February, 2002

Energy Country Analysis Brief: Nepal

Background

Nepal is well known as the land of Everest, the highest peak in the world. It is situated in the lap of the Himalayas and landlocked between India and China. It lies between the latitudes of 26° 22' N to 30° 27' N and longitudes of 80° 4' E to 88° 12' E. The elevation of the country ranges from 60m above the sea level to the highest global altitude, Mount Everest, of 8848 m, all within a distance of 150 km. This vast sudden variation in its altitude gives a country a climatic condition, which ranges from sub-tropical to that of the arctic.

The country accommodates more than 60 caste /ethnic groups. Over the history, Nepal presents an example of being united in diversity and has maintained its pride as an independent Sovereign State. Politically there is a constitutional monarchy and the people exercise rights of adult franchise. The executive, legislative and judiciary bodies function and exercise their rights independently. There are two types of legislations, the Upper House is called the *Rastriya Sava*, consisting of 60 members and the Lower House, *House of Representative*, for which members are elected from 205 electoral constituencies distributed in 75 districts of the country. The Prime Minister is the elected head of the government.

For the purpose of social and economic development the country is divided into five development regions: Eastern Central, Western, Mid-Western and Far-Western Development Regions. These regions stretch from north to south and runs across east and west.

Nepal at a Glance

Head of State: His Majesty King Gyanenda Bir Bikram Shah Dev (since June 2001)

Head of Government: Rt. Honourable Prime Minister Mr Sher Bahadur Deuba (July 2001)

Minister of Energy: Ministry of Science and Technology; Ministry of Water Resources; Ministry of Industry, Commerce and Supplies

Capital: Kathmandu

Major Economic Centers: Kathmandu, Pokhara, Biratnagar, Birgunj, Bhairahawa

Land Area (square miles): 54,363 sq. miles

Currency: Nepalese Rupee

Exchange Rate: US$1 =NR 78

Major Export Products: Readymade garments, hand-knotted woolen carpets, jute goods, pulses

Major Import Products: Classified finished goods, transportable and mechanical equipment

Largest Trading Partners: India, Germany, USA, Japan, China

Languages: Nepali, Newari, Maithali

Key Economic Indicators

Population in Millions

Census Year	1911	1920	1930	1941	1952/54	1961	1981	1991	2001
Population	5.638	5.573	5.532	6.283	8.256	9.412	15.022	18.491	23.214

Source: Center for Bureau of Statistics (CBS), 2001

Gross Domestic Product

	1998	1999	2000
GDP (Nominal) in Millions Rs	329960	365465	392532
Per Capita GDP In US Dollars	227.20	246.40	243.40
Real GDP Growth rate at 1984/85 Price	4.47%	6.44%	5.80%

Source: Economic Survey 200/2001, CBS, 2001

Major Exports Commodities (Classified by SITC Group), in NRs. Million

Merchandise Exports	**1998**	**1999**	**2000**
Food & Live Animals	3724.5	5390.9	3462.9
Tobacco & Beverage	50	110.4	54.7
Crude Materials and Inedibles	469.9	526.8	330
Mineral Fuels and Lubricants	0.5	2	2
Animals & Vegetable Oil & Fats	3597.2	3605.6	2161.4
Chemicas & Drugs	2804	4075.8	2646.1
Clssigfied by Materials	13539.6	16013.7	9796.4
Machinery & Transport Equipment	97.8	384.2	312.4
Miscellaneous Manufactured Articles	11392.8	21513.6	13735.5
Export	**35676.3**	**51623**	**32501.4**

Source: Economic Survey, 2000/2001

Major Import Commodities (Classified by SITC Group), in NRs. Million

Merchandise Exports	**1998**	**1999**	**2000**
Food & Live Animals	7619.5	10734.7	7689
Tobacco & Beverage	846.1	941.2	7689
Crude Materials and Inedibles	6246.7	7232	4130.7
Mineral Fuels and Lubricants	8737.5	9113.9	5733.4
Animals & Vegetable Oil & Fats	3329	4445.9	2825.1
Chemicas & Drugs	12476.4	15464.6	10371.7
Clssigfied by Materials	25638	33408.8	22150
Machinery & Transport Equipment	18063.7	20227.4	12496.8
Miscellaneous Manufactured Articles	4302.4	5320.2	3238.9
Imports	**87259.3**	**106888.7**	**76324.6**

