should clearly supersede Industrial Enterprise act and hydropower projects should not be demand as industry (Shrestha, R.S.2010). To implement the Hydropower Development Policy 2058 BS(2001), there is a gap in amending the enactments relating to water resources and electricity. It is further suggested that provisions be made in the legislation for each of these types befitting their uniqueness and the requirement.

Institutional Issues

Effective institutional arrangements and statutory provisions are lacking. There are overlapping roles and responsibilities of existing institutions in Nepal which in turn affects the power trade negotiations. Although the GoN policies warrant the provision of a one window system for hydropower development, DoED, currently charged with this responsibility, is unable to discharge its obligations due to non-cooperation from other GoN agencies such as Ministry of Finance, Ministry of Forest etc.

Inequitable distribution of benefits from royalty

Providing the royalty solely to district where the hydropower project is located is not equitable. For instance – power generation from a hydro installed down-stream is not possible unless the water users up-stream do not allow the water flow. A mechanism is required to share royalty equitably in the basin/sub-basin.

Lack of competition in electricity transmission and distribution

Monopoly in transmission and distribution of electricity has hindered competition of these commodities in the market and hence in electricity generation and consumption. There is lack of enabling policy and regulatory mechanism for providing level playing field to promote private sector in electricity transmission and distribution as well.

Lack of representation of the weak socio-economic groups in energy planning

Awareness of integrated energy planning and management was very low in the people. Besides, there is lack of institutions which regularly provide training to fresh trainees and upgrade and refresh the skills of existing manpower in energy sub-sectors. According to workshop participants, lack of appropriate, regular and updated knowledge and skill of the old and new staff in the energy sector for sustainable resources management, dissemination-adoption and operation of new and efficient technology and quality monitoring has held back the extension and promotion of energy resources to benefit the larger number of people.

Environmental Issues

Hydropower, although considered as renewable form of energy, has some impacts on environment. Run-off-river projects with high head and small reservoirs typically have a much smaller footprint and have fewer adverse environmental impacts than lower elevation large reservation. On other hand, in some cases, larger reservoirs can provide additional benefits such as flood-control, irrigation, aquaculture and recreation/tourism prospects.

Environment Impact Assessment

Firstly, the time frame provided for EIA is too long leading to holding right without production. In addition to that, mitigation measures to minimize the environmental impacts are not followed strictly and some times, the environmental aspects are not seriously considered while planning hydro power projects. Similarly, the use of waste land is not considered while installing high voltage transmission line. There is a need of simplification of EIA for small hydropower projects. The environmental assessments are merely taken as “add on burden” to be reckoned at the beginning of the project and despite having provisions for appraisal of these assessments once the project is constructed, it is not implemented. There is serious lag in monitoring and evaluation of post construction and operation of projects.

Delay in Processing

The process of IEE and EIA are time consuming and can last between 1.5-2 years. The main reasons for the delay can be attributed to the following reasons: Large numbers of departments and ministries involved (DoED, MoWR, Ministry of Science, Technology and Environment, Department of Forests, Department of National Parks and Watershed Conservation, Ministry of Forest), bureaucratic red tape and lack of mechanism to enforce time bound decisions, lack of professional personnel within the line department/ministries.

Resettlement policy

There is lack of appropriate resettlement policy at high dam site.

Social Issues

Another hurdle is related to problems created by local communities. It is policy of GoN to pass 1% of the royalty paid by a project to DDC concerned, Despite of such provisions, as soon as some developers start survey works, local community members tend to come forward with various demands, such as donations to the locals schools temples, for buildings roads, etc.

Lack of energy reliability and security

The country evidently lacks a reliable energy resource. As a result, each and every sector relying in national supply is facing from this ambiguity. The concept of human development which means easy, affordable and equitable access to all forms of energy supplies and services in this context is utterly misconstrued. And this lack of energy security is increasingly threatening the social stability of a developing country like Nepal. The access to energy is not only determined by grid connection but also by availability and affordability. Hence energy pricing plays a deciding factor towards making energy accessible. So if energy is to be made accessible to all especially to those who have economic constraints, then either the imported fuel should be subsidized or indigenous resources should be developed and distributed at affordable rates.

Lack of access to electricity

In present day, electricity is most useful form of energy and plays a vital role in the development process as it creates several avenues for the social and economic growth of the people and the country. Not only at the urban level but equally at the rural level, electricity is a significant medium for enhancing the livelihood of the people by providing them with an easy, efficient and cheaper source of energy. With access to electricity, people can work during nights, indulge in income generating activities, children and even adults can study at night. However, electricity as a source of energy is not accessible to 52% people in our country thus hindering the advances in the livelihood of people and overall socio-economic development of the community, region and country as a whole.

Lack of strict enforcement of Social Impact Assessment

Despite the mandatory pre-requisite of Social Impact Assessment and public hearing before commencing any commercial energy project, it is not strictly enforced by the authorities and followed by the implementers.

Lack of effective mechanism to address the Resettlement and Rehabilitation issue

Although there is Resettlement and Rehabilitation Policy for the people displaced by the energy projects, the policy is not effective in addressing this issue hence inviting dissatisfaction from the project affected people.

Lack of proper implementation of penalty system for those stealing and misappropriating energy

Despite the provision of penalizing the culprits involved in stealing or misusing energy, as for example, electricity, the penalty system is not strictly enforced by the concerned authorities. This is not only incurring loss to the country but is encouraging the proliferation of network involved in such crime.

Economic Issues

Weak investment in hydropower

There is huge scope of producing hydropower but due to the financial constraint of the government it cannot be materialized. Investment in hydropower is financially beneficial but the government is unable to attract the private producers and foreign investors to invest and boost up the hydropower development.

High electricity tariff

The electricity tariff is one of highest in the world. But IPP is supplying electricity much less charge than the NEA tariff rate in rural areas. Tariff is high due to distribution and leakage loss that can be remedied and reduce tariff.

Lack initiative for investments

Financial institutions and banking sector are unable to use 200 billion of rupees which is equivalent to 50% of the total assets of commercial banks. As it is clear that IPPs are in profit in hydroelectricity, banking institutions with surplus funds must be attracted to invest in energy production.

Lack of differential electricity price

Differential electricity and other commercial energy price are required to abide by the equity principle. There is no any subsidy and facility in case of commercial energy for the support of the rural poor.

Affordable cost of energy services

Affordability is a must essential precondition of the energy supply services. But the issues arise to provide energy at affordable cost and it is very controversial term and it is very hard to meet the condition because NEA and NOC the major commercial energy providers are claiming that they are in huge loss.

Absence of energy conservation

Energy save or energy conservation is equivalent as energy production. It is required huge investment in electricity production. It is estimated that 1.08 million dollar is required to produce one MW of hydroelectricity. So, it is required to provide incentive for energy conservation.

9.1.4.2 Other commercial energy

Technical Issues

Emphasis on indigenous resources

Although the country has huge potential of hydropower energy resources, but harnessing of these resources is dismally poor. Hence, the country has to focus in developing the indigenous renewable energy resources such as hydropower, solar, wind and bio-energy resources rather than depending on imported petroleum products.

Exploration, production & generation of indigenous energy resources

Though official documents show some reserves of fossil fuels such as coal, oil and natural gases in the country, their exploration and extraction and harnessing tasks are well lower the resource capacity. Thus the Government of Nepal requires putting much more emphasis in the exploration, production, and development of these reserves. Similarly, current development of hydropower resources is quite inadequate for meeting even the country's demand.

Efficient Transport vehicles

There seems no emphasis on usage of public mass transport instead of individual transport vehicles such as private cars, jeeps, and motorcycles. Moreover, Electrical transportation systems are not in the government's priority area. GON should prioritize development of electric vehicles such as railway systems along the East West Highway. Similarly, GON should provide necessary emphasis and incentives in the development of the Expressway between Kathmandu and Hetauda, which can tremendously save the consumption of petroleum products.

Efficient and quality energy services

Easy access to reliable energy source is the right of the consumers. But there is hardly any quality control in the products as well as the energy services. So, there is a strong need for quality control mechanism in petroleum products and coal. Excessive load shedding is not addressed by speedy development of power plant. The public

sector enterprises or the GON must effectively implement necessary steps to control adulteration in the petroleum products, supply of poor quality coal and curtailing electricity losses by giving social penalty to people involved.

Fuel transport and distribution

Currently al the solid and liquid fuels are transported to the storage facilities and to depots in tankers via road transport which is time consuming and at the same time costlier. Development of oil pipeline from Raxaul to Amlekhgunj is approved but its implementation is yet to be seen.

Policy Issues

Regulation of the Oil Sector

Petroleum products occupy an important place in the supply and distribution of energy in the country. Currently this sector is exposed to all sorts of influence from outside including political interference. It is not functioning as a commercial entity. There is lack of clear law for regulation of this sector. It suffers from lack of transparency in import and distribution. There is absence of a clear market-oriented pricing policy.

Energy Security

There is absence of a clear policy and law regarding energy security, primarily the petroleum imports. Oil is a strategic source of energy and in view of nation's total dependence on imports; its vulnerability is very high. Energy security concerns and supply sources restricted to the politically volatile Middle Eastern region. This is an issue which cannot be ignored.

Development of indigenous sources

Energy independence is not a practical proposition. However, in view of the supply completely dependent on import, national interests requires part of the need should be fulfilled by energy sources developed within the country. A sufficient amount of self-reliance is necessary. Technologies are already available for producing ethanol and biodiesel for mixing and substituting part of the imported fuels. There is lack of an effective policy for developing alternative fuels within the country.

Energy Efficiency

Energy efficiency can be the most effective source for reducing the demand-supply gap, the carbon emissions and the reliance on expensive imports of petroleum products. But no serious attention has been paid in this direction. Energy efficiency can be achieved through a host of measures such as manufacture and use of energy efficient equipment, proper energy planning and management, efficient transport planning, among others. Both supply and demand side efficiencies need to be addressed.

Energy sector reform, restructuring and governance

There is lack of effective implementation of power sector restructuring programs. Reforms in this sector include unbundling the power sector, creating an independent regulatory mechanism, and introducing competition in power generation. Progress has been slow partly due to delays in enabling legislation and lack of time bound roadmaps.

Institutional Issues

Lack of continuous policy recognition to and support for integrated energy planning at the central level

With the factors such as the political expediencies and vested mercantile sub-sectoral energy interests in oil, forests, water and other natural resources sub-sectors provide impetus for the growth of unequal, divergent and separate public institution in each energy sub-sector. Each one of these sub-sectoral public institutions plans and manages energy in its sub-sectors rather independently. Although WECS was established for institutionalizing an integrated energy planning process, it has not been able to receive policy recognition and support, so critical for the initiative.

Therefore, an integrated mechanism that link all energy sub-sectors together in terms of effective planning is clearly absent. As such Workshop participants in the commercial energy group felt the need of an overall executive body in the form of an energy ministry and suggested for integration through planning linkages between energy related institutions.

Lack of level playing field for petroleum imports

Monopoly in import of oil (petroleum products) by public utility has significantly hindered competition of petroleum commodities in the market and hence in efficient petroleum procurement, transfer and distribution. There is lack of enabling policy and regulatory mechanism for providing level playing field to promote private sector in oil import, storage, transfer and distribution.

Lack of representation of the weak socio-economic groups in energy planning

Awareness of integrated energy planning and management was very low in the people. Besides, there is lack of institutions which regularly provide training to fresh trainees and upgrade and refresh the skills of existing manpower in energy sub-sectors. According to workshop participants, lack of appropriate, regular and updated knowledge and skill of the old and new staff in the energy sector for sustainable resources management, dissemination-adoption and operation of new and efficient technology and quality monitoring has held back the extension and promotion of energy resources to benefit the larger number of people.

Environmental Issues

Pollution tax on fossil fuels

The use of fossil fuels (coal and petroleum products) in industries, transport, agricultural and domestic sector is excessively increasing, and so are the toxic emissions causing air pollution and climate change due to greenhouse gas emissions. Thus there is a need for policy on higher pollution taxes on petroleum products and reduction in their usage. This fund can be used as a cross subsidy for the promotion of environmental friendly renewable energy technologies.

Social Issues

Lack of energy reliability and security

The country evidently lacks a reliable energy resource. As a result, each and every sector relying in national supply is facing from this ambiguity. The concept of human development which means easy, affordable and equitable access to all forms of energy supplies and services in this context is utterly misconstrued. And this lack of energy security is increasingly threatening the social stability of a developing country like Nepal. The access to energy is not only determined by grid connection but also by availability and affordability. Hence energy pricing plays a deciding factor towards making energy accessible. So if energy is to be made accessible to all especially to those who have economic constraints, then either the imported fuel should be subsidized or indigenous resources should be developed and distributed at affordable rates.

Lack of strict enforcement of Social Impact Assessment

Despite the mandatory pre-requisite of Social Impact Assessment and public hearing before commencing any commercial energy project, it is not strictly enforced by the authorities and followed by the implementers.

Lack of effective mechanism to address the Resettlement and Rehabilitation issue

Although there is Resettlement and Rehabilitation Policy for the people displaced by the energy projects, the policy is not effective in addressing this issue hence inviting dissatisfaction from the project affected people.

Lack of urban planning

The ever increasing trend of migration of people to urban centers due to geo-political reasons will not only exert population pressure in the urban areas but the lack of urban planning will also result in mushrooming residents and slums. On the other hand this will create an imbalance situation in the demand and supply of energy sources at definite locations thus creating energy insecurity, supply deficit, environmental deterioration and energy misappropriation and theft.

Lack of proper implementation of penalty system for those stealing and misappropriating energy

Despite the provision of penalizing the culprits involved in stealing or misusing energy, as for example, electricity, the penalty system is not strictly enforced by the concerned authorities. This is not only incurring loss to the country but is encouraging the proliferation of network involved in such crime

Economic Issues

Lack of competitive market in petroleum sector

The petroleum product is solely controlled and regulated by NOC. Petroleum products are not allowed to the private parties to import freely and marketed at competitive price as per the liberalization policy of the government. The monopoly has barred competitive market thus affecting the economy.

Petroleum product pricing

Petroleum products prices, although with consent of government, are set by NOC that can be considered as monopoly price. Due to absence of competitive market; petroleum price are unjustified because even if the price of a commodity is hiked, NOC has been still claiming a loss.

Lack of differential energy price

Differential commercial energy price are required to abide by the equity principle. At present the situation is reverse the kerosene price in Jumla and Humla is much higher than Kathmandu. Actually the price of kerosene in these rural areas must be cheaper than other urban areas. There is no any subsidy and facility in case of commercial energy for the support of the rural poor. But there is no government control over the forest which is accessed as free.

Affordable cost of energy services

Affordability is a must essential precondition of the energy supply services. But the issues arise to provide energy at affordable cost and it is very controversial term and it is very hard to meet the condition because NEA and NOC the major commercial energy providers are claiming that they are in huge lost.

Absence of energy conservation

Energy save or energy conservation is equivalent as energy production. It is required huge investment in electricity production. It is estimated that 1.08 million dollar is required to produce one MW of hydroelectricity. So, it is required to provide incentive for energy conservation.

9.1.5 Renewable Energy

The major issues in renewable energy sector have been identified through desk study and consultations with stakeholders at various levels including that in the regional workshops conducted in the five development regions of the country. Major issues identified in technical, policy/legal, institutional, environmental and socio-economic aspects of the RE sub-sector were mostly common to all the development regions. This indicates that the issues identified are the issues at national level and not only limited to a particular region.

The major issues in the renewable energy sector have been categorized into technical, policy/legal, institutional, environmental and socio-economic issues as given in the following sections.

Technical Issues

Lack of Technical Skills

There is lack of technically skilled human resources at local level organizations which restricts the knowledge and skill share from the local level organizations to the general renewable energy users. This causes difficulty even for resolving simple operation, repair and maintenance related problem. Because of the lack of technical skills in installation, operation and management, not all of the constructed micro-hydro plants are in operation. Improvement in this aspect seems to be negligible.

Lack of Detailed Information on Appropriate Technology/Feasibility

There is lack of detailed information on appropriate technology that would be sustainable in accordance with the geographical feasibility. For example:

- biogas is mostly feasible in Terai area only and it is difficult to maintain the bio-digester temperature in cold areas;
- Solar energy is limited to household use only and has not been expanded to make optimal use of solar energy in potential areas.
- There is inadequate production of jatropha which could be used for commercial production of biodiesel.
- Wind energy has not been harnessed from areas where wind velocity are suitable for energy production;
- There is no provision to connect mini grid to national grid.

Inadequate Research and Development (R&D)

There has not been adequate research and development in different RE sub-sectors as per topography. R&D is highly lacking in areas of geo-energy, wind energy and institutional biogas. Limited research done on wind energy shows potential but there has been no development in wind energy sector.

Policy Issues

- Lack of Appropriate Rules and Regulations
- Lack of Clarity in Existing Policies at National Level.

Lack of Implementation of Existing Plans and Policies

There is lack of appropriate mechanism to implement existing plans and policies. Also, there is no proper and effective implementation of existing regulations including MOUs/agreements.

Insufficient Budget Allocation

RE is less prioritized under government budget allocation, and hence there is no adequate investment leading to lack of progress in RE at national level. There is lack of policy at local level government regarding budget allocation in renewable energy sector. The policy addressing access of Poor & Ultra poor to renewable and alternative energy resources is also not appropriate.

Social Issues

Lack of Awareness

The level of public awareness about different RE technologies and accessibility provisions is very low.

Inadequate Understanding on Technical Matters

The level of understanding of technical matters on RE technologies among public including that on carbon trading, jatropha use for biodiesel production is negligible. Unless people don't understand the importance of these things, it would be difficult to develop interest in them to make optimal use of available RE technologies.

Inadequate Sense of Ownership

Due to various factors like migration of young people to other areas, gradual decrease in local level interest and contribution, lack of knowledge on operation and management, dissatisfaction from services on repair and maintenance etc, there is inadequate sense of ownership which is leading to negligence regarding the already installed RE plants.

Likewise, debate on ownership regarding head of river and decreased flow of water (for micro hydro) from the source due to diversion for irrigation are other concerns pointed out by the stakeholders.

Cultural barrier

There is still dominant orthodox thinking in rural areas. In the first place, there is lack of awareness about connecting toilet to the bio-digester for optimal energy production, and in second place, people highly hesitate to connect the toilet to the bio-digester. People have no understanding that the characteristics of biogas as such despite of the source it is produced from is just the same.

Economic/Financial Issues

Adequate Subsidy and Inadequate Allocation of Budget for RE

There are several concerns raised in regards to subsidy allocation for installation of RE plant:

- Insufficient subsidy based on economic status and geographical location;
- Less subsidy as compared to increasing cost of installation;
- Subsidy received from stakeholder organization inadequate;
- Lack of subsidy for biogas using pig manure or other feedstock;
- Lack of support to install large size plants;
- Implementation of solar subsidy is not effective; and
- Solar subsidy doesn't go to the direct beneficiaries.

High Initial Investment Cost

Due to high initial investment cost for the installation of RE technology (basically caused by use of imported expensive parts/equipment) and inadequate financial institutions and cooperatives for investment, access to RE for poor people is very hard. In most of the cases, users contribution goes up to 50-60% which makes it difficult for ultra poor to access the RE technology.

Lack of Provision for Minimizing Associated Risk

There is no provision for insurance or any other mechanism to minimize the associated risk which makes it hard for poorer group to make decision regarding investment in RE installation.

Institutional Issues

Lack of Coordination

There is lack of coordination among related ministries at central level. The level of coordination between government and donor agencies is also not adequate which has led to duplication of effort by various agencies working in the RE

sector. This has resulted in high level of support through different projects in one area while very less support in other areas of RE.

Concerns are also raised regarding the inadequate partnership among public and private cooperatives/financial institutions.

Lack of Effectiveness

There is lack of effectiveness in implementing various plans and policies due to lack of coordination at institutional level. Lack of effectiveness in improvement in RE sector is also apparently due to insufficient capacity of human resources at different levels including local level agencies and end users.

Political Issues

Political Instability

Instability in government has led to lack of interest and poor level of commitment among all levels of government agencies to make improvement in RE sector.

CHAPTER 10
METHODOLOGICAL APPROACH FOR FUTURE ENERGY SCENARIOS

10.1 Methodological Approach: Bottom-up Modelling Using MAED-2

For modeling future demand scenarios of the energy systems of Nepal from 2010 to 2050, the IAEA's energy planning tool – Model for Analysis of Energy Demand (MAED) has been used. MAED uses a bottom-up approach to project future energy demand based on medium- to long-term scenarios of socio-economic, technological and demographic development. Energy demand is disaggregated into a large number of end-use categories corresponding to different goods and services (MAED, 2006; Hainoun, A. et al., 2006; UN-energy, 2006; UN-energy, 2007). The influences of social, economic and technological driving factors are estimated and combined in each different category to present an overall picture of future energy demand growth under the assumptions of that scenario.

For energy demand analysis and projections in MAED, the end-use categories considered are: (1) agriculture, (2) construction, (3) mining, (4) manufacturing, (5) transport, (6) Service (commercial), (7) urban households and (8) rural households. Based on intensities of energy use, the end-use categories are re-organized into sub- categories. Agriculture is sub-divided into (a) grain crops, (b) cash crops, and (c) livestock and fisheries. Construction and mining do not have any sub- categories. Manufacturing according to the national standard industrial category (NSIC) is further divided into (i) food, beverage and tobacco, (ii) textiles and leather goods, (iii) chemical, rubber, and plastics, (iv) mechanical engineering products, (v) electric engineering products, (vi) wood products and paper, (vii) cement, brick and non-metallic products, and (viii) other products. Service sector is divided into (1) commerce and tourism, (2) community and social service, and (3) finance and real estate. Household sector is divided into urban and rural sub-sectors which are further sub-divided into family house, urban dwelling on rent, village house, and rural dwelling on rent respectively. Transportation sector is the biggest sector with subdivisions. It is divided into (a) freight transport, (b) passenger transport. Freight transport is further subdivided into truck/tankers, tractors, and pickups. Similarly, passenger transport is disaggregated into inter-city and intra-city transportations. Inter-city transport is further subdivided into 10 modes of transport – (i) airplane, (ii) car gasoline, (iii) car diesel, (iv) car alcohol, (v) bus large, (vi) bus small, (vii) mini bus, (viii) micro bus, (ix) train diesel, and (x) train electric. Intra-city transport is disaggregated into 13 modes of transport – (i) car gasoline, (ii) car diesel, (iii) car alcohol, (iv) vehicle LPG, (v) car electric, (vi) bus diesel, (vii) bus CNG, (viii) metro electric, (ix) trolley bus electric, (x) mini bus, (xi) micro bus, (xii) tempo (three wheelers), and (xiii) motorcycles (two-wheelers). There are 8 types of transport fuels selected that are electricity, steam coal, diesel, gasoline, jet fuel, LPG, CNG, and alcohol.

MAED-2 calculates the energy demand for each end-use category, sub-sector and sector. It aggregates the economic sectors into four broader "energy consumer" sectors: (1) industry (consisting of Agriculture, Construction, Mining and Manufacturing), (2) Transportation, (3) Household, and (4) Service.

The first step for the MAED-2 model is construction of base year energy consumption patterns within the model. This calls for compiling and reconciling necessary data from different sources, deriving and calculating various input parameters and adjusting them to establish a base year final energy balance. This helps to calibrate the model to the country's specific situation. The base year is taken as 2009/10[19], referred here as "2010".

The next step is developing future scenarios, specific to a country's situation and objectives. The scenarios can be sub-divided into two sub-scenarios:

- One related to the socio-economic system describing the fundamental characteristics of the social and economic evolution of the country

[19]In Nepal the fiscal year starts and ends in mid of July

- The second related to the technological factors affecting the calculation of energy demand, for example, the efficiency and market penetration potential of each alternative energy form.

The key to plausible and useful scenarios is internal consistency of assumptions, especially for social, economic and technological evolution. A good understanding of the dynamic interplay among various driving forces or determining factors is necessary. The model output, i.e. future energy demand, is just a reflection of these scenario assumptions. The evaluation of output and the modification of initial assumptions is the basic process by which reasonable results are derived.

The model focuses exclusively on energy demand, and even more specifically on demand for specified energy services. When various energy forms, i.e. electricity, fossil fuels, etc., are competing for a given end-use category of energy demand, this demand is calculated first in terms of useful energy and then converted into final energy, taking into account of market penetration and the efficiency of each alternative energy source, both specified as scenario parameters. Non-substitutable energy uses such as motor fuels for cars, electricity for specific uses (electrolysis, lighting etc.) are calculated directly in terms of final energy.

