Government of Nepal

Water and Energy Commission Secretariat

Singha Durbar, Kathmandu

National Energy Strategy of Nepal

2013
Kathmandu

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Abbreviations

ADB	:	Asian Development Bank
AEPC	:	Alternative Energy Promotion Centre
AIDS	:	Acquired Immunity Deficiency Syndrome
ALCC	:	Annualized Life Cycle cost
APDC	:	Asian and Pacific Development Centre
ATF	:	Aviation Fuel
BAU	:	Business as usual
BCR	:	Benefit Cost Ratio
BSP	:	Biogas Support Programme
CBS	:	Central Bureau of Statistics
CDM	:	Clean Development Mechanism
CDR	:	Central Development Region
CES	:	Center for Energy Studies
CF	:	Community Forest
CFC	:	Chloro-fluoro Carbon
CFL	:	Compact Fluorescent Lamp
CGE	:	Computable General Equilibrium
CIDA	:	Canadian International Development Assistance
CMF	:	Community Managed Forest
CMS	:	Consolidated Management Services
CO2	:	Carbon dioxide
CPI	:	Consumer Price index
CRT/Nepal	:	Centre for Rural Technology Nepal.
DDC	:	District Development Committee
DFO	:	District Forest Officer
DFPSC	:	District level Forest Product Supply Committee
DFRS	:	Department of Forest Research and Survey
DMG	:	Department of Mines and Geology
DoED	:	Department of Electricity Development
DoF	:	Department of Forests
DSC	:	Development Studies Consult
DSM	:	Demand Side Management
EDR	:	Eastern Development Region
EIA	:	Environment Impact Assessment
EPR	:	Environmental Protection Rule
ERSF	:	Energy Resources Strategy Formulation
ESAP	:	Energy Sector Assistantship Program
ESI	:	Economic and Social Institute
ESPS	:	Environment Sector Support Programme
ETFC	:	Electricity Tariff Fixation Commission
ETSAP	:	Energy Technology Systems Analysis Programme
FAO	:	Food and Agriculture Organization of FAO
FIRR	:	Financial Internal Rate of Return
FPDB	:	Forest Products Development Board
FRISP	:	Forest Resource Information System Project
FRSO	:	Forest Resources Survey Office
FSD	:	Forest Survey Division
FSMP	:	Forestry Sector Master Plan

FUC	:	Forest Users Committee
FUG	:	Forest Users Group
FWDR	:	Far-Western Development Region
GDP	:	Gross Domestic Product
GDPPP	:	Gross Domestic Product at Producers' prices
GEF	:	Global Environmental Facility
GF	:	Government Forest
GFCF	:	Gross Fixed Capital Formation
GHG	:	Green House Gases
GIS	:	Geographical information system
GJ	:	Giga Joules
GLOF	:	Glacial Lake Outburst Flooding
GoN	:	Government of Nepal
GWC	:	Global Warming Commitment
HC	:	Hydro Carbon
HDI	:	Human Development Index
HIV	:	Human Immune-deficiency Virus
HMG	:	His Majesty's Government (now Nepal Government)
HSD	:	High Speed Diesel
IAEA	:	International Atomic Energy Agency
ICIMOD	:	International Centre for Integrated Mountain Development
ICOR	:	Incremental Capital Output Ratio
ICS	:	Improved Cook Stoves
IDA	:	International Development Association
IDS	:	Integrated Development Studies
IEA	:	International Energy Agency
IEE	:	Initial Environmental Examination
IEP	:	Integrated Energy Planning
IMF	:	International Monetary Fund
INGO	:	International Non-Governmental Organization
INPS	:	Integrated Nepal Power System
IOE	:	Institute of Engineering
IPP	:	Independent Power Producer
IRR	:	Internal Rate of Return
ITDG	:	Intermediate Technology Development Group (Practical Action)
JBIC	:	Japan Bank for Industrial Corporation
KfW	:	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
kV	:	Kilo Volt
LP	:	Linear Programming
LPG	:	Liquid Petroleum Gas
LRMP	:	Land Resources Mapping Project
MAED	:	Model for Analysis of Energy Demand
MARKAL	:	MARKet ALlocation
MDG	:	Millennium Development Goals
MoFSC	:	Ministry of Forest and Soil Conservation
MIS	:	Management Information System
MoAC	:	Ministry of Agriculture and Cooperatives
MoCS	:	Ministry of Commerce and Supplies
MoEn	:	Ministry of Energy
MoEST	:	Ministry of Environment, Science and Technology
MoF	:	Ministry of Finance
MoICS	:	Ministry of Industries, Commerce and Supplies
MoPE	:	Ministry of Population and Environment

MoWR	:	Ministry of Water Resources
MPFSP	:	Master Plan for the Forestry Sector Project
MVA	:	Mega Volt Ampere
MW	:	Mega Watt
MWDR	:	Mid-Western Development Region
NARC	:	National Agriculture Research Centre
NCL	:	Nepal Coal Limited
NDC	:	Nepal Development Council
NEA	:	Nepal Electricity Authority
NFI	:	National Forest Inventory
NGO	:	Non-Governmental Organization
NLSS	:	Nepal Living Standard Survey
NOC	:	Nepal Oil Corporation
NORAD	:	Norwegian Agency for Development Co-operation
NPC	:	National Planning Commission
NPV	:	Net Present Value
NRB	:	Nepal Rastra Bank
NRSC	:	Nepal Remote Sensing Centre
NTC	:	Nepal Telecommunications Corporation
NWP	:	Nepal Water Plan
NWRDC	:	National Water Resources Development Council
OECD	:	Organization for Economic and Co-operation and Development
OECF	:	Overseas Economic Co-operative Fund
OPVI	:	Oil Price Vulnerability Index
PCO	:	Public Call Offices
PDF	:	Power Development Fund
PEP	:	Perspective Energy Plan
PEPN	:	Prospective Energy Plan of Nepal
PIC	:	Particulate of Incomplete Combustion
POL	:	Petroleum Oil and Lubricants
PPA	:	Power Purchase Agreement
PRSP	:	Poverty Reduction Strategy Programme
PRSP	:	Poverty Reduction Strategy Paper
PV	:	Photo Voltaic
R&D	:	Research & Development
RECAST	:	Research Centre for Applied Science and Technology
REDD	:	Reduction of Emissions from Deforestation in Developing Countries
RES	:	Reference Energy System
RES-IMIOM	:	Reference Energy System –Integrated Macroeconomic Model Input-Output Model
RESOM	:	Reference Energy System Model
RET	:	Renewable Energy Technology
RMSM	:	Revised Minimum Standard Model
RMSM-X	:	Revised Minimum Standard Model-Extended
RONAST	:	Royal Nepal Academy of Science and Technology (now NAST)
ROR	:	Run-of-river
RSP	:	Respirable Suspended Particulates
RWEDP	:	Regional Wood Energy Development Programme in Asia
SAARC	:	South Asian Association for Regional Cooperation
SAGQ	:	South Asia Growth Quadrangle
SAM	:	Social Accounting Matrix
SASEC	:	South Asia Sub-regional Energy Cooperation
SCF	:	Standard Conversion Factor
SDAN	:	Sustainable Development Agenda of Nepal

SHS	:	Solar Home System
SMEC	:	Snowy Mountain Engineering Corporation
SNV	:	Netherlands Development Organization
TCN	:	Timber Corporation of Nepal
TE	:	Traditional Energy
TER	:	Traditional Energy Resources
TFY	:	Tenth Five Year Plan
TJ	:	Tera-joules (1,000 GJ = 1 TJ)
TNMOC	:	Total Non-Methane Organic Compounds
TOE	:	Tonne of Oil Equivalent
TOF	:	Trees Outside of Forest
TU	:	Tribhuvan University
UBET	:	Unified Bioenergy Terminology
UN	:	United Nations
UNCDF	:	United Nations Capital Development Fund
UNDP	:	United Nations Development Programme
UNEP	:	United Nations Environment Programme
UNICEF	:	United Nations Children Education Fund
USAID	:	United States Agency for International Development
VAT	:	Value Added Tax
VDC	:	Village Development Committee
WDR	:	Western Development Region
WEC	:	Water and Energy Commission
WECS	:	Water and Energy Commission Secretariat
WHO	:	World Health Organization
WR	:	Water Resources
WRS	:	Water Resources Strategy
WRSF	:	Water Resources Strategy Formulation

Chapter I: Introduction

Background

Energy is one of the essential drivers for social and economic development. A sustainable energy supply, both in the short and the long term, is needed for enhancing economic development, people's quality of life and protecting the environment. Availability of quality energy could augment the productivity and the effective supply of physical and/or human capital services. Advanced industrialized countries are able to use modern machinery and techniques for increasing the capital-labour ratio and productivity of the workers because of the availability of required amount of energy.

Per capita energy consumption of Nepal is low. It is only about 15 Gigajoule and used mainly in non-productive sectors. Present practices of energy consumption are neither sustainable nor economical. Country is suffering with the acute shortage of reliable energy supply. Energy supply is managed by separate entities which are working with different principles, objectives, regulatory and institutional mechanism. About two third of the total national energy comes from fuel wood that are managed by the Ministry of Forests and Soil Conservation. National Grid Electricity supply is being managed by Nepal Electricity Authority under the Ministry of Energy. Ministry of Environment looks after the promotion and development of alternative energy resources. Nepal Oil Corporation, under the Ministry of Commerce and Supply manage the petroleum imports and sales within the country. Ministry of Industry is responsible for exploring and developing the coal resources. That has created challenges to establish effective coordination mechanism among the institutions for integrated planning of the energy sector and also in implementing the planned activities.

Government of Nepal has initiated to formulate the National Energy Strategy (NES) to address the challenges as well as for the development and utilization of energy resources in sustainable manner.

The preparation of National Energy Strategy was started in 2007 and completed in two phases. The first phase of the study assessed and analysed the energy sector issues at national and regional level. Five regional consultative workshops were organized in five development regions of the country represented by energy sector stakeholders including supply side and demand side. The identified energy sector issues were grouped into different category such as general issues, specific issues, issues of traditional, commercial and renewable energy etc.

The second phase of the energy strategy preparation included the analysis of future energy supply and demand side by fuel types and economic sectors. Future energy demand was assessed for three possible economic growth scenarios of the country. Energy requirement at the business as usual economic growth scenario (3.9% average GDP growth), medium growth scenario (5.6% average GDP growth) and accelerated growth scenario (8.6% average GDP growth) were assessed up to the strategic horizon of 2030. In each scenario, the energy mix up to 2030 were assessed to understand the changes of energy consumption pattern with time. Future energy demands were assessed using different computer based programme namely the MARKAL (Market Allocation Model) and MAED-2 (Model for Analysis of Energy Demand).

After identifying the future energy demand and energy mix for different time line, the strategic programmes and activities were designed for each category of the energy

resources. The designed programme and activities were finalized by incorporating the suggestions from regional consultation workshops held in five development regions and national consultation workshop held in Kathmandu.

Global Energy Scenario

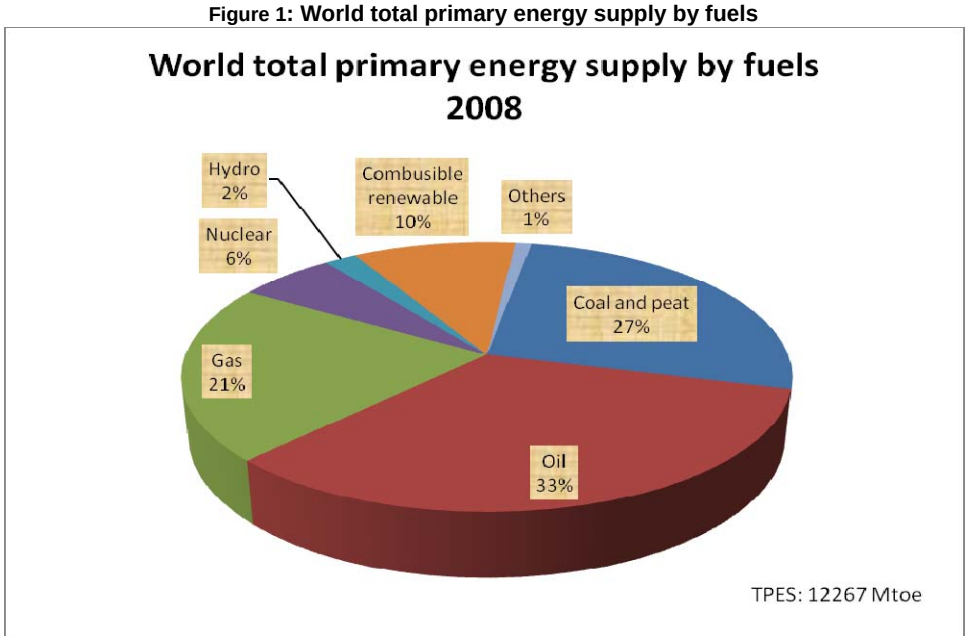
The world energy demand increased by about 3% between 2007 and 2008 reaching about 12267 Mtoe. In 2008, fossil fuels accounted for 81% of the global production (IEA, 2010a). In recent years, the growth of the coal has steeply risen and the growth of oil has been much weaker. Among non fossil fuel sources, biomass and other combustible renewable occupies about 10% share in global energy production. Nuclear and hydro resources contribute about 6% and 2% of the total production respectively. Other renewable represents about 1% of the total production with pronounced growth rate.

The world's Total Primary Energy Supply (TPES) has more than doubled in 2008 compared to 1971. Oil is the dominant fuel in 2008, reducing its share from 44% in 1971 to 33%, whereas gas increased from 16% to 21% and nuclear from 1% to 6% during the same period. The share of coal is increasing constantly in the recent years reaching the highest level (27%) since 1971.

Industry is the largest energy consuming sector accounting about 37% of the world total final energy consumption. More than one fourth (about 27%) of the total final consumption goes for transport sector followed by residential sector (about 24%), commercial and services (about 8%), agriculture (about 2%) and others (2%).

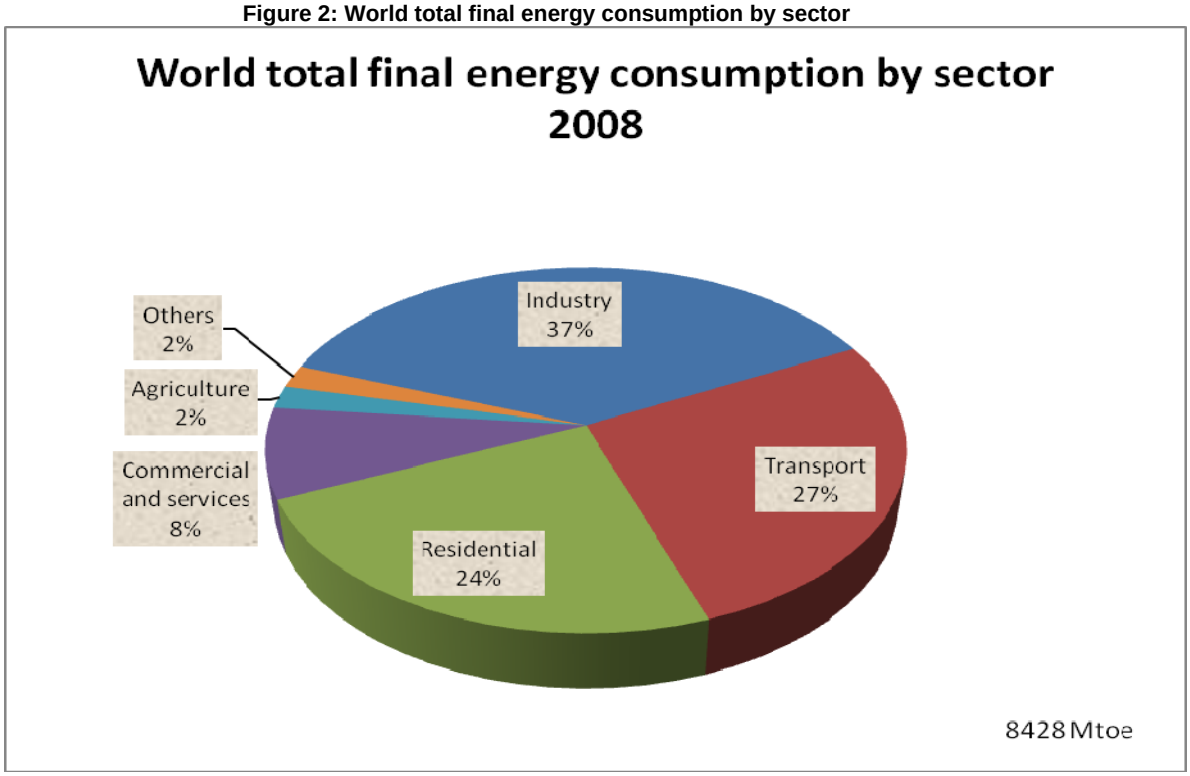
The total final consumption of energy was about 8428.41 Million Ton Oil Equivalent (Mtoe) in 2008 at global level (IEA, 2010a). Globally, fossil fuels remained the dominant source of energy, accounting more than two third of the total energy consumption. Oil is the single largest fuel in the primary energy mix in 2008 followed by gas and coal resources. Biomass and other combustible renewable accounted for about 13% of the total final consumption. Other renewable namely the geothermal, solar, wind etc. had a nominal contribution in the global energy system.

Figure 1: World total primary energy supply by fuels



Source: IEA, 2010a

Figure 2: World total final energy consumption by sector



Source: IEA, 2010a

The primary energy consumption, if policy measures are not taken, is projected to increase by 1.6 percent per year between 2004 and 2030, reaching 17.1 billion tons of oil equivalent (IEA, 2006). The average projected rate of growth is, nevertheless, slower than that over the period of 1980-2004, when demand grew by 1.8 percent per year. The pace of demand growth slackens progressively over the projection period: in the period 2004-2015, it grows by 2.1 percent. By 2015, total global energy demand is one-quarter higher than in 2004. The rate of growth drops to 1.3 percent in 2015 -2030.

Table 1: World Primary Energy demand (Mtoe)1

Energy resources	1980	2004	2010	2015	2030	2004-2030 Average Growth
Coal	1785	2773	3354	3666	4441	1.80%
Oil	3107	3940	4366	4750	5575	1.30%
Gas	1237	2302	2686	3017	3869	2.00%
Nuclear	186	714	775	810	861	0.70%
Hydro	148	242	280	317	408	2.00%
Biomass and waste	765	1176	1283	1375	1645	1.30%
Other renewable	33	57	99	136	296	6.60%
Total	7261	11204	12843	14071	17095	1.60%

Source: IEA, 2006.

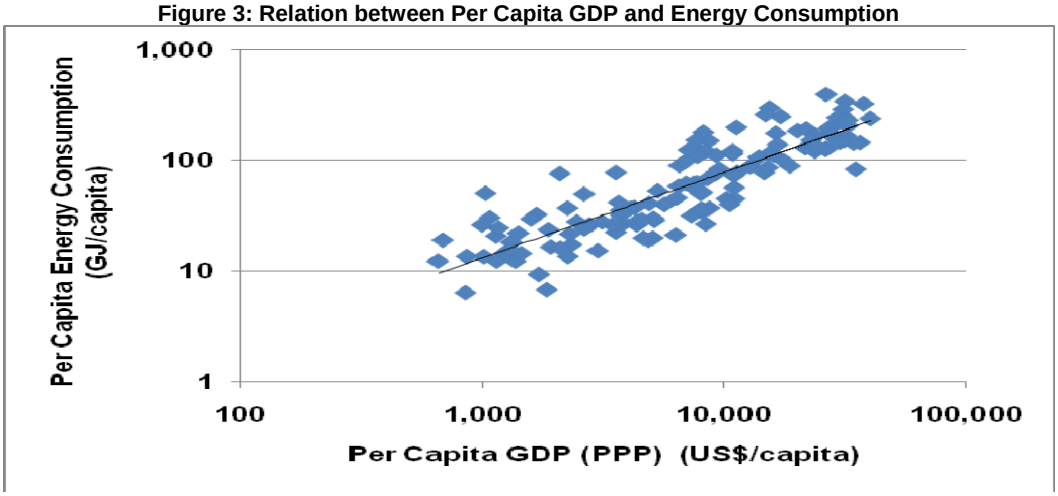
Oil is the world's vital source of energy and will remain so for many years to come, even under the most optimistic assumptions of the pace of development and deployment of alternative technology. The sources of oil to meet rising demand, the cost of producing and the prices that consumers will need to pay for are extremely uncertain. The surge in oil prices in recent years coupled with much greater short-term price volatility, have

highlighted sensitiveness of the prices to short-term market imbalances. This situation has also alerted people to the ultimately finite nature of oil (and natural gas) resources.

Global energy-related carbon dioxide emissions increase slightly faster than primary energy use, because the fuel mix becomes more carbon-intensive. The power sector contributes around half the increase in emissions from 2004 to 2030. Coal remains the leading contributor to global emissions over the outlook period.

Current Energy Scenario in the South Asia

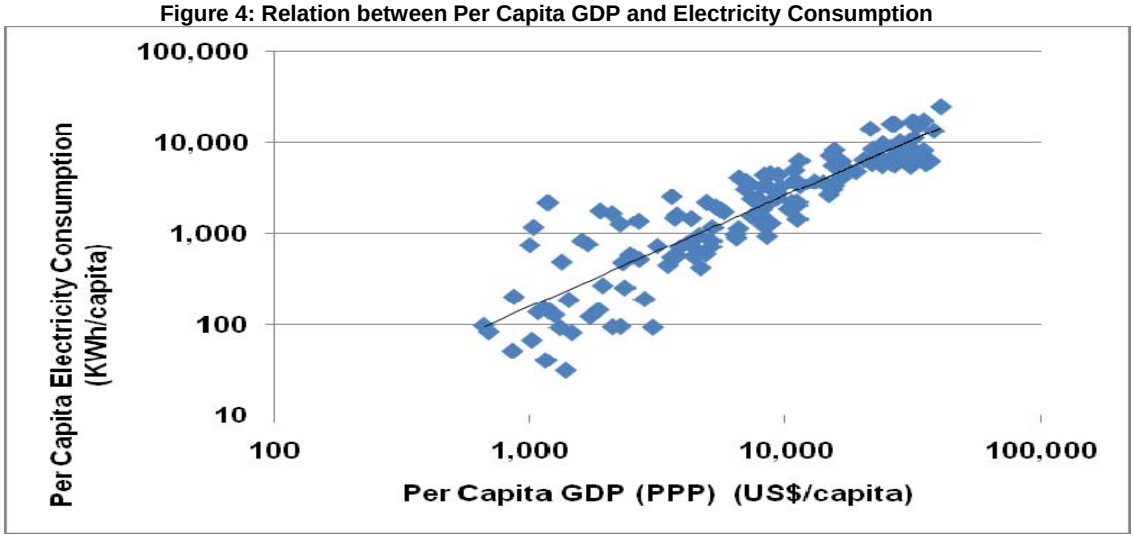
Figure 3: Relation between Per Capita GDP and Energy Consumption



Source: IEA, 2008

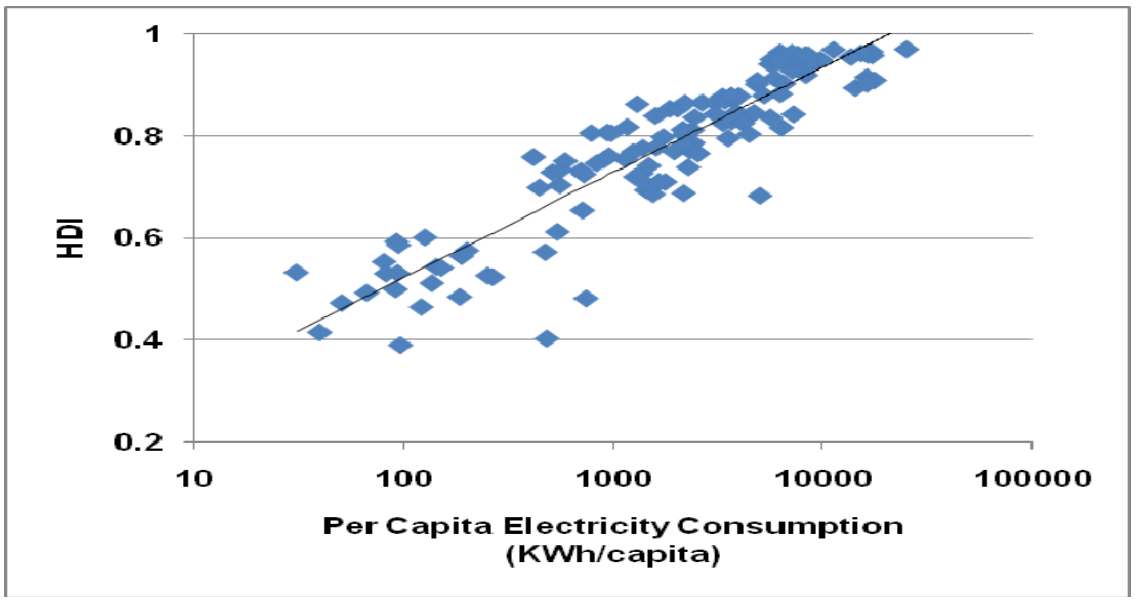
Per capita energy consumption, in general, and the electricity which is an advanced and fine form of energy, in particular, has strong positive correlation with socio-economic prosperity. It can be clearly seen from the relations between per capita GDP and per capita energy consumption and per capita GDP and per capita electricity consumption as well as the HDI and per capita electricity consumption.

Figure 4: Relation between Per Capita GDP and Electricity Consumption



Source: IEA, 2008

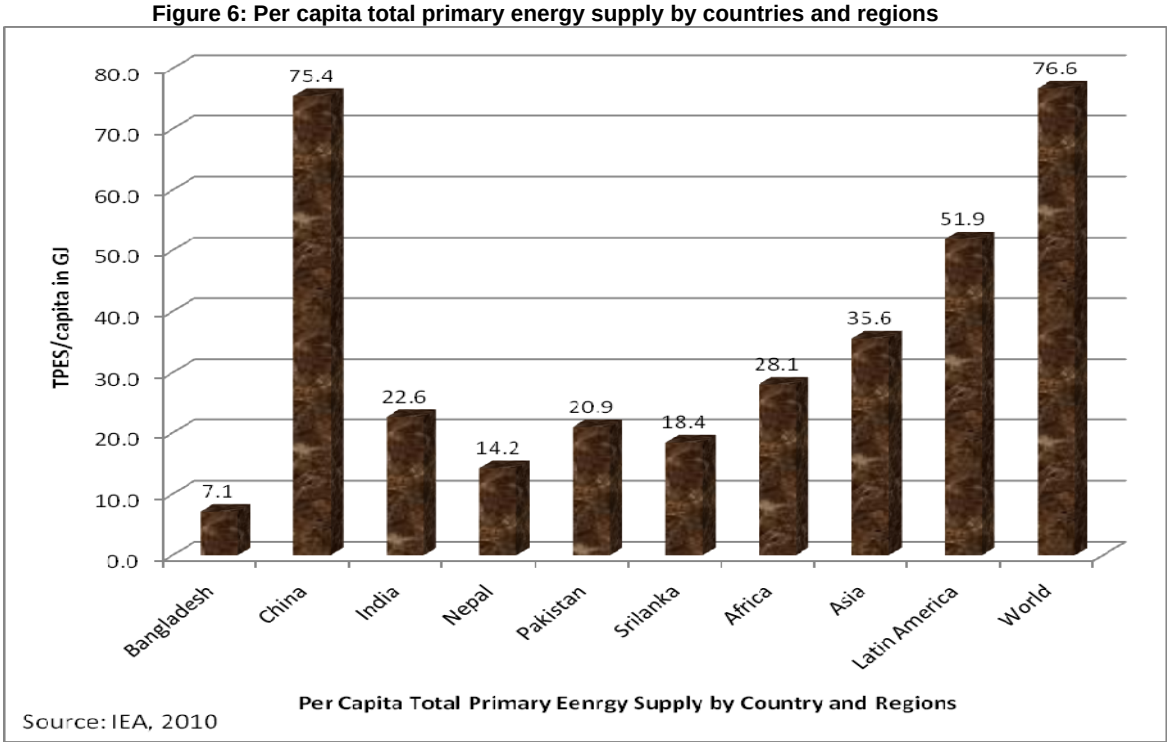
Figure 5: Relation between Per Capita GDP and Electricity Consumption



Source: IEA, 2008 and UNDP, 2009

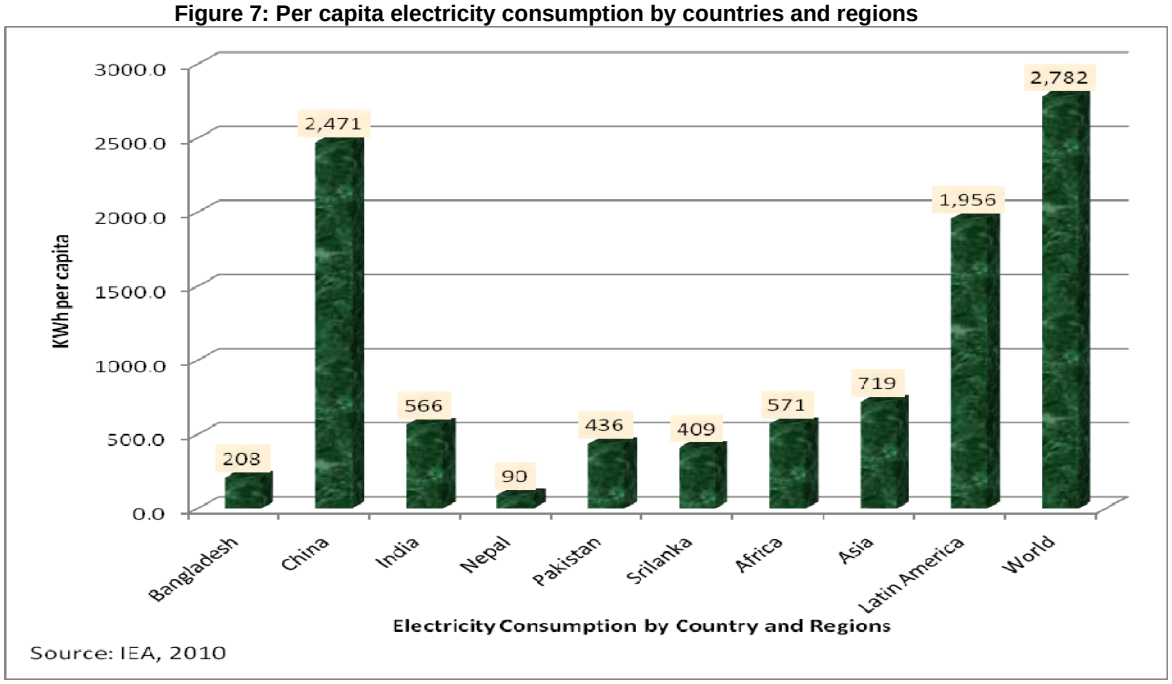
In the regional context, the per capita primary energy supply of Nepal is only 14 Giga Joule (GJ), which is one of the lowest values just above Bangladesh. Nepal's consumption is one fifth of the world's average and less than half of the asian average. The per capita consumption in China and India are 75 GJ and 22 GJ respectively.

Figure 6: Per capita total primary energy supply by countries and regions



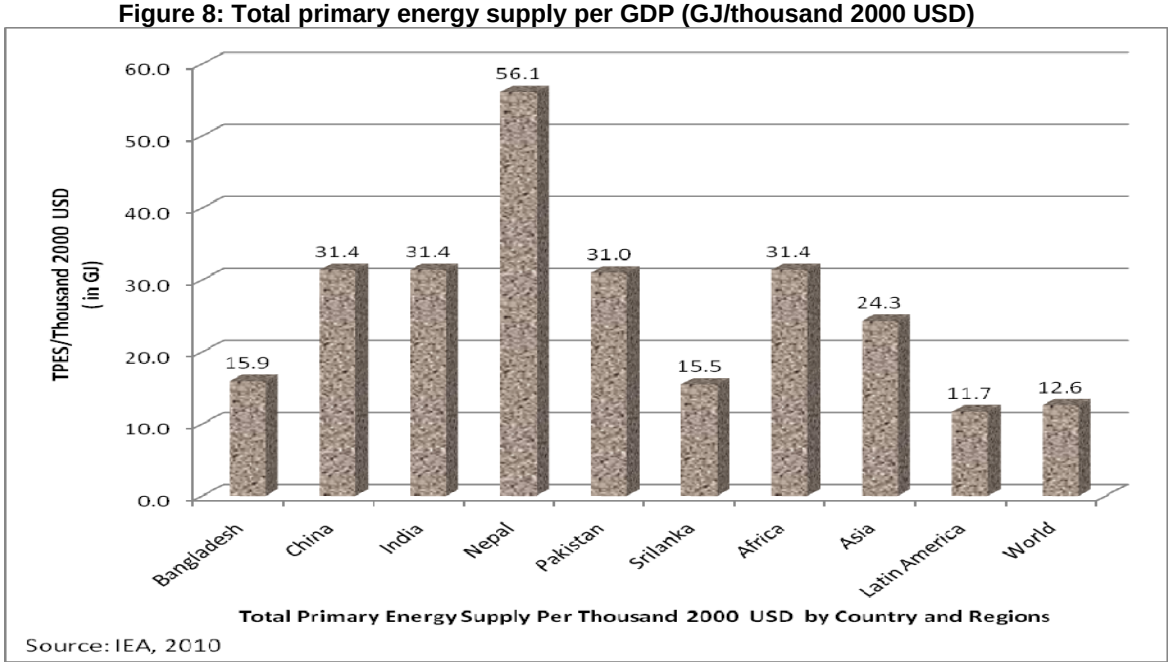
In the context of electricity consumption, Nepal's per capita consumption is 90 KWh (IEA, 2010). The asian average is 719 KWh. China has the highest per capita electricity consumption of 2471 KWh in the region.

Figure 7: Per capita electricity consumption by countries and regions



Total primary energy supply per GDP production (GJ per thousand of 2000 USD) is very high (56 GJ) in Nepal compared to other countries of Asia as well as at the region. This indicates the most inefficient energy use in term of GDP production.

Figure 8: Total primary energy supply per GDP (GJ/thousand 2000 USD)



National Energy Scenario

Nepal's energy resources are broadly divided into three categories: Traditional, Commercial and Alternative. Traditional energy resources include all types of biomass resources that are used for energy production with conventional practices. All the energy resources with well established market prices are grouped into commercial energy category, whereas, indigenous renewable energy resources are grouped into alternative category.

1.1.1 Traditional Energy Resources

The common biomass fuels that fall under the classification of traditional energy (TE) include only the solid biomass fuels derived from plants and animals. Both woody and non-woody biomass derived from shrub and grass lands, forests, agricultural lands (crop harvesting and processing residues), as well as residues of animals in the form of excreta (mostly cattle dung) are under traditional category. Recently the charred materials of some wild shrubs and other loose biomass materials were being compressed into biomass briquettes for energy.

1.1.1.1 Wood fuel Resources

Wood fuels consist of woody biomass, i.e. stems, branches, twigs, etc., saw dust, other residues from logging and wood processing activities, as well as charcoal from these sources. The primary sources of wood fuels are both forest and non-forest land. Forest and other wooded land include natural forests (including degraded forests), shrub lands, wood and timber plantations, woodlots, grasslands and non cultivated inclusion. Non-forest land includes agricultural land, agro-forestry systems, road side plantation, home gardens, etc.

Currently, accessible National Forests (areas with more than 10% crown cover) and shrub lands (areas with less than 10% crown cover) as well as private and community forests, tree plantations in block or linear lines, play a crucial role in fuel wood supply. These forests could be natural in origin or in the form of tree plantations, in blocks, lines or as scattered trees in public and community lands. Besides, private forests, and trees, including trees grown in non-forest lands of different types also contribute to both locally consumed and commercially traded fuel wood production.

All forests, excluding private forests, whether marked or unmarked with forest boundary markers are treated as national forests, including waste or uncultivated lands, unregistered lands surrounded by or adjoining to forests, as well as paths, ponds, lakes, rivers or streams and riverine lands within forests. The legal definition of forest, according to Ministry of Forest and Soil Conservation-Department of Forest (MFSC-DoF), in 1999, includes all fully or partly covered areas by trees, including land use types such as Forest, Shrub land, Grassland, Non-cultivated inclusions, and other lands. Except the cultivated land, which is mostly registered under private or institutional ownership, all other land use types are owned and managed by the forestry or other related agencies in the public sector.

Nepal’s forest resources have been regulated by Forest Act, 1993 and Forest Regulation 1995. This law and regulation has classified the forest into two broad categories for the management purpose. Such categories are National forests and Private forests. Nepal's current forest policy and legislation make a provision to earmark the national forests into a number of categories namely the Community forest, Leasehold forest, Government

managed forest, Religious forest and the protected forest. Such categories were made to support the management purpose of the forests. Collaborative Forest regime is also added in Nepalese forest management system through the government directive. Additionally, buffer zone of the protected areas are also providing large amount of fuel wood resources for locals. National Parks and Wildlife Conservation Act (1973) and Regulation has also categorized different forest type namely the Buffer zone Community forest, Buffer zone Leasehold Forest and Buffer zone Religious Forest and Buffer zone private forest.

Forest land, shrub land, grass land, non-cultivated inclusion and cultivated land are the major land use types in Nepal where forests and tree resources exists in different intensity. The remaining land uses are grouped into other land category that includes water bodies, ice and snow coverage, rocky slopes etc.

Status of Forest Resources in Nepal

Forest and tree resources of Nepal were assessed in different time period. Some assessment was made in terms of area whereas some other assessment was made both in area and stock level. The first assessment of the forest resources goes back to 1960s covering the Terai and adjoining Hill districts of Nepal. The second assessment was made only in terms of area for the year 1978/79 from Land Resource Mapping Project (LRMP). MPFS (1988) assessed the forest resources both in area and stock with some field study for the year 1985/86. Another assessment was done during 1987 to 1998 from DFRS with the support from Government of Finland. District wise forest statistics was also estimated by JAFTA in 2001 analysing the remote sensing image. Assessment to find the area coverage of 20 Terai districts was completed in 2004. Forest Resources Assessment Project is being conducted by DFRS with the support from Government of Finland using LiDAR technology.

About 6.4 million hectares of forest and shrub-land was assessed for the year 1964/65, out of which, about 58% was covered by crown, 6% by shrub-land and remaining area was not covered by crown within the forest land and about 17% wass found within the lower stocking level. About 42% forest was found in medium stocking and remaining 41% forest was highly stocked in the same duration.

The area assessment of the forest up to district level was completed for the year 1978/79. This second assessment was based on aerial photo interpretation. Land Resources Mapping Project (LRMP) estimated the area coverage of each land category. WECS (1988) had carried out a detail analysis of aerial photo of the 1978/79 and classified the land use. About 42% of the total land was found under forest and shrub-land categories. Trees and woody plants were found in their natural state in such land types. The second largest land use was cultivated land which was about 20% of the total land surface of that time. Grassland occupied about 12% of the total, whereas, shrub-land was just about 4%. Snow cover, ice cover, rocky land, water surface etc. were grouped into other land category which was about 18% of the total.

Table 2: Land use classification and area in 1978/79 in Nepal

Unit in 000 ha.

	Development region					
Landuse type	EDR	CDR	WDR	MWDR	FWDR	Grand Total
Forest	948.7	1104.0	923.7	1646.9	989.2	5612.4
Shrubland	192.1	223.7	137.4	80.1	60.8	694.0
Grassland	178.1	142.5	436.6	783.7	215.1	1755.9
NCI	236.7	234.7	226.6	177.3	111.7	986.9

Cultivated land	838.4	791.0	593.0	453.8	293.2	2969.4
Otherland	460.1	238.5	618.4	1138.4	274.4	2729.8
Grand Total	2854.1	2734.3	2935.5	4280.2	1944.3	14748.5

Source: WECS (1988)

MPFS (1988) had estimated the forest area coverage for the year 1985/86 at regional and national level based on the LRMP findings, WECS estimates and deforestation rate of the 1964/65 to 1978/79 period. Table 1.3 shows the distribution of land use by development and physiographic region in 1985/86.

Table 3: Distribution of Land Use by Dev. Region (1985/86)

Unit in 000 ha.

Region	Landuse type						Grand Total
	Cultivated land	NCI	Grassland	Forest	Shrubland	Otherland	
FWDR	302	113	212	991	52	274	1944
MWDR	465	178	783	1641	76	1138	4281
WDR	608	229	437	900	142	619	2935
CDR	818	239	138	1063	238	238	2734
EDR	859	239	175	923	198	460	2854
Grand Total	3052	998	1745	5518	706	2729	14748

Source: MPFS (1988a)

The forest of Nepal was estimated to be 5.5 million ha or 37.4% of the total area of the country. Figure 2.4 shows the distribution of forests by physiographic region. The Department of Forest Research and Survey with the support from Finland had completed assessment of forest resources both in area and stock perspective in 1999. During this assessment both the aerial photograph and satellite images were analyzed to estimate the forest and shrub coverage. Summary of the forest inventory is presented in table 1.4.

Table 4: Forest Inventory of Nepal (1987-1998)

Region	Total land (area in ha)	Total Forest (area in ha)	Forest as percent of total land (%)	Total shrub land (area in ha)	Shrub land as percent of total land (%)	Total percent of forest and shrub land (%)
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

Source: DFRS/FRISP (1999)

FAO has been carrying out Global Forest Resource Assessment in its member countries at every five years interval. Table 2.10 provides forest cover statistics of Nepal, which had been reported to FAO in the course of preparing country report on Global Forest Resource Assessment 2000 and 2005. The result is provided in table 1.5.

Table 5: Estimation of Forests and Shrub land in FAO Reports

Cover type	Unit	Year	
		2000	2005
Forest	Area (000ha)	3900	3636
	Percentage	26.5%	24.7%
Shrub	Area (000ha)	1753	1897
	Percentage	11.9%	12.9%
Total	Area (000ha)	5653	5533
	Percentage	38.4%	37.6%

Source: *FAO, 2001; **FAO 2006

The recent study shows that forest in the twenty Terai districts including protected areas cover around 1.39 million hectares (DoF, 2005). The productive forests in these regions have a significant role not only in the economic development of the country, but also in sustaining rural livelihoods. Table 2.11 provides information on forest statistics of 20 Terai districts.

Table 6: Terai Forests Resources (1990/91-2000/01)

Year	Forest & Shrub
	Unit in 000 ha
1990/91	1398.912
2000/01	1390.091
Total change	-8.821
Change/year	-0.8821
Percentage change/year	-0.06%

Source: DoF, 2005

Community forest has covered more than one fourth of the total national forests in Nepal. It is the second largest management regime after the government managed forests. Table 1.7 shows the community forest land by physiographic and development region in Nepal.

Table 7: CF area by development region and physiographic region (2010)

Unit in 000 ha

Development Region	Physiographic Region			Grand Total
	Terai	Hills	Mountain	
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	1229.7

Sources: FECOFUN, 2010.

Sustainable Wood and Fuelwood Production

Estimating fuelwood supply and demand involves many variables, both physical and socio economical. The productivity of land varies from time and space and therefore, the amount of wood producing land is very difficult to estimate. Consumption is also different in different parts of the country and is difficult to measure. Table 1.8 provides the sustainable fuel-wood supply information by land use and development region in the year 1978/79.

Table 8: Sustainable Fuelwood Supply from Accessible Land Areas (1978/79)

Unit in 000 MT

Land use	Regions					Total
	FWDR	MWDR	WDR	CDR	EDR	
Forests	1035	1082.2	1014.1	1203.6	902.5	5237.6
Shrubland	32.6	34.5	68.5	126.2	52.6	314.5
Grassland	11.2	18.5	9.4	6.1	7.3	52.5
NCI	31.5	54.9	71.5	71.2	66.5	295.6
Cultivated land	127.2	192.7	244.8	260.8	308.3	1133.8
Total	1237.5	1382.8	1408.3	1667.9	1337.2	7034.0

Sources: WECS (1987)

In the LRMP data, the non cultivated inclusion areas (NCI) which includes forests, shrubs and other land use were too small to map at a scale of 1:50,000. Therefore, estimating supply of fuel-wood from NCI, the yield per hectare used for shrub land (i.e, 0.69 tons/ha/year) is adopted for both the forest and shrub.

Sustainable Fuelwood Supply in 2008/09

The sustainable supply of fuel-wood from reachable area of all type of land resources for the year 2008/09 is presented in Table 1.9. The sustainable supply was about 12.5 million tons for the same year. This estimate is significantly different than the earlier estimation because it includes the community forest as the managed forest regime which has almost double or more annual wood yields as compared to the productivity of unmanaged natural forests. This report is further based on the proportion of timber yield and fuelwood yield equal to 25% and 75% respectively of the total annual wood yield.

Table 9: Annual Sustainable Fuelwood Production by Land use and Region (2008/09)

Unit in 000 MT

Landuse type	Development Region					Grand Total
	FWDR	MWDR	WDR	CDR	EDR	
Cultivated land	131.3	197.4	251.6	269.8	315.7	1165.9
NCI	78.0	122.8	158.0	164.9	164.9	688.6
Grassland	11.0	18.5	9.4	5.4	7.2	51.5
Forest	1619.6	2177.2	1306.7	2372.9	2561.2	10037.6
Shrubland	95.0	116.2	63.3	92.7	195.9	563.1
Grand Total	1934.9	2632.1	1789.0	2905.7	3245.0	12506.6

Source: WECS, 2010

Forest land contributes more than three fourth of the total sustainable fuelwood production in the country. Furthermore, cultivated land supplies 9.3%, NCI 5.5%, shrub land 4.5% and grassland 0.4% respectively.

The highest fuel-wood production comes from EDR supplying about 27% of the total production of community forests. About one-fourth of the supply comes from MWDR followed by CDR, WDR and FWDR respectively. Extraction and consumption of the fuel-wood derived from community forest can be different than that of its sustainable production.

1.1.1.2 Animal Dung Production potential

Where both woody and herbaceous biomass supply sources are scarce, not sufficient to meet the traditional energy needs of the people, there, historically animal excreta, mostly

gobar (cow dung) were used as a source of energy. The cow dung either in a dried cake form or mixed with other left over herbaceous biomass like cattle shade refuses and twigs and turned into stick form, has been the important traditional energy supplement in areas located away from the remaining forests, mostly in the Terai belt of western, central and eastern Nepal.

WECS' estimate of annual dung supply potential for energy, only in the form of dung (excluding bio-gas generation potential) is given in table 2.29. The table exhibits the total dung production by development region and physiographic region for the year 2008/09. Total production is about 14.9 million tons that is enough to meet about 40% of the total energy requirement of the country. However availability of the dung is just around 80% of the total production in the country. The estimate was derived based on annual dung production per unit of animal in dry form; the total animal population included only the existing cattle and buffalo's heads in 2008/09 in different development regions of the country.

Animal waste, particularly dung, is the second most important sources of indigenous energy and occupied also second largest position in terms of primary energy consumption. Animal dung in dried cake form has been the common energy for the poor, even if the energy content in dung is very low due to high moisture content. Recently, this biomass has been used for generating methane gas through anaerobic digestion. This modern form of energy produced from animal dung has become very popular. The number of new biogas digester establishment has reached more than 2,00,000 plants to date.

Table 10: Total Dung Production by Development Region and Physiographic Region (2008/09)

000 MT

Dev. Region	Phy. Region			Grand Total
	MNT	Hills	Terai	
EDR	465.9	1384.2	1918.5	3768.6
CDR	371.1	1730.8	1413.8	3515.7
WDR	12.0	2178.0	969.8	3159.8
MWDR	285.0	1317.1	950.1	2552.2
FWDR	441.5	779.9	695.7	1917.1
Grand Total	1575.5	7389.9	5948.0	14913.4

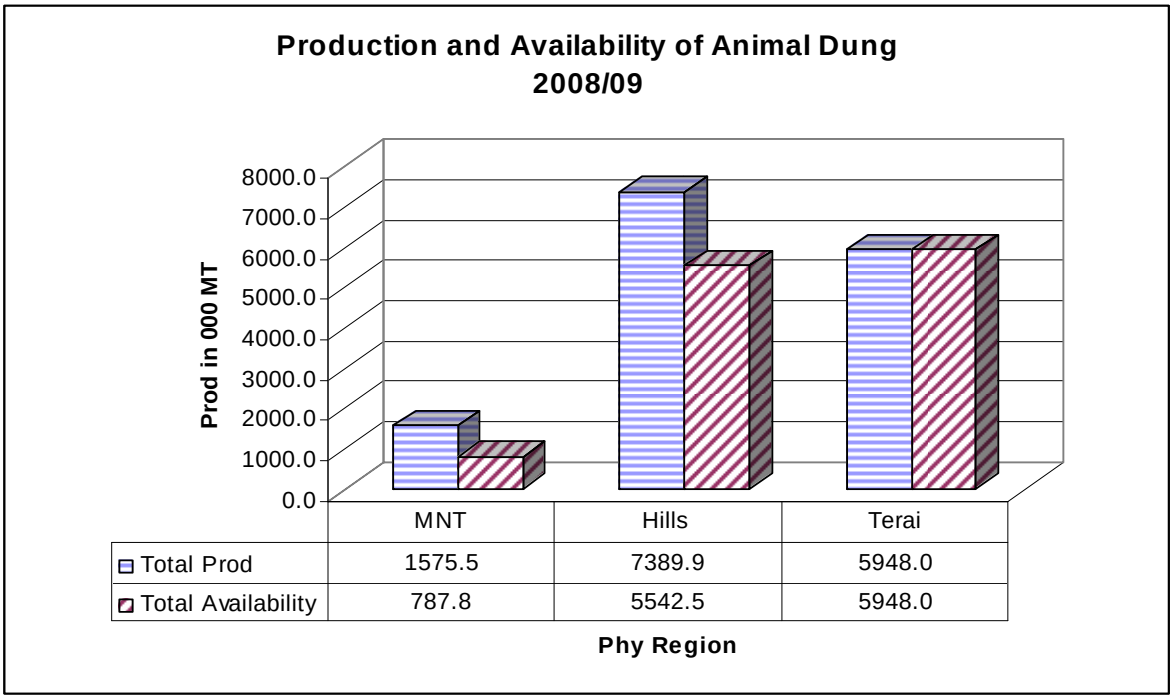
Source: WECS, 2010

Animal waste particularly dung is not only the second largest source of indigenous energy but it also occupies the second largest position in consumption terms. Dung cakes are the poorest form of energy and are regarded as the energy of the poor. However, if animal waste in the form of dung is used in a biogas plant, it turns into a clean form of energy without any adverse effects to the environment and agricultural production. Figure 1.10 shows the total supply potential of animal dung in different physiographic region for the year 2008/09, that can be used either in the form of dung cake to produce energy or in the form of compost manure to use in agriculture land. This data has considered the availability factor of animal dung in Mountain, Hills and Terai region are 50%, 75% and 100% respectively. Out of 14.9 million tons of total production, about 12.2 million tons is available for utilization. It is, therefore, around 82% of the total dung production can be considered for availability for the utilization purpose.

About 40% of the total energy requirement of the country can be met by animal dung alone if used only for energy purpose. About 15% of the total potential of dung

production has already been used for energy purpose, which effects the agricultural system of rural Nepal as subsistence oriented farming system heavily depends on animal dung for agricultural productivity.