Source: Economic Survey, 2000/2001

Direction of Foreign Trade in NRs. Million

	1998	1999	2000
India	44650.40	63546.80	40308.10
Other Countries	78551.20	95043.00	61501.20
Total Trade Balance	123201.60	158589.80	101809.30

Source: Economic Survey, 2000/2001

Foreign Loan And Debt Servicing in NRs Million

	1998	1999	2000
Net Outstanding Debt	1694659	190691.2	196377.5

Source: Economic Survey, 2000/2001

Demography and Economy

Economically Nepal is among the least developed countries in the world with an estimated total expenditure of US$ 1296 million (Ministry of Finance, 2001/02). This Budget is approximately disbursed equally for regular expenditure and development expenditure.

Population Size and Growth

According to the census of 2001, the population of Nepal stands at 23.2 million which comprises of 11.59 million males and 11.63 million females population. The annual population growth rate in the 90s was 2.27% whereas in the 80s it was 2.1%. This growth rate is considerably high compared to other developing countries as shown in Table 1.

Table 1: Population by Sex, Decade Change and Growth Rate, 1911-2001

Census Year	Population			Population Change in Preceding Decade	Growth Rate % per annum
	Total	Male	Female		
1911	5,638,749	2,820,220	2,818,529	----------	----------
1920	5,573,788	n.a.	n.a.	-64,961	-0.13
1930	5,532,574	n.a.	n.a.	-41,214	-0.07
1941	6,283,649	3,207,709	3,075,940	751,075	1.16
1952/54	8,256,625	4,141,136	4,115,489	1,972,976	2.3
1961	9,412,996	4,636,033	4,776,963	1,156,371	1.65
1971	11,555,983	5,936,814	5,789,193	2,142,987	2.07
1981	15,022,839	7,815,267	7,448,800	3,466,856	2.66
1991	18,491,097	9,220,974	9,270,123	3,468,258	2.1
2001	23,214,681	11,587,547	11,627,134	4,723,584	2.27

Source: CBS, Nepal: Population Census 2001 of Nepal: Provisional Population Report

Table 2: Population, Percent Composition and Growth Rate

		Population				Growth Rate % per annum	
Area	Number of Districts	Number		Percent			
		1991	2001	1991	2001	1981-91	1991-2001
Nepal	75	18,491,097.00	23,214,681.00	100	100	2.08	
Development Region							
Eastern Development Region	16	4,446,749.00	5,363,395.00	24.05%	23.10%	1.81	1.87
Central Development Region	19	6,183,955.00	8,058,050.00	33.44%	34.71%	2.31	2.65
Western Development Region	16	3,770,678.00	4,569,065.00	20.39%	19.68%	1.87	1.92
Mid-Western Development Region	15	2,410,414.00	3,022,210.00	13.04%	13.02%	2.13	2.26
Far-Western Development Region	9	1,679,301.00	2,201,961.00	9.08%	9.49%	2.35	2.71
Physiographical Region							
Mountain	16	1,443,130.00	1,690,263.00	7.80%	7.28%	1.02	1.58
Hill	39	8,419,889.00	10,271,506.00	45.53%	44.25%	1.6	1.99
Tarai	20	8,628,078.00	11,252,912.00	46.66%	48.47%	2.76	2.66

Source: CBS, Nepal: Population Census 2001 of Nepal: Provisional Population Report

The central development region has 8.1 million population which is the largest, while the Far-western Region has the least population, only 2.2 million. The population size in percent in each of the regions is as follows:

Eastern Development Regions	23.1%
Central Development Regions	34.7%
Western Development Regions	19.7%
Mid-Western Development Regions	13.0%
Far-Western Development Regions	9.5%

The rural-urban split scenario of both 1991 and 2001 census show a higher share of population in the rural areas. The rural population in 2001 is 85.77 percent as compared to 14.23 percent in the urban areas. However, the analysis shows a drop in the rural population of about 2% as compared to 1991 census. This is indicative of the migration towards the urban areas (Table 3).