Methodological Steps

Figure10-1 shows the basic structure of MAED's modelling procedure. The modeling procedure consists of the following calculation steps:

- The final energy structure is broken down into various consumption sectors of end-use by fuel type and energy forms (see Figure 10-1)
- Social, economic, and technological driving factors that are influencing each category of final energy consumption are identified
- The final energy consumption based on the statistical data available is reconstructed for the base year 2005
- The development scenarios with the evolution of the demographic change, trend in the economic development, lifestyle, and other technological factors influencing the final energy demand are constructed , and
- The final energy demand at various period of time is projected accordingly to the various scenarios

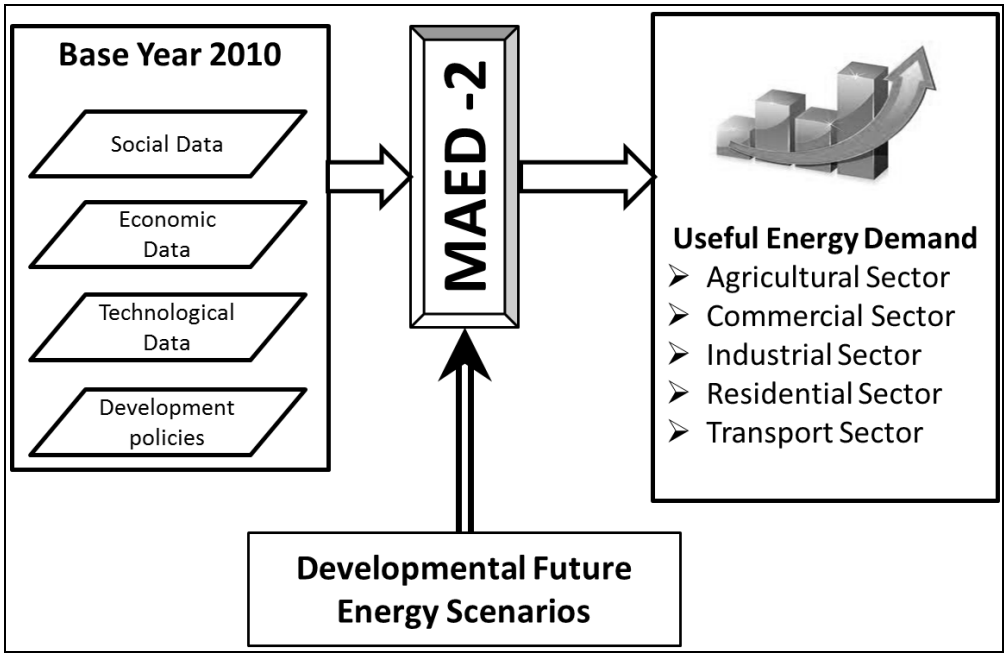


Figure 10-1: Structure of MAED-2 Model for Energy Demand Projection

Energy Balance in 2010

The final energy balance of Nepal's energy systems in 2010 given in the Table 10-1is derived based on the energy synopsis report (WECS, 2010) and the economic survey (MoF, 2012). The total Primary Energy Supply (TPES) in 2010 is calculated to be 417,000 TJ and the final energy consumption is around 410,000 TJ.

Table 10-1:Final energy consumption by different energy forms and by economic sectors in 2010

Particulars	Petroleum Products	Coal	Hydro	Electricity	Biomass	Modern Renewable	Total
Final Consumption							
Industrial	1,651	11,940		4,581	1,949		20,121
Residential	4,687			4,064	345,519	2,933	375,238
Commercial	2,994	35		747	1,794		5,535
Transport	21,289	-		20	-		21,308
Agriculture	2,872	-		184	-		3,056
Others	-	-		800	0		800
Total	33,491	11,975	-	10,396	349,262	2,933	408,058
Statistical Error	(0)	-	(0)	230	1	-	0

TJ -Source: WECS, 2006

The above table shows that the major energy carries are derived from traditional biomass i.e. fuel-wood, agri-residue and the animal waste which comprise 85.6 percent (349,262 TJ) of the total energy needs of the country followed by fossil fuels comprising of gasoline, diesel, ATF, kerosene, LPG, other petroleum and coal at 11 percent, electricity – 2.5 percent and finally modern renewables in traces. Transportation sector uses the major amount of petroleum products, 63.5 percent, while residential sector consumes a very large amount of traditional biomass of about 99% of total biomass. Over 80 percent of electric power is utilized by industrial and residential sector at nearly equal amount while modern renewable are seen to be used only in residential purposes only. In totality, residential sector is the largest energy consumer with energy consumption of 87.5 percent of total share.

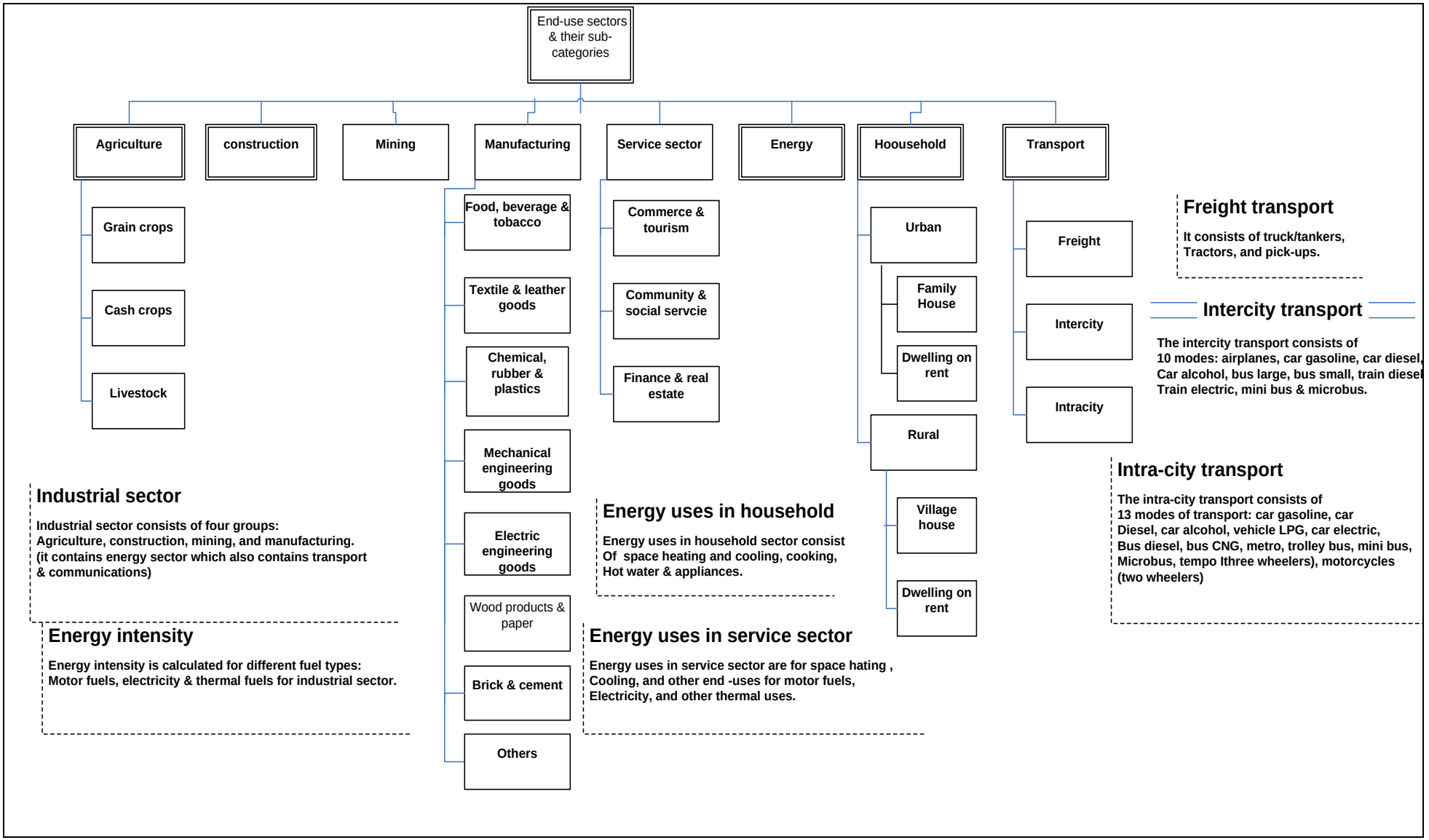


Figure 10-2: Different Sectors and Sub-sectors in MAED Model

10.2 Supply policy analysis by optimization approach MARKAL

The next step after the development of future demand scenarios is to analyze the model via MARKAL optimization model. The demand projections at various macroeconomic and demographic indicators, the future demand projections for the residential, industrial, transport, commercial (service) and agricultural sectors are used exogenously as preliminary inputs for energy systems analysis using MARKAL. Necessary calibrations were done for adjustments with the energy statistics in the base year 2010.

Choice of the Modelling Framework

Energy models are used for analyzing energy systems worldwide. There are various energy models available, each considering a different overall approach towards the analysis of energy and environment system. MARKAL (MARKetALlocation), LEAP (Long-range Energy Alternatives Planning), AIM (Asia-Pacific Integrated Model), MESSAGE (Model for Energy Supply Systems Analysis and General Environment), etc. are a few examples of them. A broad classification of energy system models are presented in the Figure 10-3.

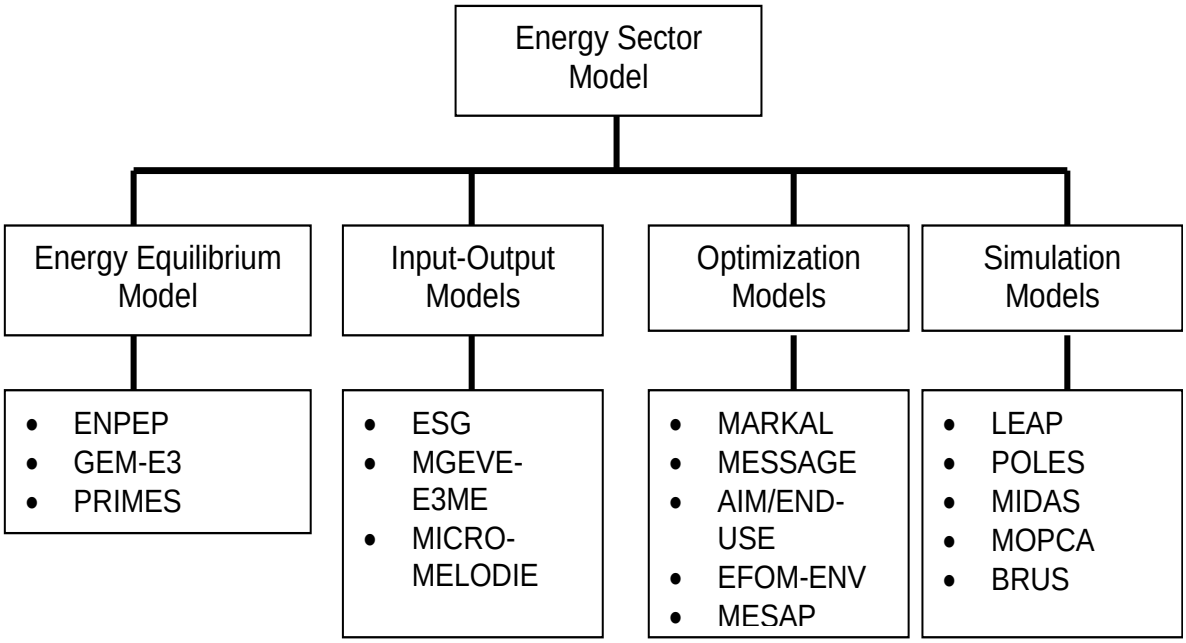


Figure 10-3: Classification of Energy Sector Models

A brief description of some of the energy sector models are given below:

1) MARKAL (Market Allocation)

MARKAL was developed in a cooperative multinational project over a period of almost two decades by the Energy Technology Systems Analysis Program (ETSAP) of the International Energy Agency. MARKAL is a generic model tailored by the input data to represent the evolution over a period of usually 40 to 50 years of a specific energy system at the national, regional, state or province, or community level. It uses the bottom-up approach and its methodology is optimization. The objective is a target-oriented integrated energy analysis and planning through a least cost approach. The energy demands are exogenously supplied in this model and the supply options are analyzed. Both linear as well as dynamic (non-linear) programming mathematical approaches can be utilized by this model.

2) LEAP (Long Range Energy Alternatives Planning System)

LEAP was developed by Stockholm Environment Institute, Boston, USA. It is a econometric/simulation model with both supply and demand endogenously supplied. The modeling approach utilized is top-down for demand calculation and bottom-up for supply analysis. Demand is calculated by econometric methodology and supply by

simulation. A high degree of indigenization is incorporated and it includes simple descriptions of end-use technologies, including renewable. Medium and long-term analysis of all sectors can be done using this model. An integrated sectoral approach is utilized and environmental effect analysis is included. LEAP is perhaps the most widely used energy modeling tool and is supplied free of cost to government and educational institutions worldwide.

3) ENPEP (Energy and Power Evaluation Program)

This is a hybrid model developed by IAEA, Austria. It incorporates a top-down approach for demand analysis and a bottom-up approach for supply analysis. As a hybrid model it uses macroeconomic methodology for demand analysis and an economic equilibrium methodology for the total energy system. Analysis of environmental impacts is incorporated in the model and a detailed analysis for electricity based on least cost optimization can be employed. It utilizes an integrated approach and allows for energy policy analysis, energy tariff development, investment analysis, generation expansion planning, and environmental policy analysis.

4) MESSAGE (Model for Energy Supply Systems Analysis and General Environment)

This is a technological model developed by International Institute for Applied System Analysis (IIASA), Austria. As a bottom-up model detailed representation of energy uses and technologies is possible. It utilizes a least cost optimization methodology to give an optimal choice of energy alternatives. It uses the mathematical approach of dynamic programming in its methodology. Features include energy demand and supply, environmental impacts, modular package, generation expansion planning, end-use analysis, environmental policy analysis, and investment policy analysis.

One of the key features of this study is to derive implications for the technological and policy interventions under different scenarios on the country's energy system. Thus, an energy modeling framework is required in order to perform a quantitative analysis of the system. The requirement on the framework would be to determine a demand-supply balance of the energy needs across various economic sectors – residential, service, industrial, agriculture and transport – in future study horizon. Different scenarios were developed for policy analysis and strategy formulation. The MARKAL framework was chosen to examine the optimal pathway to meet the end-use services.

The features of MARKAL that led to its selection as a tool in this study are explained below.

- MARKAL is an optimization model that uses a bottom-up approach to simulate an energy system. It is used widely used in developing as well as developed countries. MARKAL is currently being in used in more than 60 countries and 200 institutions worldwide.
- Being a bottom-up model it facilitates adequate scope for representing the system in detail. The modeler has flexibility in determining the description and characteristics of technologies at all stages of energy flow.
- MARKAL provides an integrated framework for determining the energy supply system from the point of extraction of resources to their end-use. Throughout the system it takes into account the conversion processes, their efficiencies and losses as well as costs such as extraction costs, transportation and distribution costs, etc.
- As an optimization model it determines the supply mix with the least total systems cost. This is preferred over a simulation model such as LEAP as it can provide relative ranking of various technological options in terms of cost minimization.
- A number of user-defined constraints, such as resource availability and environmental emission threshold, can be set in order to reflect a more realistic system.
- Modeling of electricity supply can be done in a convenient manner as MARKAL provides seasonal as well as time-of-day time-slices that enables the modeler to consider differential demand and availability of electrical power throughout the various time-slices. These time-slices are flexible and can be determined according to the need of the region being modeled.

Modeling framework of MARKAL model

As already revealed that MARKAL is a least cost optimization model. With the use of LP (Linear Programming) algorithms, it determines the least total system cost. It is demand driven in that feasible solutions are only obtained when all the specified energy demands are satisfied. Each of the specified demands for every time period are exogenously forecasted and fed into the model along with resource and technology characterization information such as cost, life and bounds. Besides, the obtained solution must satisfy all user-defined constraints. Figure 10-4 illustrates the methodological approach used by MARKAL.

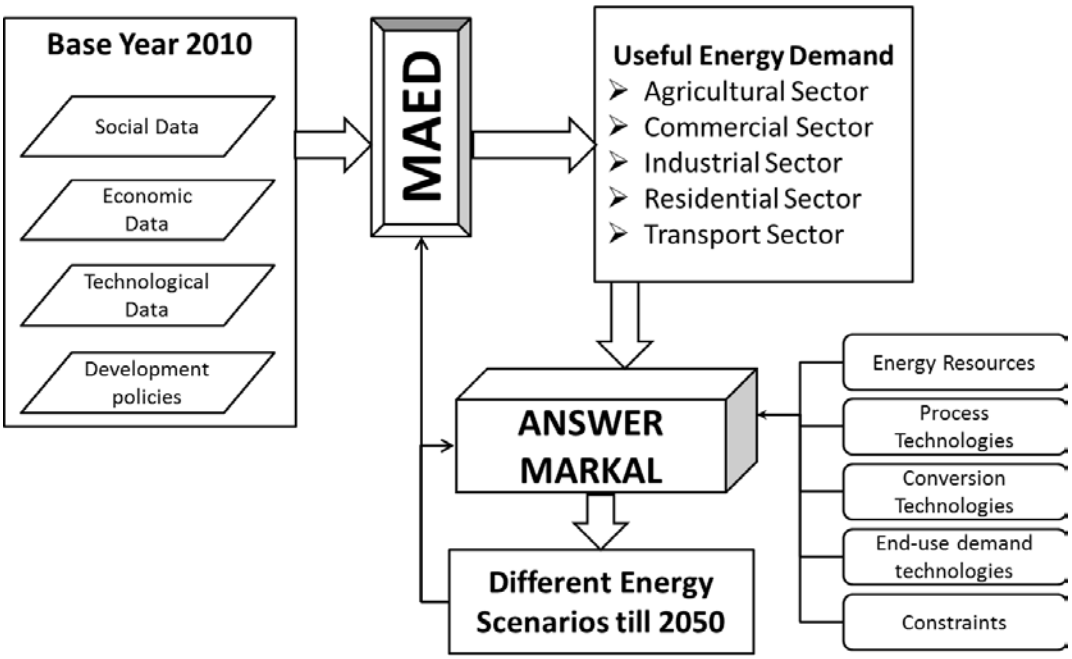


Figure 10-4: Classification of Energy Sector Models

MARKAL simulates flow of energy throughout the system with the help of various elements. These elements include energy resources, sinks, commodities (energy carriers), technologies, and end-use demands. These are structured in the modeling framework such that a systematic representation of energy flow is possible. Figure 10-5 depicts the building blocks of MARKAL.

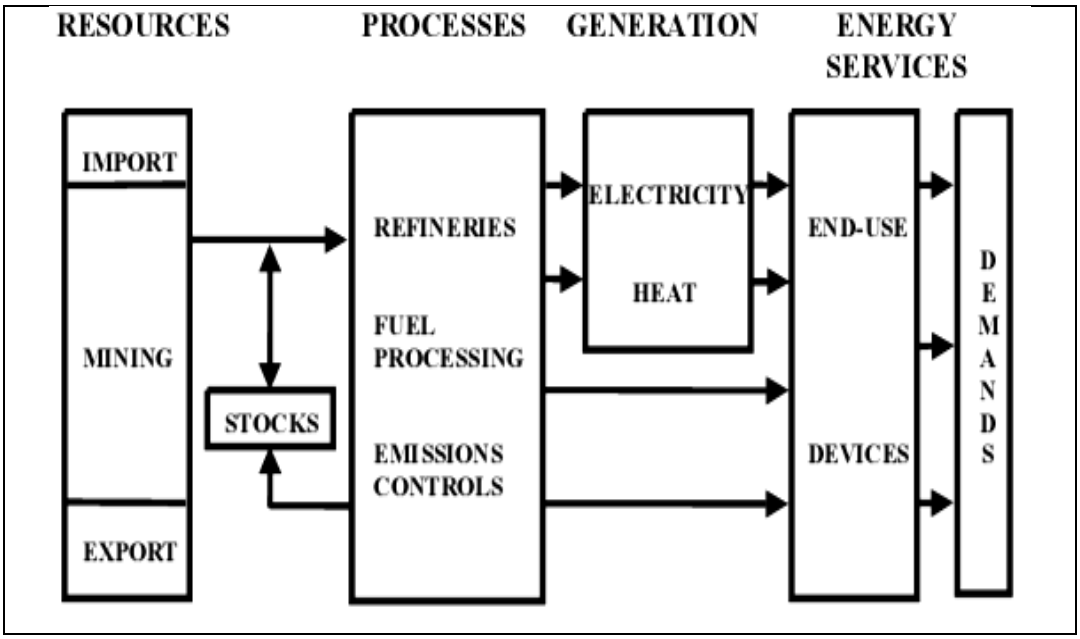


Figure 10-5:MARKAL Modelling Framework

The elements of a MARKAL energy system can be grouped as follows.

- Energy carriers encompass all the energy forms in the energy system, such as petroleum, electricity or fuelwood.
- Demands are the end-use demands of energy services, such as residential lighting or intercity freight transport demands.
- Resource technologies are the means by which energy enters or leaves the system, other than by end use consumption.
- Process technologies convert one energy carrier into another, excluding load-dependent ones such as electricity.
- Conversion technologies convert an energy carrier into electricity and/or district-heat.
- Demand technologies consume an energy carrier to meet end-use demands.
- Emissions encompass the environmental impacts of the energy system.

In MARKAL, the energy system as a whole is graphically represented in the RES (Reference Energy System) that provides a convenient outline for the user to map the flow of each energy carrier. Components are represented as blocks and lines in the RES showing the flow of energy resources from source to end-use. In the RES, commodities like energy carriers, demands and emissions are represented as lines while all technologies are represented as blocks.

MARKAL Model Run and Solutions

As in other optimization models, MARKAL also solves a model run by minimizing the objective function within the constraints given. It uses LP methods to optimize the system. The present value of the total energy system costs throughout the planning horizon is the objective function, which is subject to specific constraints. The discount rate should provided by the user. MARKAL assumes perfect foresight in making the decisions, i.e. decisions are made with full knowledge of future events.

The objective function consists of present values of the following individual costs.

- Investment costs of technologies
- Fixed and variable O&M costs of technologies
- Transportation, distribution and transmission costs of commodities
- Resource extraction costs
- Import costs of commodities
- Export revenue of commodities
- Costs incurred due to losses
- Costs associated with environmental emissions

A typical model consists of thousands of decision variables. They represent the choices made by the model. The following are the various kinds of decision variables in a MARKAL model.

- New capacity addition for technologies
- Installed capacity of technologies
- Activity level of technologies
- Quantity of resources extracted
- Quantity of import/export of commodities
- End-use demands
- Environmental emissions

In the simplest form, the MARKAL modelling framework can be represented by the following linear programming objective function

$$\text{Min } c.X$$

$$\text{s.t. } \sum_{k} CAP_{k,i}(t) \geq DM_{i}(t) \qquad i = 1,2, \ldots, I;\ t = 1,2,\ldots, T$$

and, $B.X \geq b$

Where, X = vector of all decision variables
I = number of demand categories
CAP = capacities of end-use technologies
DM = exogenous demands to be satisfied
B = coefficient of other constraints

In our modelling framework, the technology set only consists of almost 300 plus variables both for the end-use and conversion technologies.

In the conversion technologies especially in the electricity generation, although various technologies such as diesel and nuclear plants were considered for supply analysis but they were not preferred compared to hydropower plants because of the cost and availability factors. But their options for supply of electricity may not be ruled out in future.

Limitations of the Database

The energy modelling frameworks MAED and MARKAL are based on the currently available secondary database from MOF, WECS, NEA, NOC, AEPC, CBS, NPC, the World Bank, the Asian Development Bank, IAEA and IEA and etc. All the input database as required are not available and hence, thus certain data had to be extrapolated or had to be referenced from other countries similar to the socio-economic parity with Nepal. Energy surveys have to be conducted periodically and primary database has to be developed in order to ascertain the patterns of energy consumptions and energy mix in various economic sectors.

CHAPTER 11
DIFFERENT FUTURE ENERGY SCENARIOS

Scenarios are foresight of the forthcoming trend. It gives images of alternative futures. Energy scenarios provide a framework for exploring future energy perspectives and strategies, including various combinations of technology and commodities options and their implications. A number of global studies have used scenarios as a tool to assess future paths of energy system development. In more recent studies, sustainable energy development scenarios are usually carried out in many developed as well as developing countries.

This chapter deals with the demand-supply balance of the various scenarios considered for analysis. Throughout the analysis phase of the project, a large number of scenarios with different technological interventions were developed in consultation with the experts. With numerous iterations and through a constant feedback mechanism from the consultants/experts the following scenarios have been converted into as relevant for the formulation of the energy strategy of the country.

In developing the scenarios, three different sets of possible future energy demands have been considered – each of which corresponds to a future economic growth scenario. These are:

- Low economic growth scenario
- Medium economic growth scenario
- High economic growth scenario

For combined policy analysis, reference case scenario of 5.6 percent GDP growth rate is observed in detail. During the period 2001 -2005, South Asia's overall economy was growing at an average growth rate of 5 percent (IMF, 2006). Hence, it seemed appropriate to analyze the energy systems at the GDP growth rate of 5.6 percent as it is quite near to the IMF analysis for the South Asia.