Figure 9: Production and Availability of Animal Dung



Source: WECS, 2010

1.1.1.3 Agricultural Residue Production Potential

In rural areas, where national forests does not exist anymore and wood-fuel supply is limited, the field and processing residues of crops such as paddy, maize, wheat, millets, oil seeds, grain legumes, jute etc, in dry, solid form, have become the important alternative fuels to the traditional users for domestic energy (cooking and heating). The agricultural residue production potential is provided, in table 1.12.

Table 11: Potential Production of Agricultural Residue, 2008/09

Unit in 000 tons

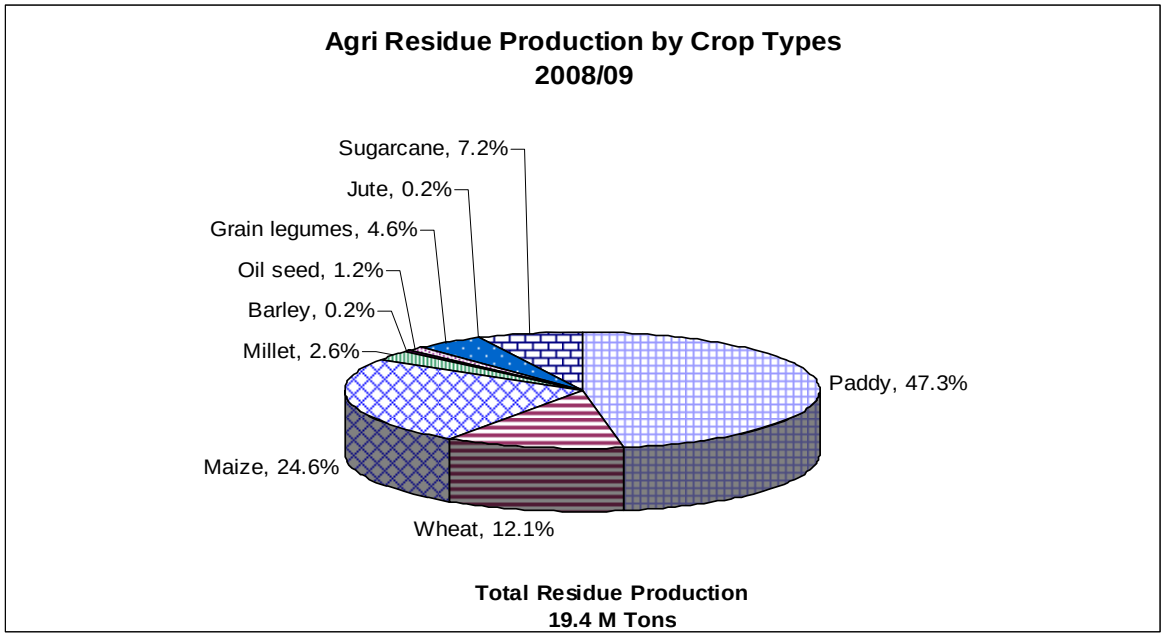
Dev. Region	Phy. Region			Grand Total
	Hills	MNT	Terai	
EDR	361.7	1436.9	3179.2	4977.8
CDR	357.5	1662.7	3939.7	5960.0
WDR	10.4	2448.1	2069.5	4528.1
MWDR	109.1	952.1	1373.7	2434.9
FWDR	141.1	296.7	1073.4	1511.2
Grand Total	979.7	6796.6	11635.5	19411.8

Source: WECS, 2010

The third largest indigenous biomass source of energy in terms of consumption is agricultural residues, which directly come from the agricultural crops. Two types of residues are generally considered for energy purpose, one is field residue generated during the crop harvesting and another is process residue derived as the by-product

during the agro processing. Residues collected at the field just after harvesting the main crops are named with field residues. Residues coming from agro-processing are called process residues such as rice husk, maize cob, wheat barn, etc. Figure 1.11 shows the contribution of individual crops in total residue production in the country. Paddy is the largest contributor in terms of crop residue production providing about 47% of the total residues. Maize gives around one quarter of the total residue production followed by wheat, sugarcane, grain legumes and millets respectively. Just three crops namely the paddy, wheat and maize provides more than three-forth of the total residue production. This figure has considered both the field residues and process residues of major crop types for assessing the agricultural residues at national level.

Figure 10: Contribution of Crops in Residue Production (2008/09)



Source: WECS, 2010

Supply potential of agricultural residues is estimated at 19.4 million tons for the year 2008/09. This amount is equivalent to 243 million GJ in terms of energy, which is about 61% of the total energy consumption of the same year. Table 1.13 shows the energy production potential of agricultural residues in 2008/09.

Table 12: Energy Production Potential of Agricultural Residue (2008/09)

Unit in 000 GJ

Dev. Region	Phy. Region			Grand Total
	Hills	MNT	Terai	
CDR	20883.8	4490.1	49483.1	74857.0
EDR	18047.7	4542.9	39930.3	62520.8
FWDR	3727.1	1771.6	13481.7	18980.4
MWDR	11958.4	1369.8	17253.6	30581.8
WDR	30748.0	131.1	25993.3	56872.5
Grand Total	85365.0	12305.5	146142.0	243812.5

Source: WECS, 2010

1.1.2 Commercial Sources of Energy

1.1.2.1 Hydro-Energy Resources

The first Hydropower development in Nepal started with the commissioning of Pharping Power Plant in 1911 located on the right bank of Bagmati River in the South of Kathmandu valley. This power plant with a capacity of 500 KW was inaugurated on 22nd May 1911. The second hydropower plant was established in 1934 with an installed capacity of 900KW at Sundarijal. This power plant is still in operation and producing 640KW. Third hydropower plant with capacity of 1600 KW was constructed in 1942 at Chisang Khola (Morang district) in the private sector by Morang Hydro electric Company. It later was damaged due to several landslides (Pradhan, 2006).

Prior to 1960, the hydropower stations were constructed through grant aid. Panauti (2.4MW) from former USSR, Trisuli (18 MW), Devighat (14.1 MW), Gandak (15 MW) and Surajpura-Kosi (20MW) from India and Sunkoshi (10MW) from China. Since 1970, bilateral and multilateral funding were available for hydropower development. The major donor countries in the period were Japan, Norway, Germany and South Korea including Canada, Finland, Denmark, Sweden and USA. The lending agencies were the World Bank, Asian Development Bank (ADB), Japan Bank for Industrial Corporation (JBIC) former Overseas Economic Co-operative Fund (OECF), Saudi Fund for Development, Kuwait Fund and others. From the 1990's subsequent to the adoption of the policy of economic liberalization, hydropower development took a new turn with the private sector entering the arena (MOWR, 2004).

Hydropower Potential

Nepal's theoretical hydropower potential has been estimated at about 83,000 MW and its technically and economically feasible potential of about 45,000 MW and 42,000 MW respectively. Table 1.14 summarizes the theoretical hydropower potential classified within the major river system in Nepal, while Table 1.15 and Table 1.16 illustrate technically and economically feasible potential. The Karnali and Mahakali river systems represent approximately 43 percent of theoretical hydropower potential and 55 percent of the technical/economical potential.

Table 13: Theoretical Hydropower Potential

River Basin	Potential in MW		Total
	Major river courses having catchments areas above 1000 km^2	Small river courses having catchments areas 300-1000 km^2	
Sapta Koshi	18750	3600	22350
Sapta Gandaki	17950	2700	20650
Karnali and Mahakali	32680	3500	36180
Southern River	3070	1040	4110
Country Total	72450	10840	83290

Table 14: Technical Hydropower Potential

River Basin	Number of Project Sites	Technical Potential Capacity in MW
Sapta Koshi	53	11400
Sapta Gandaki	18	6660
Karnali	30	25410
Mahakali	4	1160
Southern Rivers	9	980
Country Total	114	45610

Table 15: Economical Hydropower Potential

River Basin	Number of Project Sites	Economic Potential Capacity in MW
Sapta Koshi	40	10860
Sapta Gandaki	12	5270
Karnali	7	24000
Mahakali	2	1125
Southern Rivers	5	878
Country Total	66	42133

The above estimates are based on Dr. Hariman Shrestha's doctoral thesis prepared in 1966 (Shrestha, H.M., 1966).

Hydropower Generation and Supply System

Nepal, till date, has total installed capacity of 689.3 MW (Privately owned micro-hydropower plants not included). Out of which, Independent Power Procedures (IPP) contribute 158.3 MW. Table 1.17 gives the current power plants in the country. In addition to power being supplied by the indigenous hydropower plants, around 50MW of power is being imported from India (Vidyut, 2064).

Four more hydropower plants with a total installed capacity of 353.4 MW are under construction. Chameliya (30MW) and Kulekhani-III (14MW) are planned to be completed in 2011 and 2010/11 ??respectively (NEA, 2009).

Table 16: Existing Power Plants and Capacity

Major Hydropower Stations – NEA	MW	INPS Connected - IPP	MW
Kaligandaki A	144.00	Khimti I (HPL)	60.00
Marsyangdi	69.00	Bhotekoshi (BKPC)	36.00
Kulekhani 1	60.00	Chilime (CHPL)	20.00
Kulekhani 2	32.00	Jhimruk (BPC)	12.00
Trishuli	24.00	Indrawati III (NHPC)	7.50
Gandak	15.00	Andhi Khola (BPC)	5.10
Modi Khola	14.80	Khudi (KhudiHP)	3.45
Devighat	14.10	Piluwa Khola (AVHP)	3.00
Sunkoshi	10.05	Sunkoshi Small (SanimaHP)	2.50
Puwakhola	6.20	Thoppalkhola (Thoppalkhola HP)	1.65
Middle Marsyangdi	70.00	Chakukhola (APN)	1.50
	459.15	Phemekhola (Khoranga HP)	1.00
		Baramchi (Unique Hydel)	0.98
Small Hydropower Stations – NEA	MW	Sisnekhola (Gautam Buddha HP)	0.75
Chatara	3.20	Rairang (RairangHPD)	0.50
Panauti	2.40	Salinadi (Kathmandu Small HP)	0.23
Tatopani/Myagdi (i) & (ii)	2.00	Sangekhola (Sange Bidyut Company)	0.18
Seti (Pokhara)	1.50		156.34
Fewa (Pokhara)	1.00		
Tinau (Butwal)	1.02		
Sundarijal	0.64		
Pharping***	0.50	Isolated – IPP	MW
Jomsom	0.24	Namche (KBC)	0.60
Baglung	0.20	Salleri (Sceco)	0.40
Khandbari	0.25		1.00
Terhathum	0.10		
	0.20		
Phidim	0.24		
Doti	0.20		

Ramechhap	0.15		
	13.84		
Diesel Power Stations – NEA	MW	Solar Power Stations – NEA	MW
Duhabi Multifuel	39.00	Simikot	0.05
Hetauda	14.41	Gamgadhi	0.05
	53.41		0.10
Total Isolated Hydropower Stations - NEA	4.53		
Total Existing	689.35	*** Not in normal operation	

Source: NEA, 2009

Nepal Electricity Authority is primarily responsible for planning, construction and operations for electricity supply. Presently, there are various Independent Power Producers (IPPs), who generate electricity and under the Power Purchase Agreement with NEA sell the bulk power to NEA. NEA is also in the process of unbundling and there will be separate entities for generation, transmission and distribution as envisaged in National Water Plan 2005.

Power Demand Forecast

The Power demand projection for INPS has been carried out by NEA considering the Power consumption date of FY 2006, macro-economic indicators and rural electrification programs (Table 1.18).

Table 17: The Power demand projection

Year	Energy (GWh)	Peak Load (MW)	Growth in Peak Load (Annual change)
2009/10	4018.4	878.8	
2010/11	4430.7	967.1	10.0%
2011/12	4851.3	1056.9	9.3%
2012/13	5349.6	1163.2	10.1%
2013/14	5859.9	1271.7	9.3%
2014/15	6403.8	1387.2	9.1%
2015/16	6984.1	1510.0	8.9%
2016/17	7603.7	1640.8	8.7%
2017/18	8218.8	1770.2	7.9%
2018/19	8870.2	1906.9	7.7%
2019/20	9562.9	2052.0	7.6%

Source: NEA, 2009

Power Generation Expansion Plan

Table 18: Under Construction Power Plants and Capacity

NEA	Capacity (MW)	IPP	Capacity (MW)
Upper Tamakoshi	456.00	Mardikhola (GandakiHP)	3.10
Chameliya	30.00	Ridikhola (Ridi HPD)	2.40
Kulekhani 3	14.00	Patikhola (Unified HP)	0.99
Gamgadhi	0.40	Upper Hadikhola (CPDS)	0.99
		Seti-II (Task HP)	0.97
Total Under Construction	500.40	Total Under Construction	

Source: NEA - A Year in Review (FY 2007/08)

Table 19: Planned and Proposed Power Plants and Capacity

Preliminary Works in Progress		Planned and Proposed	
IPP (PPA Concluded)	MW	NEA	MW
Upper Modi	14.00	Upper Trishuli - 3'A'	60.00
Madi 1 (Annapurna Group)	10.00	Upper Trishuli - 3'B'	37.00
Mailung (MailungHP)	5.00	Budhi Gandaki	600.00
Daramkhola (Gorkha HP)	5.00	Rahughat	27.00
Lower Nyadi (Baverian HP Nepal)	4.50	Upper Seti (Storage)	128.00
Upper Malikhola (East Nepal Dev.)	3.10	Seti Trishuli (Storage)	128.00
Malikhola (Himal Dolakha HP)	2.40	Upper Modi 'A'	42.00
Phawakhola (Shivani HP)	2.07		1422.00
Lower Chakukhola (Laughing Buddha)	1.76		
Siurikhola (Nyadi Group)	0.99	IPP	
Lower Piluwa (Baneshwar HP)	0.99	Seti (West)	750
Tinaukhola Small (Namabuddha HP)	0.99	Arun 3	402
Tadikhola (Adishakti Power)	0.97	Upper Marsyangdi 'A'	121
Narayani Shankar Biomass (TMP)	0.50	Likhu 4	120
Belkhu (Multipurpose Food Ind.)	0.32	Kabeli 'A'	30
Total	352.604	Khimti II	27
		Lower Indrawati	4.5
		Balefi	20
		Upper Karnali	300
		Total	2499.5

Source: NEA,2009 *Capacity in MW

Power Demand –Supply Imbalance

Presently, the NEA system is supply deficit. This is being evident from load shedding being implemented for last several years. Data of fiscal year 2007/08 revealed that, the peak power supply demand in wet season and dry season were 640 MW/542 MW and 720 MW / 308 MW respectively, resulting into load shedding of above 30 hours a week. This kind of load shedding due to supply deficit is to continue till substantial generation of hydropower is added to the system.

Transmission and Distribution

NEA is operating at system voltage levels of 132 kV and 66 kV. Increasing load demands have created load saturation in some sectors of these transmission lines leading to poor regulation and reliability at the supply terminals resulting in high technical losses. The projects like the Middle Marshyangdi would require augmentation in the current carrying capacity of the major 132 kV network and construction of some 220 kV lines. The urgently needed 220 kV sections are Hetauda – Bardghat and Khimti – Dhalkebar. The Khimti – Dhalkebar 220 kV transmission line is under construction. Presently, Hetauda-Bharatpur 220 kV transmission Line land associated substations are under implementation. After completion, this will ease transmission congestion in Hetauda-Bharatpur corridor. In addition to the above several Grid Substation Reinforcement Project, Chandranigahpur System Reinforcement Project, Kawasoti 132 kV Substation Project are also under execution (NEA, 2007/08). NEA is also constructing three power exchange links, namely, Butwal-Sunauli, Parwanipur–Birganj and Dhalkebar–Bhittamod at the 132 kV level to enhance the transfer capability of the Nepal-India cross border interconnections (MOWR, 2004). Besides, it has recently completed

transmission line route alignment survey of a) Duhabi-Purnia 400 kV, 90 km, b) Butwal-Gorkhapur 400 kV, 100 km and c) Dhalkebar-Mujaffarpur 400 kV, 140 km.

At present, the Integrated Nepal Power System (INPS) consists of 1,132 km of 132 kV single circuit, 412.1 km of 132 kV double circuit, 231.46 Km of 66 kV single circuit, 161.3 Km of 66 kV double circuit, 22 Km of 66 kV and 132 double circuit, 3.37 Km of 66 kV four circuit and 2,362 km of 33 kV single circuit transmission line. Total sub-station capacity of the system is 902.45 MVA. All the Head Quarters of 75 districts of the country are provided with electricity (NEA, 2006). The remaining areas are being progressively electrified.

Petroleum and Natural Gas

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. All the petroleum products consumed in Nepal are imported from India or overseas in the refined form for direct consumption. Nepal Oil Corporation (NOC) is the sole organization responsible for the import and distribution of petroleum products. The NOC has storage facility for all the essential petroleum fuels, except for LPG. LPG is bottled and distributed by private companies around all parts of the country. Table 1.20 provides the petroleum storage capacity all over the country.

Table 20: Petroleum Storage Capacity in Different Places of Nepal

	Petroleum fuel (unit in KL)				
Place	Petrol	Diesel	Kerosene	ATF	Total
Kathmandu	2630	6300	6300	7640	22870
Amlekhgung	1960	10380	11120	0	23460
Pokhara	350	1520	1520	64	3454
Biratnagar	560	5710	5380	280	11930
Dhangadi	100	1590	830	30	2550
Bhairahawa	140	1914	1535	56	3645
Nepaljung	140	1520	1520	280	3460
Surkhet	0	0	44	29.3	73.3
Dipaya	0	15	45	0	60
Janakpur	30	140	70	0	240
Total	5910	29089	28364	8379.3	71742.3

Source: NOC, 2065BS

Table 1.21 shows the number of Tank Trunk used in supplying the petroleum products for Nepal Oil Corporation.

Table 21: Number of Tank Trunk Supplying Petroleum Products for NOC

Region	Number	Percentage
EDR	176	15.3%
CDR	600	52.0%
WDR	197	17.1%
MWDR	72	6.2%
FWDR	51	4.4%
Private sector	57	4.9%
Total tank truck	**1153**	100.0%

Source: NOC, 2065 BS

1.1.2.2 Coal Resources

Nepal has some sporadic deposits of low-grade lignitic coal. A very small amount of the total coal supply is extracted in Dang district for consumption in brick industries. For the major supply, coal is imported from India and abroad. Nepal Coal Limited was the sole agency for the import of coal before 1993. After 1993, NCL has become inactive and private enterprises came into existence for the import of coal. These enterprises make their own agreement with Coal India Limited or other suppliers abroad and supply coal to the market. These enterprises are entitled to fix their own prices for the coal.

There are some small occurrence of coal and lignite in Nepal, which are not commercially attractive. The occurrences of coal can be classified in to four major categories:

- Quaternary lignite of Kathmandu Valley
- Coal from Dang (Eocene coal from Mid-Western Nepal)
- Siwalik coal
- Gondwana coal

Out of these four types identified, the Quaternary lignite deposit of the Kathmandu Valley and coal from Mid-Western Nepal are of some economic significance. The Siwalik coal deposits, though widely distributed throughout the Siwalik range of the country, are small and sporadic and have not been commercially exploited. Likewise the Gondwana coal from the east of Nepal is of low quality, small in size and of no economic significance. Table 2.49 gives the primary production of coal and import statistics in Nepal.

Table 22: Primary production and Import of Coal Resources in Nepal

Unit in 000 tons

Year	Primary production	Import	Total
199899	10.95	104.22	115.18
199900	17.53	400.62	418.15
200001	16.59	279.84	296.43
200102	9.61	248.39	258.00
200203	11.85	215.91	227.76
200304	10.46	279.84	290.30
200405	9.29	247.88	257.17
200506	11.96	400.62	412.58
200607	19.58	239.48	259.06
200708	14.02	314.12	328.15
200809	14.82	293.76	308.58

Source: DoM&G, 2010 and DoC, 2010

In the year 2008/09, Nepal imported about 293 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. Primary production of coal resources within the country is about 5% of the total coal import of the year 2008/09. 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.

1.1.3 Renewable Energy Resources

1.1.3.1 Solar Energy Resources

Nepal, being located in favourable latitude, receives ample solar radiation. The average solar radiation varies from 3.6–6.2 kWh/m2/day, and the sun shines for about 300 days a year. The development of solar energy technology is thus reasonably favourable in many parts of the country. Average daily insolation in Nepal in kWh/m2 is given in the Table in annex 2. These figures also emphasize high solar energy potential and possibilities of development of solar energy technology. As per the recently published report of AEPC, 2008 under Solar & Wind Energy Resource Assessment in Nepal (SWERA), the commercial potential of solar power for grid connection is 2,100 MW.

With national average sunshine hours of 6.8/day and solar insolation intensity of about 4.7 kWh/m2/day, there is a huge potential for solar thermal devices such as Solar Water Heaters (SWH), Solar Dryers (SD), Solar Cookers (SC). Presently SWH have been fully commercialized and till 2009 more than 185,000 SWH have been installed in the country. SD and SC are still in the phase of dissemination and commercialization. This shows quite significant improvement in SWH installations in recent years.

Solar Electricity Generation

For a large part of the rural population consuming low electrical energy, there is no viable alternative to solar electricity for rural electrification. The operation and maintenance cost of diesel generators is too high, biogas technology does not work satisfactorily on the fairly cold high altitudes or in the mountains and would be difficult to achieve with roving herds of cattle. Small Hydro turbines need specific topographical conditions that are only found near a small percentage of users' dwellings. Solar electricity generating systems, which do not need fuel or extensive infrastructure, are easy and quick to install. This could be very viable option in many locations of the country. However, it cannot be claimed that solar electricity can solve rural electrification issues completely. Solar electricity too has limitations and problems but these can overcome with proper planning.

Solar Electricity Potential

The country has 300 sunny days per annum and thus is very rich in solar power potential. Using PV module of 12% efficiency, total energy generated will be 0.12* 4.5 * 147,181*10^6 = 80,000GWh/day = 17.7 TW (assuming peak sun to be 4.5 hours). This energy generated is more than energy required for fulfilling the whole energy demand of the world. The total estimated world energy demand at present is about 13 TW. If we use just 0.01% of the total area of Nepal, we can generate solar electricity of 8 GWh/day that is 2920 GWh/year (which is more than the energy generated by NEA in the year 2003 amounting 2261 GWh/year).

Major Users of Solar Electricity in Nepal

Information on first officially recorded use of solar electricity in Nepal was not available. It is said that the Nepal Telecommunications Corporation (NTC) was the first organization to use solar electricity to power a high frequency communication transceiver located in Damauli in 1974. Since then NTC has 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, without national grid supplied electricity. Seventy five percent of all the Public Call Offices (PCO) in NTC is being powered by PV.

The estimated market potential is huge and about 5 MWp of photovoltaic power is currently being used in various public and private sectors (telecommunication, utility supply, stand-alone, water supply, aviation etc.) in Nepal are shown in Table 1.23.

Table 23: Application of PV Power by Sector (until 2005)

S.N.	Service	PV Power, kWp	% Power	No. of Installation
1	Telecommunications	1001	21.6	3,000+
2	Utility supply (centralised)	100	2.1	2
3	Stand-alone system	3328	71.8	75,000+
4	Water supply	93	2.0	25
5	Aviation	37	0.8	45
6	Miscellaneous	78	1.7	100+
	Total	4,636	100	

Stand-alone Solar Home System (SHS) constitute above 5000 kWp with 185017 numbers up to 2008/09. The installation of stand-alone SHS is shown in Figure 10. The trend of SHS installation shows a steep rise after 2000 due to the subsidy policy implemented by AEPC/ESAP. Till December 2004, 51 solar PV pumping systems have been installed, of which 28 were installed after 2000 with subsidy provided from AEPC.

Table 24: Yearly Installation of Solar Home System

S.N.	Fiscal Year	District	Total No	Capacity (Wp)	MW
1	Upto 056/57		11758	442652	0.44
2	057/58	35	6211	242064	0.24
3	058/59	63	13745	543486	0.54
4	059/60	65	18482	650669	0.65
5	060/61	71	15106	411095	0.41
6	061/62	67	17887	462679	0.46
7	062/63	67	6788	175052	0.18
8	063/64	61	6690	167113	0.17
9	064/65	68	34755	822964	0.82
10	065/66	73	53595	1249430	1.25
	Total		**185017**	**5167204**	**5.17**

Source: AEPC, 2010

Some INGOs are said to have installed solar pumps (3.2 kWp in Mustang) and solar PV driven mills (1.2 kWp and 1.6 kWp in Mustang) for grinding wheat and millet.

1.1.3.2 Wind Energy Resources

Wind is still unharnessed energy resource in Nepal. Due to its diverse topography and the consequent variation in the meteorological conditions, it is difficult to generalize wind conditions in the country. Specific areas have been identified as a favourable for viable wind energy generation. Studies made for the World Bank in 1977 indicate that in the Khumbu area, average wind speed obtainable for wind energy generation is over 5 m/s. The Department of Hydrology and Meteorology (DHM) conducted a study in 1983 and recorded wind speed data for a number of stations. The conclusion drawn by DHM indicates that wind could be used for electricity generation in the hills and for irrigation and pumping of drinking water in the Terai. The study by DANGRID, a Danish consulting firm in 1992 reported that a potential to generate 200 MW of electrical power with an annual energy production of 500 GWh from the wind resources along the 12 km valley

between Kagbeni and Chusang in Mustang District. WECS along with DHM, Alternative Energy Promotion Centre (AEPC) and Nepal Academy of Science and Technology (NAST) carried out study on the Potential of Wind Resources in Nepal in the year 1999-2002. This study shows that there is not high potentiality of wind energy except for some high mountainous locations i.e. Thakmarpha, Khumbu and Khanjiroba.

Report of AEPC, 2008 under Solar & Wind Energy Resource Assessment in Nepal (SWERA), revealed that the commercial potential of wind power is 3,000 MW. A pilot project for demonstrations and dissemination is being carried out by various organizations like AEPC, ITDG etc. ITDG has installed five 200-watt wind turbines at various locations on Kavre, Tansen Palpa, Makawanpur, Chisapani (Karnali), and Udayapur for the stand-alone system whereas AEPC has installed one 400-watt wind turbine at Nagarkot for demonstration purposes. 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). They are used for the therapeutic purposes and a study is needed to investigate the possible end uses of the hot water spring resources.

1.1.3.3 Biogas Resource Potential

Biogas-a modern form of energy derived from anaerobic digestion of animal waste mainly cattle dung, and recently also human excreta mixed with cattle dung in some areas, has been the alternative source of energy for cooking and sometimes for lighting in rural households, mostly in the Terai and some low lying villages in the mid-hill districts of Nepal.

The Biogas Support Programme (BSP) under the Alternative Energy Promotion Centre and with the cooperation from various donors such as SNV and KfW is promoting the installation of biogas plant in various part of the country. There are more than 2,00,000 biogas plants installed in various districts of Nepal. Also there are about 60 private biogas companies and 15 biogas appliances manufacturing workshops in the country for the effective dissemination of this technology. Also biogas program is developed as the first CDM project in Nepal.

BSP-Nepal (2005) present the biogas production potential based upon the number of cattle/buffalo in the country in 1997/98 (Table 1.25). Their estimate takes into account the quantity of dung that could be available for biogas and the micro-climatic pockets where biogas production could be technically feasible in different parts of the country.

Table 25: Biogas Potential in Nepal (1997/98)

Animal	Number (Million)	Dung available/day (kg)	Total dung available/day ('000 tonnes)	Biogas Yield per kg of Dung (m^3/day)	Gas Volume ('000 m^3/day)
Cattle	7.0	10	70	0.036	2,520
Buffalo	3.4	15	51	0.036	1,836
Total	10.4		121		4,356

Source: CMS, 1999 (in BSP-Nepal, 2005).

Considering only 75 percent of the potential could be realized due to other uses of dung, the above data indicate a potential of 2.9 million biogas plants in Nepal (smallest size biogas plant capacity $4m^3$). The above assessment does not take into account the droppings of poultry and the excreta of pigs and goats, nor that of human beings. If all

these were added then the biogas production potential could be greatly enhanced in the country.

Different studies have tried to assess the biogas potential in the country. In 1992, Wim J. van Nes es (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, the economic potential was considered only to be 60,000 plants. This estimate takes into account the quantity of dung that could be available for biogas and the micro-climatic pockets where biogas production could be technically feasible in different parts of the country.

Table 26: Biogas Production Potential in Nepal (2008/09)

Unit in 000 GJ

Dev. Region	Phy. Region			Grand Total
	Hills	MNT	Terai	
CDR	4999.7	1059.3	4066.3	10125.3
EDR	3962.0	1334.6	5488.5	10785.1
FWDR	2240.4	1261.7	2001.9	5503.9
MWDR	3767.7	798.7	2745.4	7311.8
WDR	6349.6	33.1	2794.1	9176.8
Grand Total	21319.4	4487.3	17096.2	42902.9

Source: WECS, 2010

Total biogas production potential in the year 2008/09 is about 43 million GJ which is about 11% of the total energy demand of the same year. Table 1.27 provides the information on potential of biogas availability in 2008/09. Potential of biogas availability in the country is about 81% of the total biogas production. The availability factor of the biogas production in the Terai, Hills and Mountain region is 100%, 75% and 50% respectively.

Table 27: Potential Biogas Availability (2008/09)

Unit in 000 GJ

Dev. Region	Phy. Region			Grand Total
	Hills	MNT	Terai	
CDR	3749.8	529.6	4066.3	8345.7
EDR	2971.5	667.3	5488.5	9127.3
FWDR	1680.3	630.8	2001.9	4313.0
MWDR	2825.8	399.3	2745.4	5970.5
WDR	4762.2	16.6	2794.1	7572.9
Grand Total	15989.6	2243.7	17096.2	35329.4

Source: WECS, 2010

Table 28: Biogas production potential in Nepal (2008/09)

Animal	Number	Dung available	Total Dung Available/Day	Biogas Yield	Gas Volume
		Kg/day	KGs	m3/kg/day	(Million m3)/year
Cattle	7175198	10	71751980	0.036	942.8
Buffalo	4680486	15	70207290	0.036	922.5
Total	11855684		141959270	0.072	1865.3

Source: WECS, 2010

The estimated total technical potential of biogas plants is about 1.9 million plants of which 1,000,000 plants are thought to be economically viable. As of December 2008/09, more than 2,00,000 biogas plants of varying capacities (4, 6, 8, 10, 15 and 20 m^3) have

been installed (BSP, 2010). The trend observed during the period of 1998-2004 shows an increase, mainly because of the technical and financial support from BSP/SNV. The yearly installation and trend are shown in Table 1.29. It is also noteworthy to quote that more than 90% of these plants are operational.

Table 29: Yearly Installation of Biogas Plant by Capacity Size

Fiscal Year	District coverage	Capacity (CUM)						Total
		4	6	8	10	15	20	
2051/52	47	62	652	1,451	2,633	279	38	5,115
2052/53	58	123	1,190	2,460	3,097	249	38	7,157
2053/54	57	304	2,004	3,201	2,686	175	17	8,387
2054/55	56	265	2,861	4,234	2,303	180	26	9,869
2055/56	56	494	4,268	4,717	1,451	109	13	11,052
2056/57	58	1,771	7,850	3,001	643			13,265
2057/58	59	3,225	11,629	2,616	387			17,857
2058/59	57	2,779	10,597	1,864	287			15,527
2059/60	57	3,391	11,105	1,622	222			16,340
2060/61	58	1,859	8,072	1,191	137			11,259
2061/62	56	2,467	13,352	1,804	180			17,803
2062/63	55	2,058	12,184	1,686	190			16,118
2063/64	60	2,463	13,486	1,550	164			17,663
2064/65	62	2,224	11,558	1,099	3			14,884
2065/66	69	3,420	14,997	1,062				19,479
Total		26,905	125,805	33,558	14,383	992	132	**201,775**

Source: AEPC, 2010

Alternative Energy Promotion Centre and Biogas Support Programme have identified some of the most important socio-economic benefits of biogas plants as follows:

- Reduction of the workload of mainly women and girls by about 3 hours/day/household. The saved time is used for education, income generation activities and leisure.
- Annual savings of:
  - Fuel wood used for cooking to the extent of 282,024 (@2 tons/plant) (at 90%operability)
  - Agriculture waste to the extent of 49,354 tons (@0.35 ton/plant).
  - Dung cakes to the extent of 84,607 tons (@0.60 ton/plant).
  - Annual saving on kerosene of 3.5 million liters (@25 liters/plant).
- Annual reduction of GHG emissions to the extent of 987,084 tons CO2 – equivalent (@7 tons/plant).
- Annual production of 246,771 tons – dry weight (@1.75 tons/plant) bio slurry and bio compost
- Proper usages bio-slurry and bio-compost in 125,344 (at 80% households).
- Improved agriculture yields and reduced use of chemical fertilizer.
- Improvement of rural sanitations by connecting 98,708 toilets in 70% plants
- Reduction of indoor pollution due to kitchen smoke in 141,012 households.
- Reduced incidence of illness and expenses on health.
- Generation of direct and indirect employment.
- Annual total thermal power output 443 MW (at 3.14 kW/plant/day at 90% operability).

- 550 MW electric power stations is needed to generate 443 MW thermal energy at 80% electric stove efficiency.

1.1.3.4 Micro-Hydro Resources

The hydro power stations for generation of mechanical and electrical energy up to a capacity of 100 kW come under micro-hydro category. The installations of such units up to 1000 kW do not require any license from the Government. Till 2008/09, there were about 1977 micro-hydro (including pico-hydro) electrification schemes installed in various part of the country since 1962, with the total installed capacity of about 13.9 MW. In addition, there are about 6253 units (approx. 15.2 MW) for mechanical power generation for the milling purpose. Realizing the significant potential of micro-hydro, Government of Nepal is promoting its development by providing subsidies for the installation of micro-hydro plant according to the location and remoteness of the districts. Table 1.30 provided the some data on micro-hydro.

Table 30: Yearly Installation of Micro hydro plants

Fiscal Year	District	Water Mills		Electrict Plant		Total	
		Capacity	Numbers	Capacity	Numbers	Capacity	Numbers
upto 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, 2010

1.1.3.5 Other Biomass Waste Production Potential

Solid waste

The other biomass waste having energy potential include municipal solid waste, forest and agro-industrial 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. Among them, the Kathmandu Municipality was the largest one and produced 383 tons of solid waste on a daily basis, which was slightly less than one-third of the total municipal waste generated in the country. In the Municipal solid waste, the household waste comprised of about 75 percent. The per capita solid waste production per day varied from 0.11 to 0.93 kg (average 0.34 kg).

The households on the outskirts of smaller towns are rural in nature and used most of the waste for feeding domestic animals. This report cited SWMRMC (2004) for presenting the composition of solid wastes generated in the municipal areas, which comprised of:

- Organic material 66 percent by weight (with a range of about 39 to 95 percent from municipality to municipality);

- 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 percent.

Another source (ICIMOD/MoEST/UNEP, 2007) stated that, "Solid waste generation rates vary depending upon living standards, livelihood practices, and consumption patterns." It was also of the view that the waste generation rate has changed over the years in the urban areas, and the current estimation of municipal solid waste generation in five municipalities of the Kathmandu Valley was provided as shown below in Table 1.31.

Table 31: 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 Thimi	14.3	5	27.8
Kirtipur	11.6	4	18.1
Total	434.9	330	775.4

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

From the above table, it can be observed that five municipalities generated daily about 435 tonne of solid waste, of which more than 70 percent was from the Kathmandu municipality. Currently, management of these wastes is a challenge to these municipalities, which requires land, human and financial resources.

In the above table, most of the contents in the municipal solid wastes belonged to the classification of biodegradable organic waste, which comprised of energy potentials but the estimated energy generation potentials of these sources is yet to be determined. The non-biodegradable wastes generated in municipal areas have already been included under the municipal solid wastes in ADB/ICIMOD (2006).

The data concerning biodegradable wastes generation outside of these studied areas was not available for consideration of its energy potential. Besides the traditional forest and agro-based industries such as saw mills, rice and wheat mills etc, other industries also generate significant amount of biodegradable organic wastes in different shape and forms, i.e. molasses in sugar mills, black liquor in paper mills, etc. However, the cumulative biomass waste production data by industry type was not available, which, limited the assessment of the bio-energy potential.

Secondary Sources of Wood-fuel

Secondary sources of wood-fuels are residues from logging and wood processing industries, but also recycled wood from construction activities, packing crates, pallets, driftwood, furniture, etc.

Logging residues

Recovery rates vary considerably depending on local conditions. A 50/50 ratio is often found in the literature e.g. for every cubic meter of log removed, a cubic meter of waste remains in the forest (including the less commercial species). The logging residue consists of stump, branches, leaves, defect logs, off-cuts and sawdust. However recovery rate has been found up to 66 % in some logging areas. In some cases the

residues are converted into charcoal. In order to calculate the amount of logging residues an average recovery factor of 60% has been used.

Saw-milling

Recovery rates vary with local practices as well as species. However, for calculation purposes, a residue recovery factor (yield factor) of 50% has been used (38% solid wood waste such as bark, slabs, edgings, trimmings etc. and 12% sawdust).

Plywood production

Plywood making is a large-scale operation and involves the cutting of the logs to the length required and de-barking the logs. Residue recovery rates in plywood production vary from 45 to 50% with the main variable being the diameter and quality of the log. For calculation purposes a yield factor of 50% has been used, with 45% solid wood residues and 5% in the form of dust.

Particle board production

Particleboard production basically involves size reduction of the wood, drying, screening, mixing with resins and additives, forming of the mat, pressing and finishing. All types of wood are used for the production of particle board such as solid wood, solid wood residues (off cuts, trimmings), low grade waste such as hogged saw mill waste, sawdust and planer shavings, etc. For calculation purposes a residue factor of 10% has been taken, consisting of screening fines and dust while 17% of the residues are assumed to be recycled.

Perennial Plantation Crop Residue
Coconut

Coconut trees generate residues in the form of wood, fronds, husks and shells. About 12 to 14 fronds are shed per tree per year, yielding about 1.5 kg of dry woody biomass per frond or, assuming a density of 120 trees per ha., about 2,400 kg. per ha. Based on a literature survey, an residue to product (RPR) value of 0.419 for husks with a moisture content of 10.3% (based on actual measurements) while for shells an RPR value of 0.12 with a moisture content of 8.7% are used.

Others

Besides the plantation crops mentioned above, there are other sources of residues in the crop plantation industry, e.g. tea (pruning every 7-10 years of tea bushes and uprooting after productive life) and coffee (pruning of shade trees and uprooting). However, very little information is available and these have therefore not been considered.

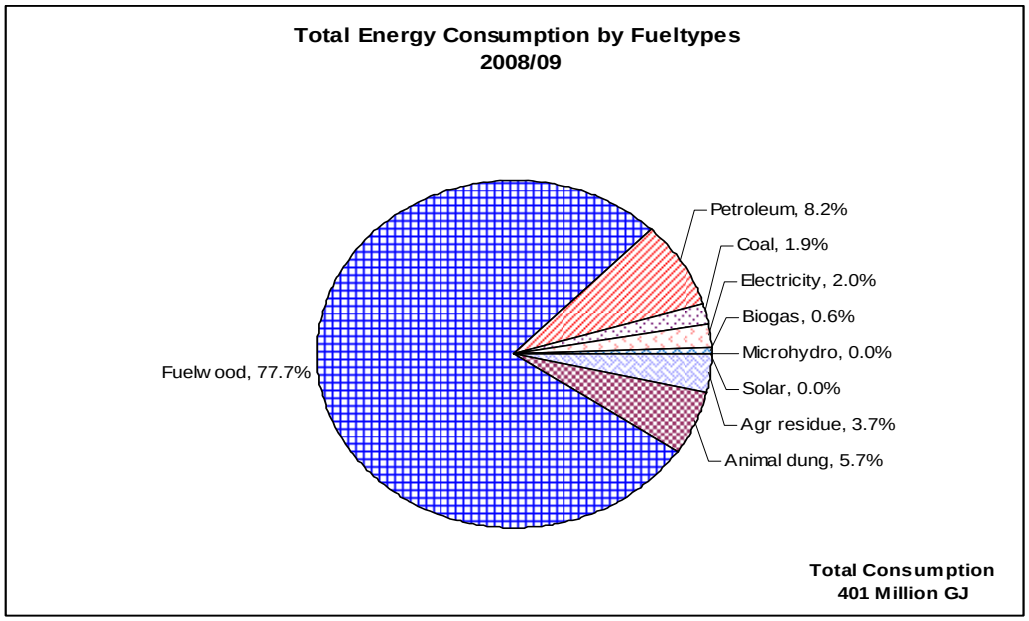
Energy Consumption Scenario

1.1.4 Energy Consumption by Fuel-types

Figure 1.12 shows the distribution of energy consumption by various fuel-types in 2008/09. The overall energy consumption of Nepal is largely dominated by the use of traditional non commercial forms of energy such as fuel-wood, agricultural residues and

animal waste. The share of traditional biomass resources, commercial energy resources and renewable energy resources are 87%, 12% and 1% respectively. The share of traditional fuel decreased from 91% in 1995/96, 88% in 2004/05 and 87% in 2008/09. The remaining 13% of energy consumed is through commercial source (Petroleum fuels, Coal and Electricity) and Renewable. There is a slow pace of energy shift from traditional to modern one. The share of commercial has increased from about 9% in 1995 to about 12% in 2008/09. Similarly there is a growing trend in the alternative energy. Within the commercial source, electricity is in the higher side in substituting other fuels. Fuel-wood is the largest energy resources in Nepal providing about 77% of the total energy demand in the year 2008/09. Other sources of biomasses are agricultural residues and animal dung, which contribute about 4% and 6% respectively. Share of petroleum fuels in the total energy system is about 8%. Other sources of commercial energy are coal and electricity both of which contributes about 4% in the total energy supply. The total consumption is about 9% higher than the year of 2004/05 with an average growth of 2.4% annually.

Figure 11: Share of Energy Consumption by Fuel-types



Source: WECS, 2010

1.1.4.1 Traditional Fuel Consumption by Sectors

Fuel-wood consumption was about 311 million GJ which is 77% of the total energy demand of the country in 2008/09. Average annual growth of fuel-wood consumption is around 2.5%. More than 99% of the total fuel-wood is consumed only in the residential sector. Other fuel-wood consuming sectors are industrial and commercial. These sectors use fuel-wood especially for heating, boiling and mixing with the coal.

Agricultural residue is the third largest fuel-types providing energy, especially in residential and industrial sectors. Total agricultural residue consumption in the year 2008/09 was about 14.6 million GJ which is about 4% of the total energy demand of the same year. Generally such residues are used for igniting the wood fuels while mixing

with the wood fuel resources. About 10% of the total residues are consumed in industrial sector for heating and boiling purposes. Rice husk is one of the major fuels in many industries that require heat for its operation. Agri- residue consumption is growing by about 1.9% annually.

Animal dung is consumed only in the residential sector so far. However, its contribution is very high in the total energy system because it supplies about 6% of the total energy demand annually. Animal dung is widely used in the Terai region of the country where forest resources are not easily available. Animal dung is being used in both form that are dry cake and gaseous. This fuel is the poorest form of energy while looking from energy ladder perspective. Growth of animal dung is around 2.3% annually. However, use of animal dung in biogas generation is increasing by about 15% in annual basis.

1.1.4.2 Commercial Fuel Consumption by Sectors

Coal is one of the important energy resources for Nepal because it provides more than half?? of the total energy requirement of the industrial sector. This resource provides heating and boiling services in the industries. Minimal amount is used in residential and commercial sector also. In earlier years, it was also used for railway transport in Janakpur-Jaynagar corridor.

With the increasing growth rate of customers availing electricity services of NEA, the power and energy demand is also increasing accordingly. In 2007/08, the numbers of customers grew by 9.07% as compared to that of previous year. Accordingly, the power and energy demand also grew by 11.31% and 10.76% respectively in that year. This growth is more significant in residential and industrial sector compared to other development sectors (NEA, 2009).

Electricity in the residential sector is mainly used for lighting. However, depending upon the degree of urbanization, it is also increasingly used for running domestic appliances. They include from the most basic electrical/electronic appliances such as cooking ranges, audio-visuals, computers, refrigerators, air conditioners etc. Approximately 1.0% of total residential energy consumption was met by electricity in 2008/09. Electricity provides about one-fourth (23%) of the industrial energy requirement. The contribution of electricity in transport sectors is minimum about 0.1% only. It is used mainly to run cable cars, ropeways and trolley buses, which are very few. The share of electricity consumption in commercial sector is only about 11%. The main uses of electricity in commercial sector, is similar to those in residential sectors, e.g. cooking, heating, lighting, water pumping and running other electrical appliances. About 5% of the energy requirement in agriculture sector comes through grid electricity. Electricity, in this sector, is used mainly for lift irrigation.

Petroleum is the second largest energy fuel after fuelwood, supplying about 8% (about 33 million GJ) of the total energy demand of the national economy. This fuel has significant role in economic development processes. Because, three major economic productive sectors namely transport, commercial and Industrial output is mostly depend on this fuel resources. About 63% of the total petroleum is consumed in the transport

sector followed by residential sector (16.6%), agriculture sector (10.5%), commercial sector (8.2%) and industrial sector (1.4%).

1.1.5 Sectoral Energy Consumption

The energy consuming sectors are classified as residential, commercial, transport, industrial and agriculture sector. For energy accounting, energy consuming entity which does not fall in the above five sectors such as, street light, temples, church and mosques, etc, are categorised as others. The total energy consumption in the year 2008/09 was 401 million GJ. The sectoral energy consumption has changed marginally compared to the previous years. Figure 5.7 shows the different share of energy consumption by various sectors in 2008/09. The figure shows that the residential accounts for the major share of energy consumption (89.1%), followed by transport (5.2%), industry (3.3%), commercial (1.3%) and then the agricultural and others.

1.1.5.1 Residential Sector Energy Consumption

The residential sector used about 356.7 million GJ (89.1%) in 2008/09. Biomass resources are the major fuels used in this sector, namely fuel-wood, agricultural residue and the animal waste. Recently, renewable sources like biogas and electricity from micro-hydro and solar home systems are substituting conventional fuels used mainly for cooking and lighting. The commercial sources of fuel used are nominal and is mainly used in the urban centers. Fuel-wood supply 86% of the total energy requirement followed by animal dung, agri-residue and petroleum. Share of alternative energy resources is still less than 1%. Residential sector is broadly divided into two categories namely the rural residential and urban residential. WECS (2006) has assessed that the energy consumption in urban residential sector was 47.7 million GJ, which is about 14.5% of the total residential energy consumption. Urban sector energy consumption pattern is different than the rural residential. About 52% of the urban energy is used for cooking purpose followed by electric appliance (14%), Lighting (13%), heating and cooling (10%), animal feeding (8%) and agricultural processing (3%).

It has been observed that the LPG is substituting as a cooking fuel in the urban centres as the consumption growth rate of about 23% per annum for the last few years followed by electricity with 10%. Though the consumption of renewable is nominal in quantitative terms, the annual growth rate of solar is quite high with more than 200% followed by biogas and electricity from micro-hydro with 15% and 32% respectively. Decreasing trend is observed in the use of kerosene in the residential sector. The overall growth rate of energy consumption in the residential sector is about 2.3 % per annum.

1.1.5.2 Industrial Sector Energy Consumption

Total Energy consumption in the industrial sector is about 13.4 million GJ (2008/09) which is about 3.3% of the total energy demand. The energy consumption has been increasing marginally during the last few years. The industrial energy consumption has increased only by about 0.4% annually since last eight years. The main end uses in the industrial sector are process heating, motive power, boiling in the boilers and lighting. WECS (1998) has assessed the industrial sector energy consumption pattern both in

traditional and modern sector. Industrial energy consumption was 9.1 million GJ for the year 1996/97. Industrial sector is broadly categorized into two types; modern and traditional. Modern industries are also grouped into large industry and medium industry. The share of energy consumption in large modern industry is about 78%, followed by medium industry (17%) and traditional industry (5%). Industrial energy consumption by physiographic region shows wide variation. 63% of the total energy is consumed in Terai region, whereas 29% in Hills and only 8% is consumed in Mountain region. Regarding end use, Boiler dominated other type of end use. Other end uses of the sectors are power motive (31%), process heating (30%) and lighting (2%).

1.1.5.3 Transport Sector Energy Consumption

Transport is the second largest energy consuming sector only after the domestic sector. Energy consumption in this sector is about 20.8 million GJ (5.2%) in the year 2008/09. The total energy consumption in the transport sector is in increasing trend. It is observed that for the past few years the energy consumption growth rate in this sector is about 8.9 % annually. It is found that High Speed Diesel takes the highest share with 67% followed by Motor Spirit with about 20% and then Air Turbine Fuel with 12%. The contribution of LPG is also increasing. LPG provides about 1% energy requirement of this sector. Electricity consumption in this sector is very minimal. There is some shift in the energy consumption pattern in transport sector is observed as compared to the year 1999/2000, in which, 78.8% High Speed Diesel followed by ATF (13.4%), Motor Spirit (11.4%), LPG (0.3%) and Grid electricity (0.2%) is used (WECS,2000).

1.1.5.4 Commercial Sector Energy Consumption

Energy consumption in the commercial sector is observed to be increasing at an annual rate of 3% since 2000/01. This sector includes large number of other sub sectors namely the Academic (school, college, university), Health (health post, hospitals), Institutions (Private and Publics), Retail shops (essential, non essential), Hotels (Star hotels, Non star hotels, Restaurant, Cinema/Hi-vision halls, Water supply, Military and Police barrack and Others (Public lighting, Religious place etc). Total energy consumed was about 5.2 million GJ in 2008/09. The main fuels used in the commercial sector are petroleum (LPG and Kerosene), fuel-wood, and electricity. The main end-uses of the commercial sector are quite similar to that of residential sector such as cooking, heating, lighting, boiling, cooling, water pumping and electric/electronic appliances etc. The largest contribution comes from petroleum specially the LPG and Kerosene providing about 53% of the sector demand. Fuel-wood supplies about 36% of the sectoral energy consumption. Electricity is the third largest sources of energy (11%). For the last few years, it has been seen that the LPG consumption growth rate is about 22%, while consumption rate of kerosene is in decreasing trend of 9% per annum. Fuel-wood and electricity consumption is increasing by about 2.1% and 9% per annum respectively. Cooking is the largest end use in this sector consuming about 68.4% of the total followed by lighting (19.3%), boiling water (0.3%), space heating and cooling (5.3%) and other electrical services such as water pumping etc.(6.7%) .

1.1.5.5 Agricultural Sector Energy Consumption

Agricultural sector uses only two types of energy sources that are electricity and petroleum. In the year 2008/09, agricultural sector consumed about 1% of the total national energy demand (3.6 Million GJ). About 95% of the total agricultural energy comes from petroleum products specially the diesel fuel. Only 5% is derived from electricity. Electricity consumption in this sector is increasing at higher rate compared to the petroleum. It is increasing by about 8% annually since 2000/01 whereas light diesel oil is increasing by about 11% annually. Average rate of change in high speed diesel consumption is around 1%.