Table 3: Population: Rural Urban Split

	Total	Male	Female	% Composition
1991				
Rural	16,203,610.00	8,043,275.00	8,160,335.00	87.63%
Urban	2,287,487.00	1,177,699.00	1,109,788.00	12.37%
2001				
Rural	19,911,181.00	9,877,595.00	10,033,586.00	85.77%
Urban	3,303,500.00	1,709,952.00	1,593,548.00	14.23%

Source: CBS, Nepal: Population Census 2001 of Nepal: Provisional Population Report

The main spoken language in Nepal is Nepali which is also the official language. This is the mother language of more than 50 percent of the population. This language is followed by Maithali which is nearly 11 percent and Bhojpuri which is spoken by nearly 7 percent.

Table 4: Proportion of Economically Active Population Involved in Various Sectors of Economy

Economic Sector	1991 Census		Labor Survey 1999	
	Active Population (No.)	% of Total Population	Active Population (No.)	% of Total Population
Agriculture Fisheries & Forestry	5,961,788.00	81.23%	7,203,000.00	76.12%
Mining & Quarry	2,361.00	0.03%	8,000.00	0.08%
Manufacturing	150,051.00	2.04%	552,000.00	5.83%
Electricity, Gas & Water	11,734.00	0.16%	26,000.00	0.27%
Construction	35,658.00	0.49%	344,000.00	3.64%
Trade, Restaurant & Hotel	256,012.00	3.49%	522,000.00	5.52%
Transport, Communication & Storage	50,808.00	0.69%	135,000.00	1.43%
Finance & Real Estate	20,847.00	0.28%	51,000.00	0.54%
Community & Social Services	752,019.00	10.25%	614,000.00	6.49%
Others	28,004.00	0.38%	8,000.00	0.08%
Unidentified Sector	70,298.00	0.96%	-	-
Grant Total	7,339,580.00	100.00%	9,463,000.00	100.00%

Source: Economic Survey, 2000/2001

Distribution of population based on economic activity show that more than 76 percent of the population are engaged in agriculture. As compared to 1991 there have been notable growth in the population engaged in manufacturing, construction and trade, restaurant and hotel (Table 1.4).

Nepal: Energy at a Glance

Adequate and consistent availability of usable energy sources is one of the prerequisites for social and economic development of a country. In Nepal, the notion of providing energy even to meet basic needs has been a big challenge mainly because of poor infrastructure development and lack of fund for investment in the generation and management of energy sources. Even after four decades of "modern" periodic planning, the country still suffers from the dogma of inefficient use of biomass energy sources.

Biomass and hydropower are two indigenous energy sources in Nepal. Fuelwood supplies almost 80 percent of total energy demand and is extracted beyond the sustainable supply capability of the forests indicating a growth in deforestation. Whereas, electricity supplies only 1 percent of total energy consumption. Only about 400 MW of 83 GW potential have been developed.

Fuelwood extraction may not be the only cause of deforestation but deforestation is definitely causing fuelwood crisis. With fuelwood 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.

Petroleum

Import is the only method to meet the demand for petroleum products, the supply of which has increased by almost eight fold since 1975 in value. Between 1995 and 2000 there was a considerable increase in the supply of liquefied petroleum gas (LPG) because of recent trend to replace the use of kerosene, electricity and fuelwood in urban and semi urban areas.

The prospecting and exploration activity for fossil fuel minerals such as petroleum and related natural gas, biogenic methane gas and coal considered as the national priority commodities began. After the formation of the full fledged departmental institution called "Bureau of Mines" in 1961.

Petroleum is categorized as the national priority commodity for exploration and development. The Petroleum Exploration Promotion Project (PEPP) established in 1982 under the Department of Mines and Geology (reorganized in 1976 from original Burea of Mines and Nepal Geological Survey), functions specially to promote petroleum exploration and development activities in the country.