Following interventions are made in combined policy scenario:

a. Replacement of traditional and fossil fuels by clean energy alternatives – electricity, LPG and ICS.
b. Replacement of incandescent bulbs by CFL and LED.
c. Promotion of electrification in all 5 sectors for lighting, heating and other purposes.
d. Intervention of more efficient process technologies in industries
e. Intervention of mass transportation system
f. Introduction of new electric and bio-fuel transportation technologies

11.1 Low Economic Growth scenario

The following are the major assumptions of this scenario:

i) GDP growth rate according to low growth case, i.e. with an average GDP growth rate of 4.4 percent.

ii) The shares of each demand technology in the energy supply in future years are considered to be invariant i.e. energy mix of total demand will be as similar as in the base year.

The Table 11.1 below shows the total energy consumption for the low growth case of various fuel types from base year to year 2050, our study horizon. The total energy consumption is expected to grow from current level of 0.407 GJ in 2010 to 1.01 GJ in year 2050 which accounts for more than two folds of increase. The average annual growth rate of energy consumption is 2% for the case.

Table 11-1: Fuel Consumption in Low Economic Growth scenario

Total Energy Consumption, TJ									
Fuel	Year								
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agri residue	13,565	14,965	16,980	20,041	24,967	28,660	34,772	43,229	54,763
Animal Dung	23,069	24,369	25,701	27,055	28,420	29,784	31,127	32,428	33,250
Av fuel	2,789	4,484	5,366	6,507	7,485	8,024	8,602	9,221	9,885
Coal	11,975	14,693	18,469	23,378	29,803	37,931	48,332	62,815	82,320
Diesel	18,747	24,213	31,190	40,561	52,655	67,880	88,690	116,380	154,334
Fuelwood	312,628	331,685	352,226	374,802	400,512	423,673	447,929	473,553	494,758
Electricity, Grid, hydro	9,985	11,776	15,726	23,343	32,413	39,790	48,761	60,830	75,209
Electricity, Off-grid+pico	31	103	213	459	467	470	471	445	445
Electricity, solar	18	18*	34	72	86	118	185	244	244
Kerosene	1,493	1,796	2,265	3,015	4,239	5,076	6,118	7,455	9,024
LPG	6,302	8,679	12,682	19,235	30,203	37,285	46,245	57,800	71,127
OPP	1,426	1,457	1,568	1,771	2,112	2,381	2,723	3,196	3,825
Petrol	3,087	4,974	5,835	6,846	8,031	9,422	11,053	12,967	15,212
BioGas	2,767	3,077	3,429	3,830	4,285	4,804	5,397	6,076	6,496
Total	407,882	446,289	491,685	550,912	625,682	695,299	780,403	886,639	1,010,891

*The solar electricity remains constant in totality in the year 2015 due to reduction in solar energy consumption in commercial sector as optimized result by MARKAL for low cost objective

The Figure 11-1 depicts the growth of different category of energy sources. The highest share in all years is by solid biomass followed by petroleum products. The consumptions of coal, petroleum products and grid electricity are seen to be increase to nearly seven folds from base year value in year 2050.

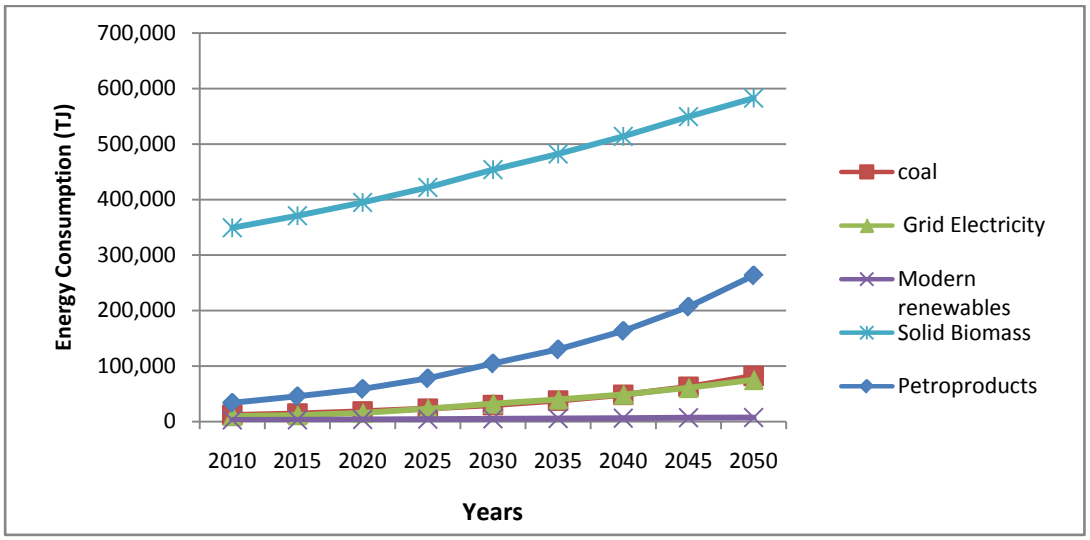


Figure 11-1 Fuel Consumption Trend at Low Economic Growth scenario

The Figures 11-2, 11-3 and 11-4 below show the energy mix in the total fuel consumptions for various years. The consumption of fuelwood is expected to decrease to 72 percent in year 2020, 64 percent in year 2030 and to 49 percent in year 2050. Whereby doubling of fossil fuels like diesel and coal. The share of electricity will increase to 3, 5.18 and 7.44 percent in year 2020, 2030 and 2050 respectively.

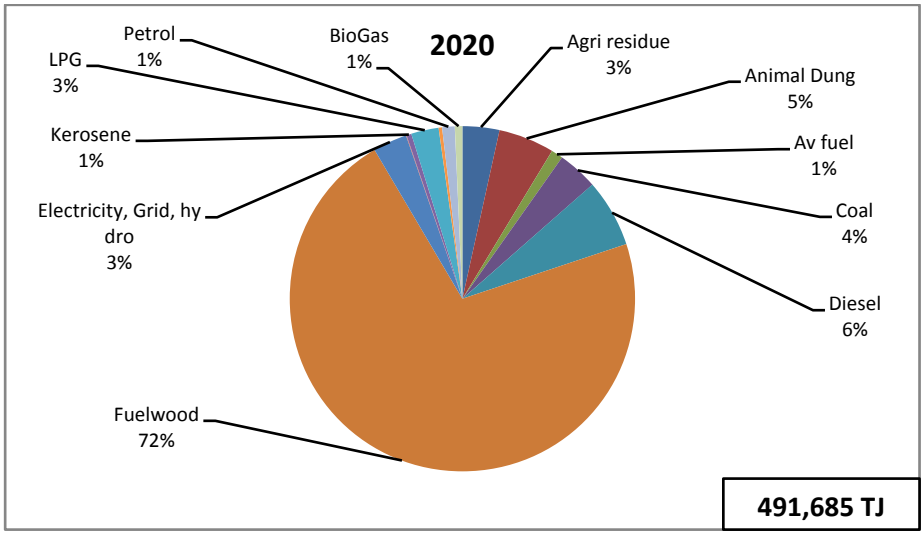


Figure 11-2: Fuel mix at Low Economic Growth scenario in 2020

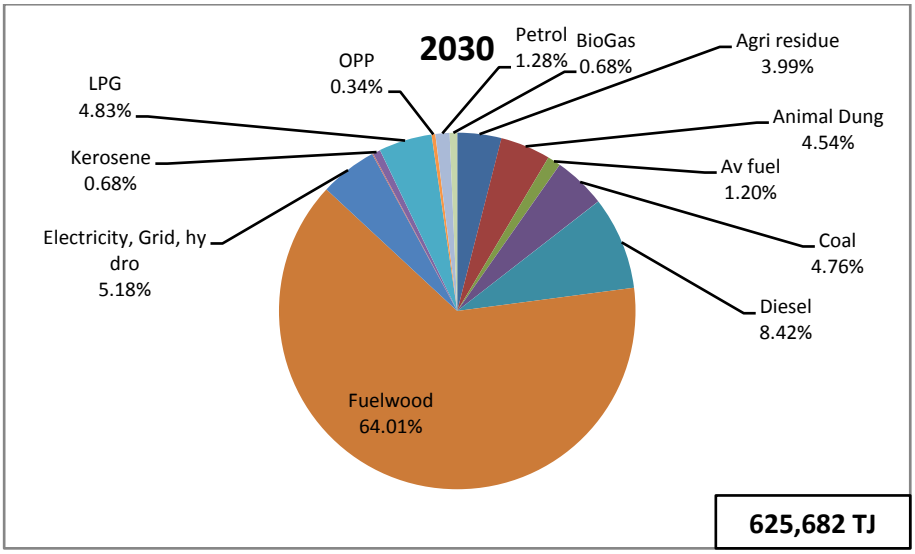


Figure 11-3: Fuel mix at Low Economic Growth scenario in 2030

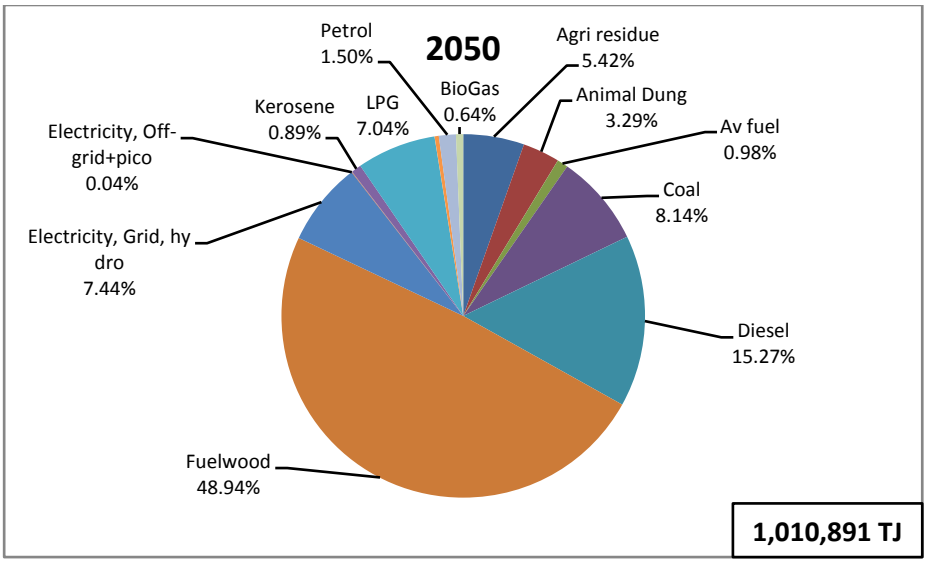


Figure 11-4: Fuel mix at Low Economic Growth scenario in 2050

The Table 11-2 shows the sectoral energy consumption in this scenario. The share of residential sector decreases to 53 percent in 2050 from 88 percent in 2010. Meanwhile, industrial sector share of energy consumption will

increase to 11 percent in 2030 and 19 percent in 2050. Whereas the share of Energy consumptions in the commercial sector will increase nearly by 11 folds from base year value of 1 percent.

Table 11-2: Sectoral consumption at Low Economic Growth scenario

Energy mix by Sector										
Sectors	Year									Av. Annual growth
	2010	2015	2020	2025	2030	2035	2040	2045	2050	
Agriculture	3,056	3,431	3,934	4,523	5,219	6,108	7,134	8,364	9,878	2.98%
Commercial	5,535	8,957	15,205	26,008	44,793	55,997	70,388	89,237	113,517	7.84%
Industrial	20,121	25,229	33,788	48,335	67,026	84,821	108,867	142,513	188,078	5.75%
Residential	357,238	378,477	400,470	423,136	446,367	470,019	493,904	517,786	531,780	1.00%
Transport	21,933	30,194	38,289	48,911	62,276	78,355	100,109	128,738	167,638	5.22%
Total	407,882	446,289	491,685	550,912	625,682	695,299	780,403	886,639	1,010,891	2.29%

The power plant capacity required for the study period. The demand for grid electricity is expected to increase at the average annual rate of 5%. Thus, the power plant capacity is required to increase to 1,884MW in 2020, 3649 MW in year 2030 to 7496 in year 2050. The electricity consumption per capita is seen to be growing by over four folds during the study horizon from current value of 104 kWh to 450 kWh in year 2050.

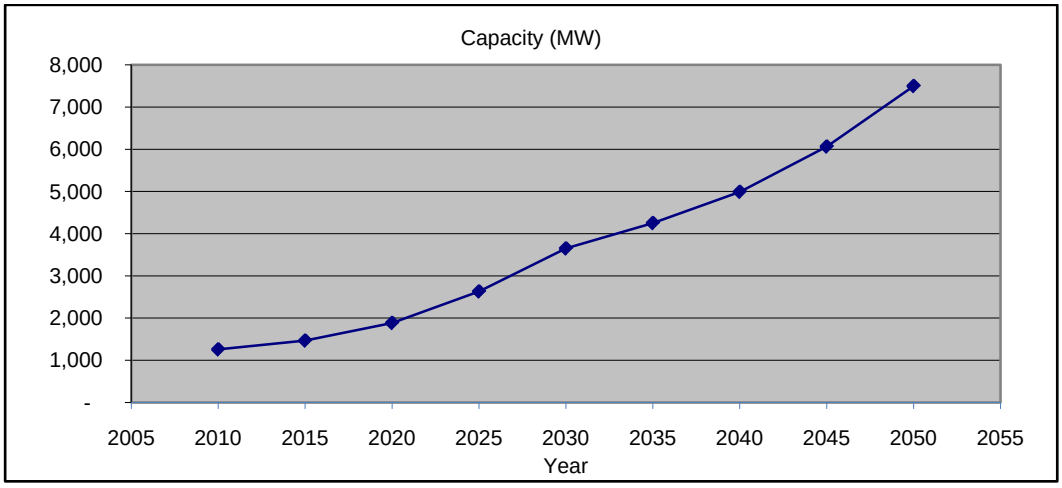


Figure 11-5: Peak Power Plant Capacity at Low Economic Growth scenario

Table 11-3: Peak Power Plant Capacity at Low Economic Growth scenario

Peak power plant capacity									
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Capacity (MW)	1,258	1,466	1,884	2,630	3,649	4,250	4,990	6,062	7,496
Electricity consumption per capita, kWh/capita	104	115	143	198	256	293	335	390	450

11.2 Medium Economic growth rate

The major assumptions of the base case scenario are as follows:

i) GDP growth rate according to Base case, i.e. with an average GDP growth rate of 5.6 percent

ii) The shares of each demand technology in the energy supply in future years are considered to be invariant i.e. energy mix of total demand will be as similar as in the base year.

The Table 11-4 shows the expected total energy consumptions of the base case scenario. The total energy consumption is expected to grow to 0.64 million GJ in year 2030 to 1.25 million GJ from the base year value of 0.4 million TJ in year 2050. The per capita energy consumption for 2050 is expected to stand at 27 GJ.

Table 11-4: Fuel Consumptions at Medium Economic growth rate

Fuel	Total Energy Consumption, TJ								
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agri residue	13,565	14,983	17,077	20,405	26,017	30,951	39,608	53,489	75,842
Animal Dung	23,069	24,369	25,701	27,055	28,420	29,784	31,127	32,428	33,250
Av fuel	2,789	4,484	5,366	6,507	7,485	8,024	8,602	9,221	9,885
Coal	11,975	14,825	18,977	24,788	32,802	44,352	60,552	86,576	127,639
Diesel	18,747	24,426	32,020	42,917	57,749	78,939	110,331	158,971	236,775
Fuel wood	312,628	331,723	352,412	375,467	402,346	427,510	455,108	487,153	519,944
Electricity, Grid, hydro	9,985	11,842	16,022	24,427	35,047	45,270	58,880	79,944	110,699
Electricity, Off-grid+pico	44	102	226	473	457	470	473	457	456
Electricity, solar	18	18*	34	72	86	118	185	244	244
Kerosene	1,493	1,800	2,290	3,108	4,506	5,638	7,172	9,460	12,748
LPG	6,302	8,723	12,911	20,094	32,665	42,425	55,842	75,917	104,546
OPP	1,426	1,462	1,584	1,819	2,226	2,618	3,162	4,030	5,383
Petrol	3,087	4,974	5,835	6,846	8,031	9,422	11,053	12,967	15,212
BioGas	2,767	3,077	3,429	3,830	4,285	4,804	5,397	6,076	6,496
Total	407,895	446,810	493,885	557,804	642,123	730,324	847,492	1,016,933	1,259,120

*The solar electricity remains constant in totality in the year 2015 due to reduction in solar energy consumption in commercial sector as optimized result by MARKAL for low cost objective

The chart shown in below figure 11-6shows the projected consumption of various energy carriers from base year 2010 to year 2050. In this scenario, petroleum products, grid electricity and coal will be increasing at annual growth rate around6 percent, Solid biomass at2.4 percent and the modern renewable fuels at 1.5 percent respectively. Meanwhile, the average growth rate of total energy consumption will be 3 percent.

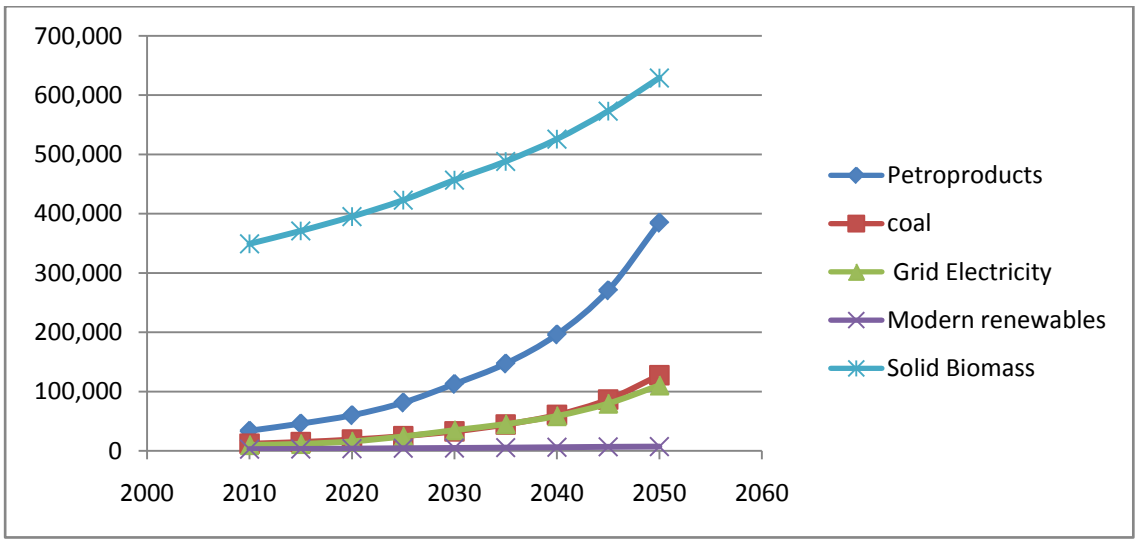


Figure 11-6: Fuel Consumption Trend at Medium Economic growth rate

The shares of fuel types are shown in the figures below for year 2020, 2030 and 2050 respectively. In year 2020, the share of fuel wood is expected to decrease from 77 percent to 71 percent. This decreasing trend is followed in successive years with 62 percent and 41 percent in year 2030 and 2050 respectively. On other hand, the share of grid electricity is expected to increase to 3.24 percent in year 2020 from 2 percent in year 2010 to 5.46 percent and 8.79 percent in years 2030 and 2050 respectively. Similarly the share of petroleum products are also expected to increase form base year value of 8 percent to 12 percent, 18 percent and 30 percent in years 2020, 2030 and 2050 respectively.

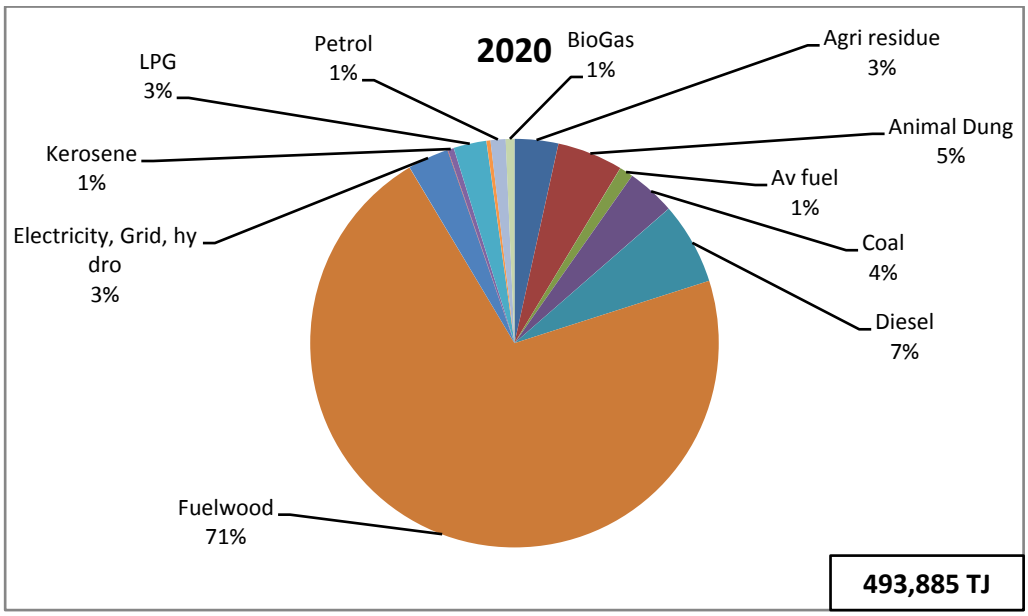


Figure 11-7: Fuel mix in Medium Economic growth rate in 2020

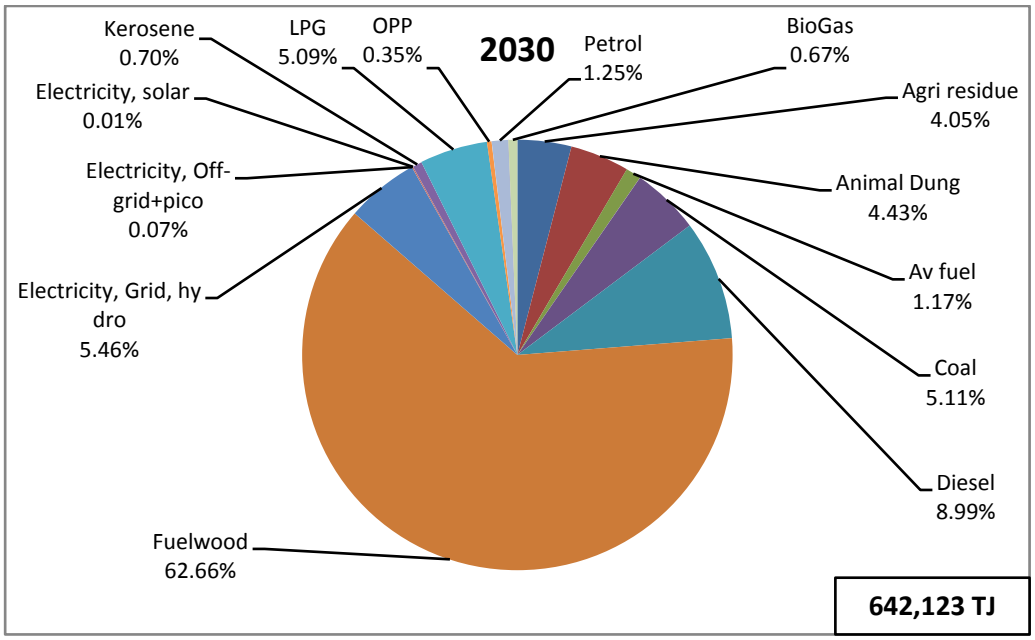


Figure 11-8: Fuel mix in Medium Economic growth rate in 2030

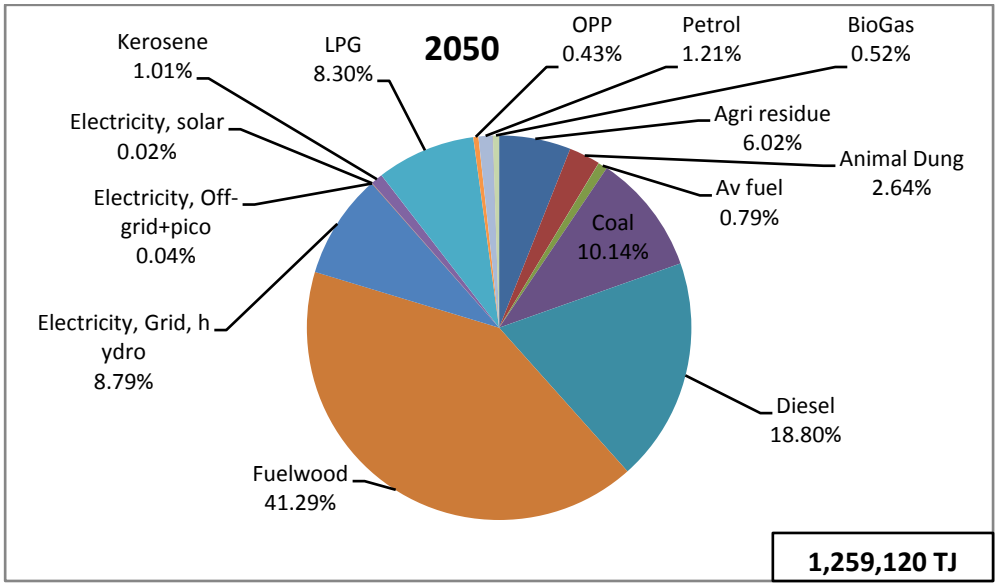


Figure11-9: Fuel mix in Medium Economic growth rate in 2050

The sectoral energy consumption pattern is shown in Table 11-5. The share of residential sector in total primary energy consumption will decrease from 87.5 percent to 81 % in year 2020 and subsequently to 69.5 and 42.2 percent in year 2030 and 2050 respectively. The share of commercial sector will increase from 1.4 percent in 2010 to 7.7 percent in 2030 and to 14 percent in 2050 in this scenario. Industrial sector will consume 11.5 percent in 2030 and 23.2 percent in 2050. The energy consumption in transportation sector also shows increasing trend from 5.4 percent in base year to 10.4 percent in 2030 and 19.3 percent in 2050. Commercial sector shows the greatest increase in share by ten folds in year 2050 compare to base year 2010.