Current Energy System Analysis

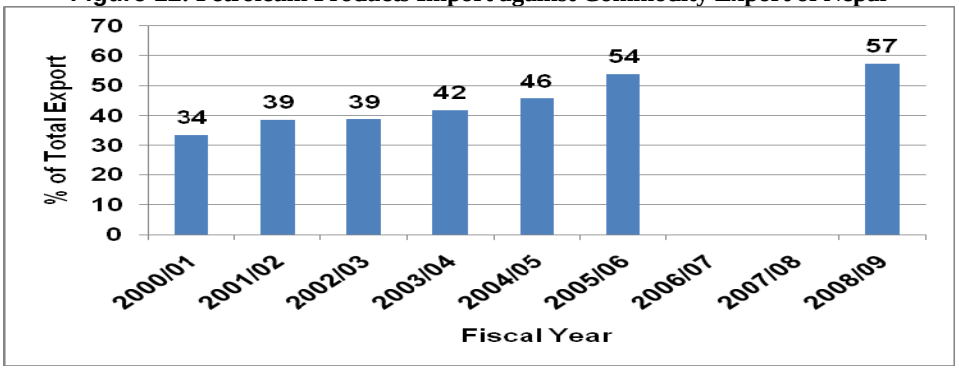
1.1.6 Dwindling traditional sources of energy

Forest coverage in the country has declined from 29% in 1999 to 25 percent in 2005 (FAO, 2005). Fuel-wood extraction may not be the only cause of deforestation but deforestation is also taking place due to immigration and resettlement. With fuel-wood crisis, the consumption of agricultural residues for energy purposes has also increased resulting in falling production, encroachment of marginal land for farming, exposure to the risks of soil erosion and further degradation in crop productivity and biomass supply.

1.1.7 Increasing imports of petroleum products

The contribution of petroleum product and coal for the total energy supply is about 10%. However, the expense incurred to import these fuels is significant. In 2008, about 52 billion rupees has been spent for different kinds of fuel (MoE, 2009). Out of this amount more than 33 billion rupees had been spent just to import the petroleum fuel and 0.8 billion for the coal. Petroleum import was 34 percent of the merchandise exports in 2000/01 (MoF, 2007). The merchandise export of the country stands at Rs 38 billion in first 8 months of 2007/08 (MoF,2009). The country had spend 57 percent of it for importing petroleum products for this period. Due to the increase in the international prices of the petroleum products and the country's growing dependence on it, much of the export earnings are being used for importing and it is in the increasing trend. This dependence is precarious for the country's economy.

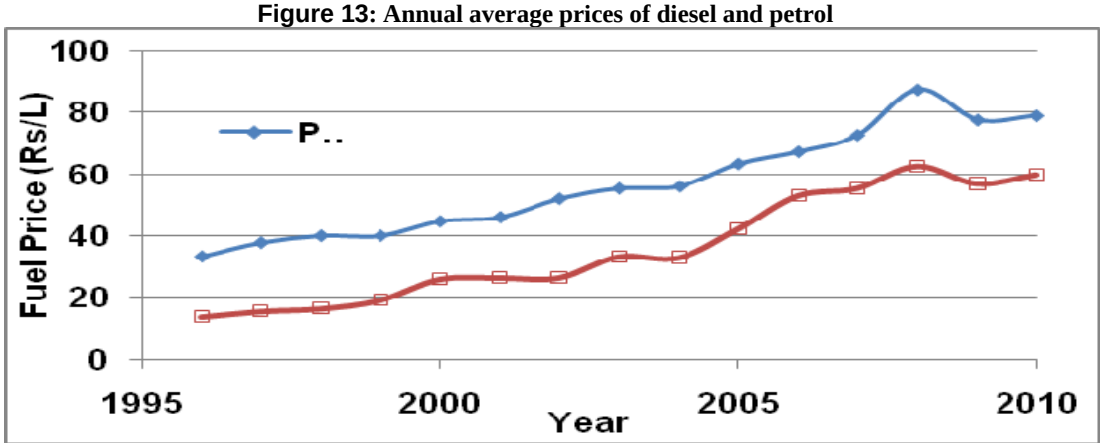
Figure 12: Petroleum Products Import against Commodity Export of Nepal



Source: MoF, 2009

The price of petroleum products in the world market is steadily rising, with some exceptional years. This rising of price has become inexorable since 2003. It was around US$22 in that year and reached to around US$ 150 a barrel in August 2008 which has eased down to US$ 50/barrel in November 2008. The repercussion of this phenomenon had been clearly reflected in the price of petrol and diesel in Nepal too. It can be seen in figure 1.14 from the annual average price of these fuels in the last 15 years.

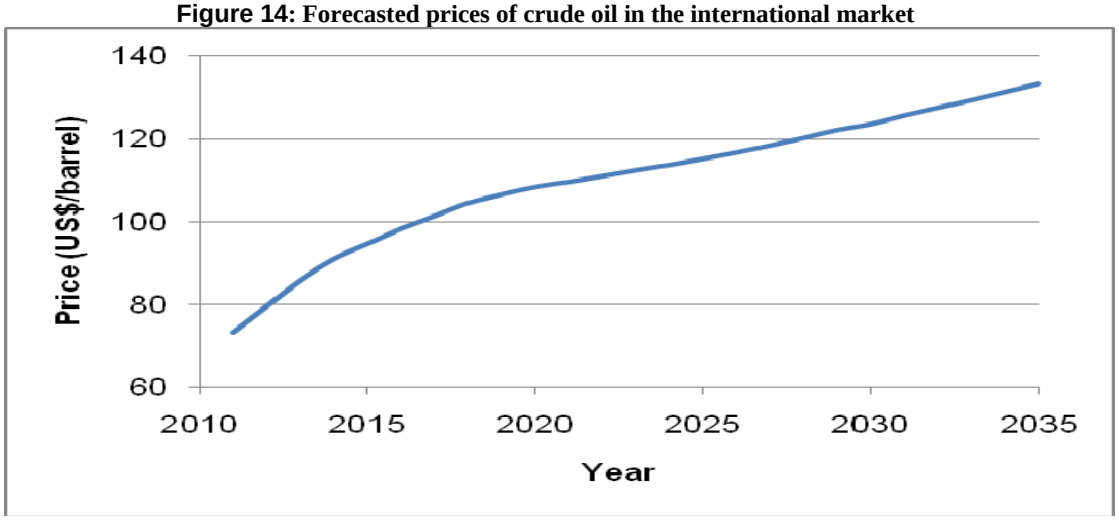
Figure 13: Annual average prices of diesel and petrol



Source: NOC, 2010

Energy analysts forecasted that prices of the crude oil will continue to rise in the coming years in the international petroleum markets (IEA, 2010) as shown in 1.15. Indeed, many developing, mostly least developed and mostly oil vulnerable countries are likely to suffer even more due to rising prices.

Figure 14: Forecasted prices of crude oil in the international market



Source: IEA, 2010

Nepal is totally dependent for imports of petroleum products for its energy requirement. In the period of 1995 to 2000, the oil import in Nepal is increased by 15.34 percent (UN, 2007). The demand of petroleum products are ever increasing, the import percentage will also increase in the years to come.

1.1.8 Some current facts on energy economics

Table 1.32 compares the market price, efficiency and effective price of the major fuel types used for cooking purpose in Nepal. The effective price of the LPG is slightly less than other fuels in terms of a single Giga Joule energy. Fuel-wood only becomes cheapest once it is available free of cost or less than NRs. 5 per kilogram. Efficiency of the fuel using devices is very important factors to decide the effective price of fuels. Because of the lower efficiency of fuel-wood using devices, its effective price is higher than other fuel-types such as LPG, electricity and kerosene. Second highest effective price of the cooking fuel is kerosene (Rs.2652/GJ) followed by Electricity (Rs. 2604/GJ) and LPG (Rs. 2395/GJ).

Table 32: Market price, efficiency and effective price of major fuel types in Nepal

Fuel type	Natural unit	Market price (Rs/ unit)	Market price (Rs./GJ)	Average Efficiency (%)	Effective Price (Rs./GJ)
Fuel wood	Kgs	5-10	417.91	15.0%	2786.07
LPG	Cylinder	1250.00	1796.49	75.0%	2395.32
Electricity	Unit	7.50	2083.33	80.0%	2604.17
Kerosene	Litre	60.00	1591.51	60.0%	2652.52

Source: WECS estimate (2010)

About 18 million tons of fuel wood is consumed annually in Nepal, out of which less than 1% is commercialized. Rest is collected by the users free of cost from forests or their own cultivated land.

Calculating the annualized life cycle cost (ALCC) of using kerosene, LPG cooking stoves, and electrical cooking appliance for an average family of five persons, the increasing price in the petroleum products have completely changed the scenario of the fuel economics.

Table 33: Monthly Life Cycle Costs of Cooking for an Average Nepali Family (NRs)

Year	Kerosene	LPG	Electricity
1997	180	465	605
2000	385	405	680
2003	410	510	788
2009*	912	794	788

(Based on the calculation and International Energy Initiative, 2004 and NOC, 2009)

In 1997, the monthly life cycle cost for cooking was Rs 180 for kerosene, Rs 465 for LPG, and Rs 605 for electricity. After the price revision in March 2009, the monthly ALCC turned up to be Rs 912 for kerosene, Rs 794 for LPG, and Rs 788 for electricity respectively. With the new price revision of petroleum prices, it has become evident that Nepal has to immediately substitute petroleum products by electricity for cooking in the residential, service, and other sectors. If the crude prices go up to US dollar 150 per

barrel in future, the monthly ALCC for petroleum products will be exorbitantly higher compared to that of electricity. Hence, in order to enhance the country's supply security, it is very imperative to emphasize on development of indigenous energy resources. Besides, it is urgent to create awareness program for consumers' switching from petroleum products to electricity especially in the urban areas where grid electricity is available. In the rural sector, it may not be possible immediately for switching to electricity because of the income disparity and the topographic terrains of the country. For rural areas, to reduce health hazards, the people should be encouraged to switch from traditional biomass energy sources to modern biomass such as biogas. They should also be encouraged to switch to energy sources such as kerosene, LPG from traditional biomass sources in the energy ladder. Finally, the ultimate objective should be to switch over to electricity in the long run.

1.1.9 Dismal situation of electricity supply

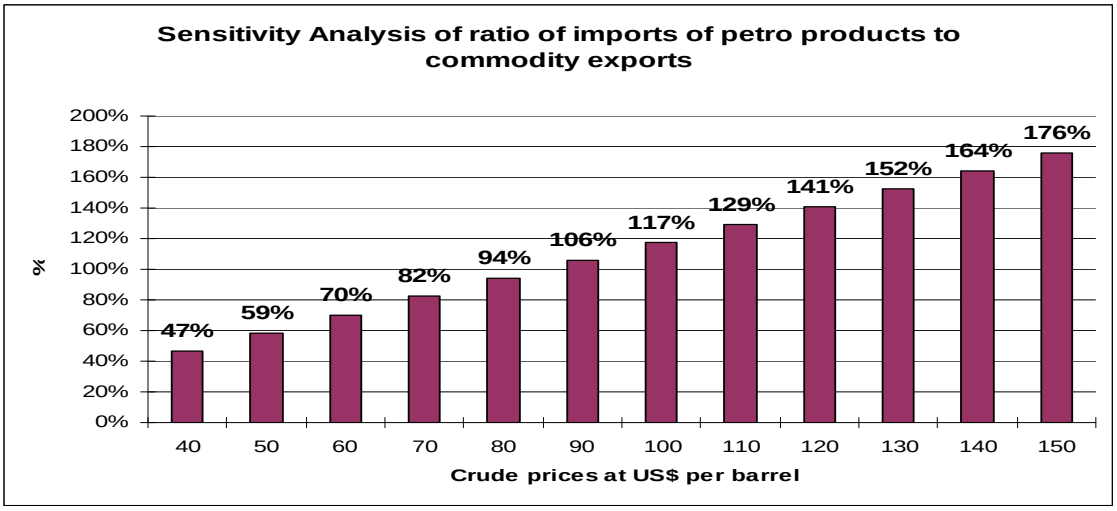
Nepal's installed electricity generating capacity is 689.3 MW, of which around 90 percent is of hydropower generation and the rest is of thermal generation. The hydropower supply capability in Nepal varies from month to month due to the dependence on run-of-river systems. This supply structure is in contrast to the demand structure. The electricity demand reaches peak in winter, when the generating capability of run-of-river plant is at the minimum level. On the contrary, the generation capacity is up to the mark in summer when demand is less compared to winter. As the production of electricity is not able to meet the demand, consumers are unable to switch over to electricity from petroleum products such as kerosene and LPG and compelled to pay the rising oil prices.

1.1.10 Problems in energy sustainability and security

The uncertainties about the stability and security of the petroleum products within the global energy market makes difficult to the country like Nepal on energy security. Nepal requires a stable, low-cost, and secure supply of energy. However, it is difficult to arrive at precise estimates of the exact economic cost of providing and unsatisfactory as well as unreliable supply of energy. Table 1.16 provides the sensitivity analysis of ration of imports of petroleum products to commodity exports.

Based on the projection till 2015 as shown in the Figure 1.16, if Nepal's export earnings were projected increasing with the average annual growth rate of 11 percent (the average growth rate of goods exports from 1995 to 2005), then the country will be requiring 59 percent of export earnings for importing petroleum products in 2015 at US$50 per barrel. But if the oil price goes at around US$150 a barrel, then Nepal may not be able to sustain the oil imports with its exports earnings only. The country may need almost twice the exports earning for importing just petroleum products. That means Nepal will be needing arrangement of funding from other sources for import of petroleum products.

Figure 15: Analysis of Percentage of Petroleum Imports to Goods Exports in 2015



(Based on the calculation and Economic Survey, GON, 2007)

If a sensitivity analysis is conducted for import of petroleum products against export earnings of Nepal at different levels of oil prices in the international market, the picture seems precarious.

1.1.11 Some options for energy security and sustainability

According to a recent report on oil vulnerability of the Asian and the Pacific countries (UN, 2007), in-between 2002 and 2005, a sample of five hundred households interviewed in China, India, Indonesia and Laos People Democratic Republic, suffered from some dramatic price increases, paying as much as 74 percent more for their energy needs. This includes 171 percent more for cooking fuels, 120 percent more for transportation, 67 percent more for electricity, and 55 percent more for lighting fuels. National vulnerability to oil price increases depends not just on oil intensity, but also on how the economy of the country is resilient. An Oil Price Vulnerability Index (OPVI) was developed for 24 Asian and the Pacific countries based on the macroeconomic indicators, the economic and energy variables (UN, 2007). Countries are grouped based on their OPVIs:

Low vulnerable countries (Low OPVI)	- China, Iran and Malaysia
Medium vulnerable countries (Medium OPVI)	- Bhutan, India, Indonesia
High vulnerable countries (High OPVI)	- Nepal, Afghanistan, Bangladesh, Cambodia, Sri-lanka, Pakistan

Nepal, being in the high vulnerable group of countries, because of its poor economic performance compared to other South Asian Countries and its total dependence on imports of oil products, requires strategic options for its energy security and sustainability.

Current Energy Policies

Current energy sector policies are scattered in various documents and executive orders. These include policy statements of the government stated in periodic development plans, sub-sector policies, government orders and notices, and laws passed by the legislature.

1.1.12 Periodic Development Plans

The Fifth Plan (1975-1980) document of the government was the first sector specific policy statement in the energy sector. In the Plan, the government emphasized the need to reduce heavy dependence on traditional source of biomass and imported oil, and increase the supply of renewable energy sources including hydropower to meet the increasing demand for energy.

Different ministries are mandated for development and management of different subsectors (Hydropower, fossil fuels, renewable energy) within energy sector. Realizing the need to establish an appropriate agency at the national level to coordinate and guide the development of energy sector, Water and Energy Commission (WEC) was established. The mandate of WEC is "to formulate and coordinate programs for the development and conservation of water and energy resources".

1.1.13 Hydropower Development Policies 1992 and 2001, Water Resources Act 1992, and Electricity Act 1992

The objectives of the 1992 Policy were to supply electricity as per the demands in urban and rural areas and meet the energy needs required for industrial development in the country. The laws passed by the legislature the same year made provisions to put the policies into practice encouraging the private sector through various fiscal and other incentives for development of hydropower in the country. The 2001 Policy in particular made policy announcements to utilize the hydropower potential to meet the domestic demands of electricity through transparent procedures to attract foreign and domestic investment, develop hydropower as an alternative to biomass and thermal energy, create rural electrification fund, control unauthorized uses of electricity and leakages, cover risks likely to occur in hydropower projects, demand side management and energy conservation.

1.1.14 Water Resources Strategy 2002 and National Water Plan 2005

The water resources strategy was guided by the principle of integrated water resources management. The strategy recognized that water resources development needs to be more closely integrated with sustainable social and economic development. In the hydropower sector, the strategy seeks to develop sufficient capacity to meet domestic needs at affordable prices and export of electricity. While putting into effect the targets set in the Strategy, the National Water Plan has fixed a target of hydropower generation of 700 MW by 2007 to meet the projected domestic demand at base case scenario without export. Similarly, a target of generation of 2,100 MW by 2017 and 4,000 MW by 2027 have been fixed to meet the projected domestic demand at base case scenario without export.

1.1.15 Nepal Electricity Regulatory Commission Bill

Nepal Government has submitted a bill on electricity regulatory body to the parliament (Constituent Assembly) for facilitating electricity production, transmission, distribution, trading, and management in a transparent way. Its other objectives are to balance supply and demand, to set electricity tariff, to develop competition in the electricity market and to protect consumer rights. With the establishment of this regulatory body, electricity market is expected to develop in a competitive environment where stakeholders' rights are protected and electricity is made accessible, affordable and acceptable.

1.1.16 National Electricity Crisis Resolution Action Plan 2008

The government brought out a 38-point Electricity Crisis Resolution Action Plan in Poush 2065 (2009). The Action Plan provides for immediate, short-term and long-term programmes. The principal concessions under immediate programmes include determining a Power Purchase Agreement at flat rate for power plants up to 25 MW, 7 years income tax holiday and waiver of the provision for doing Environmental Impact Assessment (EIA) for power projects expected to go for implementation by Chaitra 2068 (2011). Such power projects will be required to do Initial Environmental Examination (IEE). It included plans to import more power from India, build 200 MW thermal power plant and encourage power generation through captive plants by subsidizing the additional cost involved in producing power from oil, and strengthen and add transmission capacity. It will also encourage solar and wind power generation through various concessions and facilities. Emphasis has been given to encouraging efficiency through the use of low energy consumption bulbs, initiate a system of energy audit, implement a code of conduct to save energy, and raise public awareness for demand management. The concession included 80 percent subsidy for micro hydropower below I MW capacity.

Short-term measures under the plan included building additional transmission lines to import power from India, increase power production through efficient operation of current generation facilities, control technical loss and controlling theft of electricity through cooperation of political parties, the public and local administration.

The long-term programmes are building high capacity transmission lines between India and Nepal and large multi-purpose projects. Adopt national integrated energy policy with short, medium and long-term energy development plan. It also includes financial restructuring of the Nepal Electricity Authority (NEA).

1.1.17 Task Force for Hydropower development

Government of Nepal (GON) formed a task force in December 2008 to formulate programs for developing 10,000 MW in 10 years for addressing the energy crisis situation. The task force highlighted the importance of developing hydropower and provided the list of storage and run-off projects with time-line for development. The report also recommended for improvement in the institutional aspects.

GoN has again come up with the plan of development of 25,000 MW in 20 years in the plans and programs of the Government in July 2009. The 20 year plan report has elaborated the suggestion provided by the 10 year development plan report.Task Force for Hydropower development
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1.1.18 Local Self-Governance Act, 2055 (1998)

The law related to local bodies (Village and District Development Committees and Municipalities) has empowered the local government to formulate, implement, distribute and maintain the mini and micro hydropower projects and other energy projects in their respective jurisdictions. The law requires the local bodies to prepare resource map as well as annual and periodic plans. It provides for a detailed institutional framework and mechanisms for formulation and coordination of plans including a structure for integration of the plans. The District Development Committee is required to form an Integrated Plan Formulation Committee under the chairmanship of the President of the DDC with representation of Parliamentarians representing the district, among others.

1.1.19 Rural Energy Policy 2006

The Rural Energy Policy 2006 has been conceptualized with a sector-wide approach. The Policy has been designed, in particular, with the following strategies:

- Development of a coherent rural energy policy which adequately addresses the energy needs of the rural population;
- Rural energy subsidy policy with clear objectives and criteria addressing target groups;
- Development and enforcement of efficient and effective credit systems;
- Incorporation of rural energy policies of ministries and institutions related to rural development;
- Effective cross-sectoral and donor coordination of rural energy programs;
- Adequate information campaigns and education programs; and
- A broad stakeholder involvement to ensure the whole process of technology development to project identification, design and implementation.

The policy specifically targets to install improved biomass technologies to meet cooking and other heating energy needs, micro hydro installation for rural electrification through off-grid power production and distribution that is capable to be grid-connected when grid is extended, solar home systems (10 peak watt and above) and white-led and photovoltaic based solar lights replacing kerosene lamps. The policy recognizes solar

home system as a mainstream electrification option for many rural areas where grid and micro hydro is not an option for long time to come.

1.1.20 Forest Sector policies and Forest Act, 1992

The forestry sector policy has evolved through distinct phases of privatization (pre-1950), nationalization (1957) and community orientation (1970). From review of forest policies of the government as expressed in periodic plans, emphasis on protection in the initial days was replaced by a phase of scientific management of the resource. Later in the post-1970s, management of the resource was replaced by an approach of popular participation of the community. The Tenth Plan (2002-2007) emphasizes promotion of conservation and sustainable use of forest resources, development of forest product-based enterprises, adoption of participatory approaches and poverty reduction to be achieved by providing opportunities for income and employment for poor, women and disadvantaged people.

The Master Plan for Forestry Sector implemented since 1988 aims to (i) meet the people's basic needs for forestry products (fuel-wood, fodder, etc.) on a sustainable basis, and (ii) protect and manage forests through people's participation. The Forest Act and Rules framed under the act are considered to be quite progressive instruments. These instruments have also laid down provisions related to private forestry. Programs like Leasehold Forestry, Hills Leasehold Forestry and Forage Development Project that help raise incomes of families in the hills below poverty line also aim to protect and conserve forests. These programs help towards managing forests for fuel-wood. The proposed Forestry Sector Policy, 2000 on the other hand is specific in addressing the problem of energy in the rural areas by focusing its emphasis on managing the sector for fuel-wood. The long-term objective of the 2000 Policy is specific in meeting the people's basic needs for fuel-wood, timber, fodder, and other forestry products on a sustainable basis. The forestry resources will be managed and utilized in a manner which gives priority to the basic needs of the people such as fuel-wood for cooking, timber for housing, fodder for domestic animals, and medicinal plants for health. The strategies for production will be to promote commercial plantations especially in the Terai.

1.1.21 Petroleum, Coal and Natural Gas Sub-sector Policy

Nepal Oil Corporation, registered under the Company Act 2021, has the monopoly to sell and distribute petroleum products (POL) in the country. It purchases oil from the world market and arranges to receive POL products from the Indian Oil Corporation in exchange for the imported oil. Currently the arrangement is to import POL products from the Indian Oil on the basis of prevailing market price quoted on the 1st and 16th of each month.

Government with a notification in the Nepal Gazette required the NOC to distribute petrol with 10 percent of ethanol from Magh 1, 2060 (January 15, 2004) and is yet to be implemented.

The national requirement of coal is being met through import due to virtual non-existence of coal mines with economic significance. Limited amount of low grade coal is locally mined in certain areas of Nepal. Coals extracted are distributed locally for use generally

in brick kilns. Under the Mines and Minerals Act, 2042, coal mines are licensed and registered for their operation.

A limited amount of natural gas has been found in some pockets of Kathmandu Valley. Probable reserves identified so far needs further confirmation in order to be of any use for commercial exploitation. If the proven reserves can be used economically even for a limited number of years, it is worth exploring in view of total dependence on imported gas. However, the policy on natural gas is yet to be formulated.

1.1.22 National Transport Policy 2001

With the objective to develop a transport system that is sustainable, dependable, less expensive, safe, comfortable and self-reliant, the National Transport Policy 2001 was adopted by the government in 2001. Detailed policies to realize the above objective include, among others, developing a transport system with renewable sources such as electric and solar energy. It also emphasizes development of a transport system that is pollution free. The 2001 sectoral policy on transport system includes sections on rail transport, cable car and ropeways all with renewable energy sources.

Current Institutional Situation

The prevailing institutional arrangement in energy sector is broadly based upon nature and type of energy resource, legal basis of the energy organization and scale of energy generation. Accordingly, a number of institutions exist in the energy sector. They perform energy planning, development and implementation functions. Government bodies, state owned public utilities and private sector, local bodies and communities are involved in energy sub-sectors by resources – e.g. traditional, commercial and renewable. Six different ministries - Ministry of Energy (MoEn), Ministry of Forests and Soil Conservation (MoFSC), Ministry of Agriculture and Co-operatives (MoAC), Ministry of Commerce and Supplies (MoCS), Ministry of Environment, Science and Technology (MoEST), and Ministry of Industry (MoI) play different role in energy sub-sectors with several agencies attached with these ministries.

National Planning Commission (NPC) is responsible for coordination and bringing together the sub-sectoral energy development targets into the periodic development plan. Further, Water and Energy Commission/Water and Energy Commission Secretariat (WECS), the government's advisory agency in water and energy sectors, is responsible to help prepare and facilitate implementation of necessary policy, plan and legislation pertaining to the development of water and energy, and establish coordination among national and sectoral policies on water and energy.

The micro scale electricity and other alternate energies are planned, managed and facilitated by Alternative Energy Promotion Centre (AEPC) which comes under MoEST. In traditional and commercial energy sub-sectors, there is dominance of public monopolies (in forests resource generation/harvesting of Timber Corporation of Nepal/MoFSC; in procurement and marketing of petroleum products of Nepal Oil Corporation/MoCS; and in transmission and distribution of electricity of Nepal Electricity Authority/MoWR).

Chapter 2: Energy Issues in Nepal

Energy issues in Nepal are mainly concerned with technical, policy/legal, institutional, environmental and socio-economic aspects. Energy poverty is a major issue in Nepal considering the very low level of energy consumption. As energy plays an important role in economic development, energy consumption level has to be increased. The current strategy is therefore focused on reducing the energy poverty of the country by increasing energy access and affordability ensuring energy sustainability.

General Issues

2.1.1 Energy Classification

At present, energy sector is classified into traditional, commercial and renewable energy. This classification is not compatible with the international standard. There is a need for reclassification of existing energy sector.

2.1.2 Energy Poverty

Energy poverty is a major issue in Nepal considering the very low level of energy consumption. As energy plays an important role in socio-economic development, energy consumption level has to be increased. The current strategy is, therefore, focused on the reducing the energy poverty of the country by increasing energy access and affordability. This can be achieved by producing finer form of energy in a larger scale i.e. hydropower, as well as through improving and increasing the distribution system.

2.1.3 Integrated Energy Planning

Number of ministries and departments are involved in energy sector (see Chapter 3). Ministries and departments involved in planning and development operate under their sectoral/sub-sectoral regulation and for their own targets. It lacks co-ordination which slows down the development of energy sector and access to energy for all in an equitable manner.

The system and process for integrated energy planning in the existing sub-sectoral energy planning processes is lacking at present. This has resulted in lack of an integrated energy planning practices, a right energy mix framework (giving strategic priority to potential indigenous resources) and a pricing system-appropriate enough for the whole energy sector on a nation-wide basis. Besides, lack of integrated energy planning both at the central and local levels has also constrained the national ability to comprehend, envision, investigate and cash internal and external market benefits offered by opportunities such as carbon trading. An institution is, therefore needed to be specified as a lead agency that is responsible for integrated energy planning to put in place the system and processes and accordingly strengthen the capability accordingly.

Specific Issues

Major issues identified in each energy sub-sector viz. Traditional Energy, Commercial Sector and Renewable Energy can, broadly, be divided into technical, policy/legal, institutional,

environmental and socio-economical. The major issues in these aspects of each sub-sector are briefly described below.

2.1.4 Issues on Traditional Energy

Superficial recognition and low priority

The overwhelming contribution of traditional energy sources (solid biomass fuels) in total primary energy supply has only been superficially recognized in energy statistics of the country. This is because, the annual Economic Survey of MOF and other reports specific to the energy sector categorically points out that over two-third of total primary energy supply is contributed by traditional energy resources. But there is lack of proportional allocation of funds for all round development, including implementation of activities related to fuelwood supply in the forestry sector, compared to the allocations in the commercial energy and renewable energy sub-sectors. Therefore, the current allocation of development fund in the forestry sector, which has so far remained the largest contributor of primary energy (in the form of TE), faces the challenge of meeting the growing fuelwood demands (in absolute terms) from the rural households, commercial establishments and traditional industries.

Lack of awareness

Present TE applications are primitive, inefficient and unsustainable. Energy use in traditional forms is 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 energy, the country must be aware of the technological innovations needed in the TE sub-sector, including in-country R&D for identification of appropriate technology, for identification and introduction of technically proven and commercially viable imported technologies for the domestic, commercial and industrial sectors. Except biogas generation from animal dung (and also from human excreta mix in some places) for energy and the activities of ICS for reduction of fuel consumption (through combustion efficiency enhancement) as well as indoor smoke pollution, awareness about other forms of modern bioenergy applications is still limited.

Declining/depleting forest resources and conflicting management objectives

The existing forest resources in the country are declining/depleting year after year due to various reasons causing difficulties in meeting the rural energy needs for different end-uses. Besides, the management objectives of none of the managed forest today have been solely aligned for the purpose of ensuring sustainable supply of fuelwood in the country.

TE resources and supply systems

The country has not yet pursued any dedicated plantations of energy crops, either annual or perennial crops and grasses or trees solely for the purpose of sustainable biomass supply for energy, neither in the agriculture nor in the forestry sector. Land, which is currently under forest, agriculture and other land uses constitutes the present TE resources in the country, which means trees on forest, non-forest and other types of lands are the major TE resources.

Biomass residues and by-products

Currently most of the biomass fuels (i.e. fuelwood, 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. From the point of view of present TE supply in the domestic, commercial, industrial sectors all these management systems play a crucial role, but such systems would not be feasible for maintaining a sustained supply of biomass sources for the development of centralized bio-energy production.

Lack of 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 food security

Unregulated/unplanned development of energy crops/trees on productive agriculture and forest lands may lead to food insecurity, loss of biodiversity and soil and water erosion, due to deforestation in watersheds.

Non-proportional distribution of TE resources

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 has caused difficulty in the sustainable supply of TE sources for different end uses in some regions.

Lack of management/unsustainable harvest of TE resources

Not all potential TE resources have been adequately identified or put under effective management. The present production system is unreliable in terms of sustained supply of specific amount of biomass for energy in the domestic, commercial and industrial sectors. The problem remains crucial in the forestry sector, as the major TE source in the country is fuelwood that is derived mostly from forests without due consideration of the sustainable production potentials of different types of forests in different physiographical zones. In most cases present fuelwood harvest exceeds the sustainable production of existing forests in the neighborhood due to lack of management and/or over exploitation.

Lack of effort on expansion/management of TE resources

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

Limited awareness/knowledge of ICS

Currently, ICS dissemination has been limited in number and confined to specific sites. Only limited number of stakeholders seemed aware of the type of ICS being promoted and their

intended benefits. The knowledge about specific ICS dissemination programme, intended beneficiaries, associated incentives etc. however, is limited.

Besides, awareness of the need for standardization of ICS for specific end-uses at different scales still remained limited/weak at the implementation level.

Limited awareness of improved/modern bio-energy technology

The present knowledge about biomass based energy applications remained limited only to biomass fuels based traditional energy applications in the domestic, commercial and industrial sectors. The knowledge about proven and commercially viable improved (modern) biomass energy technologies in foreign markets still remained unfamiliar/ unacknowledged.

High cost of improved technology

Technology for improved TE application is available in commercial markets but has 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. Even the TE using rural industries remained reluctant to introduction of improved technology because of the high investment cost needed for innovation.

Lack/insufficient effort on the use of non-wood biomass for energy

Current effort on the use of non-wood biomass for modern energy generation is confined only to dissemination of different sizes of biogas digesters in the domestic sector, primarily for the use of cattle dung (and in some places also with human excreta mix) for biogas generation for meeting the domestic energy needs of rural farming households that maintains a minimum number of cattle heads needed for generation of biogas through specific size of digester. Regarding other non-woody residues, the only visible effort was densification of rice husk in the form of briquettes for use as a commercial fuel. But its current market price is beyond the purchasing capacity of average Nepalese for use as an alternative energy source in the domestic sector. Besides, the currently available briquette size does not match the energy needs of the households needed for diverse end-uses.

Inadequate information/consideration of the fuelwood dependency

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 fuelwood collection and use of women and children. A thorough study of the prevailing area specific TE demand/supply patterns, by end-uses seemed lacking. Such studies could provide a clear picture of what was the situation and what strategy would be necessary to overcome the problem. Where fuelwood was in short supply rural households were forced to look for inferior biomass for alternative fuel to overcome their immediate energy supply problem.

2.1.4.1 Policy Issues on Traditional Energy

Lack of a clear policy on the use of biomass

There is lack of a clear policy and law on the use of biomass as energy source. The pressure on forest for supply of fuelwood as the only source of energy to the people in the rural areas is

obvious. Forest rules do not focus on plantation for fuelwood. Conservation alone cannot be the objective in the present context. The share of traditional sources of energy will continue to dominate the energy scene of the country for many years to come.

Access to community forest

There is lack of access by non member community to community forests. Access by women, poor and Dalits are restricted. Limited members of the group still exercise power and influence over the resource. There is problem of inclusiveness in representation. There is issue of institutional development of user's group. Reform is needed in this sector.

Gap between policy and law

Implementation of private and leasehold forestry policy is ineffective. Many policies suffer from weak implementation because of absence of timely reform in law.

Research and Development

There is less priority for 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.

Efficiency of use

Not enough attention is given to efficiency in use of energy. Conservation of forest is closely related with efficiency in use of forest resources. By use of improved cook stoves, for example, a household can cut the consumption of sizable amount of fuelwood. Saving is conserving. Energy efficiency is equivalent to energy producing. Existing policy does not emphasize that improvement in efficiency is conservation.

2.1.4.2 Institutional Issues on Traditional Energy

Lack of a specified institution responsible for management of different components within traditional energy sub-sector

Public agencies and industries in forestry, agriculture and livestock do not consider energy production as a priority task of management under their specific sector and for proper utilization of the biomass residues and by-products for energy purposes. There is a lack of a public agency which is responsible for managing different components of traditional energy sub-sector.

Lack of operational recognition to and support for planning, monitoring and facilitation of energy resources development activities at the local level

Central level sub-sectoral institutions are dominant. The devolved bottom-up system of development has very little space in this centralized mechanism. Lack of operational recognition to and support for local bodies to involve them in planning, monitoring and facilitation of energy resources development activities at the local level has affected the quality of program/project implementation in each energy sub-sector and has negative impact on the sustainability of such initiatives.

Lack of level playing field in fuel wood generation

Monopoly in generation of fuel wood by public utility has hindered competitive utilization and conservation of this resource. There is lack of enabling policy and regulatory mechanism for providing level playing field to promote private sector in forest development (generation) and management.

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

Socio-economic groups of women, Dalit do not have adequate and structured representation in the relevant energy organizations. They do not have representation in the energy planning and decision making process. This has created feeling of non-ownership among the excluded groups of any energy development and planning process in the country.

Lack of integrated energy planning awareness, education and training

Awareness of integrated energy planning and management is very low among the people. 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. Educating future generation on importance of sustainable energy development and security is critical to socially optimize the benefits of any national initiative on energy resource development. 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. 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 hindered accelerated extension and promotion of energy resources to benefit the larger number of people.

2.1.4.3 Environmental Issues on Traditional Energy

Air pollution

Though biomass is carbon neutral in terms of Green House Gas (GHG), it emits carbon monoxide and other toxic gases due to incomplete combustion in inefficient cooking devices. Use of biomass in traditional inefficient stoves causes dirty kitchen as well as indoor air pollution from ashes and smokes. This primitive technology has adverse impact on health and local environment; especially women and children.

Environmental degradation

Unsustainable harvesting and over exploitation of wild forest cause deforestation, soil erosion at local level and flooding in sensitive areas. Similarly, smoke emission from traditional energy use in domestic, commercial and industry sectors (brick kilns) has caused air pollution. Very often unmanaged forest fire occurs, which depletes traditional energy resources, wild life and biodiversity.

Awareness on adverse impact

User groups of traditional energy resources are not aware of environmental degradation and impact on climate change due to excessive burning of fuel wood, animal dung and agricultural residues in traditional inefficient stoves and devices. Many of them are not aware of existence of improved cook stoves/ gasifiers that minimize kitchen smokes and fuel consumption.

Loss of wild life and biodiversity

Most of energy requirement (about 90 percent of total energy consumption at base year) is met by traditional energy resources; such as fuel wood, animal dung and agricultural residues in Nepal. Over dependence on wild forest for energy will cause loss of wild life and biodiversity in due course of time.

2.1.4.4 Social Issues on Traditional Energy

Lack of knowledge and awareness on the 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. The smoke and particulate matters coming out as the direct burning of the biomass fuel is harmful leading to cough, respiratory tract infections, asthma, eye infections, headache, etc. On the other hand shortage of biomass fuel is leading to switching into inferior fuel sources which could be even more harmful health-wise and less energy efficient. Due to depleting and scarce energy sources, the need to go to distant places and dangerous landscapes/forests for collecting forage, fodder and fuel wood renders women and children, who are primarily used for this purpose, prone to accidents and even death. Increased work load and indoor smoke pollution tend to make rural women quite vulnerable to several health maladies.

Increased work load and lack of income generating programs

The necessity to go far for collecting biomass energy and fetching water due to the scarcity of traditional biomass energy and depleting water sources adds further to the already bulky work load for women. Besides consuming a lot of their physical effort, it leaves them with a very little time to indulge in other income generating activities or even community based activities. Further, 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 and income generating program is a hindrance to rural women who have spare time to invest in income generating activities.

The practice of using child labor in collecting traditional biomass energy is a common practice in the rural context. More specifically, girls are involved in this activity and hence are deprived from the opportunities to go to school. This consequently perpetuates the cycle of female illiteracy and the prospect of their growth and development is thus handicapped.

Lack of knowledge on the use of agri–residue as a source of energy

Nepalese economy is predominantly an agrarian economy and agri-residue forms the third largest indigenous biomass source of energy in Nepal. Despite the high potential of use of agri-residue for energy purpose, it is primarily used for fodder and compost manure preparation only. This is primarily because the technology of producing energy from agri-residue is not brought into public interest and people are ignorant about it. Promoting this technology will not only provide the rural agriculture-based population with the cheapest and readily available source of energy but will also enhance the socio-economic status of people by curtailing their expense on purchasing other energy sources.

Lack of skilled manpower

Lack of incentives and opportunities, the trend of migration of skilled manpower and educated elites to the urban centers is on rise thus hindering the prospect of improving traditional energy use through technological innovations. Also migration of professionals has resulted in brain drain in energy sector at different levels.

Lack of alternative employment opportunities

There are large populations of marginal poor who are entirely dependent on the illegal cutting down and trading of fuel wood to earn their livelihood. Unless alternative employment opportunities are provided, this activity cannot cease. Hence, to prevent deforestation and depletion of forest it is essential that the concerned agencies make provisions of a different source of generating income for these socio-economically disadvantaged populations.

Inadequate information about private forest management and use

The scarcity of traditional biomass energy can be compensated by encouraging the private forest developers. However, lack of information among the interested groups on the management of private forest and its use is an impasse for adopting this practice by the concerned stakeholders.

Lack of knowledge of economically valuable species

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

Lack of awareness on stall feeding

Due to lack of awareness on stall feeding of cattle, the practice of open and rampant grazing on non-pasture lands is still prevalent. This leads to the destruction of young plants and saplings.

Difficulty in fuel wood procurement for rituals and ceremonial fires

In spite of being announced secular nation in terms of religion, the Nepalese population is still dominated by Hindu majorities. Hence, 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.

2.1.4.5 Economic and Financial Issues on Traditional Energy

Problem of valuable timber used as fuel wood

Fuel wood is only marketed in urban areas but in rural areas it is used as free gift of nature for the daily household consumption. Due to such situation there is not only the problem of deforestation but the valuable timber is also used as fuel wood which loses huge resource of national property.

Lack of commercialization of traditional energy resources

Traditional energy such as fuel wood, agricultural residue and dung is not commercialized. Fuel wood is marketed in urban areas only; residue and dung are to some extent marketed in rural

areas at negligible price in comparison to the value of its energy content. Economic price of fuel wood is not considered and it is considered as free gift of nature and freely accessed by the rural people for their daily livelihood.

2.1.5 Issues on Commercial Energy

2.1.5.1 Technical Issues

Focus on indigenous resources

The country is becoming alarmingly dependent on petroleum products for its energy requirement. 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 energy resources in the country

Though official documents show some reserves of fossil fuels such as coal, oil and natural gases in the Western Nepal, in the Southern belt and in Kathmandu valley respectively, the exploration, production and development of these reserves have not received much focus. Similarly, current development of hydropower resources is quite inadequate for meeting the country's demand.

Transport vehicles on efficient energy resources

Emphasis needs to be given more on the usage of electric vehicles and public transport. Individual transport vehicles such as private cars, jeeps, and motorcycles should be replaced by mass transport. Development of electric vehicles such as railway systems along the East West Highway should come in the list of priority. Necessary emphasis and incentives in the development of the Expressway between Kathmandu and Hetauda would significantly save the consumption of petroleum products.

Efficient and quality energy services

Quality energy service is the right of the consumers. But the existing mechanism of quality control in the products and energy services is inadequate and weak. There is a need of a strong quality control mechanism in petroleum products and coal. Excessive load shedding is not addressed by speedy development of power plant. The adulteration in the petroleum products, supply of poor quality coal and electricity losses need to be addressed by giving social penalty to people involved.

Energy transmission

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. Development of oil pipeline from Raxaul to Amlekhgunj is approved but is not implemented yet.

2.1.5.2 Policy Issues on Commercial Energy Sector

Focus on hydropower development

Despite the focus on hydropower development for meeting domestic needs, implementation has been weak. This has been mainly due to poor energy planning. The country is facing severe load shedding even during the wet season. 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.

Inappropriate energy classification

The existing energy sector classification of traditional, commercial and renewable where hydropower is grouped under commercial is not appropriate.

Regulation of the Oil Sector

Petroleum products occupy an important place in the supply and distribution of energy in the country. Currently this sector has come under various influences from outsideand 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 distributionand market-oriented pricing policy.

Energy Security

There is absence of a clear policy and law on storage of oil. Oil is a strategic source of energy and in view of nation's full dependence on imports, its vulnerability is very high.

Development of indigenous sources

Energy independence is not a practical proposition. However, in view of the supply completely dependent on import, part of the need should be fulfilled by energy sources developed within the country. Some degree of self reliance is necessary. Technologies are 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 is the most effective source for reducing the supply gap, carbon emissions and reliance on expensive imports of petroleum products. There have been a number of initiatives in EE, yet it needs more serious attention. Energy efficiency can be achieved through a host of measures such as manufacture and use of energy efficient equipments, reduction in system losses, 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 programmes. 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. Subregional power trade can be an effective way of meeting energy demand. By utilizing different peak times of neighbouring countries, regional power trade can reduce the need for building new power generation plants in each country.

2.1.5.3 Institutional Issues on Commercial Energy Sector

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

WECS's one key responsibility is to act as an overall energy planner, which would especially assist the NPC's periodic economic development plan pertaining to energy. 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 does not continuously receive policy recognition and support. Therefore, an integrated mechanism that links all energy sub-sectors together in terms of effective planning is clearly absent. It has been felt that an overall executive body is needed for integrated energy planning.

Inequitable distribution of benefits from royalty

Providing 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 allow the water flow. A mechanism is required to share royalty equitably in the basin/sub-basin.

Lack of level playing field in electricity transmission and distribution

Monopoly in transmission and distribution of electricity by public utility 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 level playing field for oil import

Monopoly in import of oil (petroleum products) by public utility has significantly hindered competition of petroleum commodities in the market and hence the petroleum procurement, transport and distribution are not efficient. 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.

Awareness of integrated energy planning and management stands low. Educating future generation on importance of sustainable energy development and security is critical to socially optimize the benefits of any national initiative on energy resource development. Besides, there is lack of institutions which regularly provide training to fresh trainees, upgrade and refresh the

skills of existing manpower in energy sub-sectors. It has been found a 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 hindered accelerated extension and promotion of energy resources to benefit the larger number of people.

2.1.5.4 Environmental Issues on Commercial Energy Sector

Pollution tax on fossil fuels

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

Environment impact assessment

Time frame provided for EIA is too long. Mitigation measures to minimize the environmental impacts are not followed strictly and sometimes, 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 for 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.

Resettlement policy

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

2.1.5.5 Social Issues on Commercial Energy Sector

Lack of energy reliability and security

It is not only the commercial sector that is suffering from the lack of reliability and security in energy but it is equally true for the domestic. 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 determined by 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

Besides other energy sources, electricity 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 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 and conduction of public hearing prior to any commercial energy project development

Despite the mandatory pre-requisite of Social Impact Assessment and public hearing before commencing any commercial energy project, the enforcement is still weak.

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 burgeoning squatters and slums. On the other hand this will create an imbalancedsituation in the demand and supply of energy sources thus creating energy insecurity, supply deficit, environmental deterioration and energy misappropriation and theft.

Non-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.

2.1.5.6 Economic Issues on Commercial Energy Sector

Lack of competitive market price in petroleum sector

The petroleum product is solely controlled and regulated by NOC. Petroleum products are not allowed to be imported freely and marketed at competitive price by the private parties as per the liberalization policy of the government.

Improper pricing of petroleum product

Petroleum products prices 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 LPG is currently increased by rupees 200 per cylinder, NOC is claiming a loss of 70 rupees per cylinder. If compared with the energy value price of kerosene which is normally used by poor people is very much higher than LPG in terms of energy content value.

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.

Lack of initiative for using local resources

Financial institutions and banking sector are unable to use 200 billions 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 and energy price

Differential electricity and other 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 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 most essential precondition of the energy supply services. But the issue to provide energy at affordable cost is very controversial term and is very hard to meet because NEA and NOC, the major commercial energy providers, are claiming that they are in huge loss.

Absence of energy conservation/ efficiency

Energy saving or energy conservation is equivalent to energy production. Huge investments are required for electricity production. On an average, about 2000 USD is required to produce one KW of hydroelectricity, so, it is required to promote energy conservation and energy efficiency.

2.1.6 Issues on Renewable Energy Sector

2.1.6.1 Technical Issues

Issues on bio-gas technology

Energy can be produced from human excreta and other biomass, however to bring this into implementation, raising public awareness and emphasizing technological utility is not given much attention. There is a lack of subsidy on the production of biogas from household garbage. Technical knowledge on the production of biogas from the by-products of vegetable farming residues is not well known to common people.

Issues on micro-hydro power

There are no practices to take advantage of multiple benefits from water use. Water used for micro-hydro can also be used for water mill and irrigation which is not considered in design of micro-hydro projects. The traditional water mill can be improved to produce electricity hence attention needs to be paid on this. Systematic operation and maintenance system in micro hydro projects need to be established. There are many difficulties in conduction of survey of MH due to

difficult landscape in rural areas. Study and survey on identification of MH potential area and its capacity are still very limited. Inadequate technical knowledge on the operation and maintenance of micro hydro sector is still hampering in the micro hydro power generation.

Issues on solar energy

The major issues are insufficient knowledge on the technology of cooking food from solar energy, its capacity and general feasibility. Sustainability of solar energy technology is another important consideration in this regard. Subsidy has been a debatable issue in this sector.

Issues on wind energy

Detail assessment of wind energy production is necessary before having any wind energy project in the country. High cost technology is the major reason not to have such wind energy projects. Mapping of solar, wind and modern biomass energy technology is needed as a part of resource assessment.

Issues on other renewable energy (bio-fuel, briquette)

There is in-adequate exploration and implementation of other viable renewable energies; such as bio-diesel, ethanol. Concept of commercially developing drumstick (biodiesel plant) as an alternative to petroleum products is also lacking. Plantation of bio-fuel plants like Khirro- Kadam is not emphasized for bio-energy. Technology development related with bio energy production is still in preliminary stage. Technical knowledge in producing bio briquette is also not matured. Briquette use is found expensive.

2.1.6.2 Policy Issues on Renewable Energy

Cumbersome subsidy procedures

There are cumbersome procedures and a centralized system of subsidy delivery mechanism. The current subsidy policy is designed according to the administrative classification of districts which fails to address the requirements of the people who actually need such support. In addition, the amount of subsidy is also not appropriate.

Credit facility

Interest on credit for rural energy technologies is high. People for whom the credit facility has been targeted simply cannot afford. There is problem of collaterals.

Energy Master Plan

There is absence of information base in the district to avail the facility speedily. A few districts have master plan of energy resources developed. Many districts lack such information.

Lack of awareness

There is wide scale lack of awareness about the policy in the districts. Even the authorities who are supposed to supervise implementation of these programmes have been found ignorant about the details of policy provisions and delivery mechanisms. Some who had knowledge expressed reservations about efficacy of the programme. The programme suffers from interference.

VAT facilities

The procedure for refund of VAT is cumbersome, and in most cases unpractical.

Research and development

Research and development programme on renewable energy is inadequate.

2.1.6.3 Institutional Issues on Renewable Energy

Lack of recognition to and prioritization of indigenous water resource as the lead energy sub-sector in integrated energy planning

Indigenous renewable energy resources like water lack effective recognition and prioritization while planning energy resources development. Ministries and departments involved in planning and development operate under their sectoral/sub-sectoral regulation and for their own target lack co-ordination. Such a situation was a result of an institutional arrangement where divergent public agencies dominated their respective energy sub-sector and no agency is clearly specified as a lead agency that is responsible for integrated energy planning.

Lack of capability for integrated energy planning

The system and process for integrated energy planning in the existing sub-sectoral energy planning processes is lacking at present. This has resulted in lack of an integrated energy planning practices, a right energy mix framework (giving strategic priority to potential indigenous resources) and a pricing system-appropriate enough for the whole energy sector on a nation-wide basis. Besides, lack of integrated energy planning both at the central and local levels has also constrained the national ability to comprehend, envision, investigate and cash internal and external market benefits offered by opportunities such as carbon trading. An institution is, therefore needed to be specified as a lead agency that is responsible for integrated energy planning to put in place the system and processes and accordingly strengthen the capability accordingly.

Ineffective information dissemination through responsible institutions

The institutions responsible to handle renewable energy related matters have weak mechanism for effective information dissemination regarding subsidies and technology adoption and updates.

2.1.6.4 Environmental Issues

Environment impact assessment

There is an inadequate implementation of mitigation measures towards environmental assessment.

Battery disposal

There is lack of rules and regulation regarding the disposal of batteries of solar home system. Many users are not aware of negative environmental impact of lead acid batteries.

Solid waste management

Users are not aware of attaching toilets to biogas plants and there is no subsidy policy for it. Also there is lack of information to users that biogas can be generated from the solid waste. Similarly information dissemination is lacking for the disposal of agricultural field residues, municipal and industrial residues.