Existence of favourable features of great interest for petroleum exploration in Nepal has been concluded based on the investigations and results obtained. These investigation results indicates the presence of buried blind thrust-fold at the base of the Siwalik involving Paleocene wedge at the front part of the Main Frontal Thrust (MFT) particularly in the Dhangadi -Nepaljung basin. The Paleocene rocks are. also believed to be geologically favourable to act as good reservoir and

source rocks for occurrence of petroleum in Nepal. It is yet to be confirm the association of petroleum at such promising sites by drilling to make the long awaited historical event as such discovery of the petroleum in Nepal.

Natural Gas

A total reserve of 300 million cu. m of methane associated with ground water and distributed over an area of 26 sq. km is the only natural biogenic gas identified in the country. Evidence on existence of natural biogenic gas in other sedimentary basin of the country have not been so far established. The feasibility study conducted in 1996/97 for utilization of biogenic natural gas in the Kathmandu Valley indicated that the use of methane is viable for both domestic and industrial purposes. The study also concludes that the resources will have 30 years life for supplying to a 21,000 families in consideration of a basis as 70% exploitable resources available. Based on the above results, the Department of Mines and Geology invited the potential investors to bid for the development and commercialization of this gas resource for the benefit of society. The department has received proposals in this respect, which are in the process of evaluation.

Coal

Coal consumption is met mainly through imports, which amounts to about 250,000 short tons per year. There are few lignite occurrences in Nepal and the maximum production capacity of these mines is estimated at about 20,000 short tons per year at present.

Electricity

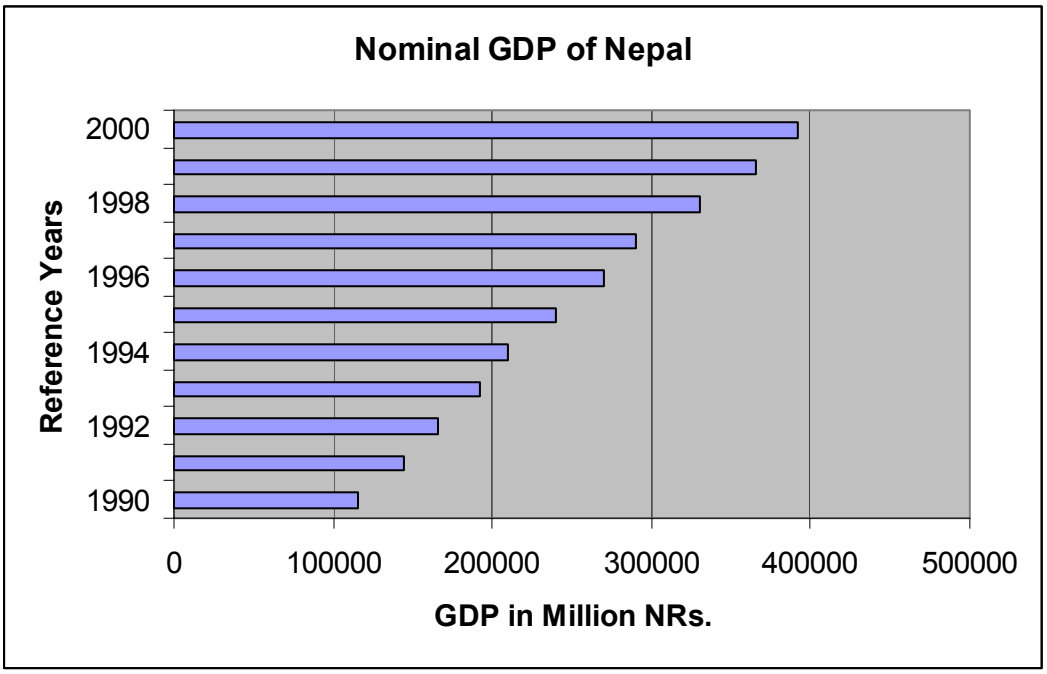
The nation could benefit most if hydropower, which is one of the major natural resources of the country, could be developed properly. Out of hydroelectricity generation potential of 83,000 MW, installed capacity by the end of 2000 totaled 400 MW or 0.4 percent of the total potential, with the completion of 36 MW Upper Bhote Koshi and 14 MW Modi Khola hydroelectric projects. Of the total installed capacity, 390 MW is connected to the national grid, while isolated micro hydropower plants supply about 10 MW of the electricity at the local level. Similarly, installed thermal centers generate 56.8 MW. Just recently Kali Gandaki A (144 MW) has been connected to the national electricity grid.