Table 11-5: Sectoral Energy Consumption (TJ) at Medium Economic growth rate

	Sectoral Energy Consumption (TJ)									Av. Annual growth
	Year									
	2010	2015	2020	2025	2030	2035	2040	2045	2050	
Agriculture	3,056	3,465	4,049	4,810	5,766	7,175	8,984	11,590	15,398	4.13%
Commercial	5,535	9,041	15,640	27,635	49,440	65,696	88,497	123,422	176,574	9.04%
Industrial	20,121	25,454	34,714	51,263	73,815	99,250	136,507	196,602	291,892	6.92%
Residential	357,238	378,477	400,470	423,136	446,367	470,019	493,904	517,786	531,780	1.00%
Transport	21,946	30,373	39,011	50,960	66,734	88,184	119,600	167,533	243,475	6.20%
Total	407,895	446,810	493,885	557,804	642,123	730,324	847,492	1,016,933	1,259,120	2.86%

The hydropower plant capacity required is shown in Figure 11-10. The capacity required shows an increasing trend as expected since the demand is also increasing. The scenario analysis shows the required power plant capacity to be installed to be1,914 MW in year 2020, 3,912 MW in year 2030 and by 2050. The total hydropower plant capacity will rise to 11,005 MW showing the 10 folds rise from base year capacity. The electricity consumption per capita will increase as well from base year value of 104kWh to 277kWh in year 2030 and to 662 kWh in year 2050.

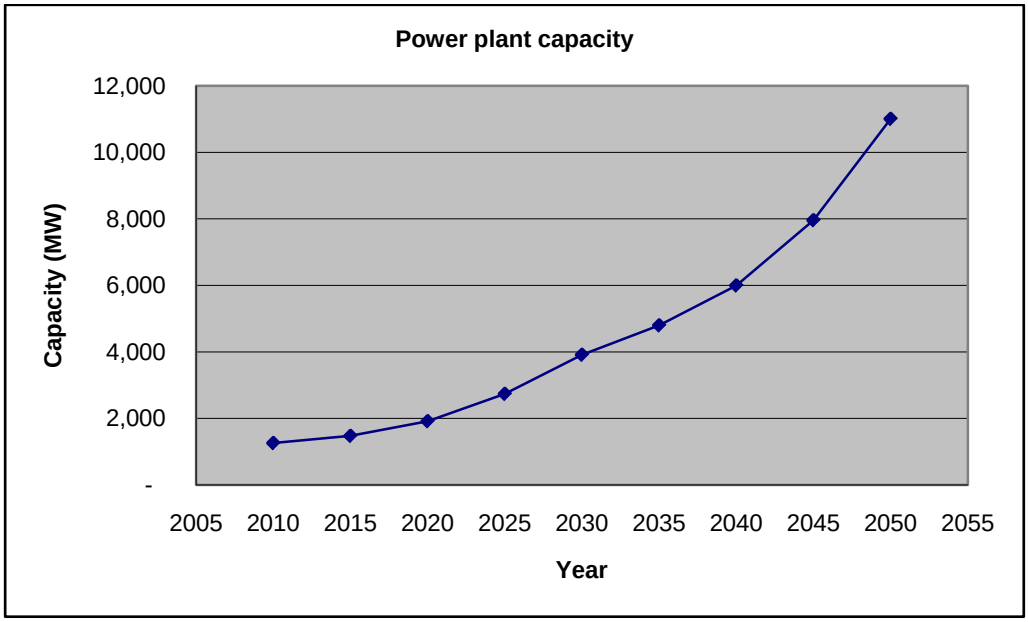


Figure 11-10: Power Plant Capacity at Medium Economic growth rate

Table 11-6: Power Plant Capacity at Medium Economic growth rate

Power Plant Capacity									
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Capacity (MW)	1,258	1,473	1,914	2,736	3,912	4,796	5,996	7,957	11,005
Electricity consumption per capita, kWh/capita	104	115	145	207	277	334	405	513	662

Energy Indicators at Reference Case

The Table 11-7 indicates that per capita final energy consumption nearly doubles from 2010value of 15 GJ to 27 GJ in 2050. Per capita electricity consumption is expected to grow from 104 KWh in 2010 to 277 KWh in 2030 and 662 kWh in year 2050. The final energy intensity shows a decreasing trendfrom0.023GJ/1000$ in 2010 to 0.015GJ/1000$ in 2030 and 0.009 GJ/1000$. Electricity intensity increases to 0.209 KWh/1000$ in 2050 from 0.231 KWh/1000$ in year 2030 which is around 0.157 KWh/1000$in the base year. The power utilization of the potential hydropower in Nepal improves staggering to26.2 percent in 2050 from 3 percent in 2010.The power utilization of the potential hydropower is nearly 9.3 percent in year 2030. The final energy used per household decreases to 57 GJ in 2050 from 66 GJ in 2010. The share of non-carbon energy in the total primary energy reaches only8.8 percent in 2050 from 5.5 percent in 2030 which was 2.4 percent in 2010, depicting the higher consumption of carbon based energy sources. Meanwhile, the share of renewable energy in total primary energy doubles from 3.1 percent in 2010 to 6.2 percent in 2030 and triples to 9.4 percent in year 2050. The ratio of net imports to total primary energy supply in physical terms increases to 39.1 percent in 2050 from 10.1 percent in 2010, thus showing the increasing dependence on imported energy fuels. The GHG emitted due to energy use rises from 149 Kg per capita in 2010 to 869 Kg in 2050 which is almost six times from the emission value in base year.

Table 11-7: Energy Indicators in Medium Economic growth rate

		2010	2015	2020	2025	2030	2035	2040	2045	2050
Final energy consumption/capita	GJ/capita	15	16	16	17	18	19	21	23	27
Final electricity consumption	kWh/capita	104	115	145	207	277	334	405	513	662
Final energy consumption	GJ/1000$	0.023	0.021	0.019	0.017	0.015	0.013	0.011	0.010	0.009
Final Electricity Consumption	kWh/1000$	0.157	0.155	0.170	0.205	0.231	0.226	0.220	0.215	0.209
Electricity power utilized	per cent	3.0%	3.5%	4.6%	6.5%	9.3%	11.4%	14.3%	18.9%	26.2%

		2010	2015	2020	2025	2030	2035	2040	2045	2050
Total Energy Consumption/ value added in industrial sector	GJ/1000$ value added	0.017	0.018	0.020	0.023	0.026	0.026	0.027	0.028	0.030
Total Energy Used/household	GJ/HH	66	65	64	63	61	60	59	57	57
share of non-carbon energy in primary supply	per cent	2.4%	2.7%	3.2%	4.4%	5.5%	6.2%	6.9%	7.9%	8.8%
Share of renewable energy in final total energy consumption	per cent	3.1%	3.4%	4.0%	5.2%	6.2%	6.9%	7.7%	8.5%	9.4%
the ratio of net import to total primary energy supply	per cent	10.1%	12.2%	14.5%	17.6%	21.1%	24.6%	28.7%	33.5%	39.1%
GHG emission for every ton of energy production and use	GHG in Kg/capita	149	180	214	264	331	404	503	651	869

11.3 High Economic Growth Scenario

The following are the major assumptions of this scenario:

i) GDP growth rate according to low growth case, i.e. with an average GDP growth rate of 6.5 percent.

ii) The shares of each demand technology in the energy supply in future years are considered to be invariant i.e. energy mix of total demand will be as similar as in the base year.

The Table 11-8 shows the total energy consumption for the high growth case of various fuel types from base year 2010 to year 2050. The total energy consumption is expected to grow from current level of 0.407 GJ in 2010 to 1.6 GJ in year 2050 showing around four folds of increment. The average annual growth rate of energy consumption is 3.5% for this case.

Table 11-8: Fuel Consumption at High Economic growth rate

Total Energy Consumption, TJ									
Fuel	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agri residue	13,565	15,006	17,208	20,847	27,379	33,616	45,288	64,814	104,897
Animal Dung	23,069	24,369	25,701	27,055	28,420	29,784	31,127	32,428	33,250
Av fuel	2,789	4,484	5,366	6,507	7,485	8,024	8,602	9,221	9,885
Coal	11,975	14,981	19,664	26,505	36,691	51,819	74,902	112,804	190,103
Diesel	18,747	24,676	33,143	45,784	64,353	91,802	135,743	205,983	350,406
Fuelwood	312,628	331,768	352,665	376,276	404,724	431,972	463,539	502,165	554,661
Electricity, Grid, hydro	9,985	11,920	16,422	25,746	38,461	51,643	70,761	101,043	159,617
Electricity, Off-grid+pico	43	98	221	473	455	456	457	473	445
Electricity, solar	18	18*	34	72	86	118	185	244	244
Kerosene	1,493	1,806	2,324	3,221	4,851	6,291	8,411	11,673	17,881
LPG	6,302	8,775	13,221	21,139	35,858	48,404	67,112	95,915	150,608
OPP	1,426	1,467	1,606	1,877	2,374	2,893	3,677	4,951	7,532
Petrol	3,087	4,974	5,835	6,846	8,031	9,422	11,053	12,967	15,212
BioGas	2,767	3,077	3,429	3,830	4,285	4,804	5,397	6,076	6,496
Total	407,894	447,418	496,840	566,174	663,453	771,047	926,253	1,160,758	1,601,237

*The solar electricity remains constant in totality in the year 2015 due to reduction in solar energy consumption in commercial sector as optimized result by MARKAL for low cost objective

The Figure 11-11, 11-12, 11-13 and 11-14 depicts the consumption of different category of energy sources. The highest share in all years is by solid biomass followed by petroleum products. The consumption of solid biomass increased to two folds till 2050 at the rate of 1.7 percent annually.

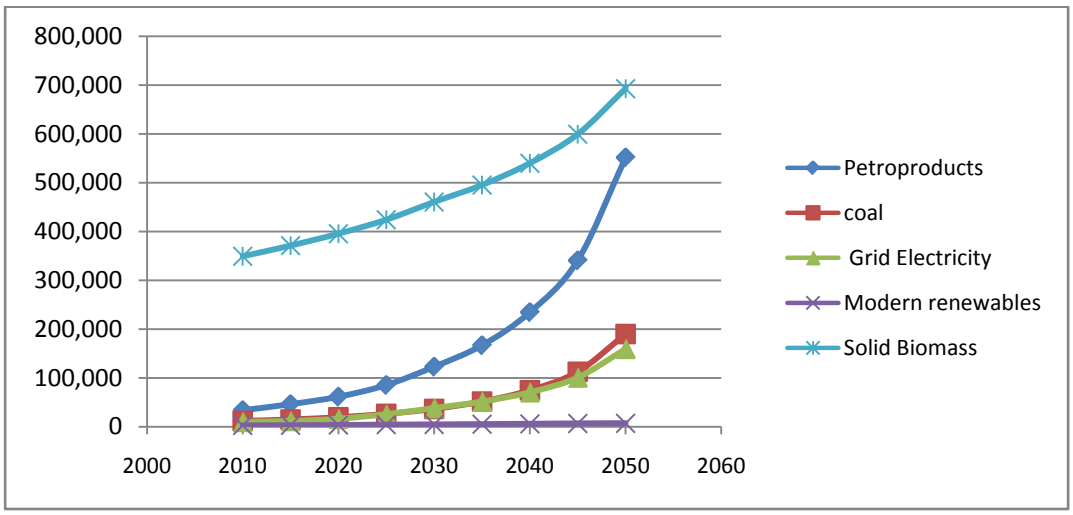


Figure 11-11: Fuel Consumption Trend in High Economic growth rate

The change in energy mix for different points of study horizon is shown below. The share of fuel-wood decreases to 61 percent in year 2030 to 35 percent in year 2050 from the base year value of 76 percent. Whereas the value share of hydroelectricity will double at each depicted years below. Whereas the consumptions of coal, petroleum products and grid electricity is seen to be increase at annual rate of around 7.2 percent. Likewise, there will be increase in share of coal and petroleum fuels as near as twice.

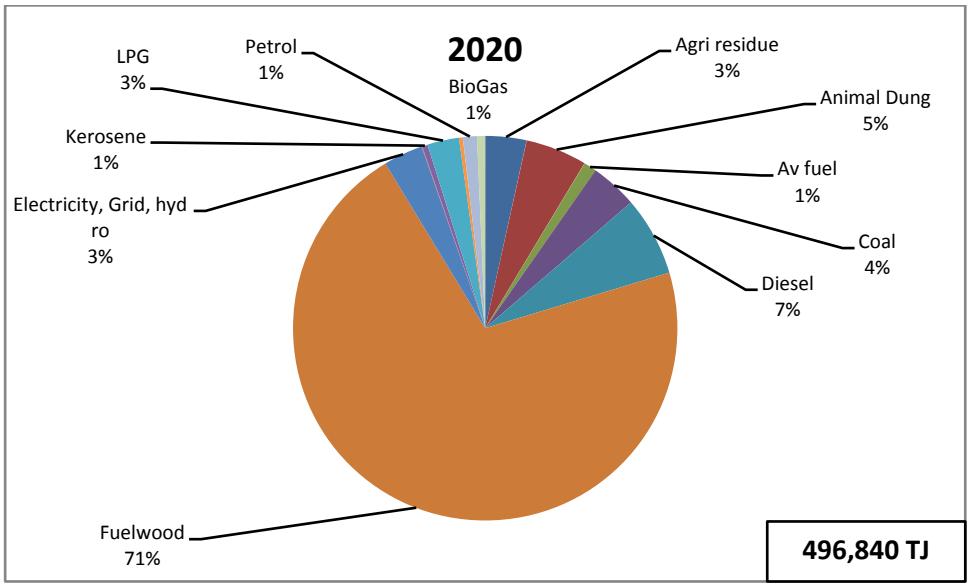


Figure 11-12: Fuel mix in High Economic growth rate in 2020

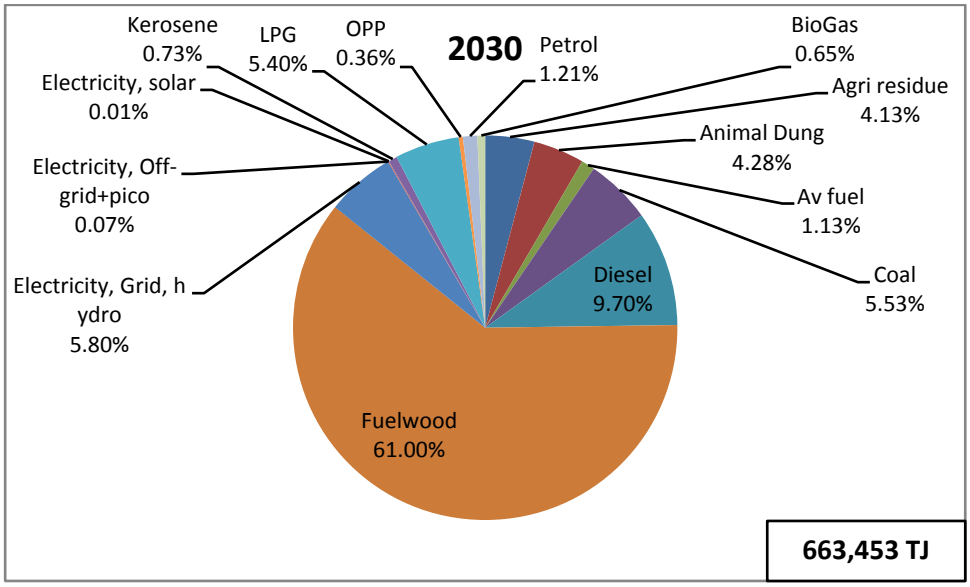


Figure 11-13: Fuel mix in High Economic growth rate in 2030

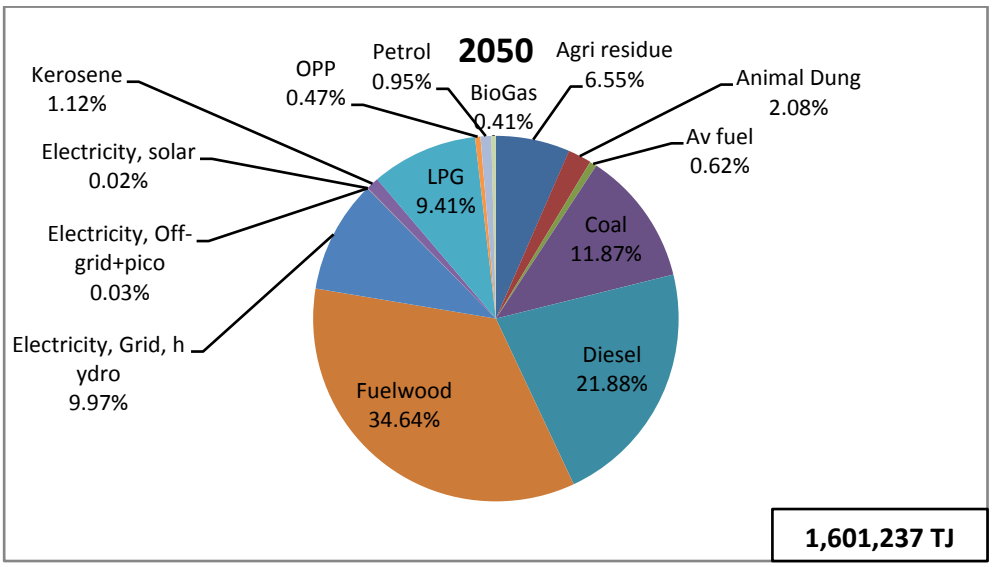


Figure 11-14: Fuel mix in High Economic Growth Rate in 2050

The sectoral energy share for the study horizon is shown in table below. The commercial sector shows the highest increase of energy consumption by nearly 48 folds from base year value at staggering rate of 10% per annum. The share of residential energy consumption reduces from 88 percent to 33 percent in year 2050. Whereas, the share of energy consumption by commercial sector increases from 1 percent base year value to 16 percent in year 2050. The shares of industrial and transportation sector in energy consumption will also increase in year 2050, thus decreasing the share of residential sector.

Table 11-9: Energy Mix by sector (TJ) in High Economic growth rate

Sectors	Year									Av. Annual growth
	2010	2015	2020	2025	2030	2035	2040	2045	2050	
Agriculture	3,056	3,504	4,206	5,160	6,476	8,416	11,156	15,151	23,005	5.18%
Commercial	5,535	9,140	16,230	29,614	55,466	76,978	109,761	161,156	263,488	10.14%
Industrial	20,121	25,719	35,968	54,828	82,618	116,031	168,963	256,305	434,984	7.99%
Residential	357,238	378,477	400,470	423,136	446,367	470,019	493,904	517,786	531,780	1.00%
Transport	21,944	30,578	39,966	53,437	72,527	99,603	142,468	210,359	347,979	7.15%
Total	407,894	447,418	496,840	566,174	663,453	771,047	926,253	1,160,758	1,601,237	3.48%

The power plant capacity required for year 2050 rise by as near as eleven times as seen in Figure 11-15 and Table 11.10 shown below. The power plant capacity of 1,954 MW is required in year 2020 and 4,253 MW by 2030 and 15,841 MW by year 2050. The electricity consumption per capita also increases as much as ten times from base year value of 104kWh to 955 kWh in year 2050.The electricity consumption per capita will increase as well from base year value of 104kWh to 304kWh in year 2030 and to 955 kWh in year 2050.

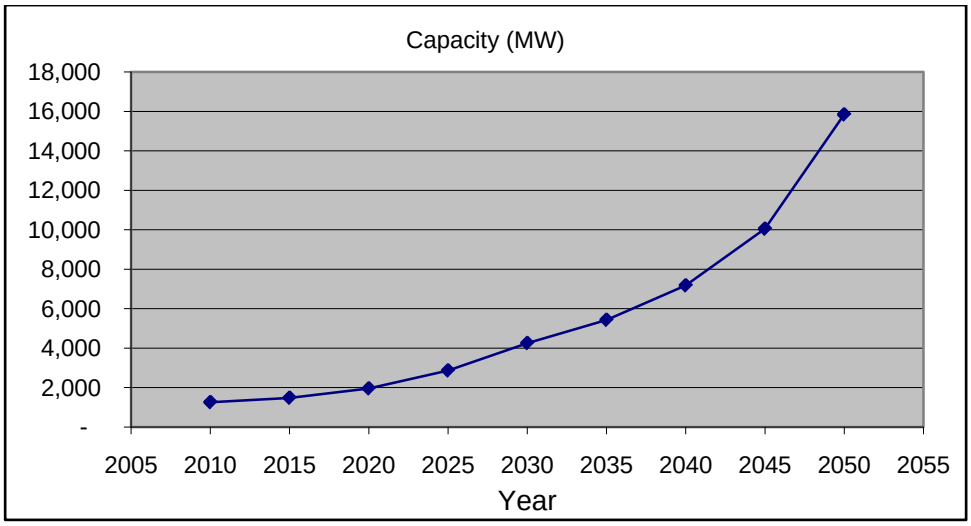


Figure 11-15: Power Plant Capacity and High Economic Growth Rate

Table 11-10: Power Plant Capacity High Economic growth rate

Power Plant Capacity									
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Capacity (MW)	1,258	1,481	1,954	2,865	4,253	5,430	7,176	10,049	15,841
Electricity consumption per capita, kWh/capita	104	116	149	218	304	381	487	648	955

11.4 All combined policy measures at Reference Case

11.4.1 Combined Policy Scenario at GDP growth 5.6% for technology Intervention:

The following are the major assumptions of this scenario.

- GDP growth rate according to reference case i.e. 5.6%.

Agriculture:

- 100% Electrification in Water pumping by 2030
- Electrification in farm machinery is totally by diesel in 2010 so new electric farm machinery is introduced and is expected to be 25% by 2030 and 50% electrified by 2050,

Commercial sector

- For 100% electrification by 2030, shares are calculated by linear interpolation in each sector taking 2010 as the base year share.

Transportation

- Introduction of electric train in freight transport and its share is assumed to be 30% by 2050

- Introduction of electric train in intercity transport and its share is assumed to be 30% by 2050, electric car is introduced in the year 2020 to reach the target of 20% share by 2050
- Share of intra city transport by 2050 is assumed as: 80% passenger bus at same time electric car and electric motorcycle is introduced to reach share of 0.1% and 0.2% respectively
- Penetration of ethanol and biodiesel in transport in the 2020 to reach the target of total its fuel share to 5% and 10% of total fuel share of gasoline and diesel respectively.

Industry:

- Boiler
  - Introduction of new electric boiler in food beverage and tobacco and 100% share by 2050
  - Introduction of new electric boiler in textile and leather and 100% share by 2050
  - Introduction of new electric boiler in chemical rubber and plastic and 100% share by 2050
  - Introduction of new electric boiler in wood products and paper and 100% share by 2050
  - Introduction of new electric boiler in food beverage and tobacco and 100% share by 2050
- Motive power and other
  - 100% electrification by 2030
  - but in case of mechanical engineering and manufacturing: other, 100% electrification is done only by 2050 since coal share is nearly 99% in 2010
- Process Heat
  - Efficiency of technology is changed in base year, which was initially taken as 1, while final energy remaining constant, only useful energy is changed

Residential sector:

Rural cooking: (rural includes peri-urban areas?)