Air pollution

Ashes and smokes are the main sources of indoor air pollution. Similarly, burning fuel wood in brick kilns causes air pollution to the surroundings.

2.1.6.5 Social Issues

Inadequate information dissemination and lack of knowledge

Exploration, development and use of other energy sources apart from the traditional biomass energy and commercial energy are still a new and emerging concept in the domestic sector. Therefore, providing knowledge and creating awareness among the people regarding investment, use, conservation and underlying opportunities in energy sector specifically renewable energy entails a thorough exercise. In order to reduce the dependence on traditional and commercial energy sources, use of renewable energy is the only alternative as a cheaper, easier and environmentally friendly technology. For this purpose, extensive information dissemination on these aspects needs to be done fervently to increase interest and gather active participation from the stakeholders and the general public. Moreover, lack of knowledge on the renewable energy technologies, is also depriving people from socio-economic, environmental and health benefits that can be reaped by using renewable energy like biogas, micro-hydro, improved cook stove, solar home systems, etc. As for example, dung cakes are a very common source of biomass producing a very inferior energy. However, the same animal residue when used in biogas plant can produce environment, health and pocket friendly energy.

Besides providing information on renewable energy, awareness regarding the effective, optimum and efficient utilization of other traditional and commercial energy sources needs to be disseminated among people, as for example, promoting power saving CFL/LED in areas having access to electricity.

Lack of proactive involvement and opportunities for women

There are very few women professionals in energy sector and these handful of professionals have negligible representation in the policy, decision-making and implementation level. Major portion of energy is utilized by the domestic sector and hence women are the major role players when it comes to energy use and conservation. It is therefore imperative to actively involve and seek participation of women in energy sector both at the professional level and at grass root level. There is an apparent lack of women professionals in energy sector who can contribute in making policy and taking decisions. Similarly, at the grass root level, there is insignificant involvement of women in taking community level decisions. Women at the grass root level can be involved in promoting, training and using renewable energy technologies, conservation of energy and its optimum utilization and creating awareness on the harmful impacts of traditional energy use. This will not only build their capacity but also instill a sense of belonging and responsibility in the development arena.

Lack of ownership/accessibility

Equity being directly linked with sustainable development is a very crucial issue in the social context. Development initiatives which are lagging in terms of equal distribution of benefits and services for all may not be sustainable and call for a shift in the development paradigm. It is realized that the energy projects which do not take local development, distribution of benefits and participation of rural poor, Dalits, marginalized people and other deprived communities into consideration are not sustainable. This lack of ownership and accessibility by the local communities leads to the non-sustainability of such efforts and hinders in bringing these groups into the development mainstream.

Rather than concentrating only on energy security, reliability and accessibility, it is equally essential to analyze the energy choices and priorities of different groups and communities to make energy projects completely socially inclusive and sustainable. Hence, the development of various model of participatory resource management process depending on the geographical set up needs to be implemented more effectively.

Inadequate local ownership/participation

Except in demand driven community based energy projects, the local participation in the projects developed by external investors is negligible. This has created a gap between the project owners and the local community whereby the of ownership by the community towards the project has become an issue. Energy projects developed without taking local development into account cannot be sustainable. This lack of equity leads to a state of social dissatisfaction and conflict.

Lack of curriculum

Energy being the engine of overall growth and development of a country, it is an issue of primary concern to every citizen and hence everyone should be acquainted with the basic concepts in energy. The teachers, students, laymen, housewives and professionals in different sectors must understand the fundamental concepts of energy as everybody is inevitably associated with energy in some way or the other. Hence, the best way to achieve this is through the introduction of curriculum on energy at all levels of educational strata.

Lack of public awareness on policy process

Lots of interest is emerging from the public/private investors in energy sector development. However, lack of knowledge or inadequate awareness about the policy process involved is creating certain complexities in the course and therefore is not attracting the investors to the desired extent. Similarly, unawareness about other policy processes associated with energy sector and of direct relevance to the general public and stakeholders is problematic.

Cultural barrier

Due to different cultural practices adopted by people and the values they adhere to, sometimes it may create difficulty in abandoning traditional energy use practices due to users' reluctance in adopting alternative unfamiliar sources/practices against their norms and values. As for example, due to attachment of toilet to biogas plant, some people in rural areas may not accept this technology as an alternative to using the traditional biomass energy.

2.1.6.6 Economic Issues

Lack of income generation of poverty people

Energy is considered as one of the major input for the development of the society. The renewable energy programs must be integrated with rural development program along with the income generating activities of the rural people to raise the income of the poverty people.

Lack of credit and subsidy facility for the development of improved technology

Energy efficiency is a must in all improved technology including ICS, solar home system, biogas system, wind energy etc. The development of efficient and improved technology in all energy resources and its application is lagging due to the lack of credit and subsidy facility for the development of improved technology in energy sector

Lack of initiative to produce solar panel by the country

There is lack of initiative to produce solar panel by the country. Solar panels are very costly and import duty is exempted by the government, which incurs a huge financial loss to the nation. But this can be curbed if solar panel can be produced in within the country.

Chapter 3: Energy Scenarios Analysis

While formulating the national energy strategy, three different future energy demands with respect to economic growth are assessed. These scenarios are:

- Business As Usual (BAU) case with an average GDP growth rate of 3.9 percent
- Reference case with an average GDP growth rate of 5.6 percent
- Accelerated growth case with an average GDP growth rate of 8.6 percent

Such future energy demands are analyzed considering the energy demand situation of 2004/05 as the base year. For policy analysis, reference scenario of 5.6 percent GDP growth rate is considered as South Asia's overall economy was growing at an average growth rate of 5 percent (IMF, 2006) during the period 2001 -2005. Further, it seems possible for Nepal to move in line with South Asia's GDP growth rate in the years to come.

BAU Scenario (Baseline Scenario)

In this scenario, analysis of future energy demand is made, assuming the average GDP growth rate equal to 3.9 percent. Another assumption is that the share of each demand technology in the energy supply in future years will be the same and similar consumption trends will continue in future as in the base year.

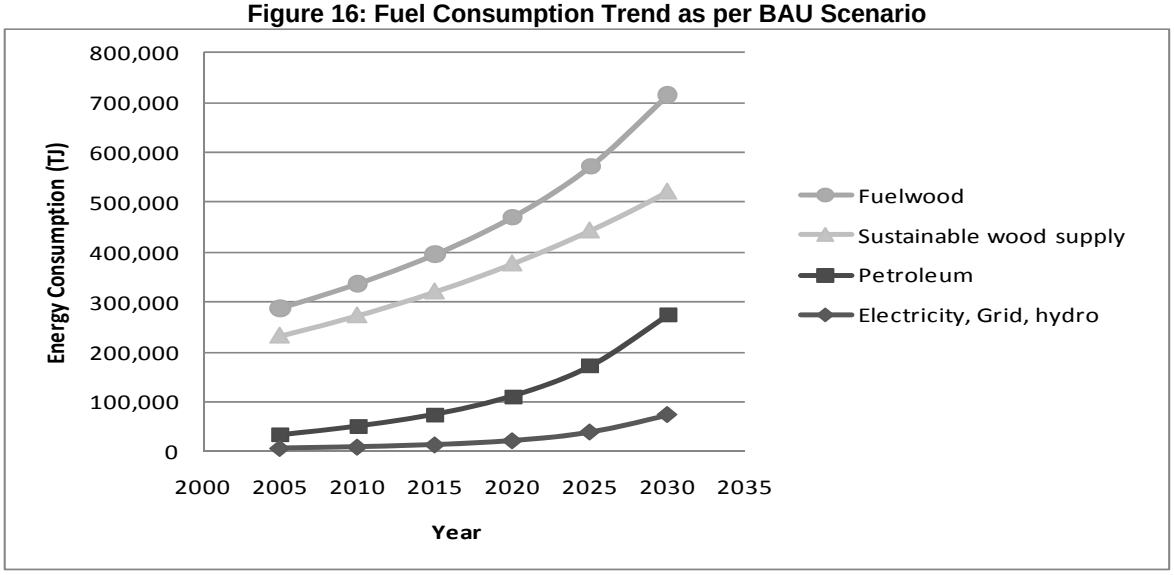
The expected final consumptions of various fuels in this scenario are presented in the table 3.1. The total energy consumption in 2030 is expected to grow to a value of 1184 million GJ from the base year value of 369 million GJ. The per capita energy consumption for 2030 is expected to stand at 29 GJ.

Table 34: Fuel Consumption by years in BAU scenario

Fuel	Total Energy Consumption, Million GJ				
	Year				
	2010	2015	2020	2025	2030
Fuelwood	336.2	395.5	470.3	572.0	715.9
Agri residue	16.1	18.7	22.0	26.2	31.7
Animal Dung	24.7	28.8	33.7	40.2	49.1
Electricity, Grid, hydro	8.7	13.3	21.5	39.1	74.2
Coal	8.8	11.9	15.4	19.3	23.2
Diesel	19.7	28.5	40.5	58.3	83.5
Petrol	4.3	5.9	7.3	9.2	11.3
Kerosene	14.3	20.5	30.8	49.2	86.4
LPG	7.2	13.7	25.3	46.0	82.1
Av fuel	3.6	4.6	5.6	6.7	8.1
BioGas	3.0	4.4	6.8	10.5	16.9
Electricity, Off-grid+pico	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0
OPP	1.0	1.2	1.5	1.7	1.9
Grand Total	447.8	547.0	680.9	878.8	1184.7

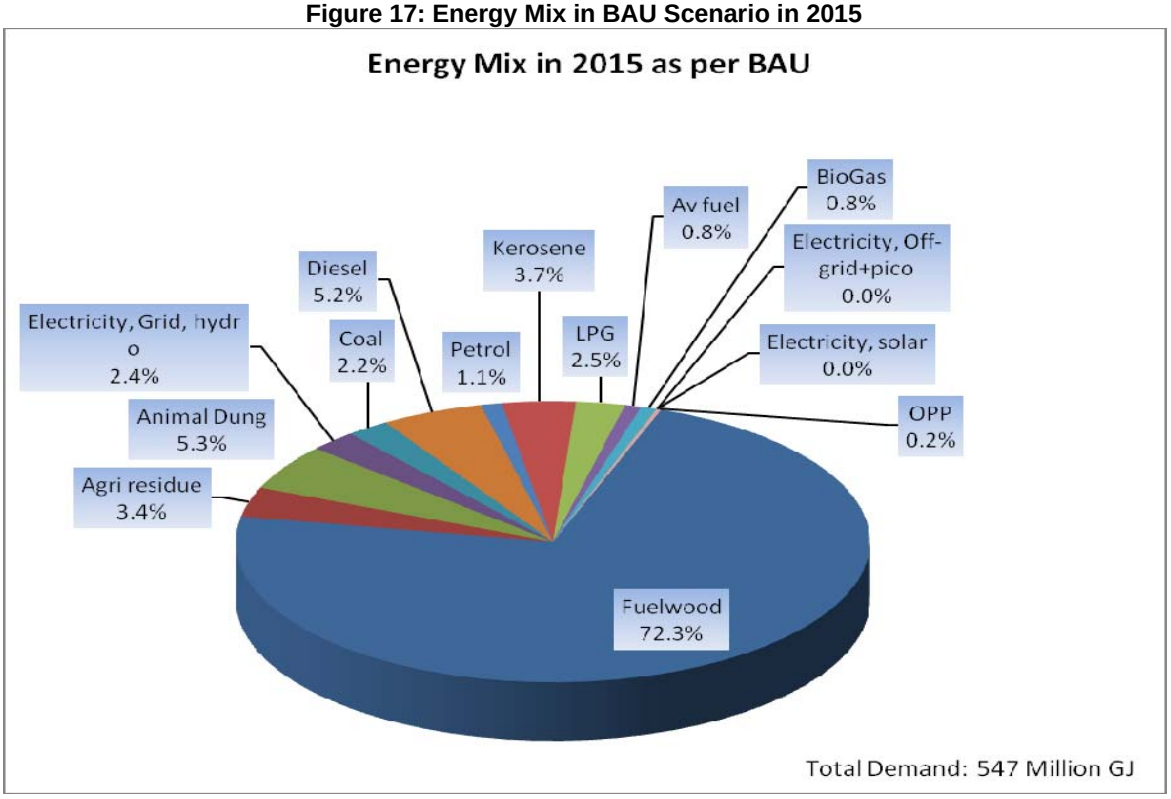
Figure 3.1 shows the projected consumption of various energy sources at an interval of five years in the BAU case. In this scenario, petroleum products will be increasing at annual growth rate of 10 percent, electricity 11 percent, coal 5 percent, biogas 9 percent and the traditional biomass fuels at 4 percent respectively.

Figure 16: Fuel Consumption Trend as per BAU Scenario



The average growth rate of total energy consumption will be 5 percent during the study horizon. The share of fuel-wood is expected to remain relatively high, surpassing the sustainable wood supply limit based upon the Forestry Sector Master Plan, 1988.

Figure 17: Energy Mix in BAU Scenario in 2015



The share of fuels in 2015 and 2030 in this scenario is given in the Figure 3.2 and Figure 3.3. Fuel wood share of the total energy consumption will decrease from 78 percent in 2005 to 72 percent in 2015 and 60 percent in 2030.

Likewise, the share of electricity will increase from 2 percent in 2005 to 6 percent in 2030. Petroleum products will occupy a share of 16 percent in 2015 from 9 percent in 2005 and they will grow to 23 percent in 2030 in the total energy consumption.

Figure 18: Energy Mix in BAU Scenario in 2030

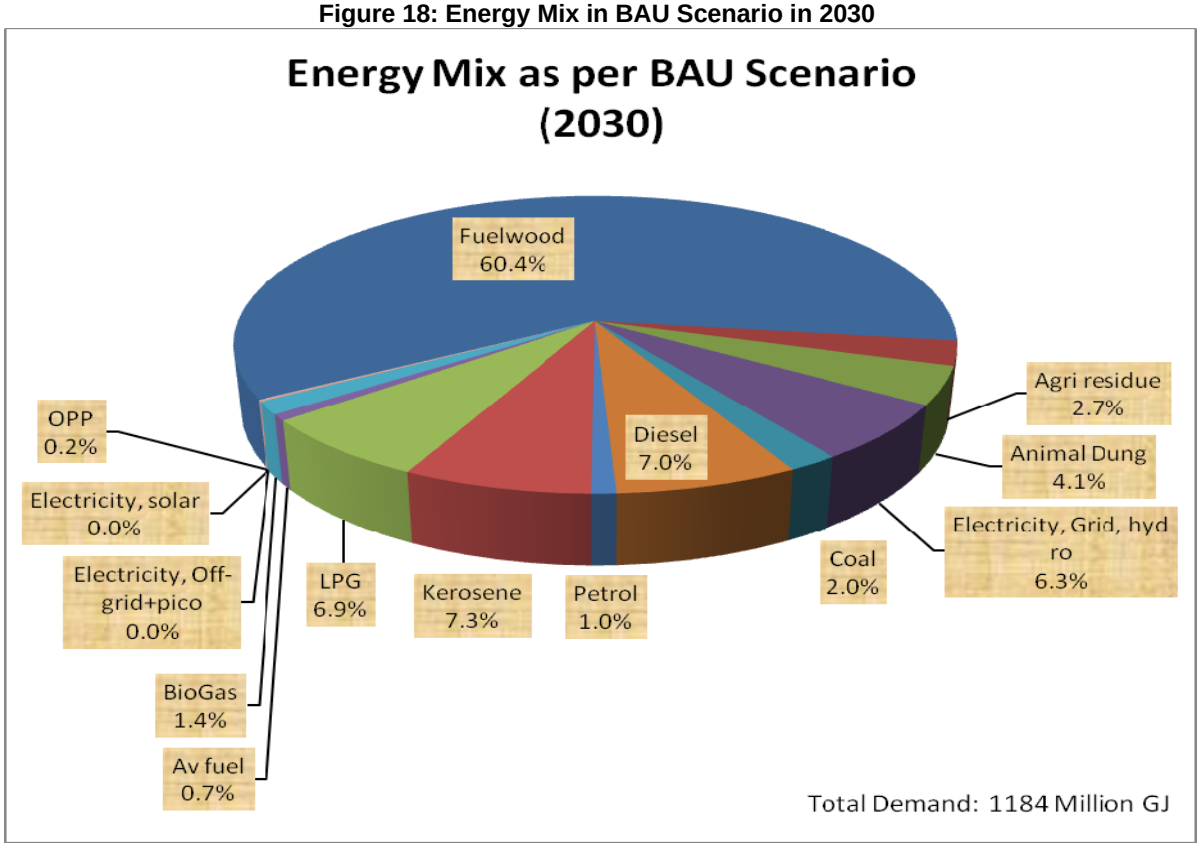


Table 35 Sectoral consumption at BAU scenario

Unit: Million GJ

Sector	Year				
	2010	**2015**	**2020**	**2025**	2030
Residential	393.2	465.1	557.5	685.0	869.0
Industrial	16.5	23.1	33.3	53.6	95.4
Transport	23.6	34.0	47.7	67.7	96.6
Commercial	10.3	19.7	36.8	67.0	118.7
Agriculture	4.2	5.1	5.5	5.5	5.0
Total	447.8	547.0	680.9	878.8	1184.7

The sectoral energy consumption pattern is shown in **Table 3.2**. The share of residential sector in total primary energy consumption will be 85 percent in 2015 and 73 percent in 2030. The share of commercial sector will increase from 1.4 percent in 2005 to 3.6 percent in 2015 and 10 percent in 2030 in this scenario. Industrial sector will consume 4.2 percent in 2015 and 8.1

percent in 2030. There will be a rapid increase in the energy consumption in transportation sector since demands in this sector are expected to increase rapidly.

The peak power plant capacity requirement will be as **Table 3.3.** The peak power plant requirement for 2015 will be 1,300 MW and in 2030, 6,300 MW. Per capita electricity consumption reaches 521 KWh in 2030 from 67 KWh in the base year. The calculation of hydro-power plant installation costs is based on NEA Corporate Plan 2005. The annual investment requirement for power plants in the period 2010-2015 will be NPR 14 billion on average, considering the base price level of 2005.

Table 36: Peak power plant capacity at BAU scenario

Particular	Year				
	2010	**2015**	**2020**	**2025**	**2030**
Capacity (MW)	855	1,297	2,065	3548	6307
Electricity consumption per capita, kWh/capita	87	121	179	299	521

In the period 2025 -2030, the average annual investment required will be NRs 85 billion from the base price of the year 2005, which is around 6 times the annual investment requirement in 2010 – 2015.

Reference Scenario or Interim Plan Scenario

This scenario assumes that the average GDP growth rate will be according to interim plan i.e with an average GDP growth rate of 5.6 percent. It further assumes that the share of each demand technology in the energy supply in future years will be the same as in the base year.

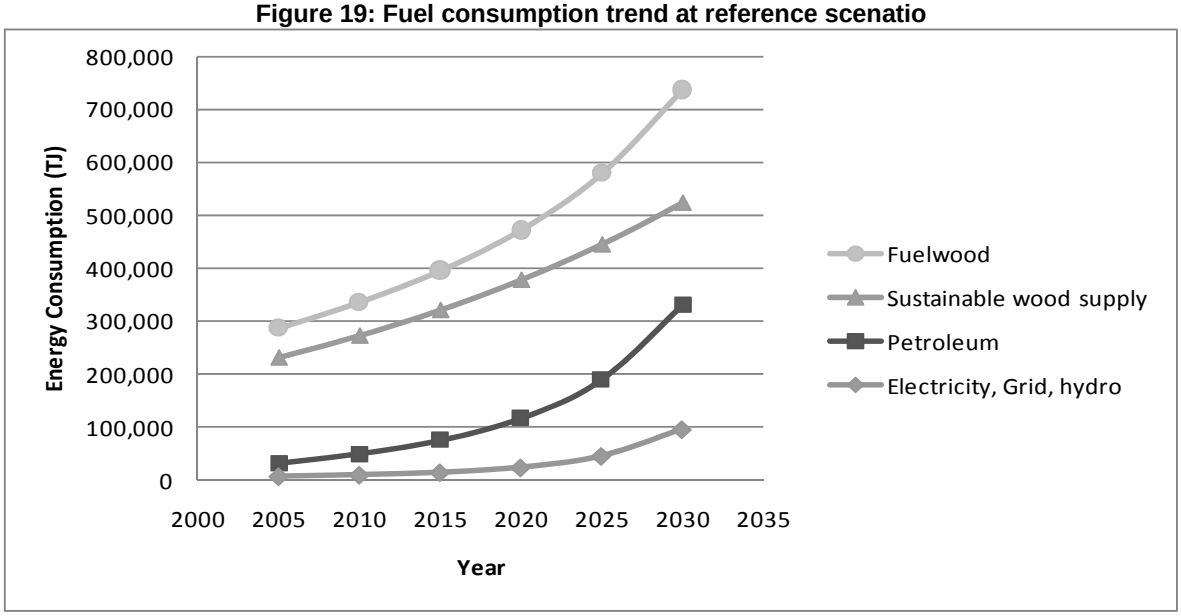
The projected final consumptions of various fuels in this scenario have been given in **Table 3.4**. The total energy consumption in 2030 is expected to grow to a value of 1301 million GJ from the base year value of 369 million GJ. The per capita energy consumption for 2030 will stand at 33 GJ.

Table 37: Fuel consumption at reference scenario

Fuel	Total Energy Consumption, Million GJ				
	Year				
	2010	2015	2020	2025	2030
Fuelwood	336.3	395.9	472.4	579.2	737.3
Agri residue	16.1	18.9	22.7	28.4	37.3
Animal Dung	24.7	28.8	33.7	40.2	49.1
Electricity, Grid, hydro	8.8	13.6	22.9	44.9	95.8
Coal	8.9	12.6	17.6	24.7	34.5
Diesel	19.8	29.1	42.8	64.0	96.1
Petrol	4.3	5.9	7.3	9.2	11.3
Kerosene	14.3	20.8	32.0	54.0	105.0
Av fuel	3.6	4.6	5.6	6.7	8.1
LPG	7.3	14.1	27.4	53.6	106.3
BioGas	3.0	4.4	6.8	10.5	16.9
Electricity, Off-grid+pico	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0
OPP	1.0	1.3	1.7	2.2	2.9
Total	448.2	550.1	693.2	918.1	1300.9

The cumulative growth rate of primary fuel consumption will be 5.2 percent. The annual growth rate of petroleum products will be 10 percent and that of electricity will be 12 percent during the study horizon.

Figure 19: Fuel consumption trend at reference scenatio



Fuelwood will be the dominant fuel in this scenario, easily surpassing the sustainable limit throughout the analysis period.

Figure 20: Energy mix as per reference scenario in 2015

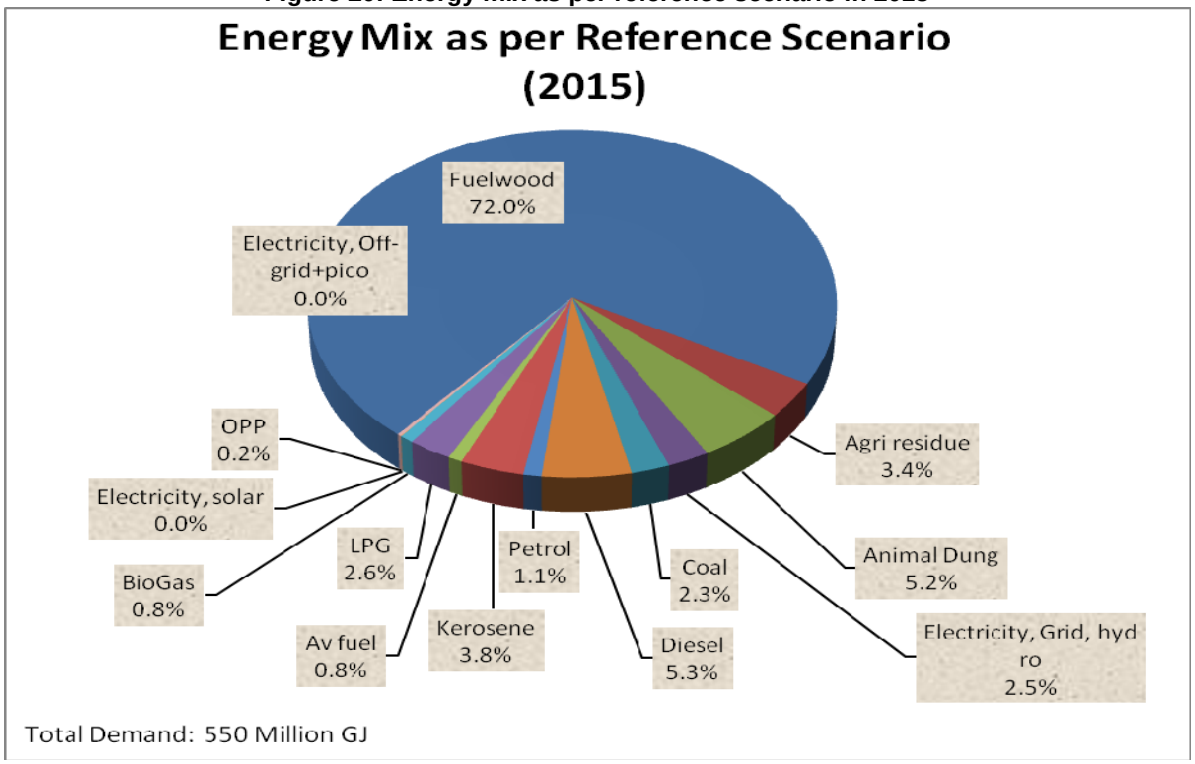


Figure 21: Energy mix as per reference scenario in 2030

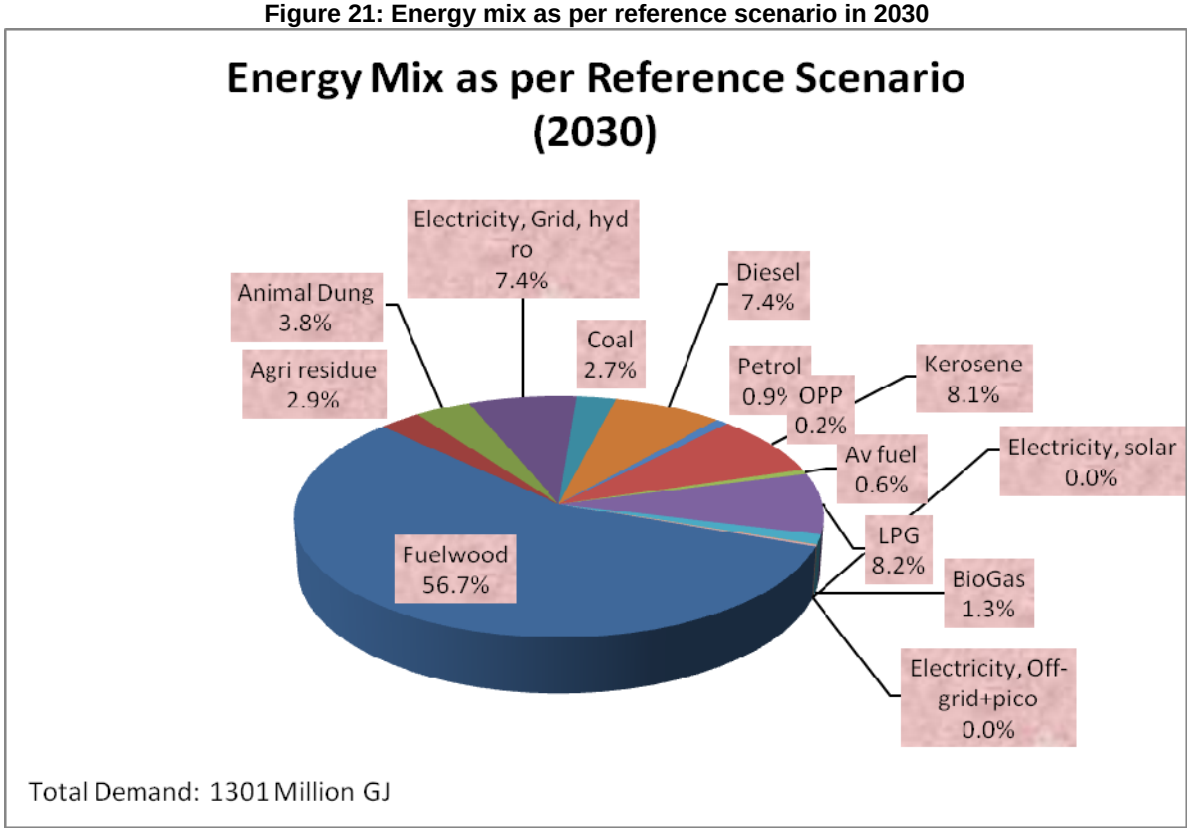


Figure 3.5 and **Figure 3.6** shows the primary fuel shares in 2015 and 2030. The share of fuel wood will be 72 percent in 2015 and 57 percent in 2030 respectively. Share of electricity will increase to 7 percent in 2030. The share of petroleum products will be 25 percent in 2030 compared to 9 percent in 2005.

Table 38: Sectoral consumption at reference scenatio

Sector	Energy Demand in TJ				
	Year				
	2010	2015	2020	2025	2030
Residential	393.2	465.1	557.5	685.0	869.0
Industrial	16.7	24.4	38.1	68.7	142.0
Transport	23.7	34.4	49.1	71.6	105.9
Commercial	10.4	20.8	42.1	85.8	176.5
Agriculture	4.2	5.4	6.3	7.1	7.5
Total	448.2	550.1	693.2	918.1	1300.9

Table 3.5 shows the sectoral energy consumption in this scenario. The share of residential sector decreases to 67 percent in 2030 from 90 percent in 2005. Industrial sector share of energy consumption will be 4 percent in 2015 and 11 percent in 2030. Energy consumptions in the commercial sector (service sector) will be 3.8 percent in 2015 and 13.6 percent in 2030.

The peak power plant capacity requirement will be according to the following **Table 3.6**. The power plant requirement for 2030 in this case will be 7,648 MW. Per year investment in power plants in the period 2025-2030 will be 115 billion NRs in 2005 base price.

Table 39: Peak power plant capacity at reference scenario

Particulars	Peak Power Plant Capacity (MW) in different years				
	2010	2015	2020	2025	2030
Capacity (MW)	858	1,322	2,167	3,933	7,648
Electricity consumption per capita, kWh/capita	87	124	191	343	672

Per capita electricity consumption in this scenario will be 124 KWh in 2015 and 672 KWh in 2030 respectively. As per the energy development projected in interim plan 2007-2010, per capita electricity projection for 2015 is expected to achieve 100 KWh which seems to be surpassed as projected in this scenario if the national economy grows at 5.6 percent.

3.1.1 Energy Indicators at Reference case or Interim Plan Scenario

Much of the current energy supply and use, based, as it is, on limited resources of biomass and fossil fuels, is deemed to be environmentally unsustainable. Combustion of fossil fuels is chiefly responsible for urban air pollution, regional acidification and the risk of human-induced climate change. Moreover, about one-third of the world's population still relies on the use of animal power and traditional biomass fuels. Some 1.7 billion people in the world have no access to electricity. Many areas in the world have no reliable and secure energy supplies. This lack of access to modern energy services severely limits socioeconomic development — an integral part of sustainable development. Nonetheless, because of improved technology and an increased understanding of the effects and impacts of energy and energy systems, a developing country today can make the transition from an agricultural to an industrial economy with much lower costs and with less environmental damage than today's developed countries were subjected to during their transition (IAEA, 2005).

When choosing energy fuels and associated technologies for the production, delivery and use of energy services, it is essential to consider economic, social and environmental consequences. Measurement and assessment of current and future effects of energy use on human health, human society, air, soil and water as well as examining the sustainability of the energy use require due attention. The strategy has analyzed some energy indicators with and without policy interventions.

Table 40: Energy indicators in reference scenario

Energy Indicators	Units	Years					
		2005	2010	2015	2020	2025	2030
Final energy consumption/capita	GJ/capita	15	16	18	21	25	33
Electricity/capita	KWh/capita	67	87	124	191	343	672
Energy Intensity	GJ/1000$	43	42	40	38	38	39
Electricity Intensity	kWh/1000$	195	226	273	351	514	801
Electricity power utilized	Per cent	0.01	0.02	0.03	0.05	0.09	0.18
Total Energy Consumption/ value added in Industry Sector	GJ/1000$	19	21	25	32	46	76
Total Energy Used/household	GJ/HH	76	81	87	96	107	124
share of non-carbon energy in Primary Supply	Per cent	0.017	0.02	0.025	0.033	0.049	0.074
Share of renewable energy in final total energy consumption	Per cent	0.117	0.117	0.12	0.125	0.136	0.153

The ratio of net import to total primary energy supply	Per cent	0.106	0.132	0.161	0.194	0.233	0.28
GHG emission for every ton of energy production and use/cap	GHG in Kg/cap	474	512	597	736	983	1432

(US$ 1.00 = NR 70.00)

The above **Table 3.7** indicates that per capita final energy consumption is almost doubled to 33 GJ in 2030 from the value of 2005. Per capita electricity consumption is expected to grow from 67 KWh in 2005 to 672 KWh in 2030. There is general improvement in energy intensity as it decreases to 39 GJ/1000$ in 2030 from 43 GJ/1000$ in 2005. Electricity intensity increases to 801 KWh/1000$ in 2030 from 195 KWh/1000$ in the base year. The power utilization of the potential hydropower improves to 18 percent in 2030 from slightly more than 1 percent in 2005. The final energy used per household increases to 124 GJ in 2030 from 76 GJ in 2005. The share of non-carbon energy in the total primary energy is less at 7.4 percent in 2030 which was 2 percent in 2005. It indicates that most of the energy consumed are carbon based and remains so if no policy intervention is done in time. Similarly, share of renewable energy in total primary energy moves from 12 percent in 2005 to 15 percent in 2030. There is little improvement in the use of renewable energy. The ratio of net imports to total primary energy supply in physical terms increases to 28 percent in 2030 from 11 percent in 2005. It shows that the dependence on imported energy fuels is increasing. Furthermore, the GHG emitted due to energy use rises from 474 Kg per capita in 2005 to 1,432 Kg in 2030 which is almost three times from the emission value in base year 2005. Despite, having low carbon dioxide emission intensity compared to other developing countries (1,650 Kg/capita), developed countries (10,960 Kg/capita) and world average (3,890 Kg/capita) in 2002 (Winkler, 2007), Nepal is suffering from climate change hazards and paying serious attention for climate change adaptation.

Accelerated Growth Scenario or High Growth Scenario

In this scenario GDP growth rate is assumed to be high, i.e. with an average GDP growth rate of 8.6 percent. Similarly, the share of each demand technology in the energy supply in future years will be the same as in the base year.

The final consumptions of various fuels in this scenario have been given in **Table 3.8**. The total energy consumption in 2030 is expected to grow to a value of 1642 Million GJ from the base year value of 369 Million GJ. The per capita energy consumption for 2030 will be 40 GJ.

Table 41: Energy consumption at accelerated growth scenario

Fuel	Total Energy Consumption, Million GJ					
	Year					
	2005	2010	2015	2020	2025	2030
Fuelwood	287.0	336.5	397.4	478.3	598.9	798.6
Agri residue	14.0	16.2	19.5	24.8	34.3	53.4
Animal Dung	21.2	24.7	28.8	33.7	40.2	49.1
Electricity, Grid, hydro	6.1	8.9	14.7	26.9	60.7	157.4
Coal	6.5	9.3	14.7	23.8	39.4	66.8
Diesel	13.4	21.3	33.0	51.9	84.5	140.5
Petrol	3.1	4.3	5.9	7.3	9.2	11.3
Kerosene	8.7	14.5	21.6	35.5	67.1	158.2
Av fuel	2.8	3.6	4.6	5.6	6.7	8.1

LPG	3.8	7.5	15.4	33.1	74.3	175.8
BioGas	1.9	3.0	4.4	6.8	10.5	16.9
Electricity, Off-grid+pico	0.0	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0	0.0
OPP	0.9	1.1	1.5	2.3	3.5	5.6
Total	369.2	451.0	561.7	730.1	1029.9	1642.2

The cumulative growth rate of total primary energy consumption in the period upto 2030 will be 6.2 percent. The consumption of fuelwood, which is already beyond sustainable limits, will continue to grow although its share will decrease. Fuelwood consumption will be unsustainable throughout the planning horizon. Electricity consumption will significantly grow by as much as 26 times from 2005 to 2030.

Figure 22: Energy consumption trend at accelerated growth

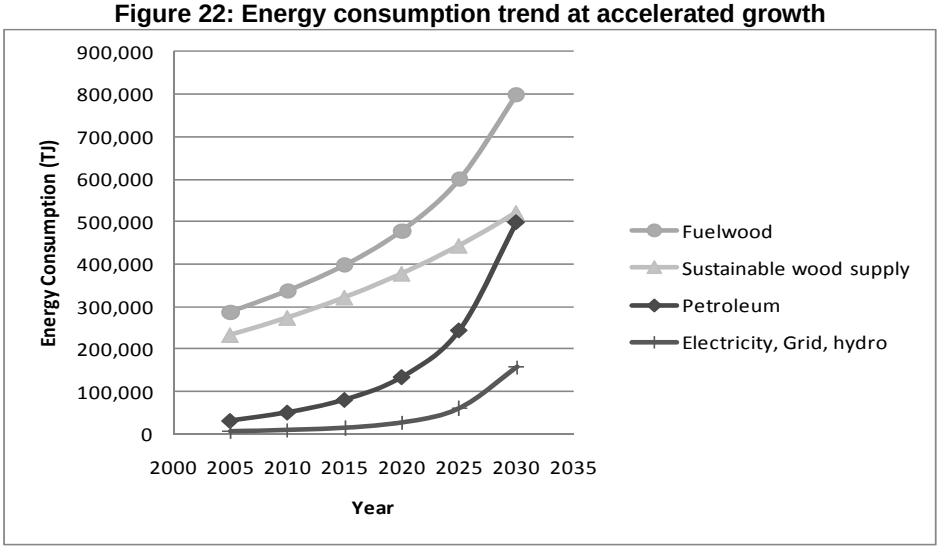


Figure 3.7 shows the trend of primary fuel consumption. The average growth rates of fuelwood, electricity and petroleum in the period 2005 – 2030 will be 4 percent, 14 percent and 12 percent respectively.

Figure 23: Energy mix as per accelerated growth in 2015

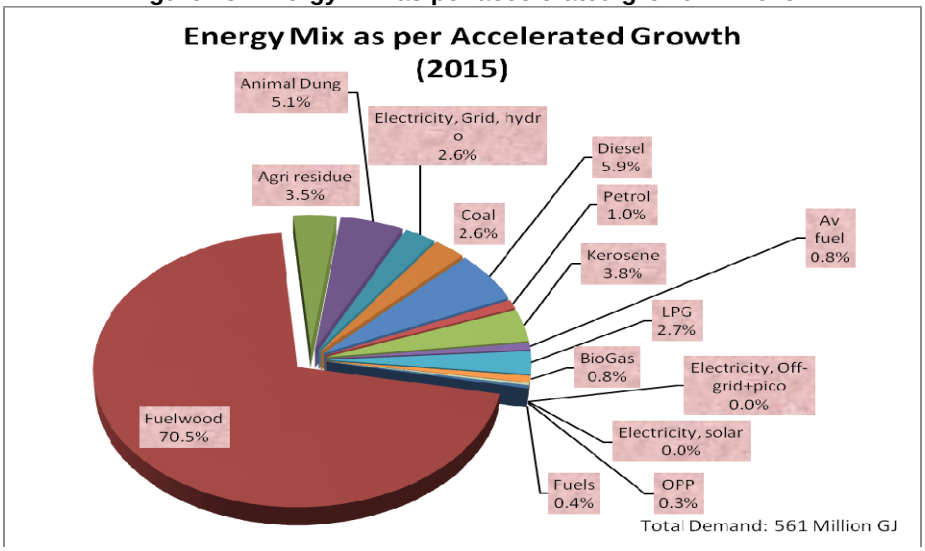
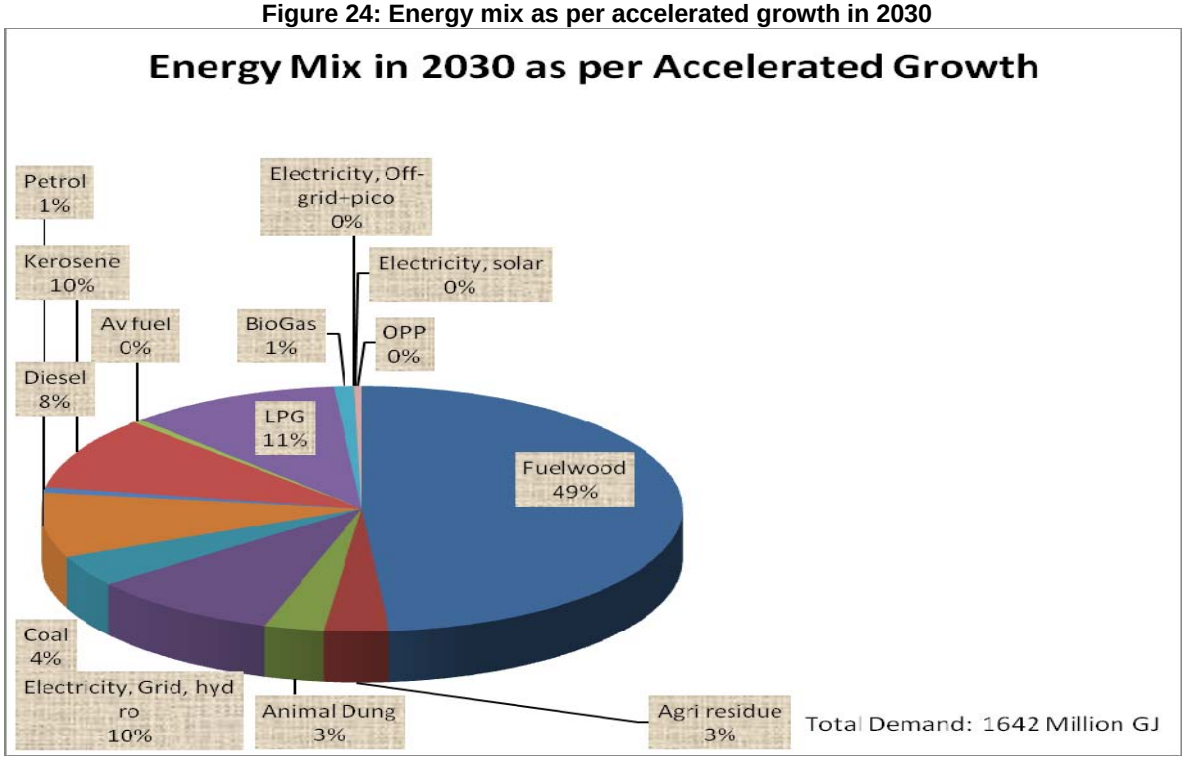


Figure 3.8 and **Figure 3.9** show the fuel mix in this scenario in the years 2015 and 2030. The consumption of fuelwood will decrease to 71 percent in 2015 and 49 percent in 2030. The share of electricity will increase to 10 percent in 2030 and that of petroleum products will be around 3.5 times that in 2005 at 30 percent.

Figure 24: Energy mix as per accelerated growth in 2030



The sectoral energy consumption pattern will be as per **Table 3.9**. The energy consumption share of residential sector will be 83 percent in 2015 and 53 percent in 2030. Likewise, the share of industrial sector in 2015 and 2030 will be respectively 5 percent and 17 percent. Commercial sector will consume 4 percent in 2015 and 21 percent in 2030 of the total energy consumptions.

Table 42: Sectoral consumption at accelerated growth scenario

Sector	Energy Demand in Million GJ					
	Year					
	2005	2010	2015	2020	2025	2030
Residential	331.6	393.2	465.1	557.5	685.0	869.1
Industrial	12.9	17.5	28.6	51.5	109.9	275.7
Transport	16.3	25.0	37.3	55.8	86.9	140.9
Commercial	5.3	10.9	24.4	56.7	136.9	342.1
Agriculture	3.1	4.4	6.3	8.6	11.3	14.5
Total	369.2	451.0	561.7	730.1	1029.9	1642.2

The peak power plant capacity requirement will be as **Table 3.10**. The power plant requirement for 2030 in this case will be 12,053 MW. The per-year investment in the last period will be 200 billion NRs at 2005 base prices.

Table 43: Peak power plant capacity in accelerated growth scenario

Particulars	Power Plant Capacity					
	Years					
	2005	2010	2015	2020	2025	2030
Capacity (MW)	615	926	1542	2845	5836	12053
Electricity consumption per capita, kWh/capita	67	87	144	265	548	1144

The per capita electricity consumption increases to 548 KWh in 2025 and 1,144 KWh in 2030 respectively.

Comparison of the energy scenarios

The variation of future energy demand in different time horizon of the strategy period is shown in Table 3.11. WECS has estimated the total energy consumption in 2004/05 equal to about 367 Million GJ. However, the energy model prepared for assessing the future energy demand was calibrated to about 369 Million GJ for the base year 2005. In the base case, the growth of average gross domestic product of 3.9% and average growth rate of total energy consumption of 5 percent was considered.

Table 44: Future energy demand by years

Unit in Million GJ

Scenarios	Years			
	2005	2010	2015	2030
Base case	369.2	447.8	547.0	1184.7
Reference case	369.2	448.2	550.1	1300.9
Accelerated growth	369.2	451.0	561.7	1642.2

In case of medium growth scenario, the cumulative growth rate of primary fuel consumption will be 5.2 percent. The annual growth rate of petroleum products will be 10 percent and that of electricity will be 12 percent during the study horizon. Fuel wood will be the dominant fuel, surpassing the sustainable limit throughout the analysis period.

Similarly, the cumulative growth rate of total primary energy consumption in the accelerated growth scenario will be 6.2 percent. The consumption of fuel wood, which is already beyond sustainable limits, will continue to grow, although, its share will decrease. Fuel wood consumption will be unsustainable throughout the planning horizon. Electricity consumption will significantly grow by as much as 26 times from 2005 to 2030.

While comparing the total fuel consumption in different scenarios, there will be more than 38% energy demand in accelerated growth case in 2030 as compared to the base case. Whereas just about 9% more energy is required in medium growth scenario compared to the base case in 2030. However, there are no such big differences in total energy consumption among the three scenarios in the year 2010 and 2015. The peak power plant capacity requirement is shown in **Table 3.12.** The peak power plant requirement for 2015 in the base case will be 1,300 MW and in 2030, 6,300 MW. Per capita electricity consumption reaches 521 KWh in 2030 from 67 KWh in the base year.

Table 45: Power requirement in different scenarios by years

Unit in MW

Scenarios	Years			
	2005	2010	2015	2030
Base case	615.0	855.0	1297.0	6307.0
Reference case	615.0	858.0	1322.0	7648.0
Accelerated growth	615.0	926.0	1542.0	12053.0

The power plant requirement in the medium growth scenario (reference case) for 2030 will be 7,648 MW. Per capita electricity consumption in this scenario will be 124 KWh in 2015 and 672 KWh in 2030 respectively. Comparing with the per capita electricity of 100 KWh as projected in interim plan 2007-2010 for the year 2015, the per capita electricity surpassed with the value of 124 KWh if the national economy grows at 5.6 percent. The power plant requirement in the accelerated growth scenario for 2030 will be 12,053 MW. The per capita electricity consumption increases to 548 KWh in 2025 and 1,144 KWh in 2030 respectively.

Strategic Interventions at Reference Scenario

Considering the possibility of continuously attaining the 5.6% GDP growth rate, the strategic interventions are made on the reference case (5.6% GDP growth rate). The main strategic interventions are:

1. Introduction of Clean Energy Technology at Reference Scenario
2. Penetration of energy efficient lighting at Reference Scenario
3. Introduction of New Transportation Technology at Reference Scenario
4. Combined policy measures (clean energy, penetration of energy efficient lighting and New transport technology) at Reference Scenario

3.1.2 Introduction of Clean Energy Technology at Reference Scenario

The following are the major assumptions of this scenario.

i) GDP growth rate according to reference case.
ii) Traditional fuels and fossil fuels replaced by electricity and/or fossil fuels. The useful energy shares of demand technologies using fuel wood or fossil fuels will decrease at the rate of:

- For Industrial and Commercial sectors, traditional and fossil fuels decreased by 20 percent of base year share in 2020 and 30 percent in 2030. They are replaced by electricity.
- For Residential Urban sector, fuel wood share decreased by 50 percent of base year share in 2020 and 75 percent in 2030. It is replaced by electricity, kerosene and LPG.
- For Residential Rural sector fuel wood share decreased by 10 percent in 2020 and 30 percent in 2030. It is replaced by electricity, kerosene and LPG.
- For Residential Rural other demands, agri-residue share decreased by 20 percent in 2020 and 80 percent in 2030. It is replaced by kerosene.

iii) Traditional fuel wood stoves in residential and commercial sectors replaced by improved cook stoves (ICS) at the rate of 25 percent in 2020 and then linearly to 50 percent in 2030.

The final consumptions of various fuels in this scenario are given in **Table 3.13**. The total energy consumption in 2030 is expected to grow to a value of 1026 million GJ. The per capita energy

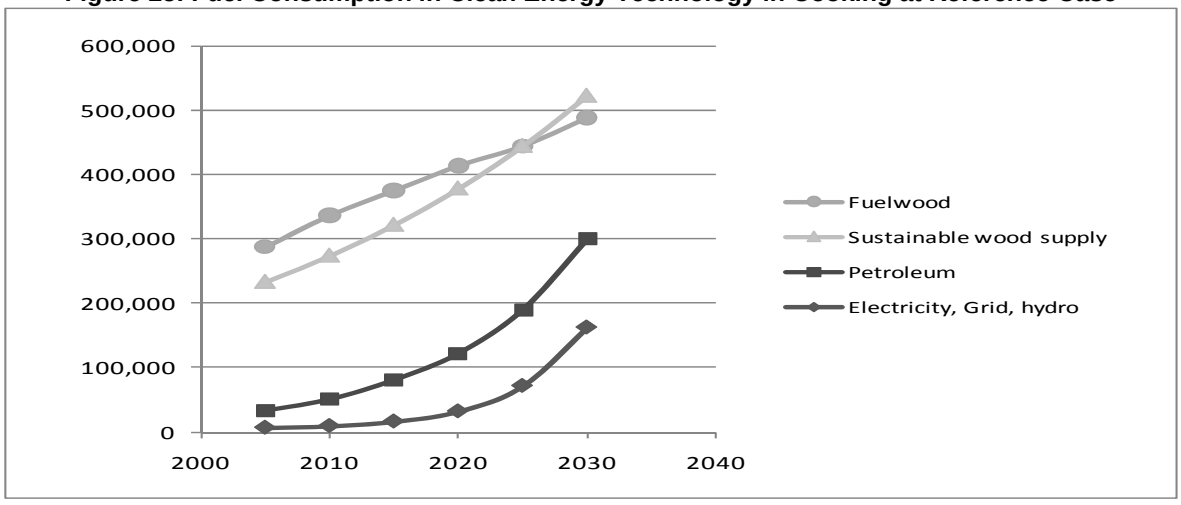
consumption for 2030 will be 26 GJ since fuels in the higher rung of energy ladder and energy efficient technologies have been utilized in this scenario.

Table 46: Fuel Consumption in Clean Energy Technology in Cooking at Reference Case

Fuel	Total Energy Consumption, Million GJ					
	Year					
	2005	2010	2015	2020	2025	2030
Fuel wood	287.0	336.3	374.9	413.3	444.1	487.9
Agri-residue	14.0	16.1	15.5	14.1	11.3	8.1
Animal Dung	21.2	24.7	22.0	20.3	17.5	16.7
Electricity, Grid, hydro	6.1	8.8	15.8	31.7	71.6	163.0
Coal	6.5	8.9	12.5	17.6	24.6	34.4
Diesel	13.4	19.8	29.1	42.6	63.6	95.3
Petrol	3.1	4.3	5.9	7.3	9.2	11.3
Kerosene	8.7	14.3	24.4	34.6	55.9	90.1
Av fuel	2.8	3.6	4.6	5.6	6.7	8.1
LPG	3.8	7.3	15.2	30.0	52.3	92.0
Bio-Gas	1.9	3.0	4.4	6.8	10.5	16.9
Electricity, Off-grid+pico	0.0	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0	0.0
OPP	0.9	1.0	1.3	1.7	2.2	2.9
Total	369.2	448.2	525.9	625.8	769.9	1026.9

Figure 3.10 shows the pattern of energy consumption. Compared to reference case, there is a decrease in fuel consumption. In 2015, the total energy consumption will be 96 percent and in 2030 this will be 79 percent of the consumption in reference case.

Figure 25: Fuel Consumption in Clean Energy Technology in Cooking at Reference Case



Fuel wood consumption will be well within sustainable limits by 2025. In this scenario per capita fuel wood consumption in 2030 will be 12 GJ which is less than sustainable per capita consumption of 13 GJ provided the forests are developed as per Forestry Master Plan, 1988. Also percentage share of fuel wood will decrease from 71 percent in 2015 to 47 percent in 2030. This will be mostly replaced by kerosene, LPG and electricity. The shares of LPG, electricity and

biogas are raised from 3 percent, 3 percent and 0.8 percent in 2015 to 9 percent, 16 percent and 1.6 percent in 2030 respectively.

Figure 26: Energy mix in clean Energy Technology in cooking at reference case in 2015

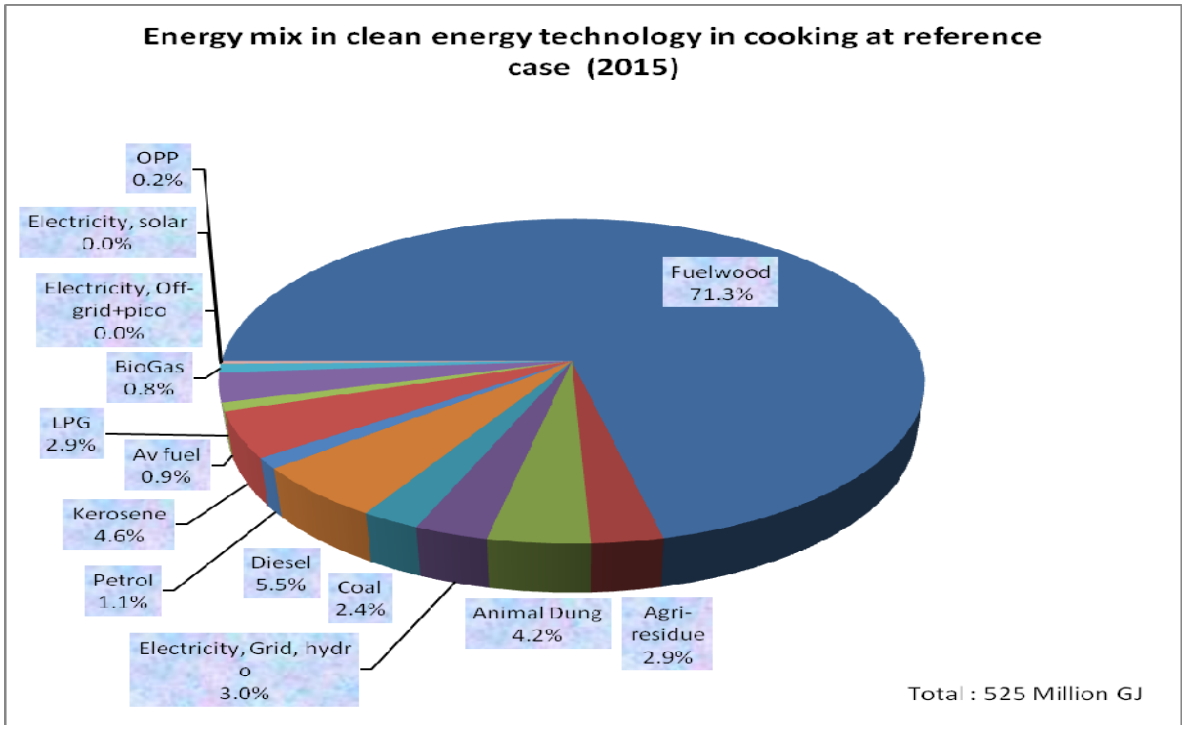
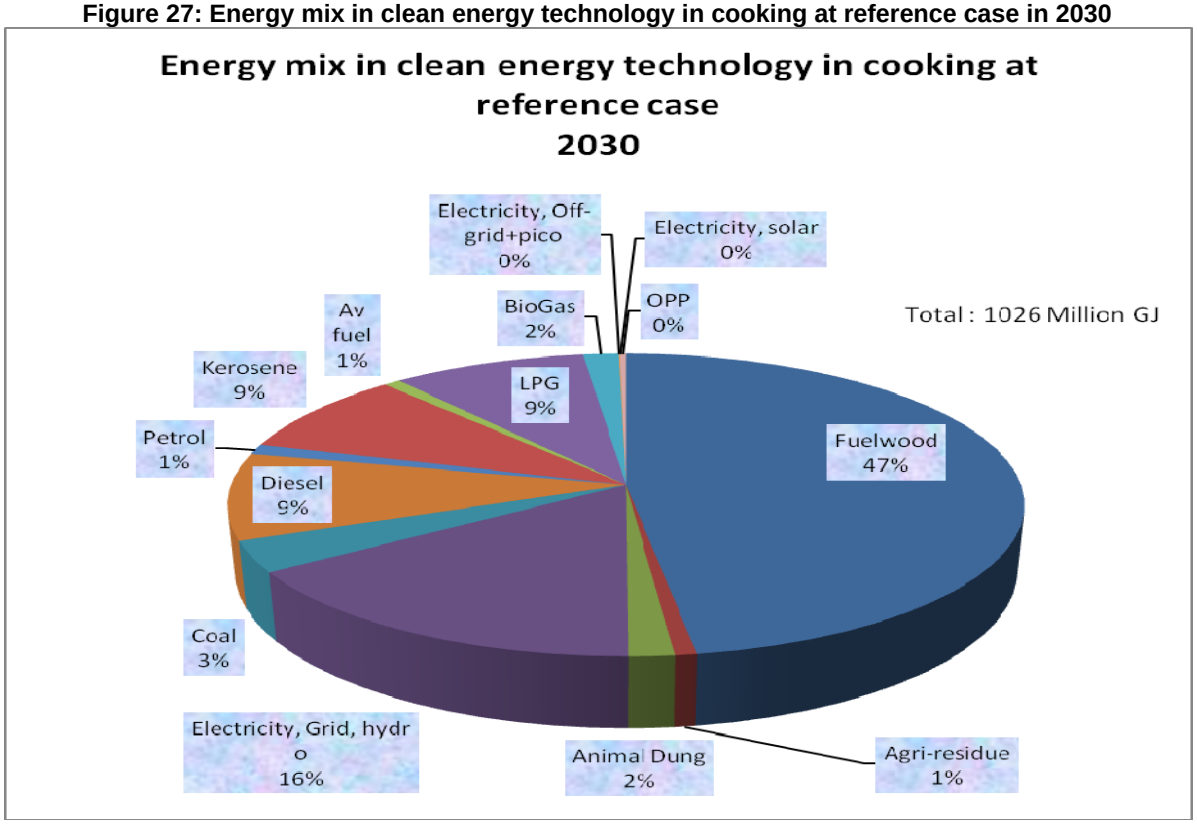


Figure 27: Energy mix in clean energy technology in cooking at reference case in 2030



The shares of primary fuels in energy supply in 2015 and 2030 are given in **Figure 3.11** and **Figure 3.12**. It is observed that the share of Petroleum will be 15 percent in 2015 and 29 percent

in 2030 of the total energy consumption. Besides, the shares of health hazardous fuels such as agri-residue and animal dung are reduced to 1 percent and 2 percent respectively.

Table 47: Sectoral Consumption in Clean Energy Technology in cooking at Reference Case

Unit in Million GJ

Sectors	Year					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Agriculture	3.1	4.2	5.4	6.3	7.1	7.5
Commercial	5.3	10.4	19.7	37.7	74.6	149.1
Industrial	12.9	16.7	24.2	37.3	66.3	137.2
Residential	331.6	393.2	442.2	495.4	550.4	627.3
Transport	16.3	23.7	34.4	49.1	71.6	105.9
Total	369.2	448.2	525.9	625.8	769.9	1,026.9

Table 3.14 shows the sectoral energy consumption pattern in this scenario. The average growth rates of commercial, industrial and transportation sectors are respectively 14 percent, 10 percent and 8 percent. In 2030, residential sector will be consuming only 61.1 percent of total energy, transportation sector 10.3 percent, industrial sector 13.4 percent, and commercial sector 14.5 percent. Significant decrease in residential share from 84.1 percent in 2015 to 61.1 percent in 2030 is observed as the energy used for residential purpose are replaced by more cleaner and efficient technology.

The peak hydropower plant installation capacity requirement to support the clean energy technology is shown in **Table 3.15**. The peak power plant requirement for 2030 will be 12,053 MW. This requirement is 58 percent higher than that of reference case scenario. Further, Per capita consumption of electricity rises to 1,144 KWh in 2030 from 67 KWh in the base year.

Table 48: Peak Power Plant Capacity in Clean Energy Technology Case

Particulars	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Capacity (MW)	615	926	1,542	2,845	5,836	12,053
Electricity consumption per capita, kWh/capita	67	87	144	265	548	1,144

3.1.3 Penetration of energy efficient lighting at Reference Scenario

The following are the major assumptions of this scenario.

i) GDP growth rate according to reference case, i.e. average GDP growth rate at 5.6 percent.
ii) Incandescent bulbs replaced by energy efficient lighting at the rate of 50 percent in 2020 and then linearly to 75 percent in 2030
iii) Transmission and distribution losses of electricity grid reduced from 25 percent in base year to 20 percent in 2015, and then linearly to 10 percent in 2030

The final consumptions of various fuels in this scenario have been given in **Table 3.16**. The total energy consumption in 2030 is expected to grow to a value of 1293 million GJ. Per capita energy consumption for 2030 will be 33 GJ.

Table 49: Fuel Consumption in CFL Penetration at Reference Scenario

Fuel	Total Energy Consumption, Million GJ					
	Year					
	2005	2010	2015	2020	2025	2030
Fuelwood	287.0	336.3	395.9	472.4	579.2	737.3

Agri residue	14.0	16.1	18.9	22.7	28.4	37.3
Animal Dung	21.2	24.7	28.8	33.7	40.2	49.1
Electricity, Grid, hydro	6.1	8.8	13.0	21.0	41.0	88.0
Coal	6.5	8.9	12.6	17.6	24.7	34.5
Diesel	13.4	19.8	29.1	42.8	64.0	96.1
Petrol	3.1	4.3	5.9	7.3	9.2	11.3
Kerosene	8.7	14.3	20.8	32.0	54.0	105.0
Av fuel	2.8	3.6	4.6	5.6	6.7	8.1
LPG	3.8	7.3	14.1	27.4	53.6	106.3
BioGas	1.9	3.0	4.4	6.8	10.5	16.9
Electricity, Off-grid+pico	0.0	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0	0.0
OPP	0.9	1.0	1.3	1.7	2.2	2.9
Total	369.2	448.2	549.5	691.2	914.2	1293.2

The energy consumption in this scenario is almost the same as in the reference case except that the electricity consumption after 2015 will decrease. Total consumption of electricity compared to the reference case is 5 percent less in 2015 and 8 percent less in 2030.

Figure 28: Fuel Consumption in Penetration of energy efficient lighting at reference scenatio

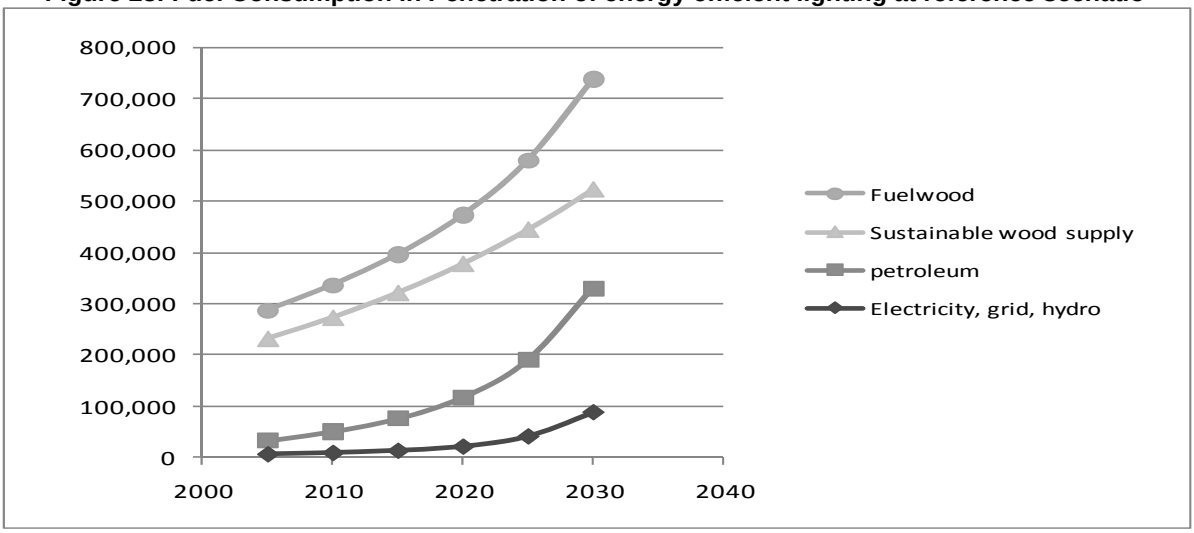


Table 50: Sectoral Consumption in Penetration of energy efficient lighting at Reference Scenario

	Year					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Agriculture	3,084	4,236	5,355	6,339	7,064	7,468
Commercial	5,335	10,387	20,776	41,890	85,215	175,324
Industrial	12,898	16,683	24,447	38,149	68,677	142,043
Residential	331,567	393,181	464,555	555,759	681,650	862,484
Transport	16,318	23,699	34,382	49,112	71,557	105,871
Total	**369,202**	**448,186**	**549,515**	**691,248**	**914,163**	**1,293,190**

The peak hydropower plant capacity requirement in this case is shown in **Table 3.18**. The power plant requirement for 2030 will be 5,667 MW compared to 7,648 MW in the reference case, i.e.,

decrease of almost 2,000 MW. In 2020, peak power demand will be reduced by 350 MW with the introduction of energy efficient technology and reduction in transmission loss.

Table 51: Power Plant Capacity in Penetration of energy efficient lighting at Reference Scenario

Particulars	2005	2010	2015	2020	2025	2030
Capacity (MW)	615	926	1,252	1,816	3,070	5,667
Electricity consumption per capita, kWh/capita	67	87	118	175	313	618

The electricity consumption per capita decreases to 175 KWh from 191 KWh in 2020 and to 618 KWh from 672 KWh in 2030 respectively. This shows that peak power plant capacity can be reduced with the use of energy efficient technologies such as CFLs and other energy efficient lighting.

3.1.4 Introduction of New Transportation Technology at Reference Scenario

The following are the major assumptions in this case:

i) GDP growth rate according to reference case.
ii) Electric and hybrid cars introduced. Diesel and petrol cars to be reduced by 10 percent of reference case in 2020, 20 percent in 2025, and 30 percent in 2030. Electric cars will be substituting at the rate of 5 percent in 2020, 10 percent in 2025, and 15 percent in 2030. Hybrid cars will be substituting the remaining as 5 percent in 2020, 10 percent in 2025, 15 percent in 2030,
iii) Ethanol and bio-diesel mixing in petrol and diesel respectively. Ethanol mix 10 percent 2020 onwards and 20 percent in 2030. Bio-diesel mix 5 percent 2020 onwards and 10 percent in 2030, and
iv) Transmission and distribution losses of electricity grid reduced from 25 percent in base year to 20 percent in 2015, and then linearly to 10 percent in 2030.

The final consumptions of various fuels in this scenario is given in **Table 3.19**. The total energy consumption in 2030 is expected to grow to a value of almost 1298 million GJ. The per capita energy consumption for 2030 will be 33 GJ.

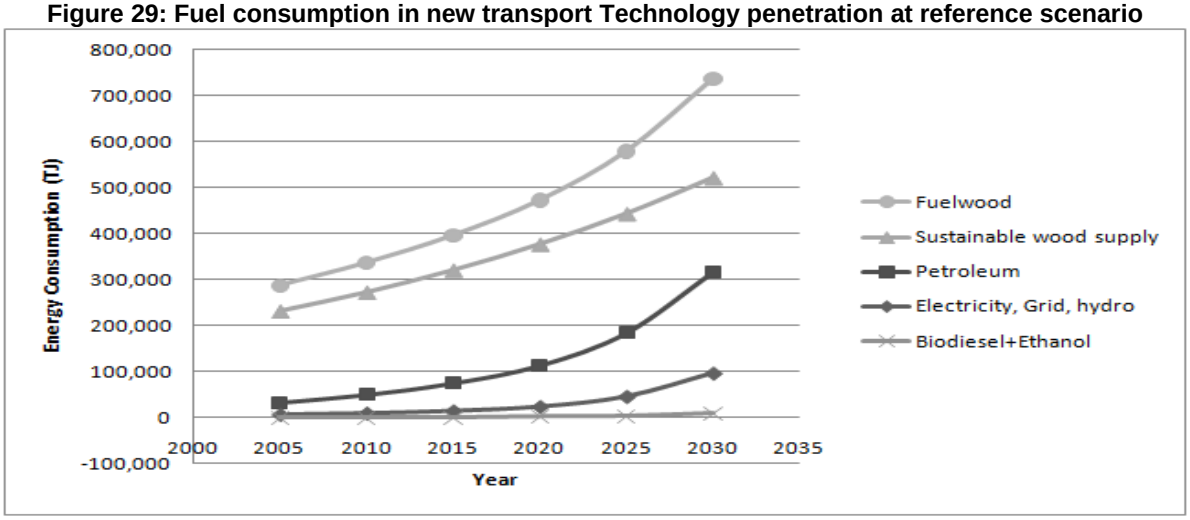
Table 52: Fuel Consumption in New Transport Technology Penetration at Reference Case

Fuel	Total Energy Consumption, Million GJ					
	Year					
	2005	2010	2015	2020	2025	2030
Fuelwood	287.0	336.3	395.9	472.4	579.2	737.3
Agri residue	14.0	16.1	18.9	22.7	28.4	37.3
Animal Dung	21.2	24.7	28.8	33.7	40.2	49.1
Electricity, Grid, hydro	6.1	9.0	14.0	23.4	45.6	96.7
Coal	6.5	8.9	12.6	17.6	24.7	34.5
Diesel	13.4	19.1	28.2	40.0	59.9	86.1
Petrol	3.1	4.3	5.9	6.6	8.1	8.9
Kerosene	8.7	14.3	20.8	32.0	54.0	105.0
Av fuel	2.8	3.6	4.6	5.6	6.7	8.1
LPG	3.8	7.3	14.1	27.4	53.6	106.3
BioGas	1.9	3.0	4.4	6.8	10.5	16.9
Bio-diesel	0.0	0.0	0.0	1.6	2.5	7.8

Ethanol	0.0	0.0	0.0	0.5	0.6	1.5
Electricity, Off-grid+pico	0.0	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0	0.0
OPP	0.9	1.0	1.3	1.7	2.2	2.9
Total	369.2	447.8	549.6	692.3	916.7	1298.8

Figure 3.14 shows the energy consumption pattern upto 2030. Compared to the reference case, there is a decrease in petroleum fuel consumption. In 2015, the petroleum consumption will be 1 percent less than that of reference scenario while same will be 4 percent less in 2030. Bio-fuels such as ethanol and Bio-diesel will occupy 3 percent of the transport fuels in 2030.

Figure 29: Fuel consumption in new transport Technology penetration at reference scenario



The average growth rate of the petroleum consumption at reference case from 2020 to 2030 is expected to be 19 percent which is reduced to 18.6 percent due to intervention of new transport technology.

Figure 30: Energy mix in new transport Technology penetration at reference scenario in 20152015

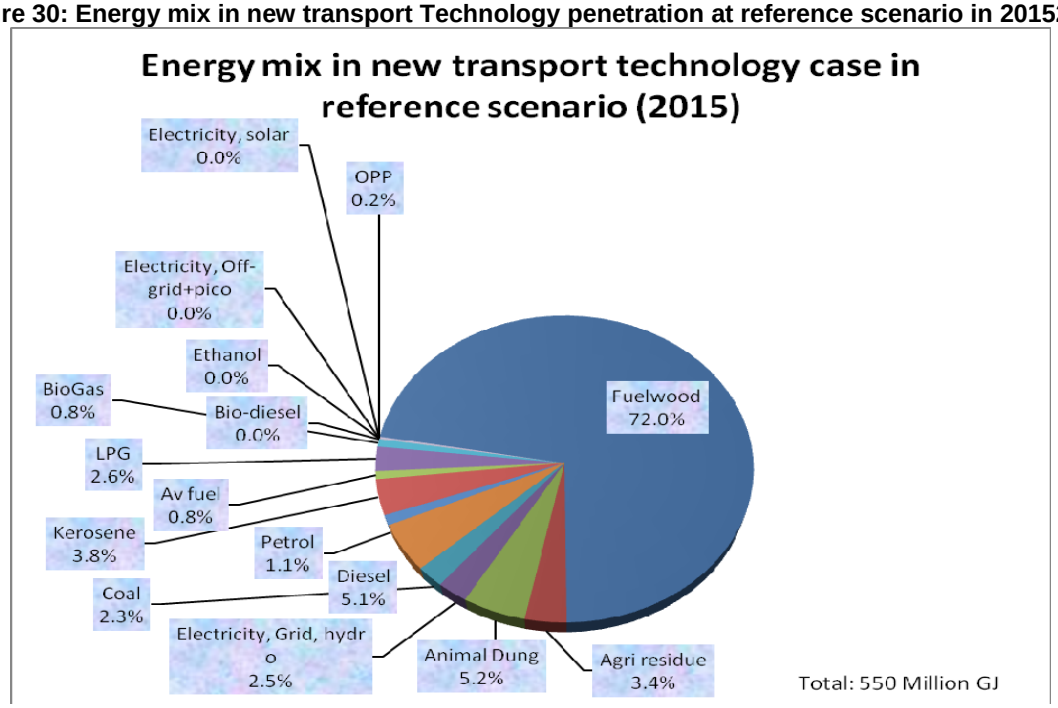
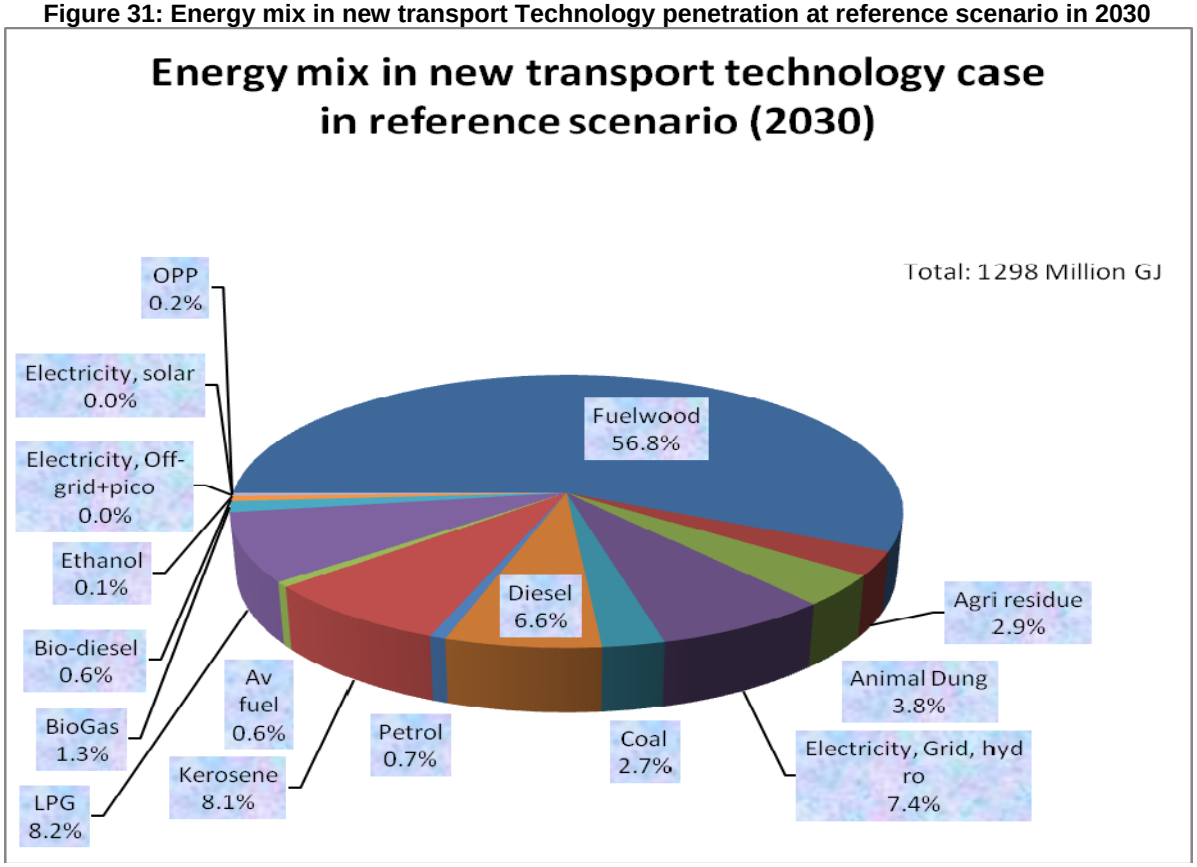


Figure 31: Energy mix in new transport Technology penetration at reference scenario in 2030



The shares of primary fuels in energy supply in 2015 and 2030 are given in **Figure 3.15** and **Figure 3.16**. Total energy consumption is found to be almost equal compared to reference case without intervention. However, percentage ratio of diesel and petrol consumption in 2030 is lower than that at reference case. At 2030 diesel share is found to be decreased from 7.4 percent to 6.6 percent and petrol from 0.9 percent to 0.7 percent.

Table 53: Sectoral Consumption in New Transportation Technology Penetration Scenario

	Year					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Agriculture	3,084	4,236	5,355	6,339	7,064	7,468
Commercial	5,335	10,387	20,842	42,128	85,756	176,516
Industrial	12,898	16,683	24,447	38,149	68,677	142,043
Residential	331,567	393,179	465,113	557,482	685,024	869,030
Transport	16,318	23,305	33,839	48,213	70,159	103,791
Total	**369,202**	**447,790**	**549,597**	**692,311**	**916,679**	**1,298,848**

Table 3.20 shows the sectoral energy consumption pattern in this scenario upto 2030. The average growth rates of energy consumptions in commercial, industrial and transportation sectors are respectively 15 percent, 10 percent and 8 percent respectively. In 2030, residential sector will be consuming 67 percent of total energy, transportation sector 8 percent, industrial sector 11 percent, and commercial sector 14 percent.

The peak hydropower plant capacity requirement is shown in **Table 3.21**. The power plant requirement for 2030 will be 6,534 MW. This requirement is 15 percent less than that of reference case without intervention.

Table 54: Peak Power Plant Capacity in New Transport Technology Penetration Case

Particulars	2005	2010	2015	2020	2025	2030
Capacity (MW)	615	940	1,345	2,066	3,537	6,534
Electricity consumption per capita, kWh/capita	67	90	127	195	349	679

The per capita electricity consumption in 2030 will be 679 KWh which is 10 times the electricity consumption in the base year. Despite the use of electricity in substituting motor fuels, the peak power demand is decreased with the expectation of improvement in the transmission and distribution losses.

3.1.5 Combined Strategic measures at Reference Scenario

The following are the major assumptions of this scenario.

i) GDP growth rate according to reference case.
ii) Transmission and distribution losses of electricity grid reduced from 25 percent in base year to 20 percent in 2015, and then linearly to 10 percent in 2030
iii) Traditional fuels and fossil fuels replaced by electricity and/or fossil fuels. The useful energy shares of demand technologies using fuel wood or fossil fuels will decrease at the rate of:

- For Industrial and Commercial sectors, traditional and fossil fuels decreased by 20 percent of base year share in 2020 and 30 percent in 2030. They are replaced by electricity.
- For Residential Urban sector, fuel wood share decreased by 50 percent of base year share in 2020 and 75 percent in 2030. It is replaced by electricity, kerosene and LPG.
- For Residential Rural sector fuel wood share decreased by 10 percent in 2020 and 30 percent in 2030. It is replaced by electricity, kerosene and LPG.
- For Residential Rural other demand, agri-residue share decreased by 20 percent in 2020 and 80 percent in 2030. It is replaced by kerosene.
- Traditional fuel wood stoves in residential and commercial sectors replaced by improved cook stoves (ICS) at the rate of 25 percent in 2020 and then linearly to 50 percent in 2030

iv) Incandescent bulbs replaced by efficient energy lightings at the rate of 50 percent in 2020 and then linearly to 75 percent in 2030
v) Electric and hybrid cars introduced. Diesel and petrol cars demand capacity reduced by 10 percent of reference case in 2020, 20 percent in 2025, and 30 percent in 2030. Electric cars substituting the capacity at the rate of 5 percent in 2020, 10 percent in 2025, 15 percent in 2030. Hybrid cars substituting the remaining as 5 percent in 2020, 10 percent in 2025, 15 percent in 2030
vi) Ethanol and bio-diesel mixing in petrol and diesel respectively. Ethanol mix 10 percent 2020 onwards and 20 percent in 2030. Bio-diesel mix 5 percent 2020 onwards and 10 percent in 2030, and
vii) Wind power plant and solar water heating system introduced.

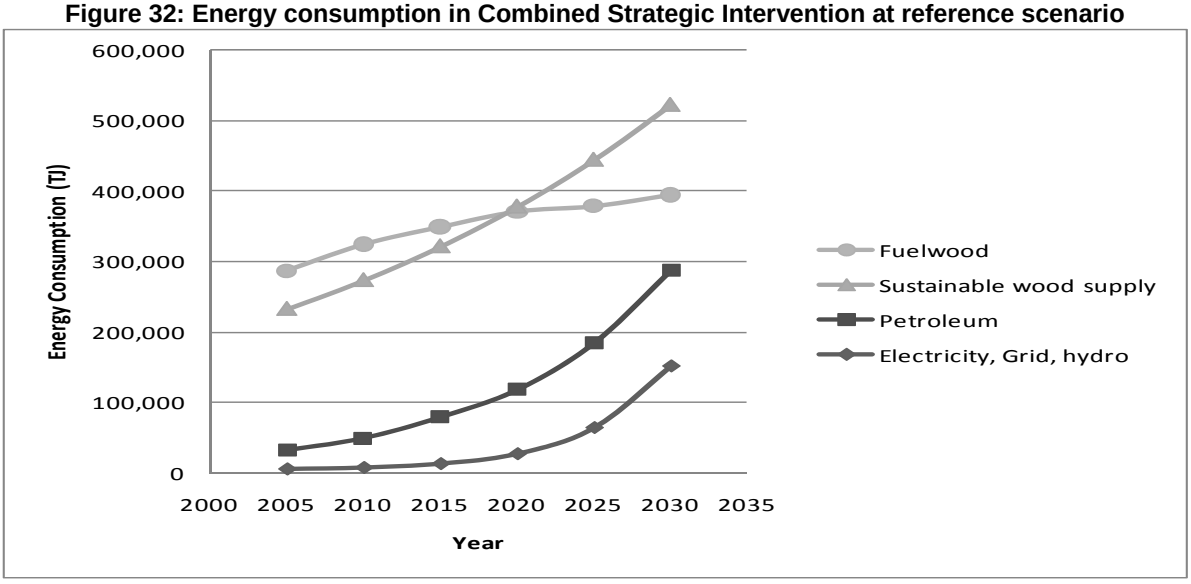
The final consumptions of various fuels in this scenario are given in **Table 3.22**. The total energy consumption in 2030 is expected to grow to a value of 924 million GJ. The per capita energy consumption for 2030 is expected to be 23 GJ since largely efficient fuels and technologies have been utilized in this scenario.

Table 55: Fuel Consumption in Combined Policy Measures at Reference Case

Fuel	Total Energy Consumption, Million GJ					
	Year					
	2005	2010	2015	2020	2025	2030
Fuelwood	287.0	324.3	348.9	370.8	378.5	394.7
Agri residue	14.0	16.1	15.5	14.0	11.2	8.1
Animal Dung	21.2	24.6	22.0	20.2	17.3	16.5
Electricity, Grid, hydro	6.1	8.1	13.7	27.8	64.9	152.4
Coal	6.5	8.9	12.5	17.6	24.6	34.4
Diesel	13.4	19.1	28.2	39.8	59.4	85.3
Petrol	3.1	4.3	5.9	6.6	8.1	8.9
Kerosene	8.7	14.3	24.4	34.6	55.9	90.0
Av fuel	2.8	3.6	4.6	5.6	6.7	8.1
LPG	3.8	7.3	15.2	30.0	52.3	92.0
BioGas	1.9	3.0	4.4	6.8	10.5	16.9
Bio-diesel	0.0	0.0	0.0	1.6	2.5	7.8
Ethanol	0.0	0.0	0.0	0.5	0.6	1.5
Wind	0.0	0.9	1.9	2.5	3.5	3.8
Electricity, Off-grid+pico	0.0	0.1	0.1	0.2	0.5	0.5
Electricity, solar	0.0	0.0	0.0	0.0	0.0	0.0
Solar thermal	0.0	0.1	0.2	0.3	0.5	0.6
OPP	0.9	1.0	1.3	1.7	2.2	2.9
Total	369.2	435.9	498.8	580.7	699.1	924.2

The total primary energy consumption in 2030 will be 29 percent less than that in the reference case. In 2015, this value will be 9 percent less than in the reference case.

Figure 32: Energy consumption in Combined Strategic Intervention at reference scenario



Fuel wood consumption will be well within 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.

Figure 33: Energy mix in Combined Strategic Intervention at reference scenario in 2015

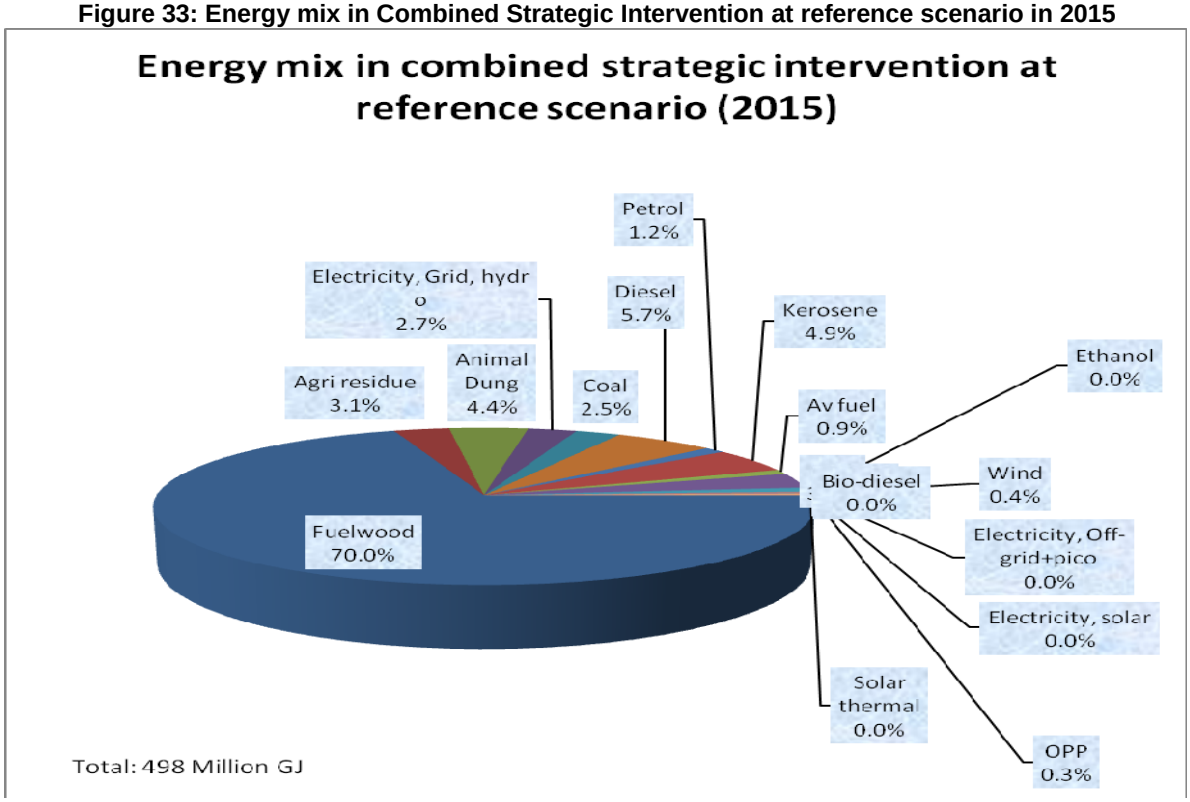


Figure 34: Energy mix in Combined Strategic Intervention at reference scenario on 2030

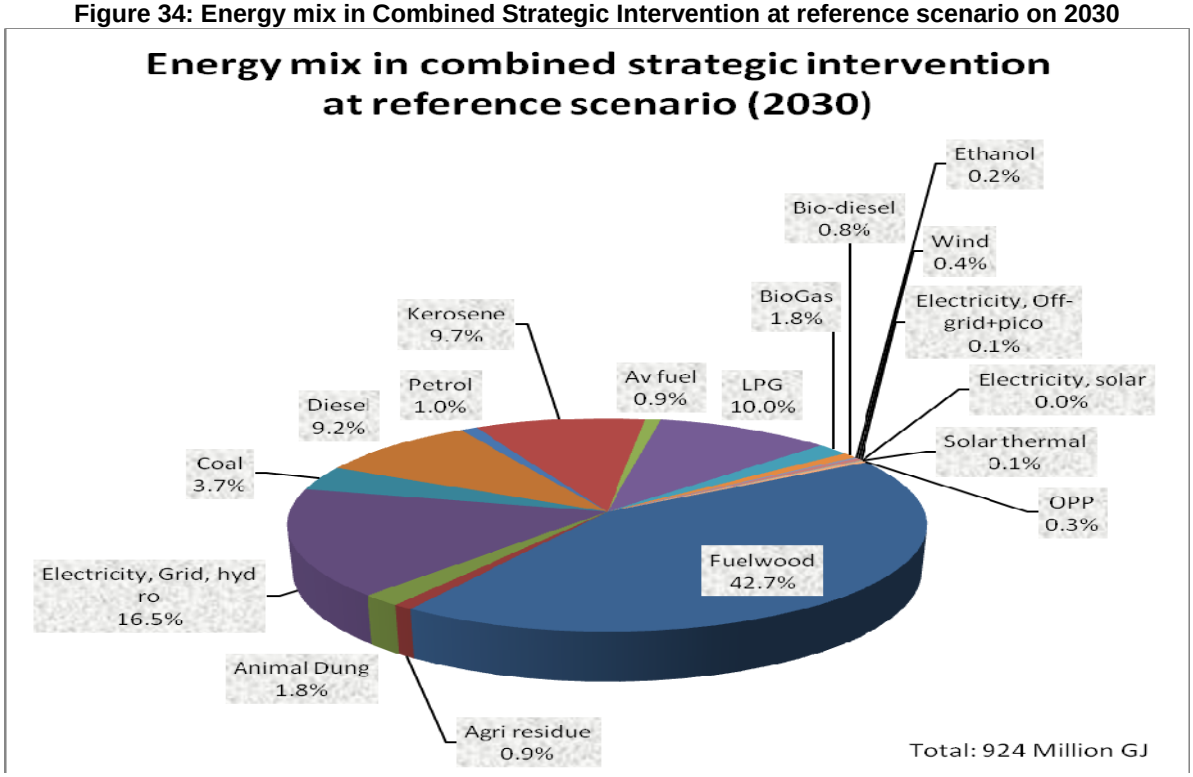


Figure 3.18 and **Figure 3.19** show the shares of primary fuels in 2015 and 2030. It can be seen that the share of fuel wood will decrease to 43 percent in 2030. Electricity share will increase from 2 percent in 2005 to 3 percent in 2015 and then to 17 percent in 2030. Petroleum products

will amount to 16 percent in 2015 and 31 percent in 2030 respectively. Renewable will contribute 12 percent in 2015 and 23 percent in 2030.

Table 56: Sectoral Consumption in Combined Strategic Intervention at Reference Scenario

Unit in Million GJ

Sectors	Year					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Agriculture	3.1	4.2	5.4	6.3	7.1	7.5
Commercial	5.3	10.2	19.1	35.8	69.5	136.5
Industrial	12.9	16.7	24.2	37.3	66.3	137.2
Residential	331.6	381.4	416.3	453.0	486.1	539.3
Transport	16.3	23.3	33.8	48.2	70.2	103.8
Total	369.2	435.9	498.8	580.7	699.1	924.2

Table 3.23 shows the sectoral pattern of energy consumption. In this scenario, residential sector will consume 83.5 percent of total energy in 2015 and only 58 percent in 2030. The shares of industrial, commercial and transport sectors in 2030 will be 15 percent, 15 percent and 11 percent respectively.

The peak hydropower plant capacity requirement is given in **Table 3.24**. The power plant requirement for 2030 will be 11,480 MW. This is about 1.5 times the requirement in the reference case. The Per capita consumption of electricity in this case would be 1,070 KWh in 2030.

Table 57: Peak Power Plant Capacity in Combined Strategic Measures at Reference Scenario

Particulars	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Capacity (MW)	615	984	1,579	2,773	5,620	11,480
Electricity consumption per capita, kWh/capita	67	80	124	231	496	1,070

3.1.6 Comparison of energy demand projection in different scenarios

Table 3.25 shows the comparison of final energy at different scenarios. The table also indicates the final energy at various time periods. Compared to reference case i.e., at GDP growth rate of 5.6 percent, the scenarios at different policy measures show that the final energy consumption will decrease proportionately as per the policy measures taken.

Table 58: Comparison of energy demand projection in different scenarios (unit in Million GJ)

Scenarios	2005	2010	2015	2020	2025	2030
BAU scenario	369.2	447.8	547.0	680.9	878.8	1,184.7
Reference scenario	369.2	448.2	550.1	693.2	918.1	1,300.9
Accelerated growth	369.2	451.0	561.7	730.1	1,029.9	1,642.2
Reference with clean energy penetration	369.2	448.2	525.9	625.8	769.9	1,026.9
Reference with energy efficient light penetration	369.2	448.2	549.5	691.2	914.2	1,293.2
Reference with bio-fuel in transport	369.2	447.8	549.6	692.3	916.7	1,298.8
Combined policy intervention in reference	369.2	435.9	498.8	580.7	699.1	924.2

Note: (based on model computation) ; *: slight difference due to end-use approach

In the combined case, the final energy consumption in 2030 will be around 924 million GJ and it is around 29 percent less than the expected consumption in the reference case.

3.1.7 Energy Indicators in the Combined Strategic Intervention Scenario

The following **Table 3.26** provides some of the key energy indicators after combined strategic intervention. The indicators show that sustainable development of energy sector can be achieved with some policy interventions.

Table 59: Energy indicators for combined case

Energy Indicators		2005	2010	2015	2020	2025	2030
Final energy consumption/capita	GJ/capita	15	16	16	17	19	23
Electricity consumption/capita	kWh/capita	67	80	124	231	496	1,070
Energy Intensity	GJ/1000$	43	40	36	32	29	28
Electricity intensity	kWh/1000$	195	208	274	425	743	1,275
Electricity power utilized	per cent	1%	2%	4%	7%	13%	27%
Total Energy Consumption/ value added in industrial sector	GJ/1000$ value added	19	21	25	31	44	73
Total Energy Used/household	GJ/HH	76	79	78	78	76	77
share of non-carbon energy in primary supply	per cent	1.7%	1.9%	2.8%	4.8%	9.3%	16.5%
Share of renewable energy in final total energy consumption	per cent	11.7%	11.9%	11.2%	12.3%	15.4%	22.1%
the ratio of net import to total primary energy supply	per cent	10.6%	13.4%	18.5%	23.4%	29.9%	34.8%
GHG emission for every ton of energy production and use/capita	GHG in kg/capita	474	459	420	392	508	672

In the combined case, as the policy measures of introduction of more highly efficient energy sources in the energy ladder than in the reference case are adopted, per capita final energy consumption stands at 23 GJ in 2030 which is almost 50 percent less than that in the reference case.

In the combined scenario, per capita electricity consumption will rise to 1,070 KWh in 2030 compared to 672 KWh in the reference case. This increase is caused by the substitution of fossil fuels, biomass solids by cleaner energy sources in industries, commercial (service), and residential sectors.

Figure 35: Comparison of per capita energy consumption

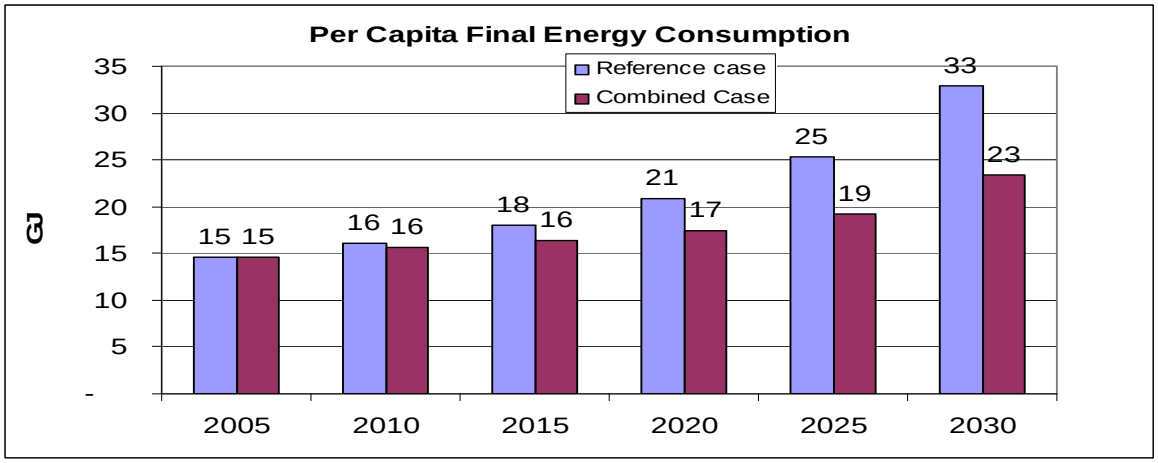
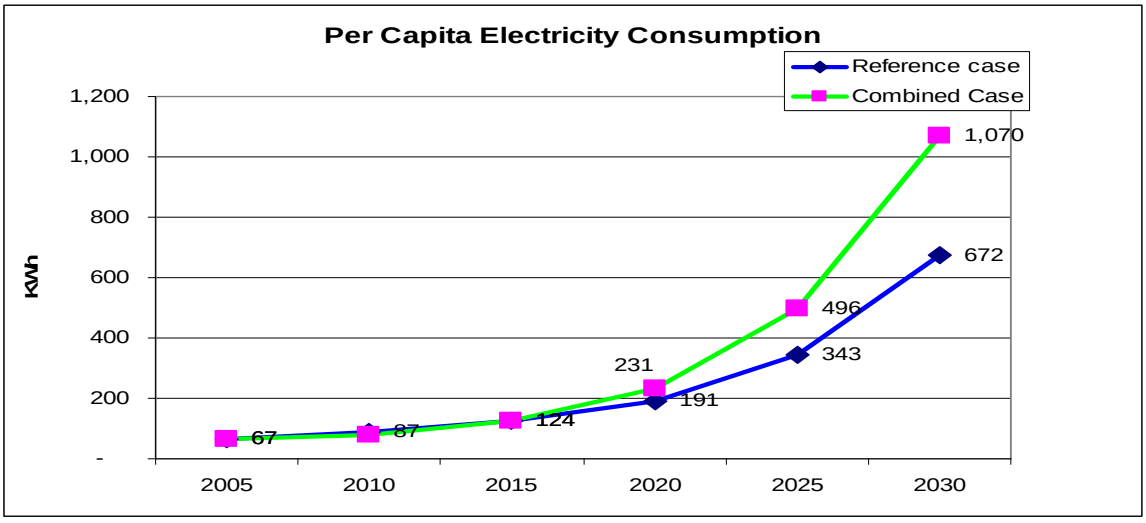


Figure 36: Growth Trend of Per Capita Electricity Consumptions



The combined case indicates that per capita household electricity consumption increases to 352 KWh compared to 213 KWh in reference case in 2030 as emphasis is focused on hydropower development.