- 40% electric, 50% fuelwood and 10% LPG share by 2030
- ICS penetration with efficiency increasing from 7% in 2010 to 15% by 2030 and remain constant till 2050

Urban cooking: 100% electrification by 2030

Rural space heating: shares remain same as base year

Urban space heating: 100% electrification by 2030

Rural water heating:

- solar thermal, new technology added, 10% share by 2030 and remain constant
- shares changed as 40% electric, 50% fuel wood and 10% LPG share by 2030

Urban water heating:

- solar thermal as a new technology is penetrated and its share reach the value of 25% by 2030 and remain constant afterward assuming100% electrification by 2030

Rural others:

- All technologies have constant share except kerosene and LPG which are dropped to zero for introduction of efficient fuel wood technology i.e efficiency of ICS is increased from 7% in 2010 to 15% by 2030 and remain constant till 2050

Urban others: 100% electrification by 2030

Rural lighting: 100% electrification by CFL by 2030

Urban lighting: 100% electrification by CFL by 2030

Efficiency of ICS is increased from 7% in base year to 15 % by 2030.

The final consumptions of various fuels in this scenario have been given in Table11-11. The total energy consumption in 2030 is expected 0.329 million TJ and 0.708 million TJ by 2050. The per capita energy consumption for 2050 will be 27 GJ in reference case and 16GJ in combined policy scenario.

Table 11-11: Fuel Consumption in Combined Policy Scenario

Total Energy Consumption, TJ									
Fuel	Year								
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Agri residue	13,565	14,663	16,699	19,982	25,566	30,470	39,095	52,942	75,288
Animal Dung	23,069	18,855	15,091	11,012	6,501	6,757	6,994	7,206	7,382
Av fuel	2,789	4,296	4,916	5,688	6,229	6,341	6,437	6,513	6,567
Coal	11,975	13,285	15,480	18,549	22,699	30,683	41,955	60,134	88,892
Diesel	18,747	24,011	29,620	37,012	46,294	60,001	79,157	101,948	128,916
Fuelwood	312,628	262,388	216,944	174,217	131,588	137,497	143,349	149,423	155,836
Electricity, Grid, hydro	9,985	17,553	29,001	48,962	79,531	99,957	127,292	168,501	228,250
Electricity, Off-grid+pico	35	99	202	357	378	549	445	301	421
Electricity, solar	18	22	40	85	114	177	306	429	429
Kerosene	1,493	493	215	181	9	10	11	12	15
LPG	6,302	6,518	7,254	7,067	3,497	3,634	3,760	3,873	3,966
OPP	1,426	1,328	1,303	1,354	1,491	1,619	1,850	2,313	3,122
Petrol	3,087	4,490	4,630	4,702	4,703	4,560	4,259	3,753	2,987
BioGas	2,767	1,603	870	335	0	0	0	0	0
Bio-diesel	0	0	67	138	211	276	328	352	332
Ethanol	0	0	192	498	969	1,696	2,832	4,424	6,588
Total	407,886	369,602	342,524	330,140	329,778	384,227	458,070	562,125	708,991

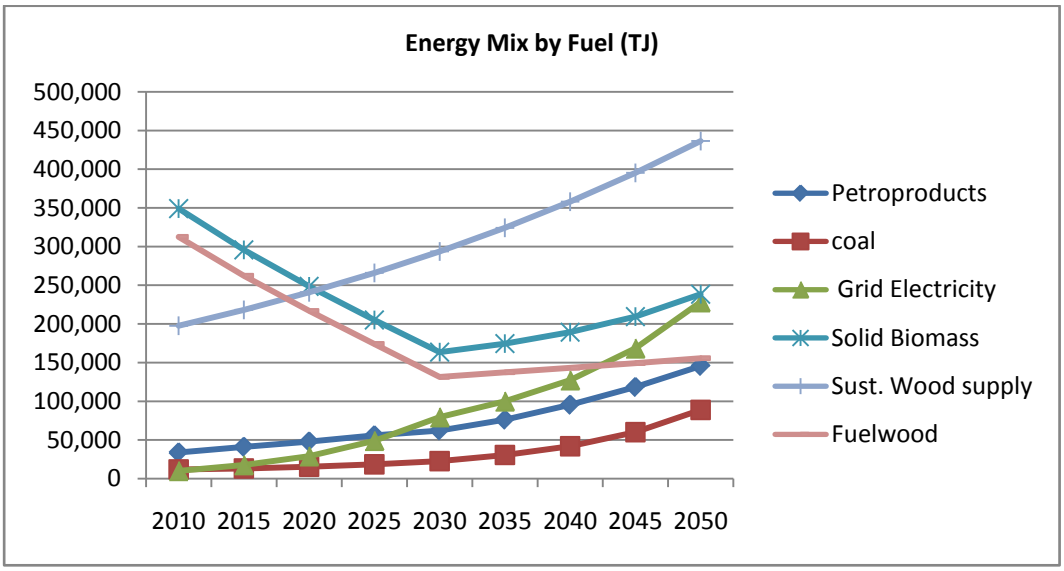


Figure 11-16: Fuel Consumption in Combined Policy Scenario

Fuelwood consumption will be well below sustainable limits by 2020 while electricity consumption grows rapidly after 2020. The cumulative growth rate of electricity consumption in this scenario is 14 percent. Petroleum consumption will grow at an average rate of 9 percent.

Figures below (Figure 11-17, 11-18 and 11-19) show the shares of primary fuels in 2020, 2030 and 2050. It can be seen that fuelwood share will decrease to 40 percent by 2030 and to 22% by 2050. Electricity share will increase from 2 percent in 2010 to 8 percent in 2020 and then to 24 percent in 2030 and 32% in 2050. Petroleum products will increase from 8 percent in base year to amount to 19 percent in 2030 and 21 percent in 2030 respectively. Solid biomass share will reduce from current 86 percent to 50% by 2030 and 34 percent by 2050

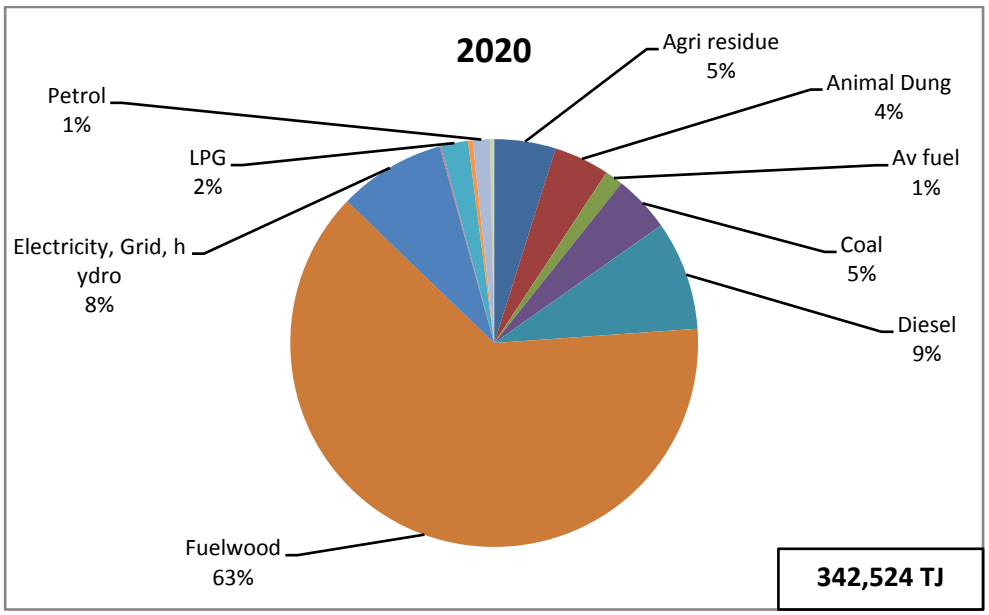


Figure 11-17: Fuel mix in Combined Policy Scenario in 2020

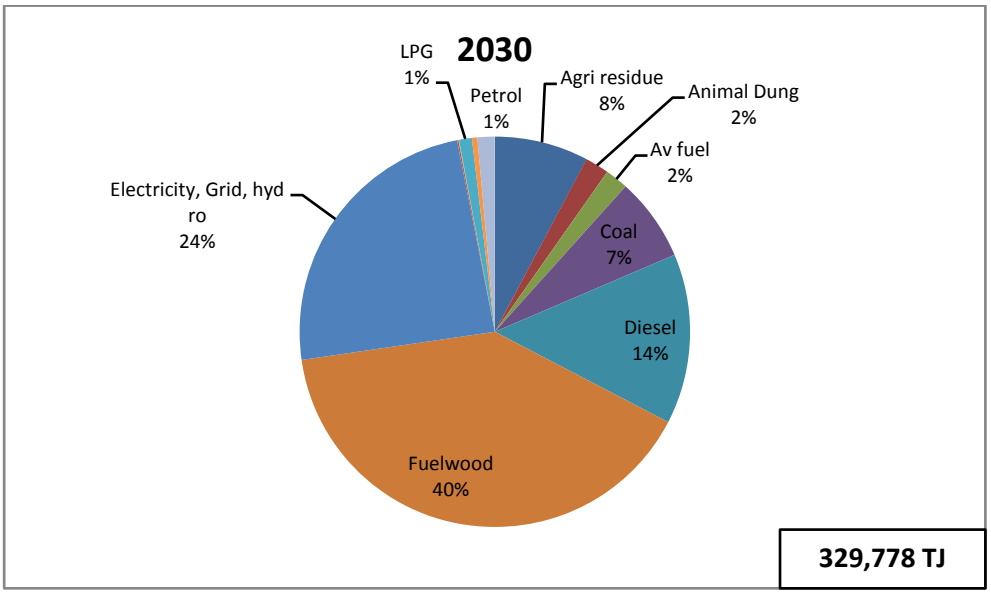


Figure 11-18: Fuel mix in Combined Policy Scenario in 2030

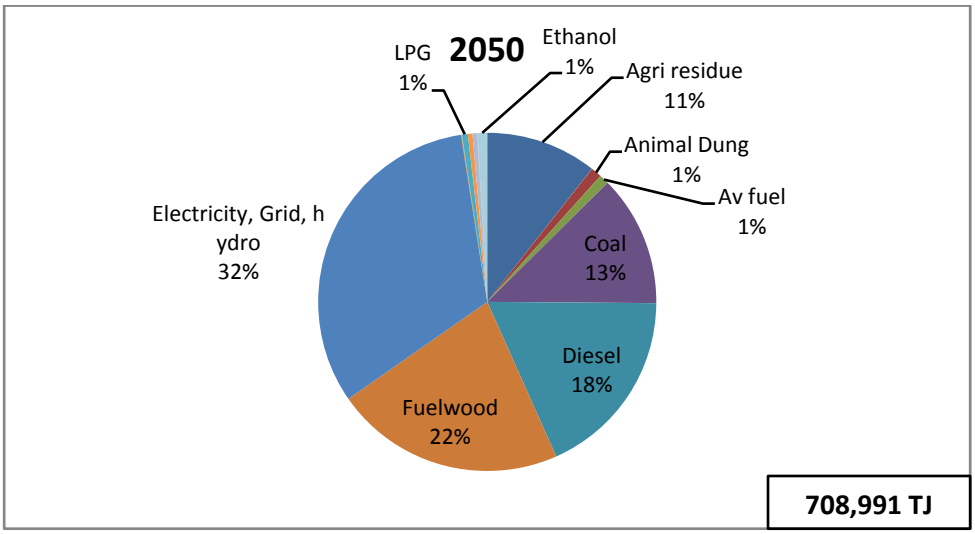


Figure 11-19: Fuel Mix in Combined Policy Scenario in 2050

Table 11-12: Sectoral Energy Consumption in TJ in Combined Policy Scenario

Sectoral Energy Consumption in TJ										Av annual growth
	2010	2015	2020	2025	2030	2035	2040	2045	2050	
Agriculture	3,056	3,120	3,243	3,374	3,471	4,114	4,903	6,005	7,553	2.29%
Commercial	5,535	7,701	11,078	17,328	27,021	35,768	48,007	66,764	96,364	7.40%
Industrial	20,121	23,967	31,157	44,480	62,428	83,768	115,307	166,266	247,177	6.47%
Residential	357,238	305,017	260,404	219,286	179,819	188,658	197,411	206,031	211,150	-1.31%
Transport	21,937	29,797	36,642	45,673	57,039	71,920	92,443	117,059	146,748	4.87%
Total	407,886	369,602	342,524	330,140	329,778	384,227	458,070	562,125	708,991	1.39%

Table 11-12 shows the sectoral pattern of energy consumption. In this scenario, residential sector consumes 87 percent of total energy in 2010 and 54 percent in 2030 which further reduces to 29 percent by 2050. The shares of commercial, industrial, and transport sectors in 2030 will be 8 percent, 18 percent and 17 percent respectively and this share is changed to 13 percent, 34 percent and 20 percent respectively. Remaining share is consumed by agriculture.

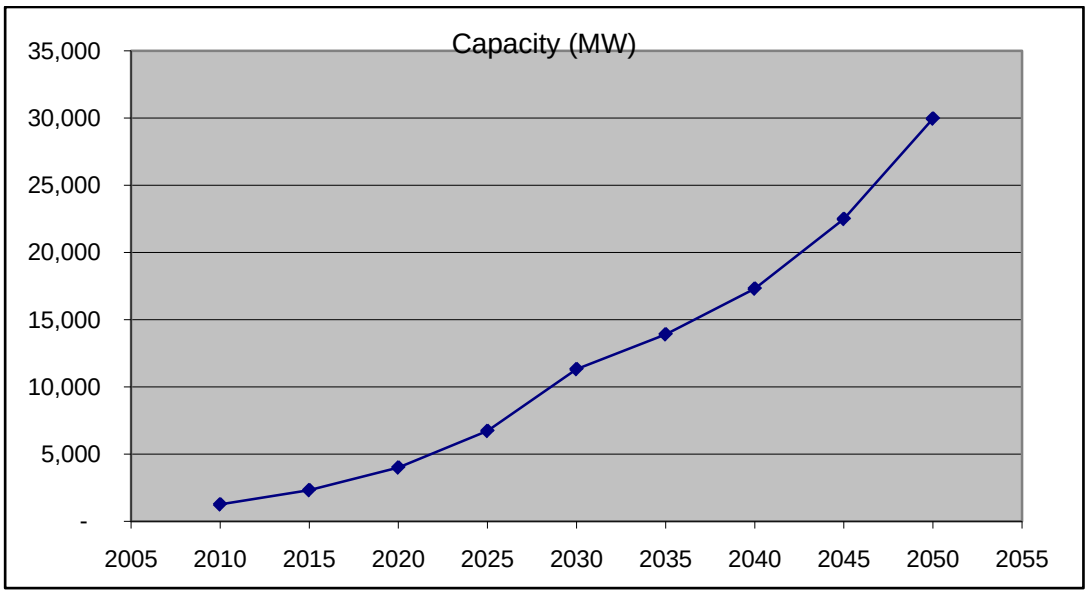


Figure 11-20: Power Plant capacity in Combined Policy Scenario

The power plant capacity required will be as Table 11-13. At present in base year 2010 peak power requirement stand at 1272MW. The power plant requirement for 2020 will be 4,061 MW, in 2030 it will be 11,536 MW and 31,133MW by 2050. This is almost 2.5 times the requirement in the reference case. This huge power plant cacpicity is required to fulfill the increased electricity demand from base year value of 104kWh to 628 kWh in year 2030 and to 1464 kWh in year 2050

Table 11-13: Power plant Capacity in Combined Policy Scenario

Power plant Capacity									
	2010	2015	2020	2025	2030	2035	2040	2045	2050
Capacity (MW)grid-conn	1,258	2,318	4,000	6,720	11,317	13,905	17,303	22,485	29,950
Capacity (MW)off-grid ren	15	29	61	129	219	410	819	1,183	1,183
Capacity (MW)offgrid genset	-	-	-	-	-	-	-	-	-
Total Capacity (MW)	1,272	2,347	4,061	6,849	11,536	14,315	18,122	23,668	31,133
Electricity consumption per capita, kWh/capita	104	171	263	415	628	737	938	1159	1464

11.4.2 Energy Indicators in the Combined Case

The following Table 11-14 shows some of the key energy indicators in this scenario. It is evident from the table that with some policy interventions Nepal can move towards a sustainable development, even though they may not be in line with some of the energy targets set by multilateral donor agencies to meet the MDGs.

Table 11-14: Energy Indicators in Combined Policy Scenario

		2010	2015	2020	2025	2030	2035	2040	2045	2050
Final energy consumption/capita	GJ/capita	15	13	11	10	9	10	12	14	16
Final electricity consumption	kWh/capita	104	171	263	415	628	737	938	1159	1464
Final energy consumption	GJ/1000$	0.0231	0.0175	0.0131	0.0100	0.0078	0.0069	0.0062	0.0054	0.0048
Final Electricity Consumption	kWh/1000$	0.1570	0.2304	0.3074	0.4113	0.5233	0.4994	0.4749	0.4535	0.4299
Electricity power utilized	per cent	3.0%	5.5%	9.5%	16.0%	26.9%	33.1%	41.2%	53.5%	71.3%
Total Energy Consumption/ value added in industrial sector	GJ/1000$ value added	0.0172	0.0169	0.0177	0.0199	0.0218	0.0222	0.0231	0.0240	0.0250
Share of non-carbon energy in primary supply	per cent	2.4%	4.7%	8.5%	14.8%	24.1%	26.0%	27.8%	30.0%	32.2%
Share of renewable energy in final total energy consumption	per cent	3.1%	5.2%	8.9%	15.3%	24.6%	26.7%	28.6%	31.0%	33.3%
The ratio of net import to total primary energy supply	per cent	10.1%	13.2%	16.9%	20.9%	24.0%	26.4%	28.8%	30.8%	32.3%
GHG emission for every ton of energy production and use	GHG in Kg/capita	139	150	160	173	184	232	279	340	421

Comparison of reference and combined case

In the combined case, per capita final energy consumption stands at 16 GJ in 2050 which is almost 50 percent less than in the reference case. This is because of the policy measures of introduction of more highly efficient energy sources in the energy ladder than in the reference case.

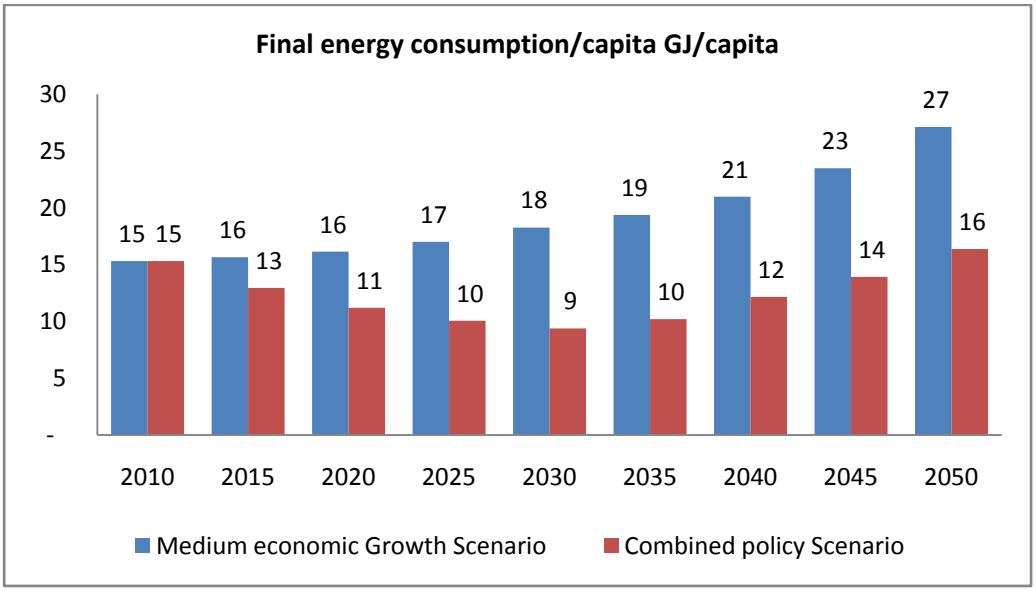


Figure 11-21: Per Capita Energy Consumption

In the combined scenario, per capita electricity consumption will rise to 1464 KWh in 2050 compared to 662 KWh in the reference case. This drastic increase is caused by the substitution of fossil fuels, biomass solids by cleaner energy sources in industries, commercial (service), and residential sectors.

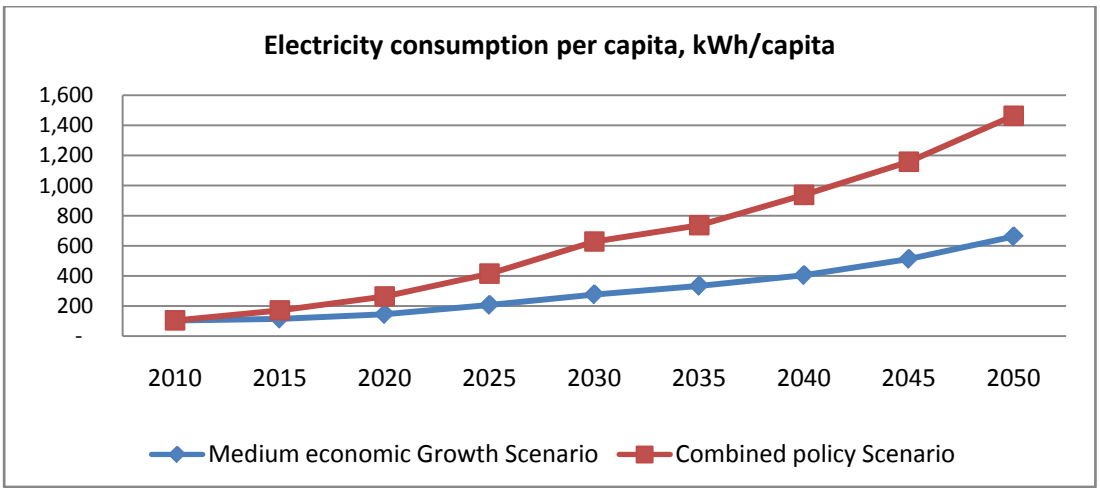


Figure 11-22: Growth Trend of Per Capita Electricity Consumptions

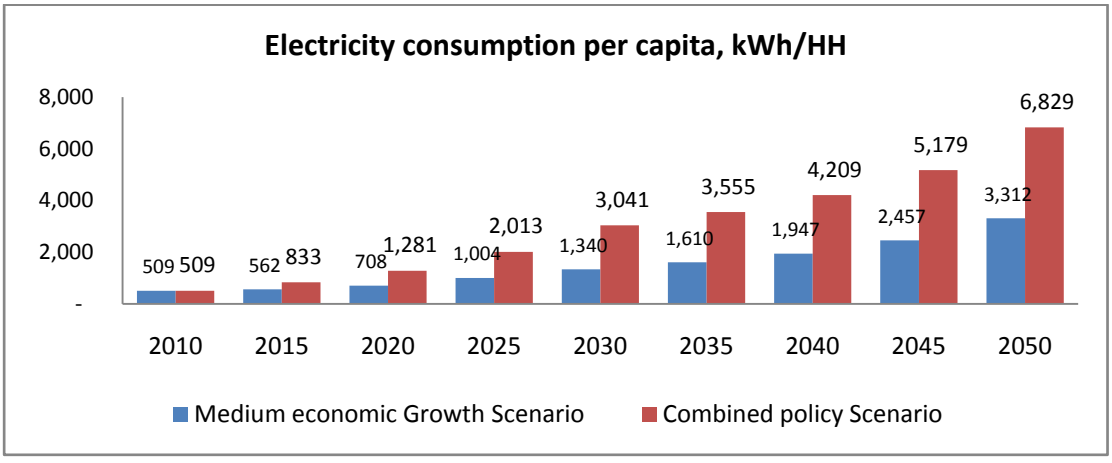


Figure 11-23: Household Electricity Consumption Per Capita

The combined case indicates that per capita household electricity consumption increases to 1004 KWh compared to 3041 KWh in reference case in 2030 and it increases to 6829Kwh and 3312Kwh in combined and reference case scenario respectively. Though the indicator shows rising growth in the electricity consumption if policy emphasis is focused on hydropower development in the country.