Figure 37: Household Electricity Consumption Per Capita

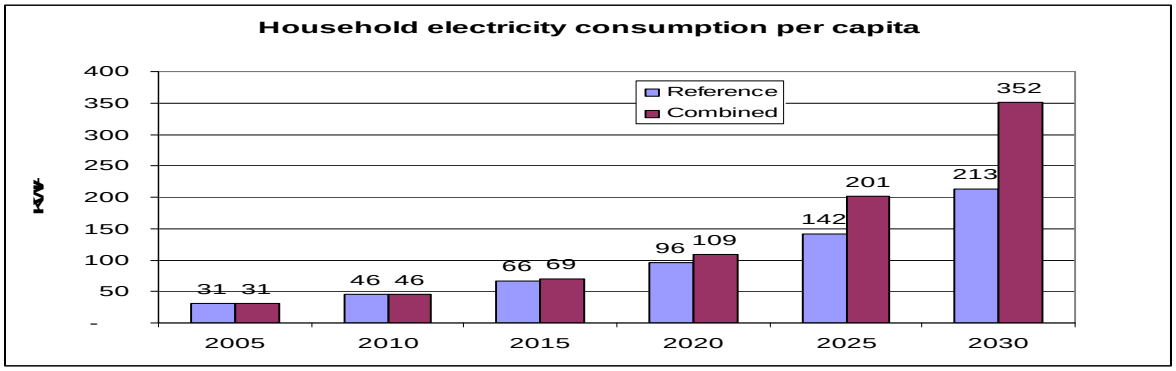
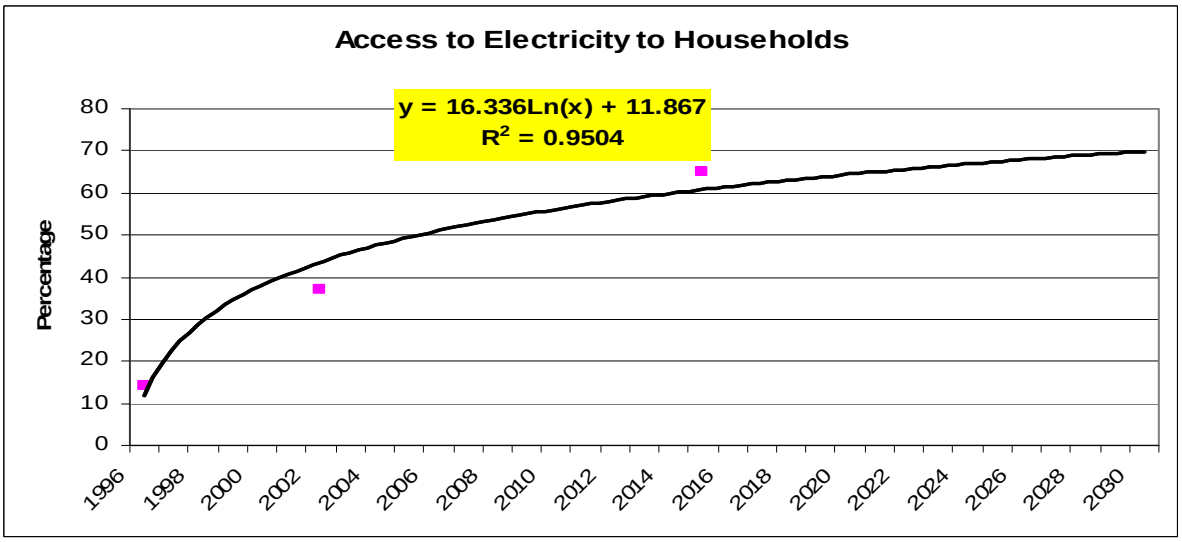


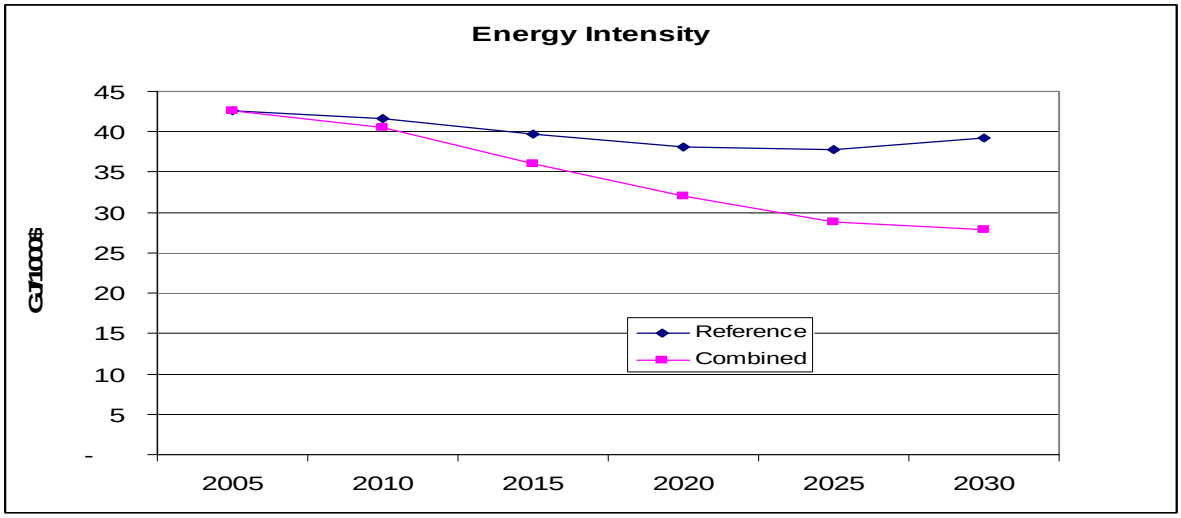
Figure 38: Access to Electricity to Households



As per NLSS 1995/96 and 2001/02 and the Interim Plan 2007 – 2010, access to electricity in households is projected. It shows that in 2030 access to electricity will reach 70 percent of

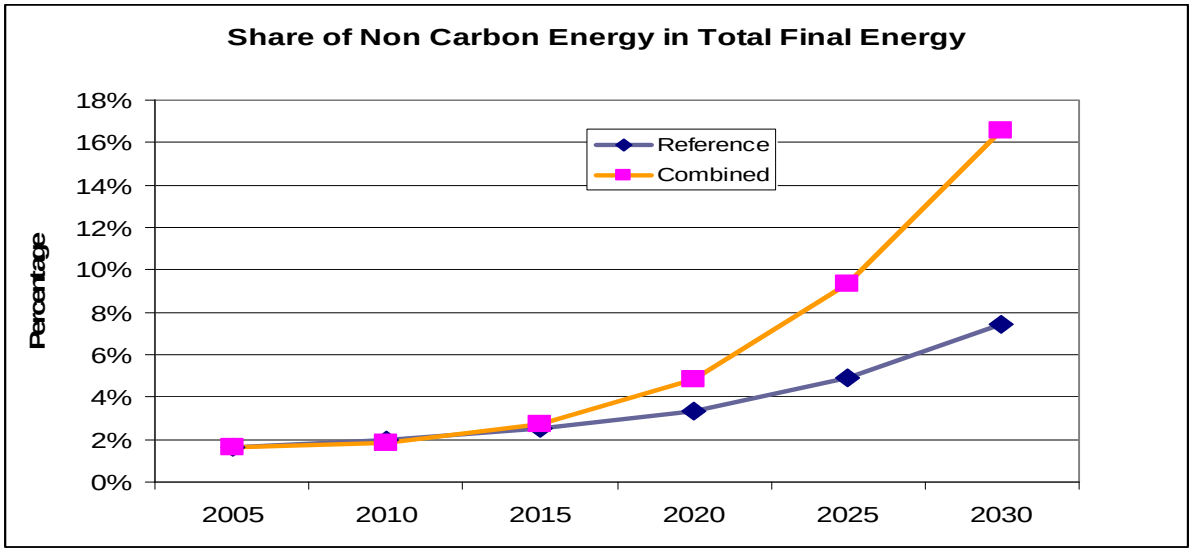
households. It is expected that 100 percent urban households and 53 percent rural households will have electricity connections in 2030 based on the NLSS.

Figure 39: Falling Trend Energy Intensity (USD1.00=NR 70.00)



With the utilization of more efficient renewable in the combined scenario, energy intensity sharply improves to 28 GJ/1000$ in 2030 from 43 GJ/1000$ in the base year.

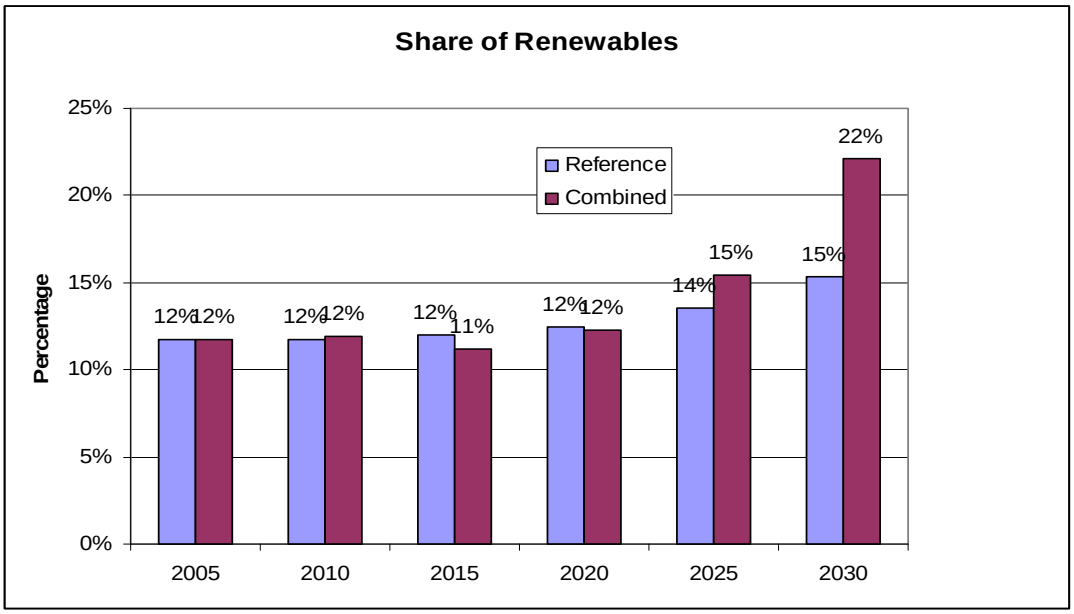
Figure 40: Share of Non Carbon Energy in Total Final Energy



Share of non carbon energy in the combined case will achieve 17 percent compared to 7 percent in 2030 in the reference case which indicating the sustainable development path of energy sector. It further supports for reduction of CO2- equivalent emissions.

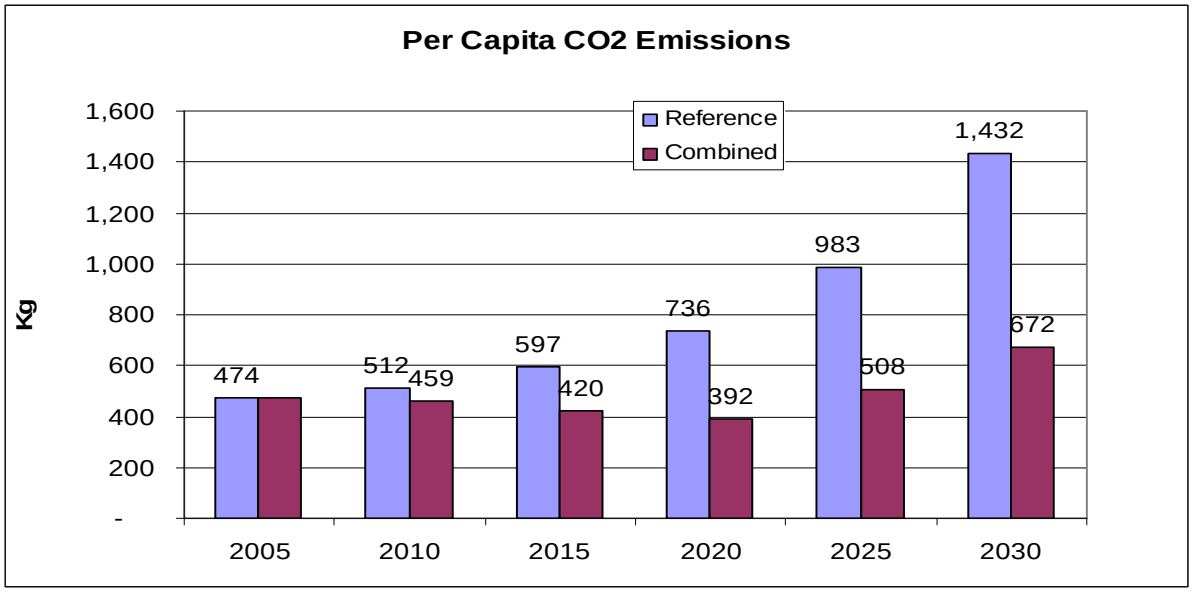
The **Figure 3.26** shows the share of renewable in the total final energy consumption. The share of renewable in 2030 is almost 50 percent higher in the combined scenario in comparison with that of reference case.

Figure 41: Share of Renewable in Total Energy Consumption



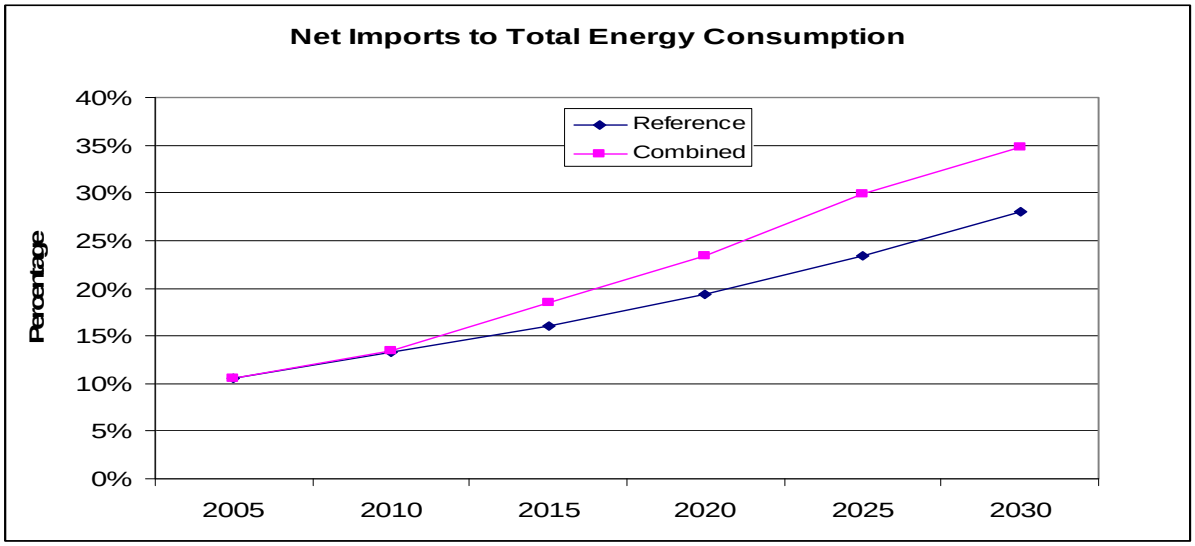
The combined case with all the policy measures taken indicates a scenario which is also environmentally sustainable. The per capita CO2 equivalent emission in 2030 in the combined scenario is 50 percent less than in the reference case (Fig 3.27).

Figure 42: Per capita CO2 Emissions



Per capita CO_2 emission in 2030, stands at 672 Kg, comparing that of 1,432 Kg in the reference case in 2030. That identifies the potentiality of taking advantages of carbon credit.

Figure 43: Comparison Net Imports of energy commodity to the Total Energy Consumptions



The above **Figure 3.28** 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. The indicator attains a value of 35 percent in 2030 in combined case compared to 28 percent in the reference case in physical quantities. Though the percentage values show import dependence increasing, however 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.

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 4: National Energy Policy Principles

Vision

To meet the demand for energy services of the people of Nepal by ensuring security, sufficiency, and sustainability for the economic development of the nation through the efficient use of the indigenous energy resources.

Strategic Objectives

The major strategic objectives are to:

1. ensure sustainability in the consumption of biomass energy resources
2. develop hydropower resources as the lead energy resources
3. reduce foreign dependency on imported fossil fuels
4. provide an adequate supply of energy at reasonable and affordable price
5. promote renewable energy technologies and energy efficiency
6. minimize detrimental environmental effects resulting from energy supply and use

Hydropower needs to be considered as the lead energy resources as socio-economic development of the country depends on its proper exploitation. Furthermore, they are clean energy and have hardly any GHG emission on their conversion to electricity. Because of higher efficiency in electric end-use technologies or devices, the useful energy obtained will be higher than energy received from technologies using traditional energy sources. In the combined scenario, the useful energy to be obtained from hydropower conversion will be higher than that of traditional energy sources in 2030.

Policy principles are the guidelines or philosophy for the development of policy. Policy is designed to effectively direct the development strategies and activities towards the vision. Here, policy principles and policy for energy sub-sectors are explained below:

Principles of Energy Sector

Principles of the overall energy sector are summarized as follows:

1. Supply of quality energy is critical to nearly everything we do in life and work. Lack of adequate supply of commercial energy and electricity in particular has, over the years, hindered overall development of the country. Heavy dependence on traditional biomass-based fuels, which are mostly obtained from forests, has resulted in deforestation and damage to the environment. A heavy and growing dependence on imported oil is not only alarming but also is detrimental to energy security of the country.
2. There exist constraints in the supplies of Biomass, oil and electricity and there is lack of coordinated efforts among the sub-sector agencies to address the supply and management of energy. Several agencies including the ministries of water resources (now energy and irrigation), commerce and supplies, environment, science and technology, forest and soil conservation are directly related to this sector. But policies and programmes of these ministries generally are developed in isolation, taking into consideration of their own areas of

operation. Fuelwood is cheap but comes with large environmental costs. Management of forests is critical for sustainable supply of fuelwood. Lack of resources for Research and Development has hindered the development of biomass and other renewable energy sources and a large amount of scarce public resources have gone to subsidize imported petroleum products due to politicization and the inability to adjust prices to world market.

3. The formulation of energy strategy therefore is directed towards developing a national strategy in a manner consistent with the overall objectives of economic growth and socioeconomic development while protecting the natural environment for a sustainable development of the economy. The energy sector needs to plan and develop energy infrastructure and facilities that meet the needs of residential, industrial, commercial, transport and agriculture sectors by making available adequate supply of all forms of energy in an integrated manner.
4. The above state of affairs requires Nepal to emphasize on exploiting its indigenous renewable energy sources and it is also essential for energy security of the country. Nepal needs to follow a development strategy that plans for the future while meeting the needs of today. Such an energy policy aims to combating climate change, limiting dependency on imports, promoting growth and providing secure and affordable energy to consumers. Nepal also can set an example of a GHG emission-free growth model.
5. The national energy strategy is guided by three basic principles:
   - The strategy is long term oriented and comprehensive
   - The strategy will increase energy supplies and encourage cleaner, more efficient energy use
   - The strategy will integrate energy, environmental and economic factors
6. The strategy has been designed to meet five specific national goals:
   - Increase renewable energy supplies
   - Increase energy security
   - Promote efficiency in the use of energy
   - Reduce and or limiting dependency on imported fuels
   - Provide secure and affordable energy to all consumers
   - Protect the environment

The energy strategy is built around the central aims of promoting domestic energy sources to meet the demand, providing secure and affordable energy to all consumers, keep fuelwood consumption under a sustainable level, limit or reduce dependency on fossil fuels in the long run and improve the sector governance.

Sectoral Energy Strategy

Energy Strategies on respective energy sub-sectors are explained below:

4.1.1 Hydropower Development

Strategic actions and plans for development of power sector are generally directed towards mega hydro power development and electricity export. The slow pace of development of hydropower in Nepal has made us to learn the lesson hard way that there is no alternative to “domestic capacity building” for development of the sector.

The approach of the national strategy will be to progressively move the nation from a country of traditional fuel like wood and dung through transitional fuels like kerosene, coal and LPG to modern fuels like electricity. The thrust will be to gradually increase the share of hydropower in the energy mix of the country. It can also distinguish itself in the future as an exporter of CO2-effective energy.

The rising demand for energy in the process and particularly in the short-to-medium term, however, will need to be met by importing fossil fuels until the development of hydropower picks up. Nepal's future lies in utilizing the potential of water as the main source of energy. Development of indigenous sources such as wind and solar energy will help ensure energy security.

There is a need to develop and implement a fast track package of accelerated development of small hydropower projects up to 25 MW capacity with soft loans and other facilities. This will not only establish a base for indigenous capacity for hydropower development in the country, it will also provide a solution to energy problem in the short-to-medium term. Activities, incentives and concessions under the package include:

1. Prepare a basin-wise list of projects that do not conflict with other uses or affect benefits from existing projects and implement a time bound programme for their approval including clearance from concerned agencies such as forests and ministry of environment. It will help us plan development where the load of demand is.
2. Prepare the sites/locations on a GIS platform.
3. Ensure water rights of power projects.
4. Offer to sign PPA at a standard wet and dry season rates with a provision of price escalation.
5. Offering fiscal and financial incentives including loans for development of power projects. If payment of subsidy is involved as incentive, arrange for a system where payment is made after the project is operational.
6. Provide tax holiday as infrastructure projects.
7. Declare hydropower investment as priority sector.
8. Encourage utilization of domestic capital by issuing "power bond".
9. Create a hydropower development consulting service center in the public sector for providing expert advice and evaluation of technical proposals before sanctioning of loan proposals.
10. Create appropriate authorities to address the problems of land acquisition and R&R for all infrastructure projects. There is a need to insulate project developers and authorities from problems arising out of land acquisition, resettlement & rehabilitation. Demands for employment in lieu of the land cost, land for land at places of land-owner's choice or problems of similar kind need resolution. All such costs incurred by developers can be considered as cost to the project and allowed to be passed through tariff. Arrangements can also be made, with the agreement of landowners, to invest a particular amount of the compensation received as shares in the power project.

There is a need to encourage capacity utilization of current generation facilities. Poor maintenance results in low capacity utilization of existing power infrastructures. Incentive

mechanisms need to be developed for maximum utilization of installed capacity of such facilities. Capacity utilization and rehabilitation is far more economical than capacity addition.

Develop and implement a plan with annual milestones to bring down transmission and distribution losses through community participation, effective enforcement and incentives to consumers. The measure for controlling losses over the years has not been particularly encouraging, or is rather dismal. The average losses in the NEA system of 23.7 percent in five years between 2056/57 and 2060/61 have actually been on the rise, at an average of 25 percent, in the last three years e.g., from 2061/62 to 2063/64. The loss, for example, in 2063/64 was 24.94 percent which is equivalent to 90 MW, the capacity of Kulekhani I and II.

The policy principles in the hydropower sub-sector are:

1. Development and management of renewable sources of energy shall be undertaken in a sustainable way addressing environmental concerns.
2. Development of hydropower shall be promoted as a “lead” sector to meet the short as well as long term demand for energy of all sectors by streamlining and simplifying the procedures for environment and forest clearances.
3. Adequate transmission infrastructures shall be developed for facilitation and utilization of added capacity generation.
4. Appropriate financing arrangements, system of targeted subsidy and incentive mechanisms shall be developed to promote micro hydropower projects for solution of energy problems in rural and remote areas.
5. Energy efficiency and conservation shall be promoted by setting standards, incentive mechanisms and stronger actions.
6. Conducive environment with consistent fiscal and tax incentives shall be promoted to encourage foreign and domestic private sector participation in hydropower development.
7. A “National Power Development Fund” shall be set-up with a levy of “Power Development Cess” on electricity consumed in the country for a faster development of power sector in the country. A “Power Development Bond” shall be issued for mobilization of internal resources for development of power sector.

4.1.2 Efficiency and Conservation

Major areas where efficiency in energy use needs to be developed are electricity generation, transmission, and distribution, industrial production and processes, transport systems, building design, lighting and household appliances.

Mandatory periodic energy audit for power intensive industries, for example, is one of the measures of energy conservation. Other industries may also be encouraged to adopt energy audits and energy conservation measures.

Better use must be made of existing energy-efficient technologies such as low-energy light bulbs, and solar panels for hot water. The policy measure of an accelerated phase-out of traditional incandescent light bulbs will not only help reduce hours of load shedding but will also allow lead time for arranging new capacity additions. The benefits of phasing-out of inefficient incandescent light bulbs will be greater if done within a short period of time say two years. In the first stage of the phase-out, an import restriction on inefficient incandescent bulbs used for general lighting

purposes will be introduced. In the second stage, a total ban will be imposed on the sale of incandescent bulbs. Although the savings to the economy which the initiative will generate will be considerable, the immediate impact may not be that visible. Because a large number of consumers fall in the category of lifeline consumption level of 20 units where there is no incentive to save energy. They have to pay the minimum charge for 20 units. Besides, there is large scale theft and pilferage in consumption where it will be difficult to measure benefits. In order to make this move really effective, other measures should accompany the efficiency drive of energy efficient lamps like compact fluorescent lamps (CFLs) and LEDs. The lowering of customs on the energy efficient lamps will have an impact on large consumers. Similarly, establishing energy performance standards and labeling of electrical appliances and equipments will help enhance energy saving by the use of more energy efficient appliances and equipments.

4.1.3 New Renewable (Alternative Energy)

The development objective will be to improve the living conditions of the rural population by enhancing their access and affordability to rural energy solutions that are environment-friendly and that address social justice. The mission is to make renewable energy a mainstream development approach. For villages where grid connectivity would not be feasible or not cost effective, off-grid solutions based on stand-alone systems may be taken up for supply of electricity. Where these also are not feasible and if only alternative is to use isolated lighting technologies like solar photovoltaic, these may be adopted. A Master Plan for the Alternative Energy Development will be prepared in line National Energy Strategy of the country. The policy principles include:

- Acceleration of rural electrification and alternative energy shall be promoted. Revenue received from hydropower royalty and taxes on fossil fuels shall be used to promote rural electrification and alternative energy.
- The framework of sector-wide approach of the current policy on rural energy shall be strengthened through a broad stakeholder involvement in the whole process of technology development to project identification, design and finally to implementation. Ministries and institutions related to rural development shall promote clean, reliable and appropriate energy sources as a means to reduce rural poverty and protect the environment.

4.1.4 Biomass

Biomass energy occupies a very important place in energy consumption of the country. As fuelwood is crucial to rural populace of the country for meeting their cooking as well as heating needs, the rate of exploitation of forest resources for fuelwood has gone beyond a sustainable level and is one of the causes of deforestation in the country. The pressure on the national forests on the one hand and the economic impact of rising import bills of oil in the economy on the other have left the policy choice extremely difficult.

The policy will be to gradually decrease the share of traditional energy in the energy mix of the country and replace it by other renewable and alternative sources of energy. The increasing demand for energy in the short-to-medium term will need to be met by fuelwood as is the practice currently. Until the plantations for fuelwood start to mature or development of hydropower gets a momentum, the demand needs to be met by kerosene and LPG. This will increase the level of fossil fuels in the energy mix. In the long term, we need to move to an energy system heavily dependent in electricity to meet the needs of the household and workplace.

The long-term objective of the Forestry Sector needs to focus on meeting the people's basic needs for fuelwood on a sustainable basis. The forestry resources should be managed and utilized in a manner which gives priority to the basic needs of the people not only of fuelwood for cooking but also timber for housing, and fodder for domestic animals. Other areas for intervention are:

- Promote technologies that improve efficiency of biomass use such as improved cookstoves.
- Exploit the potential of developing 1.9 million biogas plants benefiting the same number of households out of 5 million households in the country.
- Promote emerging biomass energy technologies such as briquettes, gasifiers, cogeneration and liquid biofuels.
- Develop biomass energy through a decentralized implementation arrangements by establishing local support structures and integrating planning activities with local governments.
- Exploit the potential of forestry sector policies and programmes to address poor people's livelihoods and poverty reduction.
- Exploit the potential of community forestry as a vehicle for social inclusion.
- Fuelwood comes to the towns from the surrounding countryside. The sale of firewood often is the main or only source of cash income of women in particular. The commercial aspects of fuelwood represent a complex problem; we need to consider the entire chain of activities from producers, sellers to consumers. Strategies such as improved cookstoves will ease the demand for fuelwood and help conserve forests. Alternative livelihood strategies will be a necessary component of the policy in responding to the needs of people dependent on fuelwood trade.
- Develop capacity to capture carbon credit benefits. The World Bank and the Asian Development Bank have technical assistance programmes to help member countries in capacity building to prepare proposals for availing the benefits. An increased forest coverage will also contribute to a GHG emission-free development and in the process qualify for REDD (Reducing Emission from Deforestation and Degradation) opportunities.
- Energy demand for cooking and heating in the rural and semi-urban area shall be met by traditional biomass such as fuelwood. Community forest user groups, cooperatives, women user groups shall be encouraged and facilitated to grow tree plantations for fuelwood production through a system of long term lease.

4.1.5 Fossil Fuels

The thrust of the national strategy will be to gradually decrease the share of fossil fuels in the energy mix of the country and replace it by renewable sources of energy. The rising demand for energy in the short-to-medium term will be met by fossil fuels until the development of hydropower picks up. Development of indigenous and renewable source such as biofuels will be promoted to ease the pressure on imports for security considerations.

Liquid biofuels can be extracted from plant seeds, and ethanol or methanol from forest products or sugarcane. Ethanol has been in use for several decades in countries such as Brazil and in recent years, it is increasing in south Asia as well. Biodiesel is made from vegetable oils, most commonly *Jatropha curcas*, animal fat or recycled greases. Biokerosene can be produced by distilling pine resin to produce turpentine, which can be used as a substitute of kerosene.

The benefits of biofuels use should be well communicated to the public. It is less polluting than petroleum fuels. New programmes to support development of farming and processing (bio-

refineries) have to be given priority. This will also provide additional income opportunities to poor rural populations.

The policy must support biofuel producers, retailers and users with tax concessions to shield them against the risks of trade restrictions.

More research and exploration of mines should continue and more study and evaluation of the current deposits of coal should also be carried out.

The policy principles include:

- Import and distribution of oil shall be deregulated. Production of bio-diesel and ethanol and their use shall be promoted with appropriate fiscal and other incentives.
- Research and Development (R&D) in the energy sector shall be supported with adequate resources.

4.1.6 Institutional and Legal

As electricity is the main source of modern energy and is one of the drivers for rapid economic growth and poverty alleviation, the country has set a target of adding 10,000 MW of capacity in the next ten years. Hence meeting the target of adding thousands of megawatt of power within a short period of time is a daunting task requiring expansion of the transmission and distribution networks. With each capacity addition, the issue of energy efficiency and conservation will need to attract more attention of the state. It requires the state to provide enabling institutional and legal frameworks as well as encourage competition with appropriate regulatory intervention.

Currently allocation of responsibilities with regard to development and management of different sources of energy is spread over several ministries and agencies such as Ministry of Energy, Ministry of Environment, Science and Technology, Ministry of Forest and Soil Conservation, Ministry of Agriculture and Cooperatives, Ministry of Commerce and Supplies, Ministry of Industry and local government bodies. The ministries are concerned with their own areas of operation and therefore policies are not always consistent and opportunities for inter-linkages and synergy are missing. Different fuels have different values in terms of efficiency and convenience. They generate different kinds and amounts of pollution. Their relative prices need to be set in a way that the resulting inter-fuel choices are socially and economically desirable. Pricing of one form of energy should not be set independently of each other. Integrated policy requires a consistent tax structure, a level playing field, uniform treatment of externalities, and consistent regulation. An integrated energy policy needs to clearly recognize the trade-offs in energy choices in an economy and optimize over the same in such a way that the end-uses for which energy is demanded are met in the most efficient and least cost manner.

Specific options for institutional mechanisms include:

- Constitute an apex body, the Energy Coordination Committee, under the chairmanship of the Prime Minister for policy decisions and coordination (The Government has already announced that the Prime Minister will oversee and coordinate development of10,000 MW capacity hydropower projects within the next ten years). This committee will review and approve policies for energy sector as a whole. Alternatively, this committee may be given a broader role of coordinating all water and energy sector policies. As more and more candidate hydropower projects come for review, the conflicts in water use are bound to increase which needs resolution at the local as well as central level. The Water and Energy

Commission and its Secretariat will review the projects for integration. As all ministries are equal, the coordination role is better played by a committee under the chairmanship of the Prime Minister. All energy and water related ministers will be the members of this committee. This committee will ensure, among others, public sector autonomy to develop commercial culture (for example, public sector companies such as the NEA or the NOC must be managed by independent boards with no more than two government nominated Directors including just one from the incumbent Ministry).

- Review and reallocate responsibilities of the Water and Energy Commission, and the National Planning Commission.
- Reallocation of responsibilities with regard to rural energy sector under a single ministry, the MOEST instead of responsibilities spread or diffused over several agencies such as MOEST, DOED, and Rural Electrification Department under the NEA.
- Create a separate Renewable Energy Development Agency or upgrade the current Alternative Energy Promotion Centre making it a purely professional body.

A comprehensive legal framework will be required for the development and management of this resource.

a. The draft legislation for the development and management of electricity needs to provide appropriate frameworks to implement the Hydropower Development Policy 2001. The planned large scale generation will attract a significant number of private investors for its development and in turn requires an independent and strong regulatory body.
b. Enact a separate law for establishing an independent regulatory body. The energy sector requires regulatory oversight to balance consumer and producer interests, to ensure energy efficiency and to create a level playing field. Natural monopolies need regulation to ensure open access to all so that competitive efficiency is realized.
c. Similar law needs to be enacted to regulate the supply, distribution and quality control of petroleum products and biofuels.
d. The issues of energy efficiency and conservation will also require development of a separate legislation for setting standards and institutional framework for efficient use of energy and its conservation.
e. 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.
f. An enabling institutional framework is essential for integrated development of the energy sector. The institutional framework for development of other renewable and non-conventional energy sources has to be strengthened.
g. The vertically integrated NEA should be restructured and unbundled to allow healthy competition and a level playing field for commercial operation of power sector. An independent regulatory authority should be created for a sound tariff setting enabling the power sector to operate in a commercial manner.
h. An appropriate legal framework should be developed for an integrated policy formulation, development and coordination in the energy sector.

4.1.7 Regional Cooperation

Electricity is a critical infrastructure on which the socio-economic development of the country depends. Recognizing that electricity is one of the key drivers for rapid economic growth and poverty alleviation, the nation has set a target of producing 10,000 MW of power in ten years. The ERSF study shows that under the combined scenario of different policy measures, the peak installed capacity in 2030 will be over 11,480 MW. Development of hydropower of this size necessarily includes several reservoir projects. Harnessing of large reservoir projects in the Himalayas, however, represents one of the great challenges in international hydropower development. The use of water, the principles of allocation of usage rights and the guarantee of seasonal flows are all highly charged political issues. These issues need resolution before we embark upon a large scale development of hydropower in the country.

The policy principles include:

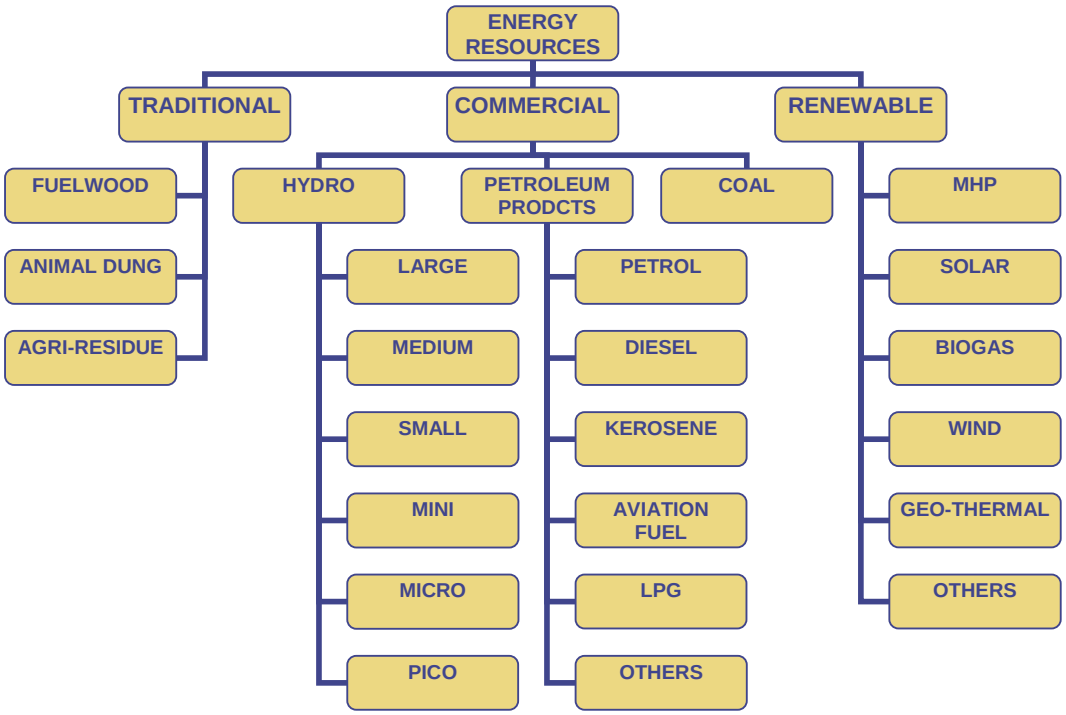
- Efforts should be made to forge regional cooperation and trade in energy in the region. Utilizing different peak times of neighboring countries, regional power trade will benefit the countries in the region. Since Nepal will have mostly ROR hydropower plants of which supply peaks in rainy season and decreases in dry season, regional power trade will be essential with exports in rainy season and imports in dry season. Regional power trading will help in optimal power investments in the country.
- Even with the discouragement of imports of petroleum products, they occupy a sizable share in the future energy scenario. Intra-regional pipelines for imports of petroleum products will be needed for the efficient transport of them.

Chapter 5: Energy Strategies and Targets

New classification of energy sectors

The current classification of energy resources is as shown in **Figure 5.1**. The energy resources are broadly classified into traditional, commercial and renewable. Traditional category consists of fuel-wood, animal dung and agricultural residue. Commercial consists of hydro, petroleum products and coal. Solar, biogas, wind, geothermal, micro-hydro and others are classified as renewable energy.

Figure 44: Current Classification of Energy Resources in Nepal

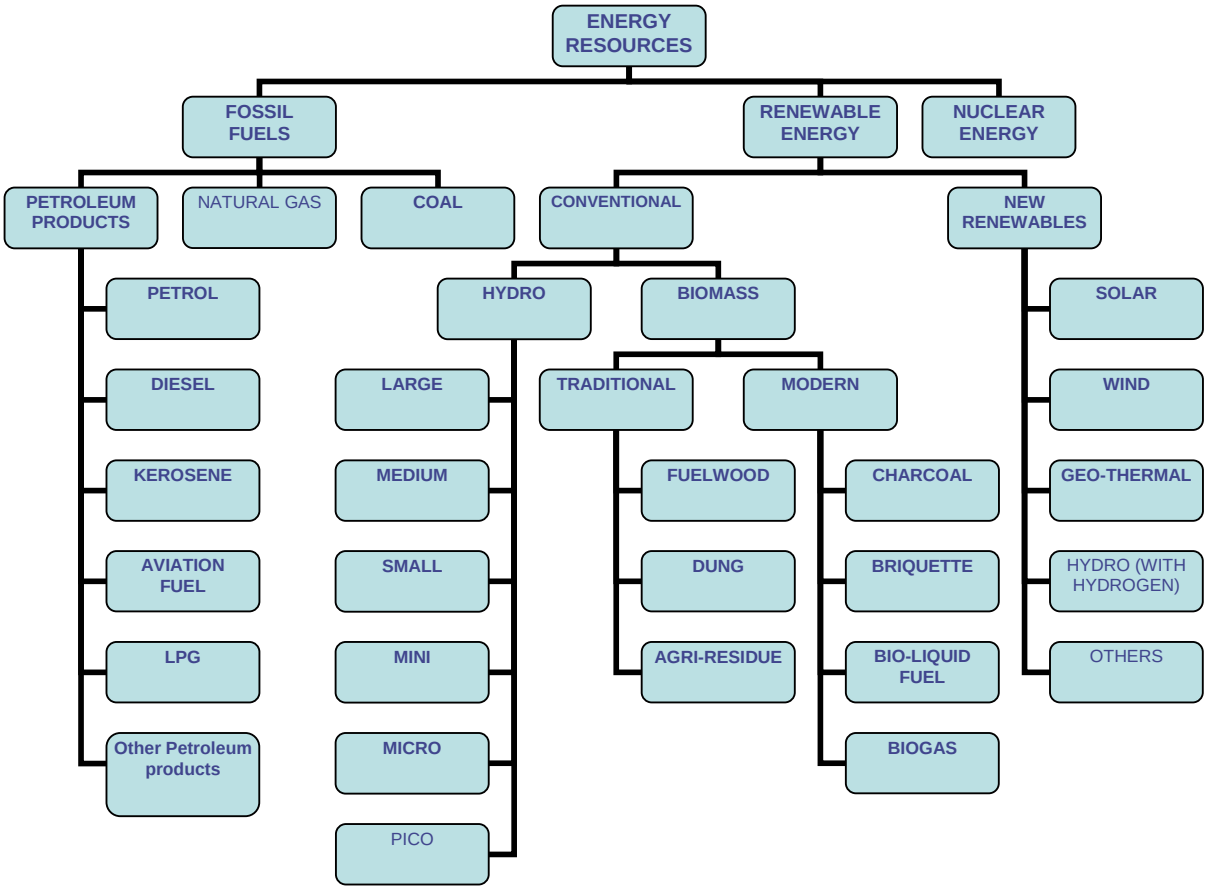


A new classification of energy resources is given in **Figure 5.2**. The energy resources are broadly classified as fossil fuels, renewable and nuclear energy. The fossil fuels category consists of petroleum products, natural gas and coal. Renewable energy is classified as conventional and new renewable.

Biomass sub-sector is now categorized under conventional renewable. It is further sub-categorized into traditional and modern biomass energy resources. Modern biomass consists of charcoal, briquette, bio-fuels such as biogas, ethanol, biodiesel etc. The new renewable sub-category consists of solar, wind, geothermal, hydrogen fuel, etc. Nuclear energy is separately classified considering the possibilities of development in future.

In the fossil fuels sub-sector, petroleum products are further classified into petrol (gasoline), diesel, kerosene, aviation fuel, liquefied petroleum gas (LPG) etc. In the conventional renewable energy sub-sector, hydro renewable are further divided into large, medium, small, mini, micro and pico hydropower.

Figure 45: New Classification of Energy Resources



Strategies on Fossil Fuels Sub-sector

Fossil fuels sub-sector includes petroleum, coal and natural gas. Major strategies and activities are explained below.

Strategy 1: Discourage use of fossil fuels by promoting alternative fuels in transport and machineries

Transport sector is dependent on imported petroleum products. Further, the growth rate of energy consumption in transport sector is continuously increasing. The economics of oil imports shows the possibility of high expenditures of earnings from all commodities exports on importing fossil fuel. The policy intervention of introducing new transport technology such as fuel blending, electric and hybrid vehicles retards the growth rate of consumption of petroleum products and accelerates the utilization of renewable and indigenous resources. The identified activities and targets are:

Short Term Targets and Activities (2010-2020)

- Introduce Ethanol blended gasoline E10 (10 percent blended with ethanol) in all gasoline vehicles.
- Introduce biodiesel B05 (5 percent blended with diesel) in all diesel vehicles.
- Exempt tax in purchase of vehicles running on alternate fuels.
- Encourage use of public transport.

- Monitor the use of fossil fuels as per standard parameters.

Mid Term Targets

- Reduce demand capacity of diesel and petrol cars by 10 percent of base case in 2020. Electric and Hybrid cars substituting this capacity by 5 percent each.

Long Term Targets

- Gradually increase ethanol percentage in gasoline from E10 to E20 (20 percent blended with ethanol).
- Increase biodiesel percentage from B05 to B10 (10 percent blended with diesel).
- Gradually replace 20 percent and 30 percent demand capacity of diesel and petrol cars of the base case in year 2025 and 2030 with electric and hybrid vehicle in equal share.

Strategy 2: Ensure sufficient storage facilities of petroleum products.

The current storage facility of Nepal Oil Corporation (NOC) is adequate to meet the daily demand for 20 days, which is less that the IEA norm of mandatory storage requirement of accommodating 90 days' daily demands. Following activities are identified under this strategy.

Short Term Targets and Activities (2010-2015)

- Upgrade petroleum oil storage facility by 45 days of daily demand.
- Upgrade LPG storage facility by 45 days.
- Involve the private sectors in purchase, storage and distribution of the petroleum products

Mid Term and Long Term Targets (2015-2030)

- Upgrade oil storage facility of petroleum oil by 90 days of daily demand.

Strategy 3: Promote and facilitate the petroleum and the natural gas exploration

The Government of Nepal has identified certain Blocks in Dhangadi, Karnali, Lumbini, Birgunj, and Malangawa as the potential sites for Petroleum exploration. Further, some areas in Kathmandu valley are identified as the potential areas for natural gas. However, exploration works are yet to be initiated. The exploration work will confirm the availability of natural gas as well as petroleum both in terms of quality and quantity. The following activities are indentified:

Short Term Activities (2010-2015)

- Explore and promote the natural gas reserved in Kathmandu.
- Create conducive environment for exploration work.

Mid Term Activities (2015-2020)

- Create favorable policy and rules to encourage the national and international companies for exploration of petroleum products.
- Provide financial and technical support to conduct feasibility study.

Strategy 4: Promote and facilitate the excavation of coal deposits

Coal deposits are found in the Western parts of Nepal near Dang and adjoining districts. Non-commercialized production of coal is being carried out and supplied to the market. The physical quantities explored are about 2.5 percent of the coal imports. Exploration of coal deposits shall be promoted. Commercial production of coal shall be initiated in case of commercially feasible.

Strategy 5: Enforce energy efficiency programme

Large amount of energy can be saved in industries and commercial complexes through energy efficiency intervention. Energy audit is therefore necessary to understand the energy conservation potential in the sectors. This activity will help in reducing load shedding hours as well as provide lead time for arranging new capacity additions. The activities identified are given below:

Short Term Activities (2010-2015)

- Prepare energy auditing manual /energy conservation manual.
- Perform energy auditing of 50% of registered industries.

Long Term Targets and Activities (2015-2030)

- Perform energy auditing of all registered industries.
- Develop energy conservation regulatory framework.

Strategies on Renewable Energy Sector

5.3.1 Hydropower Sub-sector

Hydropower is the indigenous and clean energy resource. The major strategies developed in this sector are explained below:

Strategy 6: Develop hydro-power as prioritized energy resource

The strategy aims at gradually increasing the share of hydropower in the energy mix by substituting traditional fuels such as fuel woods, dung as well as petroleum fuels such as kerosene, Diesel, LPG etc. The following activities are identified.

Short Term Activities (2010-2015)

- Prepare a long-term plan for each river basin with the aim of achieving maximum benefit to the government.
- Draft concrete plans to identify the potential projects.
- Develop hydropower plants in the pipeline under fast track process.
- Prioritize small and mini-micro hydropower plants that can be immediately developed through internal resources.

Medium Term Activities and Long Term Activities (2010-2030)

- Develop hydropower projects of multi-purpose nature.
- Develop mini grid system in remote and isolated areas.

Strategy 7: Promote Electric Transport and fuel efficient vehicles.

Promotion of alternative energy for transport sector is crucial to ease the increasing import of petroleum. From the analysis of new transport technology assumptions in energy model, promoting electric and hybrid vehicle along with ethanol and biodiesel saves petroleum consumption by 1 percent in 2015 and 4 percent in 2030.

Following activities are identified for promoting electrical and fuel efficient transport.

Short Term Targets and Activities (2010-2015)

- Facilitate imports of hybrid and electric cars by 5 percent.
- Ensure continuous supply of electricity to the electrical vehicle recharge stations.
- Provide rebates in the customs duty of hybrid/electric vehicles as much as 50% and 25% on the prevailing customs duty on conventional vehicles.
- Research on the probability of electric trains and ropeways (both electric and mechanical).

Mid Term Targets /Activities (2015-2020)

- Facilitate imports of hybrid and electric cars by 10 percent.

Long Term Activities (2020-2030)

- Facilitate imports of hybrid and electric cars by 15 percent.
- Upon sufficient generation of hydropower and reliable transmission, planning electric trains along the East – West Highways can be considered.

Strategy 8: Plan national/regional/local transmission lines at the very beginning of hydro-power project/plan formulation stage

Identify and install the high voltage cross-border and domestic transmission lines of different capacities in close coordination with the electricity generation centers to evacuate the electricity being generated at present and planned for future. Prepare Transmission Line Master Plan for effective implementation.

Strategy 9: Develop mechanisms to minimize prevailing transmission and distribution loss, and also reduce electricity misuse.

Develop and implement a plan with annual milestones to bring down transmission and distribution losses through community participation, effective enforcement and incentives to consumers. 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.

Strategy 10: Implement Demand Side Management Tools in energy consuming sectors

From energy model it can be observed that, upon implementing energy efficient lights intervention program, there is a decrease in power plant requirement of 5 percent and 9 percent in 2015 and in 2030 respectively. Besides, replacing incandescent lamps with energy efficient lights and/or electric choke, demand side management program also includes promotion of energy efficient end-use devices. The following activities are identified for demand side management.

Short Term Activities (2010-2015)

- Aware general public to use the less electrical energy consuming electrical appliances.
- Encourage the industrialists to enhance the capacity of transformers by increasing power factors through installing capacitors in the systems.

Mid Term Targets and Activities (2015-2020)

- Replace 50 percent of incandescent bulbs with Energy efficient lights in residential and service sectors.

Long Term Targets and Activities

- Replace 70 percent of incandescent bulbs with energy efficient lights in residential and service sectors.
- Operate existing transmission lines in full capacity
- Construct new transmission lines in order to minimize the prevailing technical losses.

5.3.2 Renewable Biomass

Strategy 11: Discourage the use of traditional energy in all energy sectors.

The reference case scenario of the integrated energy model indicated the dominance of fuel wood, exceeding the sustainable limit throughout the analysis period. The policy intervention of introducing more efficient energy sources in the energy ladder will maintain the fuel wood consumption within sustainable limits by 2025. Further, though, fuel wood and other low quality energy sources are cheap and readily available, it creates negative impacts on environment and health. Hence, following activities are identified for switching towards high quality energy sources.

Short Term Targets and Activities (2010-2015):

- Replace 20 percent of the traditional and fossil fuels consumption by electricity in industrial and commercial sectors as compared to the share of base year.
- Replace 10 percent and 50 percent of fuel wood share of the base year by electricity, kerosene and/or LPG in residential urban and residential rural sector respectively.
- Develop strong monitoring mechanism for auditing to address CDM.
- Develop a Mechanism for interlinking the RE Database system.
- Agriculture and solid waste should be integrated for energy generation.
- Developing fuel efficient stoves and briquettes.
- Discourage converting forest land for other development purpose.
- Adopt sector wide approach (SWAP) for RE development.
- Prepare appropriate legislation for RE (MHP, Solar Wind) grid connection.

Mid Term / Long Term Targets and Activities (2015-2030)

- Replace 30 percent of the traditional and fossil fuels consumption of the share in base year by electricity in industrial and commercial sectors.
- Replace 30 percent and 75 percent of fuel wood share of the base year by electricity, kerosene and/or LPG in residential urban and residential rural sector respectively.

Strategy 12: Identify, Introduce and Promote new and efficient biomass energy combustion devices.

Large amount of energy demand is fulfilled by traditional energy at the base year. Mostly, these sources are used inefficiently. Hence, simple efficiency improvement technology like ICS can drastically reduce the consumption of the biomass. This will not only reduce the gap of sustainable supply and consumption of biomass but also reduce the environmental and health hazards.

Mid Term Activities (2010-2015)

- Start programs of switching 25 percent of traditional cookstove to ICS.

Mid Term and Long Term Activities (2015-2030)

- Replace 50 percent of traditional cooking stoves by ICS.

Also, continuously study, develop and disseminate emerging biomass energy technologies such as briquettes, gasifiers, co-generation and liquid bio-fuels.

Strategy 13: Establish a mechanism for ensuring sustained supply of biomass materials for energy by incorporating biomass production as one of the many objectives of the resource management in agriculture, forest and livestock sectors.

This strategy includes promoting the production of all possible forms of biomass energy sources from agriculture, forest and livestock sectors as one of the objectives of the resource management in respective sectors, and the use of efficient and clean combustion devices. This integrated approach in fact improves the feasibility of those sectors.

Strategy 14: Establish and institutionalize mechanisms to share experience and have regular interaction among relevant stakeholder at national and regional levels.

Develop biomass energy through a decentralized implementation arrangements by establishing local support structures and integrating planning activities with local governments. The potential of community forestry as a vehicle for social inclusion should be exploited.

Strategy 15: Disseminate information on modern bio-energy technology.

Awareness Campaign on new bio-energy technology and its advantages in economy, environment and health among the rural population should be initiated.

Strategy 16: Identify and make use of the opportunities of carbon trading under the Clean Development Mechanism (CDM) and the new mechanism under development that is referred as Reduction of Emission from Deforestation in Developing countries (REDD)

The activities on capacity building, developing human resource, programs and assistance to the concerned parties in realization of benefits from the CDM and new mechanism of REDD shall be initiated.

5.3.3 New Renewable Energy

Strategy 17: Promote the use of alternative or renewable energy thereby reducing dependency on traditional energy source and on fossil fuels.

Over exploitation of the traditional energy resources particularly the fuel wood and increased use of fossil fuels both have negative consequences in the environment and economic setting. Hence, alternative energy technologies can substitute such energy resources for the betterment of environment and economic condition. Preparing the Master Plan for the alternative energy development shall be instrumental in planned development of such technologies.

Solar Energy:

- Adopt solar PV for rural electrification and promote its use in urban power supply.
- Enforce use of SHS in all star hotels by 2015.
- Standardize and control the quality the technologies.

Wind Energy:

- Perform wind mapping of the potential sites.
- Prepare wind energy policy.
- Conduct pilot projects for capacity building of national experts.

Other RETs:

- Develop and promote advanced RETs (such as hydrogen, nuclear, geothermal, etc.) in future.

Energy Pricing and Deregulation of Energy Sector

Strategy 18: Promote private investors in hydropower projects.

Public sector utilities like NEA should make prompt offers to sign PPA at a standard wet and dry season rates with a provision of price escalation. Offering fiscal and financial incentives including loans for development of power projects will attract private investors. If payment of subsidy is involved as incentive, arrangement for a system should be made where payment is made after the project is operational.

Strategy 19: Establish differential electricity tariff.

Differential tariffs for electricity would result to a more uniform load curve of electricity grid. This would mean greater plant load factor and reduction of generation cost.

Strategy 20: Establish free competitive market in petroleum products.

A competitive market involving private sector shall be instrumental in addressing the irregular supply of petroleum products. Petroleum pricing is still controlled by the government. An automatic pricing mechanism has to be implemented to reflect the market fluctuations in the domestic prices of the petroleum products for secured supply of the petroleum products.

Strategy 21: Ensure targeted subsidy mechanism for alternative energy resources and on energy efficient end-use devices.

The rural poor have to depend on kerosene for lighting and there are new alternate energy technologies such as solar tuki and other renewable technologies available for meeting energy needs of the rural people. The alternative energy technologies are costly upfront and do not have

high operational and maintenance costs and hence, subsidies have to be properly targeted such that these technologies are accessible to the rural poor.

Social Aspect

Strategy 22: Maintain equity in electricity access in urban and rural areas.

Reduce the current disparity in electricity access between urban and rural areas. Rural electrification can be done by alternate sources such as micro/pico hydro, solar and wind, where grid connection is not feasible.

Strategy 23: Establish mechanism for equitable benefit distribution.

The benefits of cleaner energy services must be equitably distributed. This can be achieved by implementing special programs for remote areas and providing subsidies where needed.

Strategy 24: Empower weak socio-economic group.

Social inclusion is a key to achieving developmental goals. The focus must be established on addressing empowerment, energy access and security of women, socially excluded as well as those living below the poverty line.

Strategy 25: Promote awareness, education and training related to energy sources

Awareness of the available options of energy resources and its benefits is essential for effective use. Various outreach as well as training programs regarding energy alternatives must be carried out throughout the nation.

Strategy 26: Ensure each institution will have at least one type of RETs by short term and two types by long term period.

To promote RETs, each government institutions must use one type of RETs by short term and two types by long term period.

Environmental Aspect

Strategy 27: Reduce air pollution

Many rural women and children suffer from various diseases due to exposure to indoor air pollution produced from burning of fuel wood and agricultural wastes using inefficient cooking stoves. Hence to reduce the pollution following activities must be initiated:

- Initiate large scale awareness program on the negative impact of indoor air pollution caused by burning fuel wood in traditional stoves to all rural people so that they can look for alternative cooking stoves.
- Promote improved cooking stove with chimney at affordable price to replace the existing inefficient traditional stoves.
- Research and development activities related to various kinds of improved cooking stoves should be initiated to provide choice and accessibility to these kinds of stoves to needy people.

- Fix the emission standard for all kinds of cooking stoves based on the use of biomass. This will lead to design and fabrication of better stoves which will not only reduce indoor air pollution but also lessen the fuel consumption.

Besides, in urban areas, air pollution due to vehicular emission is significant. Hence

- Strictly enforce vehicular emission standards.
- Encourage Public transport and electric vehicle in urban areas.

Strategy 28: Minimize environmental degradation

Since fuelwood is used as fuel for cooking in rural areas, the trees are cut in unsustainable manner to meet the daily requirement. The requirement of higher quantity of fuelwood in inefficient traditional stoves is another factor which leads to overexploitation of forest. Following activities are identified to reduce the impacts.

- Conduct awareness programs to the user groups on the use of traditional energy resources, environmental degradation and impact on climate change due to excessive use of biomass in inefficient traditional stoves.
- After introducing and providing improved cooking stoves accessible, local government can fix penalty to those users who do not use efficient stoves. At the same time, the government should provide the provision of loan, to user group for purchasing the efficient stoves.
- Provide incentives to the community who look after the community base forest.

Promote electrical cooking in the areas where access to the electricity is available.

Strategy 29: Minimize loss of wildlife and biodiversity

The excessive use of biomass from the forest will cause the loss of wildlife and biodiversity in course of time. Provide attractive incentives to those user groups who preserve the forest and conserve biomass energy through the use of efficient stoves and switching to different types of fuels.

Strategy 30: Introduce pollution tax on fossil fuels with the provision for alternative renewable energy sources

People should be made aware about the negative impact of air pollution caused by excessive use of fossil fuels. Hence, following activities are identified for initiation:

- Increase the fuel price. This will limit the use of vehicles as per need.
- Initiate the import of less polluting vehicles like hybrid vehicles and electrical vehicles.
- Provide incentives to electrical and hybrid vehicles.
- Make vehicle emission standard stringent and monitored accordingly at the same time by fixing high penalty to those vehicles that do not meet the set emission standards.
- Tighten air pollution standards such that users of coal and solid fuels will install efficient and pollution friendly devices in their industries.
- Provide incentives to those industries that meet the air pollution standard and fix high penalty to those who do not.

Strategy 31: Make simpler environmental impact assessment for hydropower plants

Hydropower is the lead energy source. Every projects undergo EIA or IEE. The EIA Process requires procedural simplification for approval so that the projects can be implemented on time.

- Differentiate the time frame for EIA for small, medium and big hydro power plants.
- Simplify the time frame for EIA for small hydro power plants.

Strategy 32: Introduce battery disposal rules and regulation

Every year quite a large number of solar home systems are installed in the rural areas where the national grid or micro-hydro power plants are not available. Solar home system has provided very useful services to rural people. As the number of solar home system increases so do the number of lead acid batteries. Till now there are no rules and regulation for the disposal of these batteries as well as batteries from motor vehicles, which is going to be a great nuisance in rural environment. Hence following activities are proposed:

- Conduct awareness to the user group about the impact of improper disposal of these batteries.
- Formulate the rules and regulation regarding the disposal of batteries of SHS and implement it properly.
- Establish battery collection centers in the community and provision should be made for sending these batteries for recycling.
- Provide incentives to battery recycling industries.

Strategy 33: Disseminate solid waste management technologies to public

Use of biogas reduce significant amount of fuel wood consumption and improve the indoor air pollution in the kitchen. Biogas can be generated using dung as well as any kind of biodegradable solid waste as a feed material. Further, attaching toilets to the bio-gas plants not generates bio-gas but also improves household sanitation. Despite the effort to expand the coverage of biogas plants, very poor families are still not been able to afford. The following activities are identified to disseminate biogas technology to expand the coverage:

- Construct Pilot project to generate cooking gas from solid wastes from disposal of agricultural residues, municipal and industrial residues.
- Encourage people to build such plants by providing attractive incentives.

Institutional and Capacity Development

Institutional

Strategy 34: Develop Integrated Energy Planning (IEP).

An integrated plan, encompassing all aspects of energy sector, is required to establish priorities and allocate resources for development to deliver service to people at least cost. Following activities are recommended for IEP development:

- Constitute an apex body, the Energy Coordination Council, under the chairmanship of the Prime Minister for policy decisions and coordination. Political consensus should be built and strictly adhered to by all political parties including their allied functionaries on hydropower project development. While building a hydropower project, policy formulation and

coordination should be harmonized between various functional government agencies (e.g., forest, environment, tax) realizing the importance of the energy sector.

- As more and more candidate hydropower projects come for review, the conflicts in water use are bound to increase which needs resolution at the local as well as central level. The Water and Energy Commission and its Secretariat will review the projects for integration.
- At local level, formulate and implement integrated energy development programmes by the DDCs, VDCs and municipalities as per the needs, availability of the local resources and national priority level.
- Encourage participation of locally active organization during formulation and execution of such plans.
- Develop a mechanism for interlinking the integrated energy database system at the central level at WECS with operational databases at various line operational agencies such as NEA, NOC, and AEPC etc.

Strategy 35: Review integrated energy strategy periodically in line with national economic development plans

Strategy development is a dynamic process and hence, needs periodic review in line with the national economic plans, changes in other public policies, social, and environmental events.

Strategy 36: Develop subsectoral strategies and action plans in accordance with the integrated energy strategies and action plans

In order to have coherence and proper coordination, subsectoral strategies (e.g., Energy Efficiency Strategy and Biomass Energy Strategy) and action plans are required to be developed in accordance with the integrated energy strategies and action plans. These plans and strategy shall be reviewed periodically.

Strategy 37: Review and reallocate responsibilities of the Water and Energy Commission, and the National Planning Commission.

There are conflicts and overlapping of responsibilities of WECs and NPC. Hence it must be reviewed with clear responsibilities considering the current situation and development of different sectors in the country. A separate act should be promulgated for WECS and it should be strengthened with adequate authority and jurisdiction.

Strategy 38: Reallocate responsibilities with regard to rural energy sector.

Reallocate responsibilities with regard to rural energy sector under a single ministry, the MOE, instead of responsibilities spread or diffused over several agencies such as MOEST, DOED, and Rural Electrification Department under the NEA.

Strategy 39: Establish 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. Identified activities in these context are:

- Establish an independent regulatory body for the marketing of petroleum products for domestic price fixation of petroleum products on the basis of the international prices, for

controlling and monitoring the quality of products and services in the petroleum products marketing and distribution.
- Establish an independent laboratory to check the quality of the petroleum products distributed and if needed establish in different development regions as well.

Strategy 40: Ensure level playing field for all types of stakeholders.

To ensure level playing field for all stakeholders in energy sector, eliminate monopoly in:

- Hydropower projects to be identified & prioritized (optimized in the respective basins/sub-basins) by GoN and licenses awarded through competitive bidding.
- Hydropower transmission and distribution,
- Fuelwood generation and harvesting and
- Import, storage and distribution of petroleum products.

Detailed strategic options in the institutional aspect are explained in the Annex table.

Legal

Strategy 41: Amend Electricity Act and laws to provide state incentives in income taxes, VAT and etc. in hydropower development.

Following issues shall be consider while amending Electricity Act and Nepal Electricity Regulatory Commission Act.

- Hydropower as a priority sector.
- Provide Tax holidays to energy infrastructure projects such as hydropower. Fiscal incentives and concessions should be provided through financial enactments administered by MoF.
- Ownership of the water resources should be vested in the center while the “user right” could be allocated amongst various states (provinces), basin authorities and/or local bodies.
- Involuntary resettlement, property acquisition, compensation and community development depending upon the size and type of hydropower plant.
- Sharing of revenue from hydropower plants between various levels of government.
- Type and mode of people’s participation in the benefit sharing from hydropower plants on the basis of plant size and type.

Strategy 42: Enact laws and regulations to enforce unbundling in the electricity subsector.

Unbundle electricity utility into separate entities for generation, transmission and distribution. This will make private investments possible in sectors other than generation.

Strategy 43: Enact separate law for deregulation 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.

Strategy 44: Develop laws and regulations to focus on reducing deforestation, indoor air pollution and reducing GHG emissions.

Lack of proper laws and regulations on deforestation, indoor pollution and reduction of GHG emissions have denuded the forest resources, created health hazards among women, and

promoted widespread private motorization in the country. Hence, to curtail these environmental hazards and emissions, proper laws and regulations are needed.

Strategy 45: Develop an Integrated Energy Policy

There exists some separate subsectoral policies and some are being formulated. however, an integrated policy addressing all forms of energy is yet to be formulated. There is a need to prepare Integrated Energy Policy.

Strategy on Nuclear Energy

Strategy 46: Assess the Nuclear Energy Production Potential

Nuclear energy is considered as one of the cleaner energy and many countries are developing such technology for peaceful purposes. It may be one of the vital sources of energy for the near future. Assessing the potentiality of nuclear energy production considering locational, geophysical, technical, economical and socio economic aspects may be helpful for future.

Chapter 6: Implications of Different Forms of Energy Mix on the National Economy

Energy systems modeling framework, investment requirements for two types of energy mix - (a) reference case, and (b) all combined policy interventions at Reference Case - have been estimated and presented in the **Table 6.1**

Table 60: Five Yearly Investments on Electricity Sub-sector t 2004/05 prices (Based on the Reference Scenario)

In Million NRs

Fiscal Year	Reference case	Combined policy assumptions at reference case
2006-2010	37,631	57,176
2010-2015	71,923	92,048
2015-2020	130,841	185,007
2020-2025	273,396	440,738
2025-2030	575,147	907,302

Source: Estimates

Energy requirement and its mix have been identified based on the predicted GDP growth rate based on the reference case (Interim plan scenario). Investment requirements for getting required energy mixes have also been determined. The **Table 6.2** shows the investment requirement as the percentage of Gross Fixed Capital Formation (GFCF). The combined case with all the policy interventions with 5.6 percent GDP growth rates will need 14 percent of GFCF whereas, the reference case needs only 9.3 percent in the period (2025-2030). It was about 6 percent of the GFCF in the period (2001-2005). However, the investment requirement can be met using the faster rising growth rate of remittances sent by the Nepalese laborers from outside the country by discouraging its non-productive use and adopting the appropriate policy with incentive package. This can be done by encouraging private sector to invest in the production of energy. This will relax the reliance on foreign sources of financing.

Table 61: Share of Investment on Electricity, Gas and Water in GFCF

In Percent

Scenarios	2001-2005	2006-2010	2011-2015	2016-2020	2021-2025	2025-2030
Reference case	6.1	6.3	7.3	7.6	8.6	9.3
Combined case	6.16	9.2	9.1	10.4	13.2	14.0

Source: Estimated

Now it is also essential to assess the effect of reference case and its investment requirement for the energy sector on the national economy. Average annual growth rate of the Value Added in the electricity, gas and water sub sector in reference case is estimated 6.8 percent following the existing energy mix. It will be 11.6 percent in case of adopting the combined optimal energy mix with demand management. It is natural that more investment in the sub sector leads to the higher average annual growth rate of the sub sector. Besides, the increase in sub sector investment will have naturally positive impact on the GDP growth rates. That has been explained in the following **Table 6.3**.

Table 62: Impacts of the Investment in Electricity, Gas and Water Sub Sector on the National Economy

Indicators	2006-2010	2011-2015	2016-2020	2021-2025	2025-2030	Growth Rate (%) 2006-2030
Reference case (5.6% GDP growth rate)						
Value Added in Agriculture	4.1	3.4	3.5	3.7	3.8	3.6

Value added in non-Agriculture	5.3	5.4	5.7	6.0	6.4	5.7
Value Added in Electricity, gas and Water Supply	6.8	6.5	6.8	6.9	7.0	6.8
GDP at Producer's Prices	5.0	5.0	5.4	5.8	6.3	5.6
Combined case with all policy options (5.6% GDP growth rate)						
Value Added in Agriculture	4.1	3.4	3.5	3.7	3.8	3.6
Value added in non-Agriculture	5.6	5.9	6.4	6.9	7.7	6.7
Value Added in Electricity, gas and Water Supply	7.6	9.3	10.7	12.4	14.3	11.6
GDP at Producer's Prices	5.0	5.1	5.5	6.0	6.7	5.8

Source: Computed

Macroeconomic implications of the investment in energy sector on the national economy:

- Based on Reference Growth Scenario estimate, the shares of sectoral investment in total GFCF in the period (2025-2030) in the reference case and combined optimal energy mix with demand management are 9.3 percent and 14 percent respectively, whereas it was only 6.1 percent in the period (2001-2005). Intervention in energy mix demands more investment on the sub-sector.
- Estimated annual growth rates of sectoral value added in reference case and combined case with demand management in the reference scenario are: 6.8 percent and 11.6 percent respectively.
- Estimated annual growth rates of GDPPP with existing energy mix and combined optimal energy mix with demand management based on the reference scenario are: 5.6 percent and 5.8 percent respectively.

Thus, the proposed investment in energy sector will have desired macroeconomic implications on the national economy along with increasing domestic resource mobilization, making private sector more active in this sector and attracting remittances earned from abroad towards this sector.

Chapter 7: Climate Change and Disaster Risk Reduction

Introduction

Climate change and disaster risk reduction are closely related. More extreme weather events in future are likely to increase the number and scale of disaster. But the existing methods and tools of disaster risk reduction provide powerful capacities for adaptation to climate change. Climate change means the alteration of world's climate caused by human activities through fossil fuel burning, deforestation and other practices that increase the concentration of greenhouse gases (GHG) in the atmosphere. On the other hand, disaster risk reduction is defined as "action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyze and manage the cause of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events" (http://www.unisdr.org).

A recent study (UNDP, 2004) ranked Nepal, in terms of relative vulnerability to earthquakes, as the eleventh most at risk country in the world, and thirtieth with respect to floods. Another report (World Bank, 2005) classifies Nepal as one of the global 'hot-spots' for natural disasters. Among the major hazards, floods and landslides are the most recurrent in Nepal, claiming on an average of about 211 lives annually in the past ten years. There are 3,252 glaciers and 2,323 lakes at or above 3,500 metres above sea level in Nepal. Twenty glacier lakes are at risk of bursting due to melting glaciers, according to a 2002 report by the International Centre for Integrated Mountain Development (ICIMOD) and the UN Environment Programme. Area covered by these glaciers is 5,324 sq.km. and total ice reserve is 480.48 cu.km. Every summer a part of snow melts and adds up in the next winter. This way the ice is recycled. Glacial lakes created by melting glaciers can overflow, releasing several thousand cubic meters of water per second along stream channels. Several floods down stream due to increase in water volume of many rivers have been observed. Such flooding will not only cause threat to villages but also many hydro power plants causing damage to national property.

Evidence of climate change

There are many observations increasing air and ocean temperatures, widespread melting of snow and ice, and rising sea level. Over the last 100 years (1906–2005), global temperature has increased by 0.74°C. Global sea level has risen by 17 cm during the 20th century, in part because of the melting of snow and ice from many mountains and in the Polar Regions. More regional changes have also been observed, including changes in Arctic temperatures and ice, ocean salinity, wind patterns, droughts, precipitations, frequency of heat waves and intensity of tropical cyclones.

The temperature differences are most pronounced during the dry winter season and least during the height of monsoon in Nepal. The warming is significantly greater at higher elevations, i.e., mountainous region, in the northern part of the country than at lower elevations, i.e. Terai in the south. The average temperature has risen by 1.5°C from 21.6°C of 1978 - 81 to 23.1°C for 2001-06. Rainfall shows irregular pattern. Hence, increasing or decreasing trends cannot be confirmed. However, annual rainfall data shows larger values than before. On the other hand, there is less rainfall during winter and spring and intense rainfall during rainy season. This may cause erratic climate change such as early or late monsoon that has been already evident in the environment.

Causes

Increase in the concentration of GHG in the atmosphere is the main culprit of climate change in Earth surface. With the industrial development the developed as well as developing countries are consuming a significant quantity of fossil fuels. The burning of fossil fuel and cutting of trees will add excess amount of GHG in the atmosphere. These GHG act as a “blanket” which traps the incoming solar energy and keeps the earth surface warmer than it otherwise would. The more the GHG in the atmosphere the warmer will be the earth surface causing severe climate change.

Impacts

Nepal is already highly vulnerable to water- induced disaster such as floods, landslides, slope failures and debris flow. The recent trends in climate and climate change have further aggravated this scenario, particularly in regards to hydropower development.

The continued melting of glaciers in the Himalayan region is projected to increase flooding and rock avalanches and to adversely affect water resources in the coming years. It is experiencing increase in dry periods, intense rainfall, floods, landslides, forest fires, glacial retreats and Glacier Lake Outburst Flood (GLOF) threats. The Himalayan glaciers are the sources of freshwater reserves which provide headwater for major river system flowing through Nepal. The Himalayan glaciers are shrinking more rapidly than elsewhere. This will make rivers seasonal in future. As glaciers melt, river runoff will initially increase in winter or spring but will eventually decrease as a result of loss of ice resources. This is going to be unfavourable for downstream run-of-river hydropower plants along with other uses of water like irrigation and drinking water supplies. Most of the hydropower plants in Nepal are and would be run-of-the river (ROR) type and hence, firm power outputs from these plants will decrease eventually.

Thus the impacts of climate change will be less water in perennial rivers in winter (water resources), decrease in winter and spring crop production (agriculture), change and extinction of some species and habitats (forest and biodiversity) and flooding related disasters due to glacier melting and spreading of diseases like malaria, asthma etc. (health). The intensity of impact will be higher to poor, young and old people.

GHG Emission Reduction from Energy Strategies

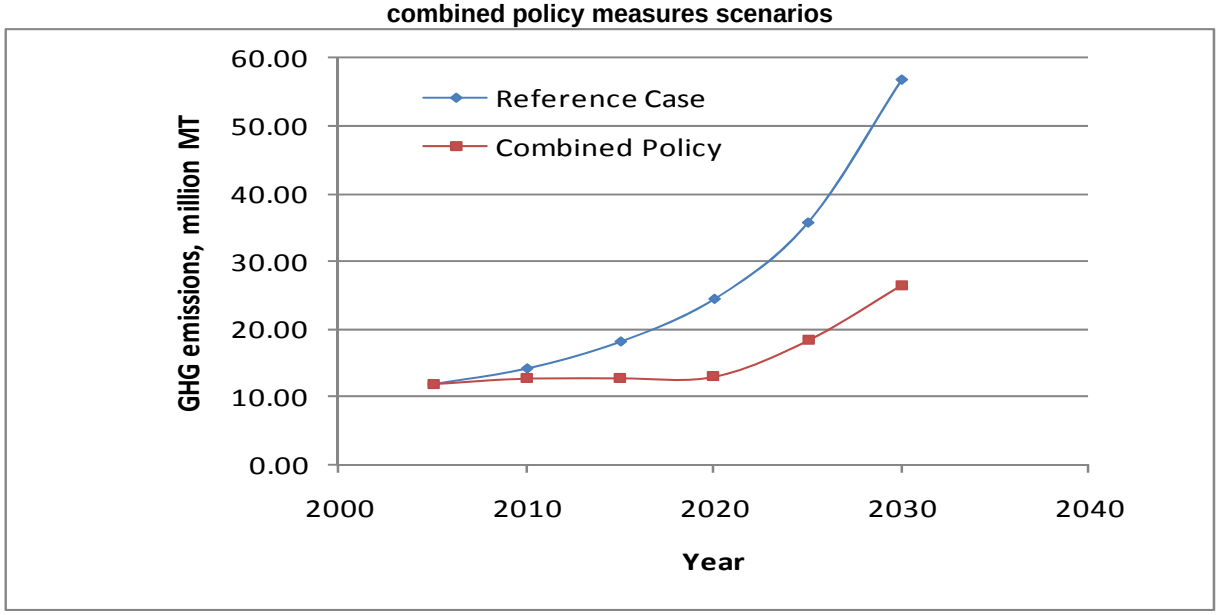
The MARKAL modelling framework can show the relationship among economy, energy and environmental activities. For instance, the green-house-gas emission (GHG) in CO_2–equivalent from the combined energy activities can be envisaged and compared for the subsequent emission impact. Hereunder, two scenarios are observed and compared between the reference case with 5.6 percent GDP growth and the combined case with all the policy measures with the same 5.6 percent GDP growth rate.

Table 7.1: GHG emission in CO2-equivalent

	2005	2010	2015	2020	2025	2030
Reference Case Scenario (million tonnes)	12.0	14.3	18.25	24.5	35.7	56.67
Demand Management at Reference Case (million tonnes)	12.0	12.8	12.83	13.07	18.43	26.6

Table 7.2 highlights that in 2030, the GHG emission can be reduced by 52 percent in the reference case from 56.67 million tones to 26.6 million tonnes if all the policy measures as mentioned above are taken.

Figure 46: Comparative GHG emissions in MT at 5.6 percent GDP growth rate for reference case and combined policy measures scenarios



By implementing the combined policy measures GHG emissions can be reduced by 30 million tons and this reduction can be used for carbon trading through CDM.

Besides, adverse impacts of climate change can be mitigated by taking proactive policy measures in time and thus disaster risk can be reduced for a sustainable development of the country.

Reference

ADB, 2003. Country Economic Review: Nepal, Asian Development Bank, Manila, Philippines

ADB, 2004. Country Environment Analysis, Asian Development Bank, Nepal

ADB, 2007. Energy for all: Addressing the Energy, Environment and Poverty Nexus in Asia, Asian Development Bank, Manila, Philippines

ADB/ICIMOD, 2006. Environment Assessment of Nepal: Emerging Issues and Challenges, International Centre for Integrated Mountain Development, Kathmandu.

ADB/ICIMOD, 2006. Environment Assessment of Nepal: Emerging Issues and Challenges, International Centre for Integrated Mountain Development, Kathmandu

AEPC, 2006. Rural Energy Policy, Alternative Energy Promotion Center

AEPC, 2006. Rural Energy Subsidy Policy, Alternative Energy Promotion Center

AEPC, 2006. Subsidy for Renewable (Rural) Energy, Alternative Energy Promotion Center Government of Nepal, Ministry of Environment, Science and Technology, September, 2006.

AEPC, 2008. Solar and Wind Energy Resource Assessment in Nepal (SWERA), Alternative Energy Promotion Center, Kathmandu

AEPC, 2010. Renewable Energy Statistics. Official correspondence.

AEPC/CES-2006. Solar and Wind Energy Resource Assessment Nepal

AEPC/CRE, 2005. Reducing Green House Emission by Promoting Bioenergy Technologies for Heat Applications: Current Status and Recommended Actions in Nepal, a paper prepared and submitted to FAO/RAP jointly by the Alternative Energy Promotion Centre and the Center for Renewable Energy, Nepal, December, 2005

Ale, B.B. 2001. Report on environmental aspects of vehicles likely to be phased out from the decision of Government in terms age and category, Ministry of pollution & environment, GON, Kathmandu, Nepal

Balla, M.K. et al., 1991. Wood Energy Flows: RRA Study in Pokhara, Nepal.

Banskota, Kamal and Dahal, Ngmindra, 2006. Saving Global Carbon to Benefit Local Communities in the Himalaya, Newsletter “For Sustainable Mountain Development in greater Himalayan region”, No. 49, 2006

Bhadra, Binayak, 2002. Hydro Energy for National Development in Energy Policy National and Regional Implications, September 2002

Bhattarai, T., 2000. Trees Outside Forests: The Woodfuel Production Context in WEN, Volume 15 No.1, FAO Regional Wood Energy Development Programme in Asia, Bangkok, June, 2000

Bose, Ranjan Kumar and V. Srinivaschary, 1997. Policies to reduce energy use and environmental emissions in the transport sector – a case of Delhi City, Energy Policy, vol. 25, Nos. 14-15, pp. 1137 -1150

BSP-Nepal., 2005. Biogas: As Renewable Source of Energy in Nepal, Theory and Development, Eds. Karki, A.B., J.N. Shrestha and S. Bajgain, BSP-Nepal, Kathmandu, 2005

Buchrer, T. and Mauro, F. D., 1992, A Computable General Equilibrium Model of Nepal, MIMEO, Nepal.

CADEC, AEPC/ESAP, 2005. Status of Solar Photovoltaic Sector in Nepal 2004, April 2005

Campbell, J.G. and Bhattarai, T.N., People and Forests in Hill Nepal: Preliminary Presentation of Community Forestry Household and Ward Leader Survey, HMG/UNDP/FAO Community Forestry Development Project, Nepal.

CBS, 1975. Population Census 1971, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu, May, 1975

CBS, 1983. Population Census 1981, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu

CBS, 1987. Population Monograph of Nepal, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu, 1987

CBS, 1993. Population Census 1991, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu, November, 1993

CBS, 1993/94. Nepal Living Standards Survey, Central Bureau of Statistics, Nepal

CBS, 1996. Nepal Living Standard Survey Report, 1995/96, National Planning Commission, GON

CBS, 1997. Census of the manufacturing establishments, 1996/97, National level, NPC, GON

CBS, 1998. Compendium on Environment Statistics 1998 Nepal, Central Bureau of Statistics

CBS, 2000. Nepal Labour Force Survey, 1998/99, National Planning Commission, GON

CBS, 2000. State of Environment, Central Bureau of Statistics

CBS, 2001. National population census, 2001, National Planning Commission, GON

CBS, 2002. Census of the manufacturing establishments, 2001/02, National level, NPC, GON

CBS, 2004. Gross Domestic Product by industry division ,1964/65 to 2003/04

CBS, 2004. Nepal Living Standards Survey Report: 1995/96-2003/04, Central Bureau of Statistics, National Planning Commission Secretariat, Nepal.

CBS, 2004. Nepal Living Standards Survey Report: 1995/96-2003/04, Central Bureau of Statistics, National Planning Commission Secretariat, Nepal

CBSa, 2003. Population Census 2001, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu, July, 2003

CBSb, 2003. Population Monograph of Nepal, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu, December, 2003

CBSc, 2003. Population Projections for Nepal, 2001-2021, National Planning Commission, GON

CBSd, 2003. State of Environment, Central Bureau of Statistics

CBSd, 2003. Statistical Year Book of Nepal, 2003, Central Bureau of Statistics, HMG/N, National Planning Commission Secretariat, Kathmandu,

CES (2000). Renewable Energy Perspective Plan of Nepal (REPPON), 2000-2020: An Approach. Centre for Energy Studies, Vol. 1. Lalitpur.

CES, 2000. Centre for Energy Studies, Renewable Energy Perspective Plan of Nepal (REPPON), 2000-2020, An Approach, Vol. 1, April 2000

CES/IGIDR, 2005. Energy efficient renewable energy technology under CDM in household (conducted in three Asian countries India, Bangladesh and Nepal), Centre for Energy Studies, Institute of Engineering, TU, Kathmandu, Nepal & Indira Gandhi Institute for Development & Research, Mumbai, India

Cruikshank, E. D. and Nord, R. H., 1990. The Role of Exchange Rate Policy: The Case of Nepal, MIMEO, Nepal

D'sa, Antonette and K. V. Narasimha Murthy, 2004, Report on the use of LPG as a domestic cooking fuel option in India, International Energy Initiative, www.iei-asia.org, June

Department of Customs, 2008. Foreign Trade Statistics, Fiscal Year 2063/64 (2006-2007). Department of Customs, Ministry of Finance, GON, Kathmandu, Nepal

Development Study Consultants, 1990. Policy Planning Models for the Nepalese Economy with Special Reference to the Industrial Sector, MIMEO, DSC/MOI/UNIDO, Kathmandu, Nepal

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.

DFRS/FRISP , 1999. Forest Resources of Nepal (1987-1998). Department of Forest Research and Survey, Government of Nepal and Forest Resources Information System Project, Government of Finland. Publication No. 74, Kathmandu.

Dhakal, Shobhakar, 2003. Implications of transportation policies on energy and environment in Kathmandu valley, Nepal, Energy policy 31, 1493-1507

Dhakal, Shobhakar, 2006. Urban Transportation and Environment in Kathmandu Valley, Institute of

DoC (2010). Foreign Trade Statistcis (2008/09). Department of Custom, Tripureshwor, Kathmandu.

DOED, 2062 B.S. Procedures for application to obtain license to develop hydropower in Nepal (Nepali), Department of Electricity Development, 2062 B.S.

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, March, 1999

DoF, 2005. Forest Cover Change Analysis of the Terai Districts (1990/91-2000/01), HMG, Ministry of Forest and Soil Conservation, Department of Forest, Kathmandu, Nepal, May 2005.

DoTM, 2005. Vehicle Registration Statistics, Department of transport management, Ministry of Physical planning and infrastructure, GON

Dwarika et. al., 2009. Federal Nepal Administrative Structure (in Nepali), Vol. 2, Institute of Integrated Development, March 2009 (Fagun 2065).

ESAP, 2005. Micro-Hydro Yearbook of Nepal

ESMAP, 2007. Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies, Energy Sector Management Assistance Program, World Bank, Washington, USA

FAO, 2001. Global Forest Resource Assessment 2000. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO, 2004. UBET- Unified Bioenergy Terminology, Food and Agriculture Organization, Forestry Department, Rome, 2004

FAO, 2004. UBET- Unified Bioenergy Terminology, Food and Agriculture Organization, Forestry Department, Rome 20004.

FAO, 2006. Global Forest Resource Assessment 2005. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO,1991. Fuel Flows: Rapid Rural Appraisal in Four Asian Countries, Field Document No. 26. FAO Regional Wood Energy Development Programme in Asia, Bangkok, August 1991.

FECOFUN (2010). Management Information System of Community Forests. Federation of Community Forests Users Group Nepal, Kathmandu.

FRS, 1973. Forest Statistics: Hill Region, Forest Resources Survey, Department of Forestry, Nepal, Babarmahal, Kathmandu

GoN, 2063 B.S. Proposed Bill for the arrangement of Nepal Electricity Regulatory Commission (Nepali), 2063

GoN, 2063B.S. Proposed Bill to amend and consolidate Electricity Act (Nepali), 2063

Hainoun, et al., 2006. Analysis of the Syrian long-term energy and electricity demand projection using the end-use methodology, Energy Policy 34, 1958-1970

Himal Energy Pvt. Ltd. and Ogerta Pvt. Ltd., 2004. Report on Solar Water Heating System Database in Nepal, HMG/MoST/AEPC, June 2004

HMG, 1988. Master Plan for the Forestry Sector Nepal, Executive Summary, MPFSP, Ministry of Forests and Soil Conservation, Kathmandu, 1988

HMG/NPC, 2002. Tenth Five Year Plan (2002 – 2007), 2002

http://www.cbs.gov.np/National%20Account/GDP%20Historical%20Series.htm

http://www.iges.or.jp/en/ue/index.htm) Global Environmental Strategies (IGES), Japan.

http://www.unisdr.org

IAEA, 2005. Energy Indicators for Sustainable Development: Guidelines and Methodologies, International Atomic Energy Agency, Vienna, Austria

ICIMOD/MoEST/UNEP, 2007. Kathmandu Valley Environmental Outlook, International Centre for Integrated Mountain Development, Kathmandu, January 2007.

IDA-World Bank, 1982. Nepal Second Forestry Project, Sociological (Baseline Survey in Project Area, Nepal Terai Project, Annex 2), The World Bank.

IDA-World Bank, 1983. Staff Appraisal Report of Nepal Second Forestry Project (Terai Forestry Project), Report No. 4353-NEP, World Bank, June 8, 1983

IEA, 1997. Indicators of energy use and efficiency: understanding the link between energy and human activity, International Energy Agency, Paris, France

IEA, 2006. World Energy Outlook, 2006, International Energy Agency, Paris, France.

IEA, 2007. Key Energy Statistics, 2007, International Energy Agency, Paris, France.

IEA, 2008. Energy Technology Perspectives, 2008: Scenarios and Strategies to 2050, International Energy Agency, Paris, France.

IEA, 2008. World Energy Outlook, 2008, International Energy Agency, Paris, France.

IEA, 2008. World Trends in Energy use and Efficiency: Key Insights from IEA Indicator Analysis, International Energy Agency, Paris, France.

IEA, 2010a. Energy Balances of Non OECD Countries. International Energy Agency, Paris, France.

IEA, 2010b. World Energy Outlook 2010. International Energy Agency, Paris, France.

International Financial Statistics: Year Book, 2002

International Monetary Fund (IMF), 2006. Nepal: 2005 article IV consultation – staff report: public information notice on the executive board discussion and statement by the Executive Director for Nepal, IMF

IPPAN, 2005. Road Map to Power Investors in Nepal, December 2005

Joshi, Ananda Raj, Shrestha, Surendra Lal and Joshi Kunjani, 2003. Environmental Management and Sustainable Development at Crossroad, Book, AnKus, Nepal

Kanel, K.R., 1998, Fuelwood Trade and Marketing in Nepal, in RWEDP, Report No.51, Woodfuel Trade in Nepal: National Workshop, Dhulikhel, 25-28 August, 1998, FAO, Regional Wood Energy Development Programme in Asia, Bangkok, January, 2000

Karki, A.B., Shrestha, and Bajgain, S., 2005. Biogas: As Renewable Source of Energy in Nepal, Theory and Development. BSP-Nepal, Kathmandu 2005.

Khanal, D. R. and Sharma, G. N., 1992. A Macroeconometric Model of Nepal in SAARC Link, S.N.H. Nagvi and S. A. Samad (ed.), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India

Khanal, D. R., Thapa, P. J. and Elbers, C., 1987. A Regionally Disaggregated Planning Models for Nepal, NPC/ESCAP/IDS/ISI, Kathmandu, Nepal

Khanal, D.R., Elbers, P.J. and Bade, J., 1989. Analysis of Sectoral Consistency and Growth Projections for the Eighth Plan (mimeo), NPC/ESCAP/ESI, Kathmandu, Nepal

Khatiwada, Yub Raj, and Suman K Sharma, 2004, Nepal: Country Report (Global Research Project), South Asia Network of Economic Research Institute (SANEI)

Loulou, Richard, Gary Goldstein and Ken Noble, 2004, Documentation for the MARKAL Family of Models, Energy Technology Systems Analysis Programme, http://www.etsap.org/tools.htm

MAED, 2006. Model for analysis of energy demand (MAED-2), Computer manual series no.18, International Atomic Energy Agency (IAEA), Vienna, Austria

Masud, Jamil, and et al, 2007, Energy for All: Addressing the Energy, Environment and Poverty Nexus in Asia, Asian Development Bank, Manila, Philippines

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 (March 1999).

MoE, 2009. *Developing Ten Thousand Megawatt of Hydropower in Ten Yearly.* Kathmandu, Nepal: Hydro-electricity Development Plan Formulation Taskforce 2065, Ministry of Energy, Kathmandu.

MOEST, 2002. National Assessment Report on Sustainable Development

MOEST, 2003. Sustainable Development Agenda for Nepal, [http://www.moest.gov.np]

MoF, 1988. Master Plan for the Forestry Sector Nepal, Executive Summary, MPFSP, Ministry of Forests and Soil Conservation, Kathmandu, 1988.

MoF, 1991. Economic Survey: Fiscal Year 1990/91, July, Ministry of Finance, Kathmandu, Nepal

MoF, 1999. Economic Survey: Fiscal Year 1998/99, July, Ministry of Finance, Kathmandu, Nepal

MoF, 2003. Economic Survey: Fiscal Year 2002/2003, July, Ministry of Finance, Kathmandu, Nepal

MoF, 2006. Economic Survey 2005/06. Ministry of Finance, GoN, Kathmandu.

MoF, 2007. Economic Survey 2006/07. Ministry of Finance, GON, Kathmandu.

MoF, 2009. Economic Survey 2008/09. Ministry of Finance, GoN, Kathmandu

MoFSC, 1988. Master Plan for the Forestry Sector Nepal, Institutional Development Plan, Ministry of Forest and Soil Conservation, GoN, 1988

MoL,1992. Electricity Act 2049, Justice and Parliamentary,Ministry of Law, GON,2049

MoWR , 2004. Working paper on Nepal development Forum 2004 on Water Resource Development sector (Hydropower), February 2004.

MoWR, 2001. The Hydropower Development Policy 2001 (2058 B.S)

MoWR, 2064 (B.S.), Report on Finding Immediate Solutions for the Removal of Load Shedding

MoWR, 2065 (B.S.), Report on Development of 10,000 MW of Hydropower in coming Ten Years.

MoWR,2009. Ten Yearly Hydro-electricity Development Plan Formulation Taskforce 2065 (in Nepali), Ministry of Water Resources, GON, 2009 (Chaitra 2065)

MPFS, 1988. Master Plan for the Forestry Sector Nepal. Main Report. Government of Nepal, Kathmandu.

NEA, 2004, Corporate Development Plan FY 2003/04-2007/08, Summary, Nepal Electricity Authority, February 2004.

NEA, 2005. Corporate Plan. Nepal Electricity Authority, Kathmandu, Nepal.

NEA, 2005/06. Nepal Electricity Authority – Annual Report

NEA, 2005/2006. A Year in Review, Nepal Electricity Authority, Durbar Marg, Kathmandu,August 2006

NEA, 2006. “White Paper” August 2006.

NEA, 2006. A Year in Review 2005/06. Nepal Electricity Authority, Kathmandu.

NEA, 2007. Presentations on Electricity Supply situations. Nepal Electricity Authority, Kathmandu, Nepal.

NEA, 2008. A Year in Review 2007/08. Nepal Electricity Authority, Kathmandu.

NEA, 2009. A Year in Review 2008/09.

NEA, 2065BS. Power Development of Nepal, Vidyut, Year 19, Vol.1, Bhadra 2065. Nepal Electricity Authority, Kathmandu

NEFEJ, 2006. Light of Progress – Lessons learnt from lighting Humla villages with Solar Energy, NEFEJ, 2006.

Noble, Ken, 2007. ANSWERV6 – MARKAL User Manual: ANSWER MARKAL, an Energy Policy Optimization Tool. Noble –Soft Systems Pty Ltd, Ridgeway, Australia.

NOC, 2007. Imports and sales statistics. Nepal Oil Corporation, Kathmandu, Nepal.

NOC, 2009. Prabhat: An Annual Report 2008/09. Nepal Oil Corporation, Babarmahan, Kathmandu.

NOC, 2010. *Annual Repor t 2010.* Nepal Oil Corporation, Kathmandu.

NOC,2065 (BS). Prabhat: An Annual Report (2064/2065). Nepal Oil Corporation, Babarmahal, Kathmandu

Norconsult, 1998. Power System Master Plan for Nepal: Generation Expansion Plan (draft report). NEA/ Asian Development Bank.

NPC, 1975. Fifth Plan (1975-1980), HMG/N, The National Planning Commission, Kathmandu, 1975

NPC, 1980. Sixth Plan (1980-1985), HMG/N, The National Planning Commission, Kathmandu, February, 1980

NPC, 1985. Seventh Plan (1985-1990), HMG/N, The National Planning Commission, Kathmandu, June, 1985

NPC, 1992. Eighth Plan (1992-1997), HMG/N, The National Planning Commission, Kathmandu, June, 1992

NPC, 1995. Perspective Energy Plan for Nepal, Vol. I: Summary, National Planning Commission Secretariat, Kathmandu, April 1995.

NPC, 1995. Perspective Energy Plan for Nepal, Vol. I: Summary, National Planning Commission Secretariat, Kathmandu, April 1995.

NPC, 1997. Ninth Plan (1997-2002), HMG/N, The National Planning Commission, Kathmandu, June, 1997

NPC, 2002. Concept Paper on PRSP/10th Plan, National Planning Commission, Singha Durbar, Kathmandu, February 2002.

NPC, 2002. Tenth Five Year Plan (2002-2007) – Poverty Reduction Strategy Programme, National Planning Commission, GON

NPC, 2003. Sustainable Agenda for Nepal, HMG-Nepal, National Planning Commission, Singha Durbar, Kathmandu.

NPC, 2003. Tenth Five -Year Plan 2002-2007, National Planning Commission, Government of Nepal, 2003

NPC, 2006. An Assessment of the Implementation of the Tenth Plan/PRSP: PRSP Review 2005/06, Government of Nepal, National Planning Commission, Singha Durbar, Kathmandu, December 2006.

NPC, 2007. Three Year Interim Plan 2007-2012. National Planning Commission, GON, Kathmandu, Nepal.

NPC,1995. Nepal Agricultural Perspective Plan, National Planning Commission Secretariat, Kathmandu, Nepal.

NPC/CBS, 2006. Statistical Pocket Book Nepal 2006, Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu.

NPC/UNDP, 2005. Nepal Millennium Development Goals: Progress Report 2005, HMG Nepal, National Planning Commission/United Nations Country Team of Nepal, Singha Durbar, Kathmandu, Nepal.

NRB, 1975. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-July, 1975

NRB, 1976. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-July, 1976

NRB, 1981. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-July, 1981

NRB, 1982. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-July, 1982

NRB, 1983. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-April, 1983

NRB, 1992. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-April, 1992

NRB, 1994. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-Jan, 1994

NRB, 2002. Quarterly Economic Bulletin, Nepal Rastra Bank, Kathmandu, Nepal, Mid-July, 2002

OECD, 2003. Development and Climate Change in Nepal: Focus on Water Resources and Hydropower, OECD, 2003.

Planning Commission, 2006. Integrated Energy Policy: Report of the Expert Committee. Planning Commission, GOI, New Delhi, India.

Planning Commission, 2007. The working group report on road transport for the eleventh five year plan. Planning Commission, GOI, New Delhi, India.

Pokhharel, Shaligram, 2004. Energy economics of cooking in households in Nepal. Energy 29, 547 - 559.

Pradhan, P.M.S., 2004. Water Resources Development Sector, February 2004

Pradhan, P.M.S., 2006 Hydropower Development 2006

Pradhan, Shreekar, 2004, Investment option in transport sector through Clean Development Mechanism, M. Sc. Unpublished Thesis, Department of Mechanical Engineering, Pulchowk Campus, Institute of Engineering, Tribhuvan University.

Pradhan, Shreekar, Ale, Bhakta Bahadur and Amatya Vishwa Bhusan, 2006. Mitigation potential of greenhouse gas emission and implications on fuel consumption due to clean energy vehicles as public passenger transport in Kathmandu Valley of Nepal: A case study of trolley buses in Ring Road, Energy, 31, 1412 – 1424

RETRUD, 2006. Proceedings of Renewable Energy Technology for Rural Development, AEPC/CES/IOE/TU/NSES

Rotberg, Fiona, 2006. Nepal Environment Scarcity and State Failure, Environmental Security Issues, Sweden

RWEDP, 1996. Woodfuel Flows: An Overview of Four Studies Carried Out on Behalf of or with Support from FAO-RWEDP, Report No.30, FAO Regional Wood Energy Development Programme in Asia, Bangkok.

RWEDP, 2000. Wood Energy, Climate and Health: International Expert Consultation, 7-9 October 1999, Phuket, Thailand, Field Document No. 58, FAO, Bangkok, April 2000.

SASEI, 2005a. Nepal: transport at a glance. The South Asia Energy and Infrastructure group of World Bank, World Bank, Washington DC, USA.

SASEI, 2005b. Srilanka: transport at a glance. The South Asia Energy and Infrastructure group of World Bank, World Bank, Washington DC, USA.

Sharma, G., 1989. Nepalese Plan Performance, Nirala Series 5, Jaipur, New Delhi

Shell, 2003. Scenarios: An Explorer's guide. Global Business Environment, Shell International Limited, London, UK.

Shrestha, D. L., 1992. Input-Output Model: Its Applications in Planning in Nepal, Strengthening the National Planning Commission Secretariat Project, UNDP/IBRD, NEP/88/017, Kathmandu, Nepal

Shrestha, D. L., 1993. An Accounting Model for Macroeconomic Analysis in Nepal, Strengthening the National Planning Commission Secretariat Project, UNDP/IBRD, NEP/88/017, Kathmandu, Nepal

Shrestha, D.L. and Sapkota, P.R., 2002. Integrated Macro-econometric and Input-Output Model of Nepal: Developed for the Formulation of the Tenth Plan, Kathmandu, Nepal

Shrestha, J. N. et. al., 2006. Solar Radiation in Nepal: Its Implications in Telecommunication Services, Proceedings of First National Conference in Renewable Energy Technology for Rural Development, Center for Energy Studies, Institute of Engineering, T.U., 12-14 October 2006

Shrestha, J. N., 2001. Application of Photovoltaic Technology for Income Generating Activities, Vol. 20, No. 2, Nataional Planning Commission, January 2001.

Shrestha, V.S., Shrestha, D.L. and Yadav, U., 1997. Final Report on Economic, Financial and Private Sector, Study Water Resources Strategy Formulation Programme, Phase I, HMG/The World Bank, (JGF) Project, Annex 2: Macroeconomic Framework, Kathmandu, Nepal

Shukla, P R, et al., 2007. Balancing Energy, Development and Climate Priorities in India: Current Trends and Future Projections. UNEP Riso Centre, Riso National Laboratory, Technical University of Denmark, Roskilde, Denmark.

Singh, Inderjeet and Axel Michaelowa, 2004.Indian urban building sector: CDM potential through energy efficiency in electricity consumption Hamburg Institute of International Economics, HWWA discussion paper 289, Hamburg, Germany.

SNC-LAVLIN, 2007. Electricity Market Surplus, Private Sector Participation and Rural Electrification, IDA, NEA, March 2007

TERI, 2002. Defining an Integrated Energy Strategy for India. Tata Energy Research Institute, New Delhi, India.

TERI, 2006. National Energy Map for India: Technology Vision 2030. Office of the Principal Scientific Advisor, Government of India & the Energy and Resources Institute, New Delhi, India.

TERI, 2008. National TERI Energy Data Directory & Year Book 2007. The Energy and Resources Institute, New Delhi, India.

THAKUR Kirti Chand. Nepal Power Sector Reform

Thapa, S.R., 2008. Jalavidyut Punasamrachana Ra Sambhavana, Kantipur Daily, 20 Bhadra 2065

UN, 2007. Assessing policy options for increasing the use of renewable energy for sustainable development: modelling energy scenarios for Sichuan, China. UN Headquarters, New York, USA.

UNDP, 2004. Visions of Risk: A Review of International Indicators of Disaster Risk and its Management. ISDR, Inter –Agency Task Force, UNDP.

UNDP, 2005. Human Development Report 2005, United Nations Development Programme

UNDP, 2005. Nepal Annual Report 2005, United Nations Development Programme

UNDP, 2006. Human Development Report, United Nations Development Programme

UNDP, 2007. Overcoming vulnerability to rising oil prices: options for Asia and Pacific. Regional Energy Programme for Poverty Reduction. UNDP Regional Center, Bangkok.

UN-energy, 2006. Assessing policy options for increasing the use of renewable energy for sustainable development: modelling energy scenarios for Ghana. UN Headquarters, New York, USA.

WECS (1998). Industrial Sector Energy Consumption: Traditional and Modern (1997/98). Water and Energy Commission Secretariat, Kathmandu.

WECS, 1988. District, Regional and National Forest Cover Class Summaries of the Area, Fuelwood Yield and Wood Volume for the Kingdom of Nepal, Vol I & II. Kathmandu.

WECS, 1997. Update and compilation of energy resources and consumption profile of Nepal. WECS, MOWR, GON.