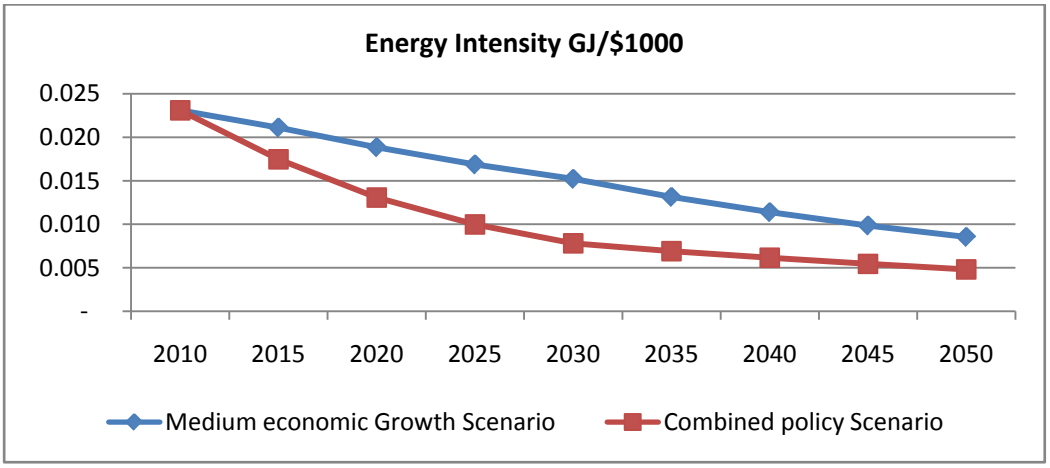


Figure 11-24: Falling Trend Energy Intensity

Energy intensity in the year 2010 stands at 0.023 GI/1000$. With the utilization of more efficient technologies in the combined scenario, energy intensity reduces to 0.0048 GJ/1000$ in 2050 in combines scenario compare to 0.008543 GJ/1000$ in the base year.

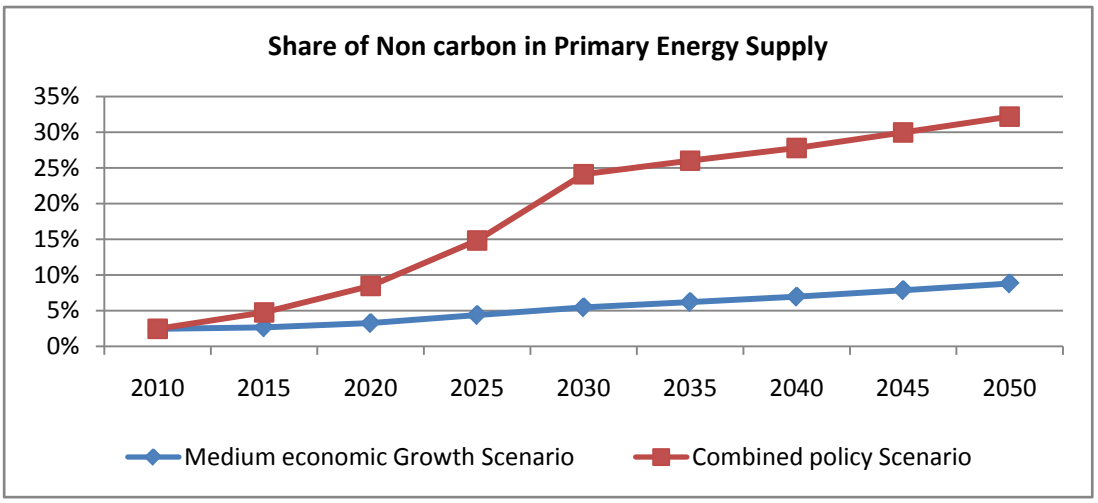


Figure 11-25: Share of Non Carbon Energy in Total Final Energy

Share of non carbon energy in the combined case will achieve 32 percent compared to 9 percent in 2050 in the reference case which indicates the path taken will move the country in the sustainable development. It directs the country in the reduction of CO2- equivalent emissions.

The combined case with all the policy measures taken indicates a scenario which is also environmentally sustainable. The per capita CO2 equivalent emission in 2030 in the combined scenario is 50 percent less than in the reference case (Figure11-26).

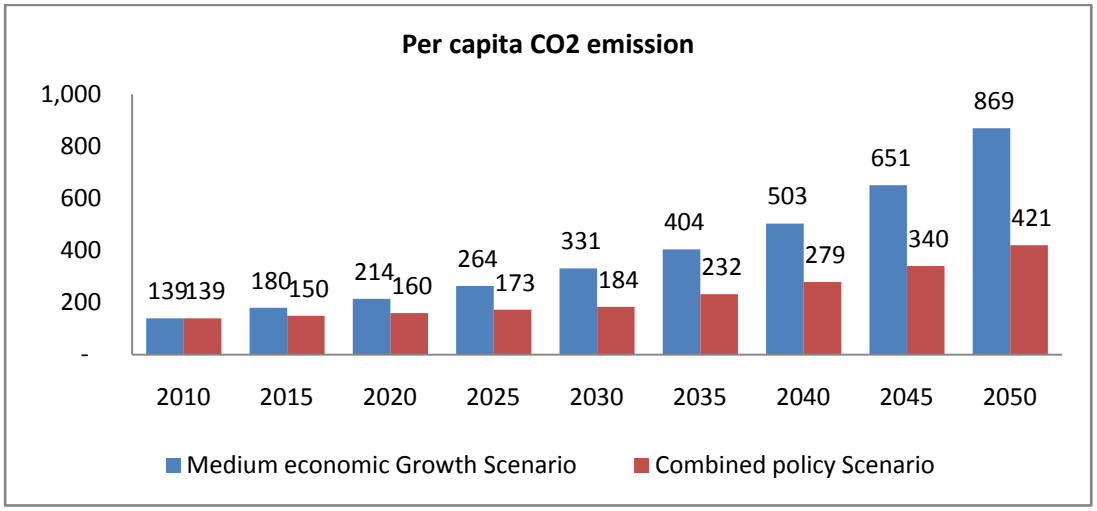


Figure 11-26: Per capita CO2 Emissions

Per capita CO2 emissions in 2030 stands at 331kg and will be 869 Kg by 2050 in the reference case while emission in 2030stands at 184kg and will be 421kg by 2050 in combined policy case scenario. Nepal can use carbon credit it if it can take various strategies for the sustainable development in the country.

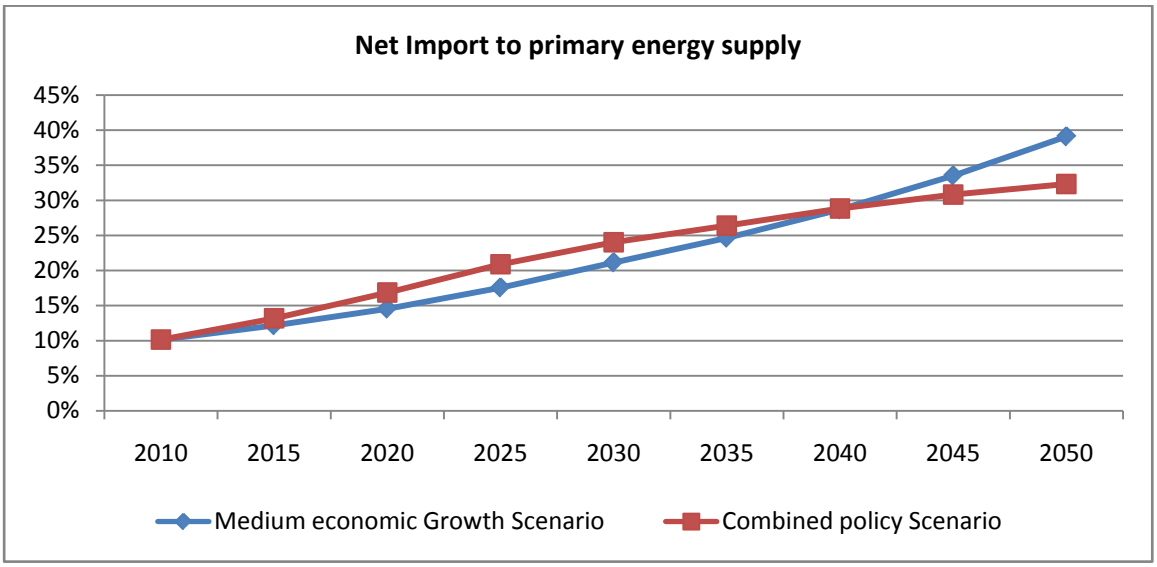


Figure 11-27: Net Imports of energy commodity to the Total Energy Consumptions

The above Figure 11-27 indicates that percentage of net imports to the total energy consumption has increased in the combined case compared to the reference case from 2015 onwards till 2040 and then decrease to attain a value of 32 percent in 2050 in combined case compared to 39 percent in the reference case in physical quantities. Though the percentage values show import dependence increasing eventually but the indicator is a relative one. In absolute terms, the imports are declining. The biomass solid fuels are being replaced by fuels in the intermediate rung in the energy ladder firstly, by kerosene and LPG and then only, by electricity. In the rural sector, consumers cannot switch over to electricity immediately due to low household income.

Overall, all these indicators show that Nepal can have a sustainable, affordable, and secure energy supply and meet its growing demand by harnessing its indigenous energy resources and deploying modern but available technologies in the end use processes.

CHAPTER 12
VISION FOR 2050 AD

12.1 Vision for Energy Sector and its Sub-Sectors for 2050 AD

12.1.1 Traditional (Biomass) Energy

The commonly perceived vision of the Traditional Energy sub-sector for 2050 firmly spelled out that "The present heavy dependence of domestic sector on TE, for cooking, heating and food processing could be greatly reduced by developing and providing modern alternative energy sources, particularly indigenous, renewable energy sources such as hydro-power, solar-power, solar-thermal, bio-gas, etc. The pace of energy transformation would depend on the economic cost and ease of use of commonly available alternative energy sources in specific areas".

About the long term, site and end-use specific TE sub-sector vision for 2050 the general perception was more specific and categorically pointed out that:

- TE use in the urban domestic sector be completely replaced by renewable, new and alternative energy sources, primarily hydro- and solar-power
- Development and widespread use of efficient TE technologies in rural areas by increasing access not only to economically feasible renewable, new and alternative energy sources, but also to various forms of modern bioenergy produced from locally available biomass resources including wastes
- Commercial and industrial sectors transformed from current TE use to renewable, new and alternative energy sources, including locally produced bioenergy sources
- Rural commercial and industrial sectors to innovate TE technology for reducing fuel consumption and environmental preservation, as well as switchover to use renewable, new and alternative energy sources including modern bioenergy sources.

12.1.2 Commercial Energy

The most important subsector of commercial energy is hydropower energy for which superior priority is given with a separate vision which is, *"To discover, explore, develop and manage sustainably all the available potential energy resources in the country, to meet the national demand for all the commercial energy, to substitute the imported energy and to contribute maximum to the national economy through the export of indigenously produced energy".*

A common point that has featured among the vision statements suggested by the participants in all the stakeholder's consultation workshops is that, apart from having met their internal demand in 2050, they would have been exporting their hydroelectricity. While this vision was moderately suggested by the participants of workshops in both the Eastern- and Western Development Regions, participants of the Central Development Region emphasized on the development of multi-purpose hydropower projects for reaching to a state of financial prosperity. Far-Western Development Region on the other hand was more particular in specifying the domestic and internal needs such as cooking, water supply, street lighting, running of cable cars to religious and touristic spots and operating other electrical transportation systems, apart from running industries and reaching the stage of economic prosperity.

In short, the Regions desired to have a state of having generated substantial amount of hydropower from all possible types of feasible hydropower projects to reach to a state of high economic prosperity through the easy access to adequate and cheap energy to all its people for meeting all their sectoral requirements (domestic, industrial, transport, commercial and agricultural) and export their excess hydropower to the neighboring countries.

12.1.3 Renewable Energy

Analysis of the different vision statements formulated in different regional workshops indicates that the common focus in each region regarding the vision is on sustainable energy use. This led to a formulation of generic integrated vision for 2050 i.e., 'Upliftment of national economy by providing sustainable energy for all through installation/promotion of appropriate renewable energy technology based on geographical feasibility'.

Different vision statements formulated by the stakeholders during the regional workshops in the five development regions are given below:

- Renewable energy will supply around one third of total primary energy demand.
- National economy will be uplifted through development and promotion of alternative and renewable energy technology in commercial, industrial, agricultural, transport, household and other areas.
- Traditional stove will be replaced by renewable/alternative energy technologies like improved cooking stove, biogas, and solar cooker.
- Every household will have access to alternative and renewable energy.
- Renewable & alternative energy will be accessible in urban & rural Areas.
- Every household in Terai will have a biogas plant installed (running with toilet/kitchen waste).
- Micro hydro will be installed in remote/inaccessible places.
- Highly efficient bio-energy technology will be implemented where possible.
- Wind mills will be installed at potential areas.

CHAPTER 13
MISSION FOR 2050 AD

13.1 Mission for Energy Sector and its Sub-Sectors in 2050 AD

13.1.1 Traditional Energy

Short term mission 2020

To address the current heavy reliance of the domestic sector on traditional fuels by substitution by alternative energy sources

Medium term mission 2030

To effectively manage the reachable National forests; continually enhancing the combustion of TE use by introduction of efficient devices in the domestic, traditional industry and commercial service sector

Long term mission 2050

To eliminate the use of solid biomass in traditional energy form with most desirable alternative energy source

The TE sub-sector mission for realizing the Vision 2050 would include the following.

- Demonstration and encouragement of the use of modern, efficient and climate friendly bio-energy technology that would be based on locally available biomass wastes and residues, as well as sustainably produced fuel wood from reachable forests for meeting the energy needs of different sectors for diverse end-uses.
- Persuasion through policy intervention and incentive mechanisms for promoting a rapid switch over to indigenous, modern, feasible, new and alternative sources of energy particularly in the urban domestic, commercial (including institutions and food and lodging providers) and industry sectors throughout the country.
- Conservation of the environment with efficient utilization of available energy resources, including prevention of the threat of world climate change by expanding the coverage of scientific forest management practices in all reachable forests.
- Promotion of tested and already proven community forest management practices, for ensuring sustained supply of wood fuel to the current TE users, particularly the domestic sector in rural areas.
- Participation in collaborative efforts of sustainable development, including sustainable supply and efficient utilization of indigenous, renewable energy sources.

13.1.2 Commercial Energy

Short term mission 2020

To develop hydropower and other renewable energy resources to improve energy access to modern and clean energy

Medium term mission 2030

To provide universal access to modern energy to every household (a) 100% electrification - 75% grid -electricity and 25% off-grid or distributed electricity based on renewable energy technology, (b) to double the energy efficiency improvement rate, and (c) to double the share of renewable energy in the total final energy consumption

Long term mission 2050

To develop indigenous hydropower and renewable energy resources for the development of the economic sectors such as industry, transport, commercial (services), agriculture and to export surplus energy for the overall economic development of the country

In overall, hydropower will be optimally developed to cater the entire electricity needs of the nation making it economically sound, socially prosperous, politically independent, and environmentally sustainable.

13.1.3 Renewable Energy

Three separate missions for short, medium and long term are given below in the form of a slogan, specifically focusing on the strategic target for each term.

Short Term (2020)

- Geographically feasible and appropriate RET installations at every level.

Medium Term (2030)

- Sustainable energy for all.

Long Term (2050)

- Upliftment of national economy through sustainable energy for all.

CHAPTER 14
OBJECTIVES AND GOALS OF THE VISIONS

14.1 Energy Resources Sector and its Sub-Sectors

14.1.1 Traditional (Biomass) Energy

Goal:

To make the development in TE sub-sector consistent with the national goal of continuous sustainable, social and economic development by promoting the use of indigenous renewable TE sources sustainably.

Objective:

The overall development objective of TE sub-sector would be to contribute to sustainable economic development by making visible changes in the present unsustainable use of TE sources through enhance production and efficient utilization of available TE sources, and wherever feasible by switching over to other alternative, modern energy sources of renewable and indigenous in nature.

The specific objectives would include to:

- Promote the management of indigenous renewable biomass resources, including forests, TOF, residues of crops and animals, industrial by-products, municipal solid wastes, etc. for enhancing the production of biomass materials for energy;
- Encourage the participation of directly relevant sectors (i.e. forestry, agriculture, industry, municipal habitat, etc.) in the management and use of available biomass residues for energy;
- Demonstrate and promote the use of efficient biomass fuel combustion devices for reducing fuel consumption and indoor air pollution in rural households and commercial establishments; and
- Complement the current traditional fuel users with indigenous, renewable, climate friendly alternative energy sources, including hydro- and solor-power for meeting the energy needs of the peri-urban and urban households and commercial establishments.

14.1.2 Commercial Energy

Goal

Short Term Strategic Targets 2020

Agriculture sector

- 50% electrification in water pumping

Commercial sector

- 50% electrification in the end-uses

Transport sector

- Introduction of electric in freight transport
- Introduction of electric train in intercity transport
- Introduction of electric cars and motorcycles
- Promotion of public transport
- Penetration of ethanol and biodiesel in the range of 10% and 5% in petrol and diesel

Industrial sector

- Introduction of new electric boiler
- Increase in electrification in motive power
- Efficiency improvement in process heat and furnaces

Residential sector

- Promotion of cooking in electricity
- Enhanced ICS penetration
- In Other end-uses electricity and clean energy promoted

Medium Term Strategic Targets 2030

Agriculture:

- 100% Electrification in Water pumping by 2030

Commercial sector

- For 100% electrification by 2030

Transportation

- Introduction of electric train in freight transport and its share is assumed to be 13% by 2030
- Introduction of electric train in intercity transport and its share is assumed to be 13% by 2030

Industry:

- Boiler: Introduction of new electric boiler in industries and 50% share by 2030
- Motive power and other
  - 100% electrification by 2030
  - Improvement of efficiency in process heat and furnaces

Residential sector:

- Rural cooking:
  - 40% electric, 50% fuelwood and 10% LPG share by 2030
  - ICS penetration with efficiency increasing from 7% in 2010 to 15% by 2030
- Urban cooking: 100% electrification by 2030

Long Term Strategic Targets 2050

Agriculture:

- Electrification in farm machinery 50% in 2050

Commercialsector

- 100% electrification by 2030 onwards to 2050

Transportation

- Introduction of electric train in freight transport and its share is assumed to be 30% by 2050
- Introduction of electric train in intercity transport and its share is assumed to be 30% by 2050, electric car is introduced in the year 2020 to reach the target of 20% share by 2050

Industry:

- Boiler: Introduction of new electric boiler in industry 100% share by 2050

Residential sector:

- Rural cooking: ICS penetration with efficiency increasing from 7% in 2010 to 15% by 2030 and remain constant till 2050
- Urban cooking: 100% in electricity from 2030 onwards to 2050
- Rural and Urban lighting:100% from 2030 onwards to 2050

Objective

- To review existing Hydropower policies, acts and regulations including the conflicting water-related laws and to get them amended/enacted.
- To develop mechanisms to get legislative frameworks functioning and adapting to changing circumstances.
- To restructure existing hydropower related institutions, strengthen their capabilities and establish new ones.
- To create an autonomous organization for planning and operation of national and regional transmission grids to facilitate wheeling of energy.
- To establish a separate autonomous rural electrification agency to enhance rural electrification.
- To develop and implement hydropower projects to attain the electrification of all the development sectors targeted for the year 2050.

14.1.3 Renewable Energy

Goal

- To provide sustainable energy for all through installation of geographically feasible and appropriate RE technology at every level (residential, community, regional and national);
- To transform the way public think and act in relation to energy use by motivating them to choose renewable energy over traditional and commercial energy for sustainability

Objective

As given in prior sections, the integrated vision for 2050 for the RE Sector is 'Upliftment of national economy by providing sustainable energy for all through installation/promotion of appropriate renewable energy technology based on geographical feasibility".

The objective of the above vision is economic upliftment initiating at grass root level through access to sustainable energy at various strata (local, regional and national) thus contributing to the strengthening of national economy.

CHAPTER 15
STRATEGY FOR MATERIALIZING THE VISIONS

While the sub-sectoral visions in the energy sector deal with a particular technical area, the policy and legislative framework is a cross cutting subject encompassing several sub-sectoral areas and a wide range of institutions engaged in the development, management and delivery of energy services. The legislative framework will need to address all sub-sectors and recommend appropriate legal frame for each of these sub-sectors. As such, they are in most instances not stand-alone actions. They complement other sub-sectors and create an enabling environment for effective delivery and regulation of energy services.

- Hydro-power will be declared as “lead” energy sector.
- Hydropower Strategic sector vision 2050 is endorsed by political parties and mentioned in their manifestos.
- Policies are further reviewed and amended/enacted to changing circumstances.

15.1 Strategy for Formulation of Energy Policy and Legislative Framework

With large number of ministries involved in the development and management of different forms of energy such as traditional, commercial and renewable sources, only an integrated policy will be able to ensure a balanced development of the sector. On the basis of a broad framework of integrated development, sub-sector policies will need to be revised or formulated for development of their respective sub-sector areas. Similarly, the roles and responsibilities of each ministry will need to be defined to ensure a coordinated development.

In order to achieve the objective of the vision, the starting point will be to formulate and implement an integrated energy policy for a coordinated development of the sector and thus need to create or revive a political forum like the defunct National Water Resources Development Council (NWRDC). Along with this, institutional arrangement for coordination at the national level should receive higher priority. The Water and Energy Commission (WEC) should be reorganized to lead the process. An institution at the national level is essential to carry out this important process. Similarly, rationalization of the roles of the WEC and the National Planning Commission (NPC) should be taken up without any delay.

- Mechanisms will be developed to make legislative frameworks functioning and adapting to changing circumstances.
- The high voltage cross-border and domestic transmission lines of different capacities will be identified and installed in close coordination with the electricity generation centers Prepare Transmission Line Master Plan for effective implementation.
- Appropriate authorities to address the problems of land acquisition and resettlement & rehabilitation (R&R) for all infrastructure projects will be created to insulate project developers and authorities from problems arising out of land acquisition, resettlement & rehabilitation.
- Various bilateral and multilateral projects for irrigation, hydropower, flood control, transmission grid and navigation will be completed and substantial mutual benefits will be achieved.
- Regional cooperation mechanisms will be developed.
- Hydropower development will be maximized for cent percent electrification including its uses for energy-intensive industries and export of power providing substantial benefits to the country.

15.2 Legislative and Regulatory Framework

- Policy, Acts and Regulations are further amended/enacted to changing circumstances. Water-related conflicts will be reduced by bringing appropriate laws; acts and regulations equitable water use rights will be established.
- Policy, Acts and Regulations will be further reviewed and amended/enacted, if necessary to comply with changing circumstances
- The national regulatory framework and the regulatory authorities are well equipped to deal with foreign investment related issues in a professional and fair manner.
- The regulatory provisions is made to solve the infrastructure issues, such as road access to remote hilly areas, and the problems related to transmission networks and high investment costs for their construction.
- Provision of regulatory framework is made to positively influence the total price of energy, energy consumption levels and load management by inviting more than one supplier, which enables consumers to choose their preferred scheme offered by service providers.

15.3 Specific Targets

The target for the short term includes review, drafting and enactment of relevant laws (Acts of Parliament and regulations). The strategy will be to create enabling rules, policy instruments, establishing of social and institutional infrastructures for carrying out the programmes. These arrangements will be further strengthened to successfully carry out the programmes in the sector. The specific targets are:

By 2020 (Short Term)

- Declare hydropower as the "lead" sector for energy supply in the country.
- Integrated Energy Sector Policy is approved
- Sub-sector Policies, Acts and Regulations are reviewed and/or enacted
- Legal frameworks in Renewable Energy, Feed in Tariff and Feed in Law, Regulatory Authority enacted
- Electricity Act and Regulations are amended
- Reform policies to attract private sector with incentives such as soft loan and others.
- An autonomous organization for planning and operation of national and regional transmission grids to facilitate wheeling of energy is created
- Provision of security for projects at nominal costs is made
- Existing hydropower related institutions are restructured/strengthened and new ones are established
- Conflicting energy-related laws are amended
- Water rights of power projects are ensured and people are made aware of water rights and obligations
- People are made aware of water rights and obligations
- WEC, ministries and departments are restructured/strengthened
- Rationalize the role of the National Planning Commission

By 2030 (Medium Term)

In the medium term the strategy will be to see that the mechanisms or policy and legal instruments are functioning well and revised according to changing circumstances. Specific targets are:

- Hydropower development is maximized for cent percent electrification including its uses for energy-intensive industries and export of power providing substantial benefits to the country
- Capabilities of existing physical infrastructure such as road access and transmission lines are strengthened and new ones are added
- Development of skilled manpower is continued
- Additional efforts are made to attract investments

- Regulatory bodies and enforcement mechanisms will be strengthened with clear responsibilities, regulations and effective monitoring
- The legal instruments will be reviewed regularly and adaptive measures taken so that they remain compatible with the changing circumstances
- Necessary conflict resolution mechanisms will be made functional so that most of the water-related conflicts are resolved quickly
- All individual and community water use rights will be registered and documented, and regulatory compliance will be strictly enforced
- Environment for incremental domestic capital market and foreign capital for hydropower development is improved

By 2040 and 2050 (Long Term)

The long term strategy will be to make the system is functioning and adapting to changing times. Specific targets are:

- Hydropower optimally developed to cover the entire need of electricity including the need of maximum export
- Capabilities of existing physical infrastructure such as road access and transmission lines are strengthened and new ones are added
- By the end of 2050 mechanisms will be in place whereby adequate legislative frameworks are functioning and adapting to changing circumstances
- Water-related conflicts will have decreased substantially and those remaining will be resolved quickly

15.4 Institutional Strategic Programs

- The integrated planning should prioritize water as the lead energy resource. WEC/WECS should be the lead agency for integrated energy planning. All the sub sectoral institutions in energy will integrate the sub-sectoral energy plan with the integrated energy plan to be prepared by the WEC/WECS. The WEC should be the apex body for national energy security and integrated planning.
- Institutional reform of the existing institutions to eliminate the monopoly. Monopoly of (i) NEA in hydropower transmission, distribution and (ii) NOC in import, storage, transfer and distribution of petroleum product. This will make them competitive improving the service delivery. The syndicate system in renewable energy for example in biogas and solar lighting should be eliminated.
- Explore the possibilities and capitalize on benefits from new initiatives like Clean Development Mechanism.
- Establish energy information and dissemination center to share experience and have regular interaction among relevant stakeholder at all levels.
- Promote efficiency and conservation culture through demand-side-management.
- Regulation Commission (NERC) is created and PPA is brought under it.
- Existing hydropower related institutions do not comply any more with the changing scenario of hydropower development. Hence they are restructured/strengthened and new ones are established
- WECS is transformed to WEC and designated and empowered to coordinate national-level planning for the entire water sector, operating full time with a permanent office and with the provision of chief commissioner and commissioners, who will be full-time office bearers.