WECS, 1998. Energy Synopsis Report-Nepal, 1994/95, Water and Energy Commission Secretariat, Singh Darbar, 1998

WECS, 2000. Detailed Energy Consumption Survey in Transport Sector of Nepal. Water and Energy Commission Secretariat, Ministry of Water Resources, Government of Nepal, Kathmandu, Nepal.

WECS, 2000. Nepal Water Resources Strategy 2000, Water and Energy Commission Secretariat

WECS, 2001, Agricultural Sector Energy Consumption in Nepal, Water and Energy Commission Secretariat, Ministry of Water Resources, Government of Nepal, Kathmandu, Nepal.

WECS, 2001. Wood Energy Planning: Nepal. A country case study sponsored by Regional Wood Energy Development Programme, FAO, Thailand and WECS International Development Project, CIDA, Kathmandu, Nepal.

WECS, 2002. Water Resources Strategy Nepal, HMG/N, Water and Energy Commission Secretariat, January, 2002

WECS, 2004. National Water Plan Draft Report, HMG/N, Water and Energy Commission Secretariat, Water Resources Strategy Formulation, Project III: National Water Plan, February, 2004

WECS, 2005. Final Report for Detailed Energy Consumption Survey in Urban Residential Sector of Nepal. Water and Energy Commission Secretariat, Ministry of Water Resources, Government of Nepal, Kathmandu, Nepal.

WECS, 2005. National Water Plan for Nepal. Water and Energy Commission Secretariat, Ministry of Water Resources, Government of Nepal, Kathmandu, Nepal.

WECS, 2006. Energy Synopsis Report 2006, Government of Nepal, Water and Energy Commission Secretariat, June 2006.

WECS, 2010. Energy Sector Synopsis Report 2010. Water and Energy Commission Secretariat, Kathmandu.

WECS,1987. Fuelwood Supply in the District of Nepal. Water and Energy Commission Secretariat, Kathmandu.

WECS,1995. Institutional Arrangements: Energy Sector, Perspective Energy Plan, supporting document No. 10: Water and Energy Commission Secretariat, Nepal, 1995

WECS. 2005. National Water Plan Nepal, Water and Energy Commission Secretariat, Kathmandu

WFSC, 1988. Master Plan for the Forestry Sector Nepal. Ministry of Forests & Soil Conservation, HMG/N, Kathmandu, Nepal.

Winkler, Harald and et. al, 2005. Cape Town Energy Futures: Policies and Scenarios for Sustainable City Energy Development. Energy Research Centre, University of Cape Town, South Africa.

Winkler, Harald, 2007. Energy Policies for Sustainable Development in South Africa. Energy for Sustainable Development, vol XI No.1.

World Bank, 2006. Cambodia Energy Sector Strategy Review: Issue Paper. World Bank, Washington DC, USA.

World Bank, 2006. Technical and Economic Assessment of Off-grid, Mini - grid, and grid Electrification Technologies: Annexes. Energy Unit, Energy, Transport, and Water Department, The World Bank Group.

World Bank, 2007. The Little Green Data Book.

WRSF Consortium, 2000. Water Resources Strategy Formulation, Phase II Study, Annex 2: Macroeconomic Framework, Kathmandu, Nepal

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Strategic Options

Institutional Strategy

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S.no	**Strategy**	**Strategic Action**	**Time Frame**	**Main Responsibility**	**Co-operating Institutions**
1	Integrated Energy Planning (IEP)	- Prioritize water as the lead energy resource	- Short-term	Government of Nepal (GoN)/ Council of Ministers (COM)	NPC, WEC/WECS, MOE
		- Designate WEC/WECS at the lead central agency for IEP	- Short-term	GoN/COM	NPC, WEC/WECS, MOE, MOEST, MOFSC, MOI, MOCS,MOAC
		- Elevate Chairmanship of WEC to prime ministerial level to make it apex body for national energy security and integrated planning - Broaden WEC into a water and energy council to make it more representative for all relevant stakeholders - Cause all the sub-sectoral public institutions in energy to procedurally link their sub-sectoral plan with the integrated energy plan to be prepared by WEC/WECS to support NPC periodic plan	- Short-term	GoN/COM	MOE, WEC/WECS
		- Develop IEP capacity at the central level	- Short-term	WEC/WECS	Professional/Academic Institutions
2	Level Playing field for all types of stakeholders (public, private, local/ regional bodies, cooperatives)	- Eliminate monopoly in a) hydropower transmission, distribution, b) fuelwood generation/ harvesting, c) import, storage, transfer and distribution of petroleum product	- Short-term	GoN/COM	MOE/NEA, MOCS/NOC, MOFSC/TCN
3	Autonomy to Public Company	- Grant autonomy to NEA, NOC, AEPC and TCN from instable and partisan political leadership in order to support them to grow as competitive self-managed entity - Fix respective ministry as contact ministry for NEA, NOC, AEPC and TCN	- Short-term	GoN/COM	WEC/WECS, MOE, MOEST/AEPC, MOFSC,TCN, MOCS/NOC

S.no	Strategy	Strategic Action	Time Frame	Main Responsibility	Co-operating Institutions
4	Independent integrated energy regulatory commission	- Expedite enactment of proposed independent Electricity Regulatory Commission (ERC)	- Short-term	GoN/COM	MOE/NEA, MOCS/NOC, MOFSC/TCN, Private Developers
		- Authorize ERC to prepare regulatory provisions for fossil fuels and integrate them in ERC Act	- Short-term	GoN	MOCS/NOC, MOL, Private Sectors
		- Empower ERC to act as regulator for fossil fuels as well under the amended Act	- Medium term	GoN	MOCS/NOC, MOL, Private Sectors
		- Continue to develop Act to include regulatory provisions for other energy sub-sectors in a phased manner	- Medium term	GoN	MOEST/AEPC, MOFSC,TCN, Proposed Biomass Promotion Center
5	Official Recognition to partnership	- Provide official recognition to partnership forged between any of the public, private, Local government bodies, co-operative and community entities established under law for energy development	- Short-term and Continuous	GoN	NPC, WEC/WECS, MOF
6	Decentralized Integrated Energy Plan	- Formulate and implement decentralized integrated energy plan to balance demand and supply of energy at the local level	- Short-term and Continuous	DDC/EEU	WEC/WECS and other Energy Institutions
7	Empowerment of weak Socio-economic groups	- Empower weak socio-economic groups	- Short-term and Continuous	DDC/EEU	WEC/WECS and other Energy Institutions
8	Equitable benefit distribution from energy development programs	- Establish a local mechanism for equitable benefit distribution from energy development programs - Financially compensate each member in hydropower project-affected family at the average current national per capita level through out the life of the project (100% of per capita for very severely affected; 60% for severely affected and 30% for moderately affected).	- Short-term - Short-term	GoN	WEC/WECS, MOE, MOF, DDC, Energy and Environment Unit (EEU)
9	Regular experience Sharing and interaction among stakeholders at all levels for raising awareness on sustainable energy development	- Establish Energy Information and Dissemination Center for regular experience sharing and interaction among stakeholders at national, regional/basin and local levels	- Short-term and Continuous	WEC/WECS	NEA, NOC, AEPC, TCN, Professional Training/Academic Institutions, relevant regional level agencies, DDC/EEU

S.no	Strategy	Strategic Action	Time Frame	Main Responsibility	Co-operating Institutions
10	Multi-pronged forest and agriculture development programs with energy component	- Introduce and strengthen multi-pronged forest and agriculture development programs with energy component	- Short-term and Continuous	MOFSC, MOA	WEC/WECS, AEPC
11	Energy efficiency and conservation culture	- Authorize and strengthen Nepal Bureau of Standard for promoting energy efficiency and conservation culture	- Short-term	GoN	MOI, WEC/WECS, MOE
		- Amend Nepal Standard Act 1980 and Nepal Standard Certification Act 1988 for Energy Audit, Investigation, Cost-Benefit based technical analysis, Consumption standards, Certification, information dissemination and curriculum development	- Medium-term	GoN	NBS/MOI, MOE/NEA, MOL, Industries Information Centers, Media, Professional/Academic Institutions
12	Biomass Energy Promotion	- Establish a separate autonomous and self-managed biomass promotion center as per the proposed energy classification to identify and promote modern biomass energy, (Improved Cook stoves, charcoal, forest and agriculture residues, bio-liquid, biogas)	- Short-term and Continuous	GoN	MOA, MOFSC, WEC/WECS, MOEST/AEPC

The strategies and the related activities are tabulated in detailed form in the following energy strategic options matrix.

Group 1	1 Fossil Fuel Petroleum Products, Natural Gas and Coal		
S.N	Strategic Options	Major Activities	Target
1.1	Discourage the use of fossil fuels by promoting the use of alternative fuels in transportion and machineries	1.1.1 Progressively decrease the use of fossil fuels in transportation and machineries, and subsequently increase the use of alternative fuel.	1.1.1 Immediately (by 2012)
		1.1.2 Promote the production and use of producer gas in gasifier, bio-diesel, and ethanol in motor vehicles.	1.1.2 Within 2 Years
		1.1.3 Promote the use of electric vehicles in urban areas as per the need. Exempt tax in the purchase of such vehicles.	1.1.3 Immediately (by 2012)
		1.1.4 Promote walking (upto 5 km distance, wherever possible).	1.1.4 Immediately (by 2012)
		1.1.5 Prohibit the use of the polluting vehicles in the core parts of the city.	1.1.5 By 2015
		1.1.6 Displace 2-stroke vehicles operating on fossil fuels from the country.	1.1.6 Immediately (by 2012)
		1.1.7 Organize mass awareness and interaction programmes on the use of appropriate and good quality fossil fuels.	1.1.7 Immediately (by 2012)
		1.1.8 Monitor the use of fossil fuel as per standard parameters.	1.1.8 Immediately (by 2012)
1.2	Increase the storage capacity of petroleum products	1.2.1 Increase the storage capacity of petroleum products.	1.2.1 Maintain the storage capacity of 45 days and 90 days by 2015 and 2030 respectively.
		1.2.2 Involve the private sectors in purchase, storage and distribution of the petroleum products.	1.2.2 Immediately (by 2012)
		1.2.3 Assist the private sectors to provide loans and develop infrastructures.	1.2.3 Immediately (by 2012)

Group 1	1 Fossil Fuel Petroleum Products, Natural Gas and Coal		
S.N	Strategic Options	Major Activities	Target
1.3	Plan the exploration and promotion of petroleum, coal and natural gas in the country	1.3.1 Conduct feasibility study. Provide financial and technical support. 1.3.2 Formulate appropriate policy and rules for implementation. 1.3.3 Create favorable environment to encourage the national and international companies for exploration of petroleum products. 1.3.4 Explore and promote the natural gas reserved in Kathmandu Valley. 1.3.5 Create favourable condition as well as provide necessary security for exploration work. Ensure coordination and cooperation among the political parties in the exploration areas.	1.3.1 by 2015 1.3.2 by 2012 1.3.3 by 2012 1.3.4 Immediately (by 2012) 1.3.5 Immediately (by 2012)
1.4	Develop an effective mechanism to reduce air pollution from the use of fossil fuels	1.4.1 Fix the vehicular emission standards and enforce them strictly. 1.4.2 Permit the operation of new industries running on fossil fuels as per standard in allocated areas only. 1.4.3 Promote the vehicles operated by alternative energy (Electric and Hybrid Vehicles). Exempt import tax to these vehicles. 1.4.4 Make the amendments in the existing rules for the displacement of 20 years old vehicles, and strictly implement the new rule. 1.4.5 Fix equal price for all the petroleum products to reduce adulteration in petroleum products. 1.4.6 Introduce electric rail-way system.	1.4.1 Immediately (by 2012) 1.4.2 Immediately (by 2012) 1.4.3 Immediately (by 2012) 1.4.4 Immediately (by 2012) 1.4.5 Immediately (by 2012) 1.4.6 Immediately (by 2012)

Group 1	1 Fossil Fuel Petroleum Products, Natural Gas and Coal		
S.N	Strategic Options	Major Activities	Target
		1.4.7 Inform people about the harmful effects of pollution generated by petroleum products.	1.4.7 Immediately (by 2012)
		1.4.8 Make public transportation more accessible. Encourage people to use public vehicles.	1.4.8 Immediately (by 2012)
		1.4.9 Use Pollution Tax collected from the use of fossil fuels in environment conservation activities.	1.4.9 Immediately (by 2012)
		1.4.10 Use energy efficient technology/ies in industries and factories.	1.4.10 Immediately (by 2012)
		1.4.11 Update timely the Air Quality Standards and strictly enforce them.	1.4.11 Immediately (by 2012)
		1.4.12 Implement afforestation plan in energy fuel exploration area.	1.4.12 Immediately (by 2012)
1.5	Enact separate law for effective execution of import, purchase, distribution and quality control of petroleum products and energy auditing	1.5.1 Prepare Deregulatory Act to introduce fair competition on purchase, import and distribution of the petroleum products. Enforce the act along with development of regulatory mechanism.	1.5.1 Immediately (by 2012)
		1.5.2 Establish a separate unit equipped with rights and resources under Department of Quality Control and Measurement for quality control of petroleum products.	1.5.2 Immediately (by 2012)
		1.5.3 Make regular quality test of petroleum products mandatory. Strictly enforce energy auditing for quality assurance.	1.5.3 Immediately (by 2012)
		1.5.4 Conduct awareness programmes on Energy Auditing. Produce competent manpower for energy auditing.	1.5.4 Immediately (by 2012)
		1.5.5 Prepare manual on energy auditing.	1.5.5 Immediately (by 2012)

Group 1	1 Fossil Fuel Petroleum Products, Natural Gas and Coal		
S.N	Strategic Options	Major Activities	Target
		1.5.6 Legally make the sale of petroleum products not matching the specified quality/standards a punishable crime.	1.5.6 Immediately (by 2012)
		1.5.7 Notify the people about the quality standards of petroleum products at the petrol pumps.	1.5.7 Immediately (by 2012)
		1.5.8 Make the monitoring of awareness programmes open to the local consumers' Rights Forum/Committees.	1.5.8 Immediately (by 2012)
		1.5.9 Establish the agencies for quality standardization of the petroleum products in accessible sites in the districts and regions.	1.5.9 Immediately (by 2012)
1.6	Formulate Integrated Energy Development Plan in a way to implement it in a decentralized manner	1.6.1 Establish a Ministry of Energy and Provide rights to the local bodies for energy plan formulation and implementation at their level.	1.6.1 by 2018 (ministry already established)
1.7	Establish mechanism for equitable distribution of the state royalty earned by energy	1.7.1 Equitably distribute state royalty to the local bodies.	1.7.1 Immediately (by 2012)
1.8	Indicate a responsible agency to coordinate the energy development plans developed by such sectoral agencies	Propose Ministry of Energy to be responsible for this task.	1.8.1 After establishment of Ministry of Energy
		Ensure level playing field for all types of stakeholders (local bodies, public agencies, private sectors etc.) and develop the capacity of these institutions.	1.8.2 Immediately (by 2012)
1.9	Establish and institutionalize mechanisms to share experience and have regular interaction among relevant stakeholder at national,	1.9.1 Establish Energy Information Centre at central and regional levels. These centers will facilitate dissemination of information about energy and experience sharing.	1.9.1 Immediately (by 2012)
		1.9.2 Disseminate information about energy through conduction of	

Group 1	1 Fossil Fuel Petroleum Products, Natural Gas and Coal		
S.N	Strategic Options	Major Activities	Target
	regional and local levels	Radio Programmes, workshops, TV programmes and use of internet.	1.9.2 Immediately (by 2012)
		1.9.3 Conduct various energy related programmes to develop skill, to create mass awareness.	1.9.3 Immediately (by 2012)
		1.9.4 Provide governmental scholarship to produce experts on fossil fuels. Also, provide training, study and exposure visits for high skill and knowledge development on fossil fuels.	1.9.4 Immediately (by 2012)
		1.9.5 Develop curricula on energy and introduce these curricula at colleges and universities.	1.9.5 Immediately (by 2012)
		1.9.6 Publish articles as well as disseminate information and advertisement through television and other means of communication.	1.9.6 Immediately (by 2012)
		1.9.7 Establish Information Division or Information Section under WECS for communication and dissemination of information about the uses and effects of energy.	1.9.7 Immediately (by 2012)
		1.9.8 Encourage the local communication media to present programmes about energy in the local language.	1.9.8 Immediately (by 2012)
		1.9.9 Mobilize the media to communicate the positive impacts realized as a result of efficient energy use through press conference, field visit etc.	1.9.9 Immediately (by 2012)

Group 2	2. Renewable Energy Hydropower (Large, medium, small and micro hydropower project)		
S.N	Strategic Options	Major Activities	Target
2.1	Prioritize hydro-power as lead energy resource in National Energy Strategy and develop it accordingly.	2.1.1. Prepare a long-term plan for each river basin with the aim of achieving maximum benefit to the government. 2.1.2. Draft concrete plans to identify the potential projects, prioritize them on the basis of economic and technical aspects considering present and future demand of electricity and generate it to meet the projected demand. The formulation of such plans must include storage type projects of optimum capacities to fulfill the highest electricity demand. 2.1.3. Develop hydropower projects of multi-purpose nature (i.e. by considering Agriculture, Tourism and Irrigation sectors), wherever they are economically and technically feasible. Give due consideration to the conservation of water shed areas wherever possible during such process. 2.1.4. Give priority to small and mini-micro hydropower plants that can be immediately developed through internal resources, specially the ones in the rural and remote areas, where extension of national grid is economically not feasible. Attract local investors by creating investment friendly-environment and providing necessary facilities for the development of these projects. 2.1.5. The prevailing system of extending the validity of expired licenses, on the pretension of various excuses, should be immediately discouraged and the ones which are being developed seriously should be highly encouraged 2.1.6. Analyze the cost of production of storage projects and propose appropriate and attractive purchase price to encourage the private sectors for the investments in storage type projects.	
2.2	Provision of national/regional/local transmission lines at the very beginning of hydro-power project/plan formulation stage.	2.2.1. Identify and install the high voltage cross-border and domestic transmission lines of different capacities in close coordination with the electricity generation centers to evacuate the electricity being generated at present and the ones planned for the future for power trade between Nepal and India.	

Group 2	2. Renewable Energy Hydropower (Large, medium, small and micro hydropower project)		
S.N	Strategic Options	Major Activities	Target
		2.2.2. Prepare Transmission Line Master Plan to evacuate the electricity generated from the hydropower projects to be implemented in future as described in section 2.1.1. 2.2.3. On the basis of need and feasibility, initiate in coordination with respective municipalities, the installation of underground transmission and distribution systems within the metropolitan areas.	
2.3	Assure the effective Implementation of Demand Side Management Process.	2.3.1. Encourage the general public to use the less electrical energy consuming bulbs and other electrical appliances. 2.3.2. Encourage the industrialists to enhance the capacity of their transformers by increasing their power factors by installing capacitors in their systems. 2.3.3. Take necessary actions to operate the existing transmission lines in full capacity or also construct the new ones in order to minimize the prevailing technical losses. Encourage the community people and private sectors to mobilize themselves to take the necessary actions to reduce non-technical losses of electricity.	
2.4	Assure the effective implementation of electricity supply process	2.4.1. Since the repairs and maintenance of hydropower related appliances and equipment- the obvious regular jobs at any hydropower plants- are not being undertaken by the concerned agencies, arrangements be made to make it mandatory for them. Implement the projects which can be launched immediately. Minimize electric leakages. 2.4.2. Prepare a Transmission Line Master Plan by taking into account the hydropower development projects as formulated in river basin development plans. 2.4.3. Encourage communities to make the use of solar and other alternative energy sources for providing lights in public areas including roads.	

Group 2	2. Renewable Energy Hydropower (Large, medium, small and micro hydropower project)		
S.N	Strategic Options	Major Activities	Target
		2.4.4. Implement the feasible hydropower projects immediately.	
2.5	Ensure encouragement and promotion of electric and energy efficient transportation means in National Transport Policy	2.5.1. Identify the most feasible electrical and fuel efficient transportation systems and encourage their smooth operation by providing them with duty free tax facilities, developing necessary infrastructures and draft National Electric Transport Policy to materialize them. 2.5.2. Ensure continuous supply of electricity to the electrical vehicle recharge stations.	
2.6	Encourage the national as well as international private investors in hydropower sectors	2.6.1. In order to attract the international investments in the large hydropower projects giving maximum benefits to the country, ensure the guarantee of security of investment, provide income tax facilities for a specified time, create investment-friendly environment, develop necessary infrastructures like transmission lines and roads and implement strictly the existing one-door policy. 2.6.2. The role of facilitator be played by the government by taking the local people into confidence and thus avoiding any obstacle from the side of local people – a prerequisite for ensuring international investments on large hydropower projects. 2.6.3. Ensure guarantee of local investment, provide income tax facilities in the imported construction materials and hydropower related goods and draft simple policy to create investment friendly environment so that the local investments of individual people, groups and developing agencies are attracted in medium scale hydropower projects.	
2.7	Develop mechanism for equitable and decentralized distribution of the benefit achieved from hydropower projects	2.7.1. Make necessary arrangements to connect the surplus seasonal electricity, which is generated from the small hydropower plants developed on local initiatives, to the national grid. 2.7.2. Revise, modify, if necessary, and subsequently implement the Manual on Electricity Royalty Distribution Directives (*Jalbidhyutko Royalti Baadphaad Nirdesika)*.	

Group 2	2. Renewable Energy Hydropower (Large, medium, small and micro hydropower project)		
S.N	Strategic Options	Major Activities	Target
		2.7.3. Draft National Electrification Plan with due priority on rural electrification.	
2.8	Establish an integrated and autonomous regulatory body for the development of hydropower sector	2.8.1. Immediately establish an autonomous regulatory commission, which is already under Parliamentary committee review, to coordinate the power generation, transmission and distribution agencies of hydropower sectors.	
2.9	Ensure level playing field for all types of stakeholders (local bodies, public agencies, private sectors etc.) and develop the capacity of these institutions	2.9.1 Identify the local stakeholders of hydropower sector and make their roles effective. 2.9.2 Provide regular training to the stakeholders of hydropower sector and organize regular interaction programs among them to enhance their capacities in their respective roles.	
2.10	Enact laws and regulations to review the current electricity generation, transmission and distribution tasks of NEA and enforce unbundling in the electricity sub-sector.	2.10.1 Take initiatives to implement the electricity act which has been proposed for long and is presently still under review.	
2.11	Ensure the role of the disadvantaged groups in electricity generation as well as its use	2.11.1 Educate on and make aware of the people from the disadvantaged/economically backward communities the different aspects of hydropower sector by providing them with various hydropower related training and interaction opportunities and uplifting the status of their education, economy, health and employment by making them the fund available from the part of the royalty that goes to the account of respective districts from different hydropower projects. 2.11.2 Make amendments in Electricity Act to ensure the utmost priority to the disadvantaged groups while recruiting manpower for the works in all kinds of hydropower related projects starting from the feasibility study to power generation, transmission, distribution and monitoring.	

Group 3: Renewable Biomass Energy A. Traditional Biomass Energy: Fire wood, Animal dung cake and agricultural residues B. Improved/Modern: Charcoal, Briquettes produced from biomass, biomass liquid fuel (Ethanol, methanol, bio-diesel, pyrolytic oil etc.), and gas produced from animal dung and other biomass produces (biogas, producer's gas etc.)			
S.N.	Strategic Options	Major Activities	Target
3.1	Nominate the Water and Energy Commission as the central focal node of the Government of Nepal with responsibility of coordination of all energy related development programmes/activities under different sectors	3.1.1 Nominate WEC as the central coordinating body with a full authority of coordination and provide necessary infrastructures to WEC.	3.1.1 To Complete by 2015.
		3.1.2 Ensue, through legislation establishment, a mechanism in WEC for periodic organization of interactions between the stakeholders of traditional and modern renewable energy resources working at different levels (i.e. central, regional and local). And also ensue similar mechanisms for coordination with other ministries related to energy development	3.1.2 To Complete by 2015.
		3.1.3 Review the present structure of WEC and ensure the representation of NGO and women's group in it	3.1.3 To Complete by 2015.
		3.1.4 Collect, compile and periodically update the list of active associations/institutions in the field of energy from district to central level.	3.1.4 Immediate initiation and to continue
		3.1.5 Establish energy units in all 75 DDCs, and if necessary also at VDC and Municipality levels, that have a clear mandate of local level coordination.	3.1.5 Immediate initiation and continuation with financial support
		3.1.6 Assist the district and (local level) energy units in their capacity development.	3.1.6 WECS to formulate appropriate mechanism and implement
		3.1.7 Establish a Basket Fund in WEC to assure financial resources needed for implementing the activities at local level.	3.1.7 As needed

Group 3: Renewable Biomass Energy A. Traditional Biomass Energy: Fire wood, Animal dung cake and agricultural residues B. Improved/Modern: Charcoal, Briquettes produced from biomass, biomass liquid fuel (Ethanol, methanol, bio-diesel, pyrolytic oil etc.), and gas produced from animal dung and other biomass produces (biogas, producer's gas etc.)			
S.N.	Strategic Options	Major Activities	Target
		3.1.8 Invite the institutions from GOs and NGOs sectors related to energy for review of the development in the energy sector 3.1.9 Establish offices at regions or near by water basins of WECS as per need and timely organize review meetings.	3.1.8 At every 2-3 year interval 3.1.9 As per need.
3.2	Ensure a conducive work environment for all stakeholders (eg. NGOs, Cooperatives and private sectors working at Centre, regions and districts) to play a supportive role from their side in the development of energy sector	3.2.1 Ensure, through legal provisions, so that WEC plays the role of facilitating agent at the central level. 3.2.2 WEC to make necessary arrangements for organizing meetings, workshops, seminars, etc. at different levels, covering different aspects of biomass energy development. 3.2.3 At the district level the respective energy units play the role of facilitator and arrange the participation of local level stakeholders. 3.2.4 Establish Energy Development Fund in the Energy Unit of DDC. 3.2.5 Make the enrollment of energy related agencies/institutions in the energy unit of DDC mandatory in energy development activities at the local level. 3.2.6 Give priority for the participation of concerned stakeholders while conducting energy related awareness raising programmes by WEC. 3.2.7 WEC to make standards for identification of stakeholders that have been working in the field of energy and to collect and periodically update their list.	3.2.1 Promulgation and Implementation of law by 2015 3.2.2 WEC to implement immediately in consultation with relevant parties 3.2.3 Include in possible/potential programme. 3.2.4 Prepare necessary outlines for establishment and conduction of fund, and go for its execution. 3.2.5 Include in methodology for management. 3.2.6 Immediate implementation 3.2.7 Initiation by 2015.

Group 3: Renewable Biomass Energy A. Traditional Biomass Energy: Fire wood, Animal dung cake and agricultural residues B. Improved/Modern: Charcoal, Briquettes produced from biomass, biomass liquid fuel (Ethanol, methanol, bio-diesel, pyrolytic oil etc.), and gas produced from animal dung and other biomass produces (biogas, producer's gas etc.)			
S.N.	Strategic Options	Major Activities	Target
3.3	Establish a mechanism for ensuring sustained supply of biomass materials for energy by incorporating biomass production as one of the many objectives of resource management in agriculture, forest and livestock sectors	3.3.1 Assure integration of biomass production and utilization for energy as one of the multiple objectives of management in forest, agriculture and livestock sectors through a long-term national energy policy (i.e. through initiation of agro-forestry activities in forestry and agriculture development programmes and bio-gas production from animal wastes in livestock development programmes). 3.3.2 Ensure WEC in raising awareness about production and utilization of biomass energy through various means at different levels. 3.3.3 Implement integrated energy development programmes by incorporating energy production into the activities of agriculture, forest and livestock development. 3.3.4 Ensure Forest Department to adopt a multiple production objective while formulating scientific management plans for the existing forests in order to increase fuelwood production. 3.3.5 Integrate traditional energy production from the residues of trees and crops in the development programme of respective sectors of Forest and Agriculture Department. 3.3.6 Make it mandatory to make use of the surplus biomass materials from agricultural crops not needed for animal feed, and the other biomass waste not needed for maintaining soil fertility, for energy purposes through national energy policy. 3.3.7 Follow and strengthen the concept of public-private partnership in biogas development programmes.	3.3.1 WEC to implement immediately in coordination with concerned sectors 3.3.2 WEC to implement immediately in coordination with concerned sectors 3.3.3 National energy policy to make it mandatory. 3.3.4 Include firewood production objective in the management plan of all production forests. 3.3.5 To be incorporated in national policy, and gradual enhancement of the capacity. 3.3.6 WEC to implement in coordination with MoAC. 3.3.7 Immediate initiation of study on methodology

Group 3: Renewable Biomass Energy A. Traditional Biomass Energy: Fire wood, Animal dung cake and agricultural residues B. Improved/Modern: Charcoal, Briquettes produced from biomass, biomass liquid fuel (Ethanol, methanol, bio-diesel, pyrolytic oil etc.), and gas produced from animal dung and other biomass produces (biogas, producer's gas etc.)			
S.N.	Strategic Options	Major Activities	Target
			design.
		3.3.8 Implement the awareness raising activities covering different aspects biomass energy development at various levels.	3.3.8 Prepare and execute programmes.
		3.3.9 Assign responsibility to Ministry of Agriculture and Cooperatives (MoAC) in collecting the information about biomass residues that could be used for modern biomass energy generation, and in managing its collection, storage and distribution.	3.3.9 Prepare and execute programmes.
		3.3.10 Make it legally mandatory for all commercial-scale animal farms, including dairy, pigary and poultry firms, to make use of the residues of these animals for biogas production. Provide additional incentives for accelerating the pace of biogass promotion programme.	3.3.10 Promulgation of act and implementation by 2015.
		3.3.11 Emphasize on the activities that replace the use of traditional stove with improved cook stove (ICS), other modern technology or alternative energy sources.	3.3.11 Replacement of 25% traditional stoves by 2020 and 50% by ICS and other improved technology by 2030.
		3.3.12 Ban the burning of biomass materials that emits smoke into the atmosphere beyond a prescribed limit or the use of in-efficient technology (i.e. traditional stoves, kilns, furnaces) in heavily populated urban centers.	3.3.12 MoEST to fix a legal threashold and implement.
3.4	Conserve biodiversity through implementation of proper management plans for managing traditional fuel supply sources (primarily forest), and protect forest from illicit felling and wildlife hunting by the woodfuel	3.4.1 Make necessary amendments in the present Forest Act and to protect the existing forests through its effective implementation.	3.4.1 MFSC to implement immediately
		3.4.2 Implement the policy of community, private and leasehold forestry development for conserving the forest effectively.	3.4.2 Integrate energy production and expand program coverage
		3.4.3 Implement activities for enhancing the capacity of forest users'	3.4.3 Forest managers to

Group 3: Renewable Biomass Energy A. Traditional Biomass Energy: Fire wood, Animal dung cake and agricultural residues B. Improved/Modern: Charcoal, Briquettes produced from biomass, biomass liquid fuel (Ethanol, methanol, bio-diesel, pyrolytic oil etc.), and gas produced from animal dung and other biomass produces (biogas, producer's gas etc.)					
S.N.	Strategic Options	Major Activities		Target	
	collectors		group.		initiate immediately.
		3.4.4	Initiate awareness raising programmes up to village level for promoting the integration of biomass production for energy in the forestry, agriculture and livestock development programmes.	3.4.4	Design activity, mobilize resources and implement on a continuous basis.
		3.4.5	Promote tree planting and forest protection under the private, leasehold and community forestry development programmes. Reduce dependency of the people on forests by creating alternative firewood collection sources.	3.4.5	Provide opportunities for livelihoods and income generation in forest development.
		3.4.6	Enhance awareness about renewable biomass energy and alternative energy by conducting awareness raising activities at different levels.	3.4.6	Include in energy development programme.
		3.4.7	Substitute the demand of traditional energy by modern renewable biomass energy (i.e. biogas).	3.4.7	Gradual substitution.
		3.4.8	Government agencies and local communities to collaborate in the development and promotion of biomass energy resource conservation and utilization systems.	3.4.8	Policy to include this provision.
		3.4.9	Ensure the livelihoods of the forest dependant, economically and socially suppressed people, particularly *aadibasi, janajati* and *dalits,* by making them partner in the management of local forest resources.	3.4.9	Policy to include this provision
3.5	Promote efficient use of traditional fuel sources and dessiminate efficient technology to users, establish mechanism for	3.5.1	Assign responsibility to WEC to collect the information on modern biomass energy technology and disseminate it through a MIS to stakeholders.	3.5.1	Immediate execution.

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S.N.	Strategic Options	Major Activities	Target
	identification and experimentation of appropriate technology, and as far as possible by selecting the technology that would be possible to manufacture within the country, for enhancing the users accessibility	3.5.2 Ensure biodiversity conservation by making use of the Environmental Impact Assessment (EIA) mandatory before construction of roads, power-houses, industries or factories.	3.5.2 Simply EIA process, monitor implementation.
		3.5.3 Assign WEC to coordinate with concerned stakeholders, such as NAST, RECAST, AEPC, MOEST and others in the non-government sector, to identify the appropriate biomass energy technology for dissemination.	3.5.3 Legal arrangement and implementation by 2015.
		3.5.4 Exumption of custom tariff on the import of appropriate modern technology and additional incentives (in the form of subsidy) for technology extension.	3.5.4 Energy Policy to incorporate.
		3.5.5 Make arrangement for the production of ICS, as far as possible using indigenous materials and local artisans, and for dissemination at affordable cost to the users.	3.5.5 Energy Policy to incorporate.
		3.5.6 Organize free training on repair and maintenance of the technology disseminated at the village level.	3.5.6 Concerned sectoral programme to incorporate
		3.5.7 Assign MoEST with the responsibility of identification of modern appropriate technology from agencies such as NAST, RECAST, and the researchers in universities.	3.5.7 Energy Policy to incorporate
		3.5.8 Motivate private companies in the production and distribution of improved technology in urban areas.	3.5.8 Energy Policy to incorporate
		3.5.9 Dissemination of tested/proven technology through markets in urban areas and through AEPC, with additional incentives, in rural areas.	3.5.9 Energy Policy to incorporate

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S.N.	Strategic Options	Major Activities	Target
		3.5.10 Prioritize the traditional energy dependant areas in Far-western Development Region and the Karnali Zone for demonstration and dissemination of new technology.	3.5.10 On-going programmes to make provisions.
3.6	Replace the use of traditional energy technology through gradual replacement of it with renewable, clean and modern biomass energy sources, as well as with alternative energy	3.6.1 Make policy for promoting nation wide dissemination of improved technology of indigenous biomass energy use.	3.6.1 WEC to initiate within 2015.
		3.6.2 Widely publicize about the positive benefits of modern biomass technology and negative effects of traditional energy use (i.e. health impact of smoke, environmental degrewdation associated with unsustainable fuelwood collection, including floods, landslides and natural disastors).	3.6.2 WEC to initiate through various means.
		3.6.3 Initiate celebration of national biomass energy day.	3.6.3 WEC to diclare the Sivaratri day for this occasion.
		3.6.4 Disseminate the proven and approved technology at local levels through appropriate means.	3.6.4 WEC to organize suitable programmes.
		3.6.5 Continue the expansion of biogas development programme with a high priority.	3.6.5 Existing agencies to continue the on-going activities.
		3.6.6 Extend the gobargas programme in the Terai region and declare the villages that do not have to use cow dung for energy as *Guitha free* villages.	3.6.6 Initiate the process.
		3.6.7 As in the past, reinstate the provision of accepting the biogas plants to be established as collaterals for granting loan to the interested households.	3.6.7 Reintroduce the provision of 50% collateral on to be established plant from its total cost.

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S.N.	Strategic Options	Major Activities	Target
		3.6.8 Include different models of improved cook stoves (ICS), including *Bai-panchi stoves* and rice husk stoves, in national programme and promote their use in rural villages.	3.6.8 WEC to help in the extension of improved technology.
		3.6.9 Introduce a system of recognition with reward and encouragement to individuals or groups that plays pioneering roles in adoption of improved biomass energy technology.	3.6.9 Concerned agencies to incorporate this provision.
3.7	Give legal recognition of energy source to the residues and by-products generated in forest, agriculture and livestock sectors, promote the use of residues and by-products at local level through improved/modern biomass energy technology (i.e. briquette, charcoal, biogas, etc)	3.7.1 Make provisions in national energy policy followed with promulgation of legislation that forces the use of biomass residues for energy generation.	3.7.1 WEC to implent by 2015.
		3.7.2 Support research centers such as universities for identifying appropriate technology at the local level.	3.7.2 WEC to coordinate.
		3.7.3 Recognize biomass residues and wastes generated in urban areas as important energy source identify appropriate technology for its use in energy generation from; disseminate the proven technology at local level by incorporating it into the national energy programme.	3.7.3 Progressive implementation
		3.7.4 Promote the desimination of proven technology, by incorpoarating them into the national energy programme and through mobilization of local resources by DDCs, VDCs, Municipalities and others.	3.7.4 Progressive implementation
		3.7.5 Identify the areas with potential of commercial-scale bioenergy development and arrange attractive incentives for implementation through AEPC and other agencies.	3.7.5 Progressive implementation
		3.7.6 Give recognition to the biomass residues produced in agricultural and livestock farms, including commercial-scale poultry farms as important biomass sources and make mandatory conditions	3.7.6 Progressive implementation

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S.N.	Strategic Options	Major Activities	Target
		through legislation for their use in energy generation.	
3.8	Increase accessibility of weaker section of the society to use improved/modern biomass energy technology by integrating specific targeted activities for their economic empowerment while formulating the programmes of biomass energy development	3.8.1 Collect data on the socio-economically backwarded communities; implement awareness raising activities and specially tailored subsidy package for improving their access to improved technology. 3.8.2 Ensure the participation of locally active institutions and agencies during formulation and implementation of integrated energy development programmes. 3.8.3 Ensure access of improved technology to the socio-economically deprived people at affordable cost with subsidy or other financing options. 3.8.4 Establish Energy Development Fund at the local level to increase the access of socio-economically deprived people to improved technology.	3.8.1 Progressive incorporation in policy. 3.8.2 Progressive incorporation in policy. 3.8.3 Progressive incorporation in policy. 3.8.4 Progressive incorporation in policy.
3.9	Design and implement decentralized integrated energy development programmes for managing the supply/demand imbalance of energy at the local level	3.9.1 Formulate and implement Integrated Energy Development programmes at DDCs, VDCs and Municipalities as per their need and constraints of their local resources (i.e. financial, infrastructure, human power etc) at their disposal. 3.9.2 Ensure the participation of locally active organizations during formulation and execution of Integrated Energy Development Plan. 3.9.3 Incorporate the current successful activities at the local level administered by AEPC in the Integrated Energy Development Programmes, for maintaining continuity of these activities at local level.	3.9.1 Prograssive implementation. 3.9.2 WEC to incorporate in policy 3.9.3 Prograssive implementation.

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S.N.	Strategic Options	Major Activities	Target
		3.9.3 In areas not covered by current activities of AEPC, formulate, implement and monitor additional activities in collaboration with local agencies such as DDCs, VDCs, and Municipalities.	3.9.4 Execution by 2015
3.10	Establishment of an independent regulatory body for the development of energy sector	3.10.1 Establish a central regulatory authority under the proposed National integrated energy policy. 3.10.2 Finalize the scopes, i.e. right, functions and responsibilities, of the central regulatory authority by the WECS in consultation with the subject matter experts.	3.10.1 Promulgate Act by 2015 and implementation 3.10.2 Execution by 2015
3.11	Establish of mechanisms for distribution of benefits that may accrue from the implementation of energy development programmes at local levels	3.11.1 Establish local users group's right from feasibility study stage of energy development projects in affected areas and decide on the modality for sharing of the benefits of the project. 3.11.2 Formulate legislation that assigns the responsibility of providing a Common Platform to such user groups by the concerned DDC, VDC or Municipility. 3.11.3 Make provision for allocation of certain portion of the benefits/returns from locally implemented energy development projects for community development activities.	3.11.1 Incorporation in policy 3.11.2 Incorporation in policy 3.11.3 Incorporation in policy
3.12	Identify and make use of the opportunities of carbon trading under the Clean Development Mechanism (CDM) and the new mechanism under development that is referred as Reduction of Emission from Deforestation in Developing countries (REDD)	3.12.1. Publicize about the significance of CDM/REDD mechanisms to the public. 3.12.2. Implement a national campaign: "Jaibik urjako prayog, baidesik mudrako arjanko swroat", for advocating biomass energy use in the country. 3.12.3. Introduce a reward and promotion system for motivating the	3.12.1 Formulate & implement programme 3.12.2 Formulate/implement programme. 3.12.3 Formulate/implement

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S.N.	Strategic Options	Major Activities	Target
		renewable biomass energy (i.e. *gobar gas*) users.	programme.
		3.12.4. Prepare sound programmes to assist the concerned parties in realization of benefits from the CDM along with human resource development on the subject matter.	3.12.4 Formulate/implement programme.
		3.12.5. Identify methodologies which would simplify the process of implementing CDM. Submit this to the Designated Authority (i.e. MoST) through WECS. Maintain information related to CDM projects in WECS.	3.12.5 Formulate programme in consultation with concerned agencies.
3.13	Design and implement human resource development programme for enhancing the capacity of agencies and individuals working in the field of renewable/ alternative energy sector	3.13.1. Formulate and implement information dissemination programmes for raising awareness about the benefits and use of alternative energy.	3.13.1 Make use of existing institutions in and implementation of programme.
		3.13.2. Identify the organizations/institutions working in the field of alternative or renewable energy and assess their present status/capacity.	3.13.2 Make use of existing institutions in and implementation of programme.
		3.13.3. Incorporate alternative/renewable energy development issues in the curricula of both formal and informal education at different levels.	3.13.3 Make use of existing institutions in and implementation of programme.
		3.13.4. Arrange training programmes for motivation of existing staff and for human resources development in relevant institutions.	3.13.4 Make use of existing institutions in and implementation of programme.

Group 4	4. Renewable Energy: New Renewable (Alternative)		
S.N.	Strategic Options	Major Activities	Target
4.1	Promote the use of alternative or renewable energy to reduce dependency on traditional energy sources and fossil fuels.	4.1.1. Ensure the wide accessibility of people on solar technologies. 4.1.2. Ensure the accessibility of people on the subsidy provided in the new renewable technologies. Manage paying in installment system for this task. 4.1.3. Conduct awareness programmes for information dissemination and extension of the new renewable energy technologies. Manage exhibition as well as celebration of Energy Technology Day. 4.1.4. Provide employment opportunities to the poor/ultra-poor groups by providing energy related trainings to them. 4.1.5. Ensure participation of community women in planning, management and development of the new renewable energy technologies.	Conduct programmes in VDCs and Municipalities at least one a year including all the concerned people.
4.2	Develop mechanism to ensure the accessibility of targeted groups on the subsidy provided for production and use of new renewable energy sources/technologies	4.2.1. Provide the subsidy to those who are identified as the targeted groups (economically vulnerable groups) based on some specified standards and procedures of verification from the respective VDCs.	
4.3	Ensure development of new technologies for the promotion of new renewable energy technologies, and develop human power	4.3.1. Conduct study on working approach of governmental, educational and the private institutions for the development of renewable energy technologies. Disseminate the findings of the study. 4.3.2. Assist and encourage the human resource and institutions involved in the development of new renewable energy technologies.	

Group 4	4. Renewable Energy: New Renewable (Alternative)		
S.N.	Strategic Options	Major Activities	Target
		4.3.3. Conduct studies within the country for the development of renewable energy technologies.	
4.4	Formulate and execute battery disposal rules and regulation	4.4.1 Provide tax free concession for the safe disposal of batteries. 4.4.2 Ensure institutional management for standardization of battery disposal and implementation of rules and regulations for battery disposal. 4.4.3 Establish and operate Battery Re-cycling Plant.	
4.5	Ensure coordination between the agencies working in the field of new renewable energy and indicate their roles and responsibilities	4.5.1 Establish mechanisms to coordinate the local agencies working in the field of new renewable energy technologies. 4.5.2 Indicate the roles and responsibilities of the agencies working in the field of new renewable energy and make their works transparent.	
4.6	Capture the opportunities of trading on Clean Development Mechanism (CDM)	4.6.1 Identify the potential areas for trading on CDM. Use the benefits achieved from trading of CDM on other potential areas. 4.6.2 Conduct awareness programmes on CDM.	
4.7	Establish an independent regulatory body for regulation of new renewable energy sector	4.7.1 Establish an independent regulatory body for monitoring and regulation of new renewable energy sector. Include the Subject Matter Specialists (SMSs) in this body.	
4.8	Ensure institutional cooperation and coordination between the local level	4.8.1 Establish mechanisms to coordinate the local agencies working in the field of new renewable energy	

Group 4	4. Renewable Energy: New Renewable (Alternative)		
S.N.	Strategic Options	Major Activities	Target
	agencies (local agencies, cooperatives, private sectors) working in the field of new renewable energy technologies	technologies.	
4.9	Establish institutional mechanism to share experience and have regular interaction among relevant stakeholder at national, regional and local levels.	4.9.1 Establish and strengthen the Water and Energy Commission Secretariat as Energy Information Collection and Dissemination Centre at Central level. Also, develop WECS as the facilitating agent for experience sharing among different agencies.	
4.10	Conduct Decentralized Energy Development Programme.	4.10.1 Formulate and implement Integrated Energy Development Plan in the local level.	
4.11	Establish an independent regulatory body for development of new renewable energy sector.	4.11.1 Establish an independent body by including Subject Matter Specialists (SMSs).	
4.12	Make contribution of New Renewable Energy on Integrated Nepal Power System (INPS)	4.12.1 Encourage the concerned personnel to connect the electricity generated from new renewable energy technologies to the national grid.	

SN	Policy Instruments	Objectives	Implementation status and issues
1.	1. Fifth Plan (1975-80)	The policy emphasized reducing dependence on traditional sources of biomass and imported oil and increasing the supply of renewable sources to meet the growing demand for energy.	
	2. Water and Energy Commission (WEC)	The WEC was established in 1976 with a mandate "to formulate and coordinate programmes for the development and conservation of water and energy resources".	Reorganization of WEC in 1999 resulted in dilution of its authority to "cause to coordinate" from a stronger previous role of coordination and integration of programmes in the energy sector.
2.	1. Hydropower Development Policy 1992, Hydropower Development Policy 2001, Water Resources Act 1992 and Electricity Act 1992	The policy encouraged participation of foreign private sector to develop hydropower to meet, in particular, the interim demand until 2001. The 2001 Policy set out to develop the potential of hydropower through a transparent procedure to attract foreign and domestic private sector investment, create an independent regulatory body, create a rural electrification fund, and controlling unauthorized uses and leakages, among others. The Water Resources Act 1992 sets out regulatory procedures for use of water in the country through a system of licensing.	Scraping of income tax holiday and bringing the hydropower projects under the usual corporate tax net in the 2001 Policy have actually curtailed fiscal incentives in spite of the declared policy objectives of "transparent procedures" and "investment-friendly". It has come at a time when the state should be providing all possible facilities for hydropower development in the country. While the provision of the 2001 Policy such as increasing royalty rates has been implemented, other procedures for encouraging the private sector for taking up power projects and provide a level playing field have not been made operational through enactment of new laws. A Bill for enactment of a new Electricity Act is still pending with the Legislature-Parliament. While the provision of licensing for generation of hydropower has been in operation, a system of licensing of consumptive uses is lacking due to the absence of a functioning district water resources committee.

SN	Policy Instruments	Objectives	Implementation status and issues
3.	1. Water Resources Strategy 2002 and National Water Plan 2005	The Strategy recognizes that water resources development needs to be more closely integrated with sustainable social and economic development. It seeks to develop sufficient capacity (700 MW by 2007, 2,100 MW by 2017 and 4,000 MW by 2027) to meet the projected domestic demand at base case scenario without export.	Because of a pending draft Bill on Electricity Act in the Legislature-Parliament, most of the policy initiatives including the policy on integrated water management remain to be implemented. Generation capacity in 2009 has remained below 700 MW.
4.	1. National Electricity Crisis Resolution Action Plan 2008 and Procedures for PPA for projects up to 25 MW Capacity 2065	The government set out a 38-point Action Plan in Poush 2065 with provision of various concessions for a quick addition of capacity to reduce load shedding. The policy include doing PPA at flat rate for power plants up to 25 MW capacity, provide income tax concessions, strengthen and add transmission capacity, initiate a system of energy audit, implement a code of conduct to save energy, encouraging efficiency through use of low energy consumption bulbs, and increase power production through efficient operation of current generation facilities. The NEA under the new approval procedure 2065 has developed a six-stage, 99-day approval procedure.	Suffers from weak implementation of measures planned for improving supply and promote a faster pace for developing additional generation capacity. The 99-day approval procedure lacks effective implementation.
5.	1. Local Self-Governance Act, 2055	The Act provides for formulation, implementation, distribution and maintenance of mini and micro hydropower projects and other energy projects within their respective jurisdictions.	Following enactment of Water Resources Act which gives the state ownership rights in water resources that is available in the country, similar ownership title over natural resources is also vested upon the local bodies through the Local Self-Governance Act 2055 resulting in conflict. In the absence of a formal interpretation, it is not clear which law prevails if there is a dispute between the state and a local body over ownership rights over water.
6.	2. Rural Energy Policy 2006, Subsidy for Renewable (Rural) Energy 2006 and	The overall goal of the policy is to contribute to rural poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy in the rural areas. Specific objectives are to reduce dependency on traditional energy and	Lack of awareness was observed in various districts about policy provisions as well as delivery mechanism. Other issues include cumbersome procedures, centralized system of subsidy delivery mechanism,

SN	Policy Instruments	Objectives	Implementation status and issues
	Renewable (Rural)Energy Subsidy Delivery Mechanism 2006	conserve environment and integrate rural energy with social and economic activities, among others.	impractical procedures for refund of the VAT and inadequate research and development programmes.
7.	Master Plan for Forestry Sector 1988 and Forestry Sector Policy 2000	The Master Plan aims to meet the people's basic needs for forestry products on a sustainable basis and protecting and managing forests through people's participation. The 2000 Policy seeks to address the problem of energy in the rural areas by focusing emphasis on managing the sector for fuelwood.	The pressure on forest for supply of fuelwood as the only source of energy to the people in the rural areas has continued. Forest programmes focus on plantation and management is inadequate. The share of traditional sources of energy is expected to continue to dominate the energy scene of the country.
8.	Petroleum, Coal and Natural Gas Sub-sector Policy	The Nepal Oil Corporation (NOC) has the monopoly to sell and distribute petroleum products in the country. The NOC is required to sell petrol in the market with 10 percent ethanol. Under the Mines and Minerals Act, 2042, coal mines are licensed and registered for their operation.	Currently the oil sector is exposed to outside influence including political interference. It is not functioning as a commercial entity. There is lack of a clear law on its regulation. The sector also suffers from an absence of a clear market-oriented pricing policy.
9.	National Transport Policy 2001	The objectives of the policy are to develop a transport system that is sustainable, safe, comfortable and self-reliant. The policy emphasizes development of a transport system that is pollution free.	Although the policy provides for a balanced development of a transport system with a combination of a mix of railways, river transport and ropeways with power from renewable sources, development to date, however, remains highly focused towards road transport alone.