Traditional (Biomass) Energy

The strategies for materializing the Visions in the TE sub-sectors include primarily three important areas:

- Enhanced production through better management of TE resources;
- Efficient utilization of available biomass sources by promoting the use of improved, modern, energy efficient, and health and environment friendly TE technology; promote the use of modern bioenergy generation by using indigenous biomass by-products, including forest by-products, animal excreta, as well as wastes and residues of agriculture, industry, urban areas and others; and,
- Substitute the present unsustainable use of TE, primarily traditional application of dried solid biomass materials using primitive inefficient technology in the household, industry and commercial sectors, with modern, renewable, indigenous energy sources, primarily with hydro- and solar-power and to some extent also with modern bioenergy sources as and wherever feasible.

Commercial Energy

The strategies for materializing the Visions in the CE sub-sectors include following tactics:

- Promotion of electricity operated small appliances, machines, with a target of complete electrification in selected possible sectorial end-uses.
- Promotion of use of energy efficient technologies in all sectors.
- Promote hydropower development (both RoR and Storage)
- Introduction of biofuels (ethanol and Bio-diesel) and electric cars and promotion of mass transportation

Renewable Energy

The strategies for materializing the Visions in the RE sub-sectors include following tactics:

- Create awareness amongst broader public about RET;
- Formulation of appropriate legislative tools to enable implementation of plans and policies;
- Expand appropriate RET installations at every level based on geographical feasibility;
- Ensure implementation and monitoring of RET plans and policies.
- Uplift national economy through grid connection.

CHAPTER 16
PLANS/PROGRAMS/PROJECTS

16.1 Plans/Programs/Project of Traditional (Biomass) Energy

No dedicated plan, program or project has been recommended exclusively for the purpose of enhancing TE production. As the biomass materials that have been currently used for TE purpose have mostly been derived as by-products of forest and agricultural crop harvesting and processing and as excreta of animals or wastes and by-products of industries, urban centers and commercial establishments, better management of these available materials through improved collection, handling, storage, preparation and use for energy in efficient devices is expected to overcome part of the present problems.

As the economy progresses the demand for energy for all types of applications (i.e. cooking, heating, cooling, lighting, services, etc) would be growing not only in the household sector, but also in industry and commercial sectors in most urban and peri-urban areas. And the incremental energy demand would not be for TE sources but for modern, clean commercial energy sources, including renewable solar- and hydro-power as well as modern bioenergy sources. Therefore, it would be only that part of the urban and peri-urban population that currently fall below the absolute poverty line and those others who, despite of the fact that their economic condition might not be poor but due to remoteness of the area and non-availability of alternative modern clean energy sources would be relying solely on cheap and often self-collected biomass materials at source for meeting their energy needs. This part of the TE demand is not expected to be difficult to fulfillment in many villages in the middle hills and many mountainous districts. However, in the case of heavily populated villages in the southern Terai districts, the situation concerning biomass fuel supply would be different and difficult to manage. As the forests that once existed in the adjoining areas of these villages have long been destroyed, therefore the only feasible and best domestic energy supply alternative in these areas would be further continuation of the use of animal dung, more specifically *gobar*gas, by producing it from whatever animal excreta that would be available at the household level for meeting their domestic energy needs. Besides, solidification of loose biomass residues into briquettes like form, with or without conversion into secondary energy form, seemed the next feasible alternative available at hand for meeting the household energy demands in the Terai.And dissemination of ICS and other improved biomass fuel combustion devices would be the most essential activity to promote throughout the country in the TE sub-sector.Activities of these types have currently been under the institutional mandate of of AEPC under MoST.. So, the only extra effort needed to achieve the TE related Vision of 2050 would be for AEPC to continue playing these important roles with a much expanded scope, annual work target and area cover in coming years. And it should continue not only with the activities of demonstration, extension and dissemination, but also with dissemination of new information and providing support for innovation to in-country R&D institutions.

16.2 Plans/Programs/Project of Commercial Energy

Projects under planning and proposed

- Projects under planning and proposed are 37 MW Upper Trishuli-3'B', 600 MW BudhiGandaki, 140 MW Upper Seti (storage type), 510 MW DudhKhoshi (Storage), 47 MW Upper Modi 'A', 400 MW Nalsing Gad (storage type), 530 MW Tamor and 300 MW Uttar Ganga (storage type) (NEA, 2012).
- Planning is underway to generate 35 MW from Sunkoshi-Marin and and 80 MW from Kaligandaki-Tinau multipurpose hydropower projects throughout the year. The government expects to complete the construction works of additional 668 MW of hydropower projects and start with additional hydropower projects with a total capacity of 584 MW during its 13th Three Years plan starting the Fiscal Year 2013/14.
- NEA is planning to expand its transmission line to 3272 kilometers or circuit. This includes 78 kilometers of 33 kV, 1409 kilometers of 132 kV, 755 km of 200 kV and 1030 kilometers of 400 kV in the coming ten years. The government estimates that additional 400 km transmission lines will also be constructed during

the same period. It is also estimated that the current electricity leakage by the end of this period will be limited to 21 pecentage.

- The Aankhukhola Hydropower Project with the capacity of 8.5 MW would be linked to the central transmission grid within few months[20]15 High Voltage Transmission Lines with a capacity of 132 kV each and a total length of 1540 cktkm, 8 with a capacity of 220kV each and a total length of 1129.80 cktkm and another 5 with a capacity of 400 kV each and a total length of 1880.4 cktkm are planned/proposed.
- 21 substations of up to 132 kV with a capacity of 917 MW, 18 of up to 200 kV with a total capacity of 3876 MW, and 5 including Anarmani (Nepal)–Silgurhi (West Bengal), Duhabi (Nepal)–Purnea (Bihar), Dhalkebar(Nepal)–Muzzafarpur (Bihar), and Butwal/Bhiarahawa(Nepal)–Anandanagar/Gorkhapur (UP) of up to 400 kV with a total capacity of 2025 MW are planned/proposed (Dhungel, 2008).
- Planning is underway to develop storage and run-off-river hydropower at a ratio of 30:70 (Task force, 2065)

Hydropower plans and projects		
Period	Cumulative Installing Capacity	Cumulative total Capacity
2010-2014	2,057	2,057
2015-2019	12,423	14,480
2020-2024	5,114	19,594
2025-2029	18,034	37,628

Hydropower Projects Planned for 2024	
Projects	Capacity
DudhKoshi Storage	300
Pancheswor	2,940
Naumure	245
Upper Marsyangdi-A	50
Upper Marsyangdi-2	250
Upper Trishuli-1	200
Tamor-Mewa	101
Sharada-Babai Storage	93
Tamakoshi-2	600
Madi-1	20
Upper Madi	20
Upper Tamor	100
Mid-Tamor	57
Upper Tamor-A	90
Bheri-Babai	48
	5,114

[20] • (BikasThapa, New Spotlight Magazine, Thursday, April11, 2013, available at http://www.spotlightnepal.com/News/Article/Transmission-Line-Challenges)

20 years plan for Hydropower generation till 2029	
Hydro-Projects	Capacity
Sunkoshi-2	1,700
Karnali-Chisapani	10,884
Saptakoshi	3,450
Bheri	2,000
Total	18,034

(Task force hydro-report -2065)

Projects/Programs under construction

- The 456 MW Upper Tamakoshi Hydropower Project is under construction in Lamabagar of Dolakha District. Forty per cent of its civil works is already completed. Its estimated total project cost is around Rs 35.29 billion.
- Another Major Hydropower plant under construction is 60 MW Upper trishuli "A" in Rasuwa and Nuwakot districts. It was initiated in FY 2010/11.
- The 14 MW Kulekhani III Hydroelectric Project, located in Makawanpur district, is also under construction which is expected to generate about 40.85 Gigawatt-hours (GWh) of electric energy per annum. So far overall progress of 67% has been achieved. A fund of NRs. 2.43 billion is being provided by the Government of Nepal for the construction of this project.
- Similarly, the 32 MW Rahughat Hydroelectric Project, located in Galeshwor, Myagdi, is also under construction. This project, funded by Government of India and scheduled to be completed in 2016 A.D., is estimated to generate 187.66 GWh energy per annum (NEA, 2012/13).
- One another hydropower project under construction is Chameliya Hydroelectric Project with an installed capacity of 30 MW. Located at Sikhar VDC, ward nO. 4, Balanch of Darchula District, this project is expected to generate an average annual energy of 184.21GWh. It was started in 2007 and is scheduled to be completed in March 14, 2015. So far this project has achieved 87% progress (NEA, 2012/13).

Other ongoing projects

- Other ongoing projects areSaptaKoshi High Dam Multipurpose Project and Sunkoshi Storage cum Diversion Project and Pancheshwar Multipurpose Project.
- 9 High Voltage Transmission Lines with a capacity of 132 kV each and a total length of 793 cktkm and another 3 with a capacity of 220kV each and a total length of 446cktkm are under construction.
- 1substation of 132 kV with a capacity of 30 MW, 4 of 132/11 kV with a total capacity of 175 MW, 6 of 132/33 kV with a total capacity of 180 MW and 3 of 132/33/11 with a total capacity of 214. 5MW are under construction (NEA and Vidyut 2011-12).

16.3 Plans/Programs/Projects of Renewable Energy

Rather than stipulating specific plans and programs at this stage, it is considered that plans, programs and projects would specifically rely on specific need in an area, availability of funds, ongoing projects through government/donor agencies at the time and other related factors. However, it is emphasized that the formulation of plans, programs and projects in RE Sector should be broadly guided by the vision and strategies in RE sector. In other words, the plans, programs and projects in RE sector should be focused on:

- Dissemination of information about economic, social and environmental benefits about renewable energy technologies to the broader public;
- Expansion of current installation of different forms of available RETs (e.g, biogas, solar, microhydro, etc) at local level based on geographical feasibility;
- Implementation of pilot projects for comparatively newer forms of RETs in context of Nepal (e.g, wind energy, biomass gasification, biofuel, large scale solar power etc);
- Connection of offgrid electricity to national grid.

It is considered that these strategic actions should prove to be a guiding tool to formulate and implement plans, programs and projects based on timeline targets in the RE sector.

CHAPTER 17
ACTIVITIES

17.1 Traditional (Biomass) Energy

Forestry and Fuelwood Related Activities

The essential activities in the forestry sector for implementation primarily in short- and medium-terms would be:

- Continuation, if possible enhancement of fuelwood supply from its current level through effective management of existing reachable forests under multiple objectives in which enhancement of fuelwood production would be one of the important objectives
- Dissemination of ICS must also be continued under the aegis of AEPC throughout the period of short-term at a much expanded pace and covering the whole country
- In the long term the use of traditional fuels in urban and peri-urban domestic sector as well as commercial sectors are expected to be replaced almost totally with the use of renewable, modern energy sources.

Agricultural Residues Related Activities

- Improvement in currently used devises for using agricultural residues for improving their combustion efficiencies
- Wherever possible, the surplus agricultural residues could be promoted for use in modern energy generation by promoting the use of technology that would be based on these residues as feed-stocks.

Animal Dung Related Activities

- The use of dried raw animal dung cake for household energy is not only unhealthy to human health and unfriendly to the environment, but also would deprive the agricultural fields with soil nutrients. Therefore, no activity has been recommended for its use in crude form after the short-term period.
- During the short-term the main activity would be again improvement in combustion technology of currently used solid biomass fuel using devices
- Its modern energy application as biogas deserves further promotion in the coming decades.
- Wherever feasible, the current use of raw dung cake must be discouraged and supplemented with locally feasible modern bioenergy sources.

Combined Actions

A combined policy intervention would be a must for overcoming the chronic problem of domestic energy supply in the country. So, it would require an integrated policy and action plan that would incorporate the concerns and make use of the development potentials in other sub-sectors of energy. This process would continue in all three terms.

17.2 Commercial Energy

Major strategies and activities are explained below:

17.2.1 Hydropower

- Projects under Preparation

Development Committees have been formed to look after BudhiGandaki and Nalsinghgad Hydropower Projects. To prepare feasibility study and detail design of the project, procurement for the consulting services of the project is presently underway.

Dudhkoshi Storage Hydroelectric Project (300 MW) has been identified as one of the prospective and viable projects among other storage projects for implementation in near future.

Preparatory works for Detailed Engineering Design of Upper Arun Hydropower Project (335 MW) have been initiated.

NEA plans to complete the Detailed Engineering Design of Tamakoshi V Hydropower Project (87 MW) in this fiscal year (NEA, 2012/13)..

PPAs for 104 projects have been concluded as of end of fiscal year 2011/12 that would generate 1,574 MW installed capacity on their completion. Twenty five of those projects with total installed capacity of 181.67 MW are already in operation.

During the fiscal year under review, 23 new PPAs for a total capacity of 334 MW were signed whereas five PPAs for capacity up gradation totaling 20.72 MW were amended.

Middle Bhotekoshi (102 MW) and JurambaKhola are preparing for PPA.

NEA has also created Tanahu Hydropower Limited, a Special Purpose Vehicle (SPV) with full NEA ownership for the development of the 140 MW Tanahu Hydropower Project. ADB & JICA are the potential donors for this project. The detailed engineering study of the project is in the final stage of completion. The infrastructure development activity is underway. If financing agreement could be concluded in the year 2012, the construction is planned to begin by mid 2013.

NEA's other subsidiary/associate companies TrisuliJalvidut Company Limited (TJCL) are developing the Upper Trishuli "3B" Hydroelectric Project with an installed capacity of 37 MW (NEA, 2012).

- Projects Signed and Agreed Upon

A MoU has been signed between Nepal government and Chinese company for 750 MW West Seti project. It is Nepal's biggest ever foreign investment project where China's Three Gorges International is to build the US$ 1.6 billion West Seti hydropower plant in west Nepal. Nepal Electricity Authority will own 25 percent share and the latter will own 75 percent of the 750 MW project.

The Asian Development Bank (ADB) has agreed to lend $US 150 million to build the Tanahun Hydropower Project. Besides the ADB, the Japan International Cooperation Agency (JICA), European Investment Bank and Abu Dhabi Fund for Development are co-financing the project whose estimated cost is US$ 500 million (SDMC, 2013).

NEA and K-Water A have signed in a Joint Development Agreement (JDA) to develop Upper Modi 'A' Hydropower project. It is an about 47 MW (238 GWh) run off the river type project located at the bank of ModiKhola bordered between the Ghandruk VDC of Parbat district and Kaski district. The project will be pushed ahead through a Special Purpose Company (SPC) to be formed by the K-water, in which NEA will have a share of 20% and K-Water 80%. Local people can have the ownership of up to 1%. The JDA will expire in a year.

Kuwait Fund for Economic Development pledged to provide a loan assistance of US$17 million for the 20-MW Budhi Ganga Hydro Project in Achham district[21]. Department of Electricity Development will bear the rest US$17 million for the project. Meanwhile, NEA is building a 118-km transmission line to evacuate the power from the project.

[21] "Signing a loan agreement in the republic of Nepal", Friday, 22 March 2013 <http://www.kuwait-fund.org>

Japan International Cooperation Agency (JAICA) has signed in an agreement with GoN to provide a soft loan assistance of ¥15 billion130million 7000 (Rs.141, 68,000,000) at an interest of 0.1% for the construction of 140 MW Upper Seti (Tanahun) Hydropower Project (Storage type). This project is expected to get similar assistance from ADB, European Investment fund and Abu-dhabi Fund. Talks are underway to make agreement with other donors as well. Detailed engineering study of the project is already at the verge of completion..

An agreement for the purchase of additional 9 MW of power from Bhotekoshi hydropower project at a nominal price of NRs. 1.625 per kWh was concluded with the Bhotekoshi Power Company Limited.

The contract agreement for the consultancy services for the supervision of construction of main civil works of Rahughat Project was signed with the selected Consultant on 16 February 2012 and the concurrence from the Export-Import Bank of India is awaited.

An agreement was signed between Nepal Electricity Authority and M/S Tractebei Engineering SA, France on December 2, 2012 for consultancy services for detailed engineering design and preparation of tender documents and tender drawings of BudhiGandaki Storage Hydroelectric Project (600 MW).

Leaders of six major political parties and the Chairman of the interim election government Khil Raj Regmi signed a commitment paper, pledging not to disturb hydropower development in the country.

Power purchase agreement (PPA) has been already reached with 19 different hydropower projects

- Projects Permission Granted to

Permission for carrying out survey has been given to 16 promoters to generate 960 MW and permission of generating power has been already given to 15 projects to generate 590 MW electricity.

Generation licences have been issued to KhaniKhola of Dolkha(30 MW), Middle Modi of Parbat(15.1 MW), SardiKhola of Kaski (4.0 MW), Upper Puwa of Ilam(3.2 MW), GelunKhola of Sindhupalchowk(3.2 MW) and DaramKhola of Baglung (2.5 MW). These projects are now waiting for PPA.

- Projects Foundation Stone Laid for

Foundation stone has been laid to construct the Upper Trishuli 3A (60 MW) on 2068 Mangsir 7 Wednesday. It is a medium sized run of river scheme, which is envisaged to generate nearly 460.4 GWh of average energy per year out of which 46% is dry season energy. The project economic evaluation indicates that specific energy cost is about 3.03 cents per kWh. The construction work is targeted to be completed by 2014 May. Construction of Upper Trishuli 3A will also enable tailrace development of Upper Trishuli 3B which has a capacity of 37 MW. The project cost estimate is about 125.78 Million US$ which excludes VAT and interest during construction. This project is being implemented with funds from Nepal government, NEA and concessional loan from China Exim Bank. The 115.7 Million US $ concessional loan from the bank is made available at an interest rate of 1.75% per annum payable over 25 years period including 5 year grace period.

Foundation stone has been laid for the construction of 1MW Miyakhola Hydropower project in Khotang. The project will be constructed at an estimated cost of Rs. 170million.

Foundaton stone has been laid on Hetauda-Bharatpur 220 kV Transmission Lines on 2068 Poush 18, Monday.

- Projects Under Construction

Construction works of Upper Hugdikhola Hydropower Project have started to produce 5MW of power. The project is located near Khasimarekhola of Rupakot, Gulmi. It will be constructed before July 2014 at an estimated cost of 75 Million Rupees. Construction works of Lower Tadikhola Hydropower project (5MW) have started from the month of December in Thaprek VDC of Nuwakot district. It is expected to be completed in about 3 years.Construction of

Kulekhani-3 Hydroelectric Project is in progress. Completion date set for September 13, 2014. Construction of this 750 megawatt West Seti project is to start in 2015, with electricity generation to begin starting in 2019. Chaku Hydropower Project (3.3 MW) located in Sindhupalchowk district has started its test generation from December 2012.

The Chilime Hydropower Company Limited, a subsidiary of NEA, is undertaking the implementation of Rasuwagadhi Hydroelectric Project (111 MW), Middle Bhotekoshi Hydroelectric Project (102 MW), Upper Sanjen Hydroelectric Project (14.8 MW) and Sanjen Hydroelectric Project (42.5 MW) through its subsidiary companies.

The construction of Upper Trishuli -3A Project started from 1st June 2011.

Bhairabkunda of Larcha, Tatopani (3.0 MW) is on the verge of completion.

Bheri-Babai Diversion project is being constructed to generate 48 MW of electricity round the clock and throughout the year.

Construction of the Hetauda- Bharatpur - Bardghat 220 kV transmission line is under way. Construction of Syangja 132 kV substation is almost complete and is expected to be commissioned soon. Substantial progress have been achieved in the construction of: Dumre – Damauli – Marsyangdi 132 kV transmission line, Singati - Lamosangu 132 kV transmission line, Kabeli 132 kV transmission corridor, Chapali 132 kV substation, Pathlaiya 132 kV substation, Matatirtha 132 kV substation extension, second circuit stringing of Butwal – Kohalpur- Mahendranagar 132 kV transmission line and second circuit stringing of Hetauda –

Kulekhani-II - Siuchatar 132 kV transmission line. To improve the voltage profile, capacitor banks in different grid substations have been installed. In some, they will be installed soon. The Hetauda – Dhalkebar – Duhabi 400 kV transmission line project is being implemented to enhance cross border power exchange with India and augment the transfer capacity of the INPS. Seven transmission line/substation projects are also being implemented to facilitate power supply to cement industries. Similarly, a number of other transmission lines are planned for implementation. Most are under project preparatory stage under-going various studies. Similarly, a number of electrification projects, distribution substation construction and upgrading projects and 33 kV transmission line and substation projects are underway throughout the country to increase the accessibility of electricity to the rural population.

- Projects Recently Completed

HewaKhola of capacity 4,455 kW, Lower Piluwa of capacity 990 kW, and 400 kW Gamgad Small Hydropower Project came on-stream to NEA's Integrated Nepal Power Systemduring fiscal year 2011/12. 30 MW Chameliya (average annual energy generation of 184.21 GWh) - located in Balanch of DarchulaDistrict,Gamgad Small Hydropower Project, Lower Modikhola and Springkhola -10 MW each and Siuri and Bijaypurkhola micro hydropower projects - 4.95 MW and 4.5 MW respectively have been Recently Completed.

Distribution works of electricity has begonnen in Mugu district as well. Currently the distribution works of meters is underway through the 400 Volts distribution lines installed in five VDC of the district. Detailed survey of LipingKhola of Tatopani (4.5 MW) has been completed.

Works on detailed engineering design of the Kabeli Corridor of 133 KV transmission line have been completed. Similarly, the construction of Syangja 132 kV substation and Pathalaiya 132 kV substation has been completed (NEA, 2012/13). Out of 188 pylons to connect Khimti-Dhalkebar 220 KV transmission line, the government installed 178 pylons. The transmission lines have been installed on 60 kilometers out of the 75 kilometers distance.

196 survey licenses for the generation of144.670 MW (below 1 MW), 120 survey licenses for the generation of 719.543 MW (1-25 MW), 36 survey licenses for the generation of 2021.540 MW (25-100 MW), 29 survey licenses for the generation of 8793.000 MW (above 100 MW) and other 57survey licenses for the generation of 1840.820 MW have been issued.

All together 142 Transmission Survey Licenses (33-400kV) including West Seti HEP Transmission Line, Dhalkebar-Bhittamore Cross Border Transmission Line, Duhabi-Jogbani Cross Border Transmission Line, Lower Arun HEP Transmission Line, Hetauda - Dhalkebar - Duhabi Transmission Line, Upper Karnali Hydroelectric Project Transmission Line, Upper Marsyangdi-2 Hydroelectric Project Transmission Line, Tila Hydropower Project Namlanarnali D/C Transmission Line and Karnali-7 D/C Transmission Line of 400kV have been distributed.

17.2.2 Other commercial Energy

- Prioritize hydro-power development

To decrease dependence on traditional and imported energy resource, the approach should be to increase gradually the share of hydropower in the energy mix of the country. And, prepare a long-term plan for each river basin with the aim of achieving maximum benefit to the government.

- Minimize prevailing transmission and distribution loss

There is a strong need for bringing down the transmission and distribution losses to 10/12 percent, a benchmark which needs to be achieved for reliable and efficient operations of the transmission and distribution systems.

- Promote DSM tools

The loss of energy is not only from supply side , but major losses are at demand side due to inefficient endues technologies such as incandescent bulb, low efficiency freezers and other industrial technologies such as boilers and process heat technologies. The use of CFL, LED for lighting, electric cooking stoves can reduce energy demand by substantial amount.

- Discourage use of fossil fuels

The transport sector is nearly completely dependent on foreign import of petroleum products with only traces of electrical vehicles. Some ambitious policy assumptions of introduction of new transport technology like fuel blending, electric vehicles are introduced in the energy model, which would help in decreasing petroleum dependence in transport sector. Below are some major activities:

  - Encourage use of public mass transport
  - Introduce Ethanol blended gasoline E10 and biodiesel B05 (5 percent blended with diesel) in all diesel vehicles.
  - Exempt tax in purchase of vehicles running on alternate fuels
  - Implement emission tax on fuel oils.
  - Monitor the use of fossil fuels as per standard parameters

- Increase the storage facilities of petroleum products

The existing storage facilities of petroleum are sufficient to meet the usual daily demand in the range of 20 days which is inadequate. In case of LPG bottling plant, however, it is just 3 days. IEA norms state mandatory storage requirement of accommodating 90 days' daily demands. Hence following activities are recommended:

  - Upgrade petroleum oil storage facility by 45 days of daily demand in short term and to 90 days of daily defend in long term.
  - Upgrade LPG storage facility by 45 days.
  - Involve the private sectors in purchase, storage and distribution of the petroleum products

- Facilitate the petroleum and the natural gas exploration activities

The Government of Nepal has signed two Petroleum agreements with Cairns Energy PLC, UK in 2004 for the petroleum explorations in the Blocks 1 (Dhangadi), 2 (Karnali), 4 (Lumbini), 6 (Birgunj), and 7 (Malangawa). Though

the company has started its preliminary study and planning for conducting exploration works in its acreage but the actual exploration work has not been initiated. The GON has to facilitate the exploration and distribution of the natural gas in the valley, which can save almost 10 percent of the outflow of the foreign currency.

- Encourage exploration of coal deposits

Coal deposits are found in the Western parts of Nepal near Dang and adjoining districts and non-commercialized production is being carried out and supplied to the market. The government should encourage evaluating the coal deposits and facilitating commercial production of coal in the country if they are found commercially feasible.

- Enforce energy auditing

Large amount of energy can be saved in industries by enforcing energy auditing. It will not only help in reducing load-shedding hours but allow lead time for arranging new capacity additions. Some of the activities needed to be executed are explained below:

- Prepare manual on energy auditing
- Start programs of energy auditing and make it a compulsion

17.3 Renewable Energy

- Disseminate information about economic, social and environmental benefits about renewable energy technologies to the broader public;
- Improve efficiency through awareness on energy saving devices and equipment including effects of power consumption by standby electronic devices even in urban areas;
- Improve and expand the current installations of micro-hydro and pico-hydro plants;
- Expand pilot scale installations of institutional biogas plants in urban, semi-urban areas promoting waste-to-energy concept;
- Remove any existing tax or royalties on any equipment related to renewable energy installation;
- Promote private sector in equipment manufacture, distribution and installation at competitive price;
- Make mandatory provision through legislation to maintain public register on renewable energy service providers (private/government/I/NGOs/donors or even private sponsors) and also provision for 'right to information' whereby the register is accessible by public through the government agencies at various levels;
- Connect micro-hydro to grid;
- Connect solar to grid;
- Connect wind to grid;
- Continuously improve implementation of policies and regulations.

CHAPTER 18
POTENTIAL THREATS AND MITIGATION MEASURES/PLANS

18.1 Climate Change

Impacts on Energy Resources and Energy Sub-Sectors

The potential threat of continuing over and unsustainable use of TE resources would invite national disasters of crucial nature, such as widespread forest growing stock depletion, localized deforestation and biodiversity loss, rampant landslides and accelerated soil erosion, riverbank scouring, loss of habitat for threatened flora and fauna, unregulated and polluted water flow, degraded environment, etc.

Multiple reports have identified hydroelectric generation around the world as highly vulnerable to climate change (Whittington, H.W & Gundry, S.W, 1998), (Mimikou, M.A &Baltas, E.A, 1998), (Garr, C.e.&Fitzharris, B.B., 1994). Hydroelectric power potential depends on stream flow, which depends directly on precipitation, temperature levels and potential evapotranspiration. Precipitation directly impacts runoff levels and stream flows which then determine the amount of water available for hydroelectric generation. Another potential consequence of altered river flow patterns is the increased incidence of elevated flow rates and flooding that exceed the safety margins of existing hydro plants. On the other hand, increased flow rates, if timed and managed correctly, may result in increased hydropower generation. For example, a shift in higher stream flow rates from dry to wet season (e.g., changes to less frequent rains but with higher quantities of rain at a particular moment) may increase hydropower generation more in the wet season than it is reduced in the dry season. However, there remain questions as to whether existing hydropower plants would be able to take full advantage of increased flows, and whether storage systems would be adequate to deal with such flows. Climate change leading to river flow changes outside the margin of safety can have a negative impact on hydropower generation, regardless of whether the flow rate increases or decreases (IPCC, 2001, W.G II).

An aspect challenge which may pose a challenge in the future is the fact that most Renewable Energy Technologies (RETs) are dependent on meteorological and climatic variables and patterns such as hydrological resources, wind patterns and solar radiation, and they therefore tend to be very vulnerable to climate change and variability. If the hydrological cycle, the atmospheric conditions, or the solar distribution changes, alterations in the availability of RE resources can be expected. Depending on the specific location and time a renewable energy system is established, changes in wind, solar or hydro energy potential may determine the viability of these specific RE projects. Furthermore, RE systems are not immune to damages caused by extreme weather events. It is widely recognized that to combat climate change it is important to reduce energy-related greenhouse gas emissions.

18.2 Political Change

Impacts on Energy Resources and Energy Sub-Sectors

Instability in government would lead to lack of interest and poor level of commitment among all levels of government agencies to make improvement in energy sector, specifically, at local and regional levels. Political instability also creates hopelessness among people and encourages the skilled people to migrate to other places for better opportunities and career security. Withdrawal of funding by donor agencies would cause adverse impact in implementation of plans, programs and projects. Likewise, shortage of government budget allocated to energy sector would cause hindrance in R&D, subsidy provisions, installation of RETs and implementation of plans and programs.

18.3 Global Economy and International Market

Impacts on Energy Resources and Energy Sub-Sectors

As the world struggles to emerge from a global recession and financial crisis, countries are looking for solutions to improve domestic economic performance and put people back to work. The energy sector constitutes a relatively modest share of GDP in most countries, except for those in which oil and gas income loom large. However, the energy sector's impact on the economy is greater than the sum of its parts. Most importantly, almost none of the economy's goods and services could be provided without it. Thus, stable and reasonable energy prices are needed to reignite, sustain and expand economic growth. The price of imported RE related equipment may differ for various energy sub-types based on international market, e.g, solar panels, thus making it unaffordable for the poorer households. It is also challenging to supply high quality equipment in competitive price affordable to general public

CHAPTER 19
STRATEGIES AND MEASURES TO DEAL WITH THE THREATS

The mitigation measures to deal with potential threats in energy sector may include:

- Massive awareness in public through inclusion of energy related curriculum in schools and higher levels
- Effective implementation of training provisions for the broader dissemination of knowledge and skill to the broader public.
- Promote substitution in favor of renewable energy wherever feasible
- Increase awareness about modern efficient technologies through demonstration and extension
- Promote local fabrication of efficient bio-energy application devices
- Review and revise the Inconsistency between policy and law of concerned sector
- Create local mechanism for support and promotion of modern efficient technologies
- Implement decentralized development policy and encourage good governance
- Create leveled playing field for private sector participation in TE development
- Initiate Action to Integrate Energy Planning, Extension and Training
- Develop strategy to attract and retain the trained human resources
- Enhancing confidence level of donor agencies
- Establish free competitive market in energy sector
- Allocate adequate resources for enhancement in production and efficient use as well as for providing incentives for traditional energy substitution
- Expand fuel-wood supply base by promoting private and community participation with attractive incentives and simplify regulatory measures of fuel-wood harvest
- Enforce land zoning to control deforestation and forest encroachment for ensuring TE Security in rural areas
- Identify alternative energy supply system for current TE deficit peri-urban areas, and promote development in rural areas
- Formulate conducive energy sector policy to promote TE, and modern bio-energy development
- Introduce attractive incentive package for improved technology dissemination

REFERENCES:

ADB, 2012, "Key Indicators for Asia & Pacific 2012", Asian Development Bank.,Manila,Philippines. (Available online at http://www.adb.org/publications/key-indicators-asia-and-pacific-2012)

ADB, 2012.Energy Efficiency Technical Report -Nepal. RETA 8025: SASECSubregion Energy Efficiency Initiative Prepared for the Asian Development Bank, Manila, Philippines.

AEPC and BSP/N reports

AEPC Annual Progress Report, FY 2009-10

AEPC, 2008.Solar and Wind Energy Resource Assessment in Nepal (SWERA).United Nations Environment Program, Global Environment Facility, Alternative Energy Promotion Centre, Ministry of Science, Technology and Environment, Government of Nepal, Kathmandu, Nepal.

AEPC, 2012, "Statistics on Renewable Energy Technology (internal data)", Alternative Energy Promotion Centre, Ministry of Science, Technology and Environment, Government of Nepal, Kathmandu, Nepal.

AEPC, 2013a.Renewable Energy Subsidy Policy 2013.Alternative Energy Promotion Centre, Ministry of Science, Technology and Environment, Government of Nepal, Kathmandu, Nepal.

AEPC, 2013b.Concept note on clean cooking solution for all by 2017.Alternative Energy Promotion Centre, Ministry of Science, Technology and Environment, Government of Nepal, Kathmandu, Nepal.

AEPC/ESAP (2012) Status of Solar PV Sector in Nepal

ANDS (2008) Energy Sector Strategy, 2007/08-2012/13, Afghanistan National Development Strategy, Islamic Republic of Afghanistan, 2008.

APFSOS II/WP/2009/26, Biomass Energy in the Asia-Pacific Region: Current Status, Trends and Future Setting, FAO Bangkok.

Ariyadasa, L. (2011). Current status of the energy situation in Sri Lanka.

Banerjee, S.G., Singh, A. and Samad, H. (2011) Power and People- The Benefits of Renewable Energy in Nepal, The World Bank

BSP (2012) Year Book 2011/2012

BSP-Nepal., 2005, *Biogas: As Renewable Source of Energy in Nepal, Theory and Development*, Eds. Karki, A.B., J.N. Shrestha and S. Bajgain, Biogas Support Program - Nepal, Kathmandu, Nepal.

CBS, 2012.National Population and Housing Census 2011.National report.Central Bureau of Statistics, National Planning Commission Secretariat, Kathmandu, Nepal.

CMS (1996) Biogas Technology: A Training Manual for Extension. FAO of UN

CMS (1999) Biogas Potential in Nepal (in BSP-Nepal, 2005)

CMS (2009), Sectoral Report on Modern Renewable Energy, CMS/CES, September 2009

CRT (2005) National Energy Situation Survey Report Nepal-Focus on Renewable Energy & Poverty Reduction, International Network for Sustainable Energy

CSO (2013) ,Energy Statistics 2013, Central Statistics Office, Ministry Of Statistics And Programme Implementation, Government Of India, 2013

D'sa, A. and Narasimha Murthy, K. V., 2004, "Report on the use of LPG as a domestic cooking fuel option in India", International Energy Initiative, (was available online on http://www.iei- asia.org.)

DFRS (1999). Forest Resources of Nepal (1987-1998), Publication No. 74, Forest Resource Information System Project, Government of Finland, HMGN Department of Forest Research and Survey, Kathmandu, November 1999.

Dhungel ,Dwarika N., 2008, Energy, Reforms and Cross-border Cooperation between Nepal and India: A Professional Perspective ; http://www.iids.org.np/dn4.pdf

DoE (2009), Overview of energy policies if Bhutan, 2009, Department of Energy, Ministry of Economic Affair, Royal Government ff Bhutan.

DoF (2012). Hamro Ban, Annual Report of Department of Forest, Financial Year 2067/068 (in Nepali), Government of Nepal, Ministry of Forest and Soil Conservation, Department of Forest, Kathmandu.

Draft Vision Report (2012) TA 7762-NEP Preparation of the Agricultural Development Strategy (ADS), 7 February 2012

Energy Sector Synopsis Report (2010); Water and Energy Commission Secretariats (WECS)

FAO (2009a). Asia-Pacific Forestry Sector Outlook Study II, Working Paper No. APFSOS II/WP/2009/5, Nepal Forestry Outlook Study, FAO Bangkok.

FAO (2009b). Asia-Pacific Forestry Sector Outlook Study II, Working Paper No.

FAO (2010). Asia-Pacific Forests and Forestry to 2020: The Second Asia-Pacific

FAO (2012). South Asia Subregional Report: Asia-Pacific Forestry Sector Outlook Study II, RAP Publication 2012/10, Asia-Pacific Forestry Commission, South Asian Forests and Forestry to 2020: Subregional Report of the Second Asia-Pacific Forestry Sector Outlook Study, Food and Agriculture Organization, Bangkok, Thailand (pp 44-48).

FICCI (2011). India's energy security: key issues impacting the Indian oil and gas sector. Ernst & Young, India

Forestry Sector Outlook Study, RAP Publication 2010/06, Asia-Pacific Forestry Commission, Report of the Second Asia-Pacific Forestry Sector Outlook Study, FAO Bangkok (pp 59-64).

GED (2010), Outline perspective plan of Bangladesh 2010-2021, General Economics Division, Planning Commission, Government of The People's Republic of Bangladesh, 2012

Ghimire, D. P., 2011, RURAL ELECTRIFICATION - An Experience from Nepal, http://www.oasyssouthasia.info/docs/oasyssouthasia_Jan2011_ppt4.pdf

GoN, (2011), Scaling-up Renewable Energy Program: Investment Plan for Nepal (Draft), Government of Nepal, September 2011

GoP (2012), Economic survey of Pakistan, 2011–12, Ministry of Planning and Commission, Federal Bureau of Statistics, Government of Pakistan, Islamabad Wing (2012)

ICIMOD/MoEST/UNEP (2007). Kathmandu Valley Environmental Outlook, International Centre for Integrated Mountain Development, Kathmandu, January 2007.

IEA (2007), Renewables in global energy supply: An IEA facts sheet , 2007

IEA (2012). Key World Energy Statistics, International Energy Agency, Paris, France. (http://www.iea.org/publications/freepublications/publication/kwes.pdf)

IEA, 2006.World Energy Outlook 2006.International Energy Agency, Paris, France.

IEA, 2010, "Energy Poverty: How to make modern energy access universal?", Special early excerpt of the World Energy Outlook 2010 for the UN General Assembly on the Millennium Development Goal, InternationalEnergyAgency, Paris, France.

IEA, 2011.Energy for All.Financing access for the poor. Special early excerpt of the World Energy Outlook 2011.International Energy Agency, Paris, France.

IEA, 2012, Key World Energy Statistics 2012, International Energy Agency, Paris, France. (available online at www.iea.org)

IEA/World Bank, 2013.SE4ALL database for Nepal coverage 1990 -2010.

IEEN (2012). Innovative Energy and Environment Nepal (accessed 2013) fromhttp://www.ieen.org.np/about-us/

IHA 2013 World Congress: Nepal Hydropower Association: Hydropower Development in Nepal

Indian Renewable Energy Status Report 2011 (http://www.ren21.net/Portals/97/documents/Indian_RE_Status_Report.pdf)

Information regarding First Plan to Tenth Plan in the Table is sourced from National Energy Resources Strategy Formulation:Sectoral Report on Modern Renewable Energy, September 2009, CMS/CES

Integrated Energy Potential of South Asia – Vision 2020 (https://www.saarcenergy.org/PDF%20Files/IEPSA_Vision2020-Obaid.pdf)

IRENA, 2012. Renewable Energy Technologies: Cost Analysis Series. Solar Photovoltaics. Volume 1: Power sector, Issue 4/5. International Renewable Energy Agency, Abu Dhabi, United Arab Emirates.

IRIB (2013). $138 Million Maldives renewable energy project backed by World Bank launched. Online available at: 〈http://english.irib.ir/subcontinent/culture/tourism/item/84774-$138-million-maldives-renewable-energy-project-backed-by-world-bank-launched〉 (accessed August, 2013)

Karki, A.B., Shrestha J.N., Bajgain, J. and Sharma, I.(2009) Biogas as Renewable Source of Energy in Nepal: Theory and Development, BSP-Nepal

Kawajiri, K., Oozeki, T., and Genchi, Y., 2011, "Effect of Temperature on PV Potential in the World", Environmental Science & technology, 45 (20): 9030- 9035

Mahapatra, SB., (2011). On financial management & cost concern for the officers of coal/energy industry of SAARC countries. Indian Institute of Coal Management, Ranchi, online available at: 〈http://www.sari-energy.org/PageFiles/What_We_Do/activities/advanced_coal_managment_dec-2009/Presentations/Day3/FinancialManagement&CostConcerns-SBMahapatra.pdf〉 (accessed on 17th December, 2012).

Managing the risk in renewable energy, The Economic Intelligence Unit Limited, 2011

Mapping of the Micro Hydropower and Preparation of District Electrification Master Plan, 2010/11, AEPC, Nepal.

Mapping of the Micro Hydropower and Preparation of District Electrification Master Plan, 2010/11, AEPC, Nepal.

MFSC (1987). Master Plan for Forestry Sector Nepal: The Forest Resources of Nepal, ADB T.A. No.670-NEP (II-2457-Ejpn-15), HMGN/ADB/FINNIDA Agreement, by JAAKKO POYRY OY and MADECOR in collaboration with Nepalese Authorities, Kathmandu, June 1987.

MFSC-DOF (1999),Forest Act 1993 (2049 BS) and Forest Rule 1995 (2051 BS) (in Nepali), Ministry of Forest and Soil conservation, Department of Forest, Forest Development Project, Babar Mahal, Kathmandu.

Mittra, S., 2012, Pride and Disgrace: China and India Power Development

MOF (2012). Economic Survey: Fiscal Year 2011/12, Government of Nepal, Ministry of Finance, Kathmandu, Nepal.

MOFSC, 1987, "Master Plan for Forestry Sector Nepal: The Forest Resources of Nepal", ADB T.A. No.670- NEP (II-2457-Ejpn-15), Ministry of Forest and Soil Conservation, HMGN/ADB/FINNIDA Agreement, by JAAKKO POYRY OY and MADECOR in collaboration with Nepalese Authorities, Kathmandu, Nepal.

MoWR, 2009, Ten year hydro plan Taskforce Report, 2065, Ministry of Water resources, Government of Nepal, 2009.

National Energy Resources Strategy Formulation: Sectoral Report on Modern Renewable Energy, September 2009, CMS/CES

National Energy Strategy Report-2011

National Water Plan, 2005,Water and Energy Commission Secretariat (WECS), Singh

NEA, 2011/12, A Year in Review-Fiscal Year 2011/12, August 2012, Kathmandu, Nepal

NEA, 2012, Vidyut, year 23, vol. 1, 2069 Bhadra

NEA, 2012/13, A Year in Review-Fiscal Year 2012/13, August 2013, Kathmandu, Nepal

NEEP/GIZ, 2012. Report on Baseline Study of selected sector industries to assess the potentials for more efficient use of energy. Nepal Energy Efficiency Programme (NEEP/GIZ), Lalitpur, Nepal (submitted by PACE Nepal Pvt. Ltd.)

Nehzad, H. (2009), World Energy Scenarios to 2050: Issues and Options, September 2009.

Nepal's 20 Years Renewable Energy Perspective Plan draft version (2011): Alternative Energy Promotion Centre/Energy Sector Assistance Program

NLSS II, 2004. Nepal Living Standards Survey 2003/04.Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal.

NLSS III, 2011. Nepal Living Standards Survey 2010/11.Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal.

Noble, Ken, 2007. ANSWERV6 – MARKAL User Manual: ANSWER MARKAL, an Energy Policy Optimization Tool. Noble –Soft Systems Pty Ltd, Ridgeway, Australia

NOC, 2011, "Import and sales statistics of Nepal Oil Corporation Ltd.", (available online at http://www.nepaloil.com.np/)

NPC, 2010, "Three Year Plan Approach Paper (2010/11-2012/13)", National Planning Commission, Government of Nepal. Available online at http://www.npc.gov.np/new/uploadedFiles/allFiles/TYP_2012.pdf)

NPC, 2049-65, National Eight Five Years Plan (2049-54), National Planning Commission, Singha Durbar, Kathmandu, Nep

NREL (2008), National Renewable Energy Laboratory, 2008

NREL (2010), Indian Renewable Energy Status Report, National Renewable Energy Library, 2010

Pokharel, B. 2010, Power Shortage, its impacts and the Hydropower Sustainability AssessmentProtocol: in the context of South Asia. NRSC 616 Project Paper, Department of NaturalResource Sciences, McGill University, Montréal, QC, Canada, December.

REN21, (2012) Renewables 2012 – Global Status Report, Renewable Energy Network Policy for 21st Century, 2012.

Renewable Energy Data Book 2009, AEPC updated with current statistics from AEPC

Renewable Energy Data Book 2011, AEPC

Renewables 2012 – Global Status Report (http://www.ren21.net/Portals/97/documents/GSR/GSR2012_low%20res_FINAL.pdf)

Renewables in global energy supply: An IEA facts sheet , 2007, IEA

RWEDP (1997). Regional Study on Wood Energy Today and Tomorrow in Asia, Field Document No. 50, Regional

SEF Nepal (2011) Solar and Wind Energy Policy Gap 2011, Renewable Energy Project (REP)/AEPC

Sherchan, B. M., 2008, Hydropower Development in Nepal - The Developers' Dilemma

Shrestha, B. (2010) State of Energy in Nepal, presented at Conference on Energy Efficiency and Renewable Energy, Oct 25-29, 2011, Islamabad, Pakistan

Shrestha, R. S., 2010), Financial issues for hydropower development in Nepal, [online] available at www.ratnasansar.com/2010/07/financial-issues-for-hydropower.html

Status of Solar PV Sector in Nepal 2010; Alternative Energy Promotion Centre/Energy Sector Assistance Program

UNDP, 2005.Energy Services for the Millennium Development Goals.United Nations Development Program, New York, USA.

UNDP, 2009.Nepal Human Development Report 2009.State Transformation and Human Development.United Nations Development Program, Kathmandu, Nepal.

UNEP (2012), Global Trends in Renewable Energy investment 2012: Frankfort School, UNEP Collaboration Centre

UNIDO, 2009.UNIDO and Energy Efficiency. A low-carbon path for industry United Nations Industrial Development Organization, Vienna, Austria.

URJA Nepal September 2012: Special Edition on Biomass Component of AEPC/ESAP

Vipramshree Energy Pvt. Ltd (2012) Evaluation of National Bio-fuel Program and Preparation of Guidelines for Effective Implementation, AEPC

WB, 2012.World Development Indicators 2012. World Bank, Washington DC, USA

WEC (2007). Survey of Energy Resources 2007, World Energy Council, London, United Kingdom.

WEC (2010). Survey of Energy Resources 2010, World Energy Council, London, United Kingdom (pp 359-407). (http://www.worldenergy.org/documents/ser_2010_report_1.pdf)

WECS (2006). Energy Synopsis Report 2006, Water and Energy Commission Secretariat, Government of Nepal, Kathmandu.

WECS (2010). Energy Sector Synopsis Report. Government of Nepal, Water and Energy Commission Secretariat, Government of Nepal, Kathmandu

WECS, 2009.Energy Resources Strategy Formulation of Nepal. Water & Energy Commission Secretariat, Government of Nepal, Singha Durbar, Kathmandu, Nepal (*yet to be ratified by the council of ministers*).

WECS, 2010.Energy Sector Synopsis Report 2010.Water & Energy Commission Secretariat, Ministry of Energy, Government of Nepal.

Wood Energy Development Programme in Asia, FAO Bangkok.

World Energy Scenarios to 2050: Issues and Options, September 2009 (http://www.nezhadpmd.com/worldenergyscenarios.pdf)

Yanrui Wu, Electricity market integration: Global trends and implications for the EAS region, Energy Strategy Reviews, Available online 23 December 2012, ISSN 2211-467X, http://dx.doi.org/10.1016/j.esr.2012.12.002.

IEA key world energy statistics report 2012

Global Trends in Renewable Energy Investment 2012, UNEP

Alternative Energy Development Board, Pakistan, current status of on-grid wind power generation projects

Klaas van Alphen, Marko P. Hekkert, Wilfried G.J.H.M. van Sark, 2008, "Renewable energy technologies in Maldives: Realizing the potential" Renewable & Sustainable Energy Reviews

MoFA, 2008 Japan

Maldives National Strategy for Sustainable Development, 2009

Obaidullah A N M, " Integrated Energy Potential of South Asia: Vision 2020, SEC, September, 2009

Energy for Sustainable Development Sri Lanka - A Brief Report with Focus on Renewable Energy & Poverty Reduction , Integrated Development Association (IDEA),Sri lanka