Economy and Demographics

The economy of Nepal is based mainly on agriculture with more than 76% engaged in it. The contribution of the agricultural sector was more than 45 percent in the early 90s, however, in recent years this share of contribution by agriculture and non-agricultural sectors has seen significant changes. According to the studies carried out in 2000, the contribution of the agricultural sectors has declined to 38.1 percent and that of the non-agricultural sector increased to 61.9 percent. .

The real GDP at constant price (19854/85) shows a growth rate of 6.44 percent between the years 1998 and 1999 as compared to 3.44 percent of the previous year. This current year has shown a change of nearly 5.8 percent for the period of eight months but according to the Ministry of Finance, it is expected to change by nearly 7 percent at the end of the year, rise by of At factor price, GDP is expected to grow by 7.4 percent.

Figure 1: Nominal GDP of Nepal



Source: Economic Survey, 2001

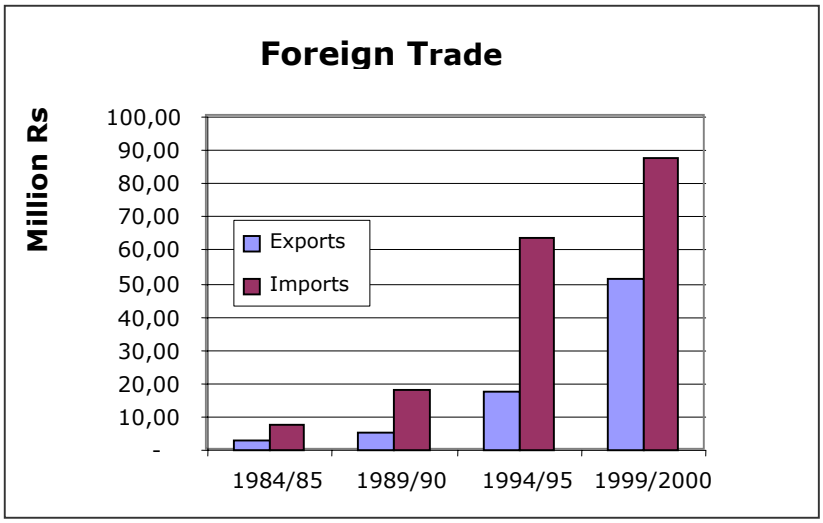
Nepal in the International Market

Adoption of liberal economic policy in 1991 has played a positive role in the expansion and diversification of foreign trade of the country. Encouraging trend is clearly visible in the areas of foreign trade and payments as a result of the implementation of foreign trade policy and reforms initiated in the exchange regime. The programs that are implemented over the years for the promotion of exportable goods, quality improvement, and market management are continued for the further expansion of foreign trade and to enhance its competitiveness. A remarkable growth of 28.7% in total foreign trade was recorded in FY 1999/2000 as compared to FY 1998/99 totaling RS 158,589.8 million. Of this total, trade with India recorded growth of 42.3% reaching RS 63,546.8 million as compared with that of FY 1998/99.

As compared with FY 1998/99, imports during the FY 1999/2000 rose by 22.2% totaling RS 106,966.8 million. Of this total, imports from India rose by 27.4% totaling RS 40,928.1 million.

Trade deficit during 1999/2000 had increased by 6.7% to RS 55,343.8 million as compared with that of 1998/99.During this period, total trade deficit went up as a result of 14.8% rise in deficit with other countries apart from India. Proportion of trade deficit with India and other countries for the FY 1999/2000 remained at 33.1% and 66.9% respectively.

Figure 2: Foreign Trade

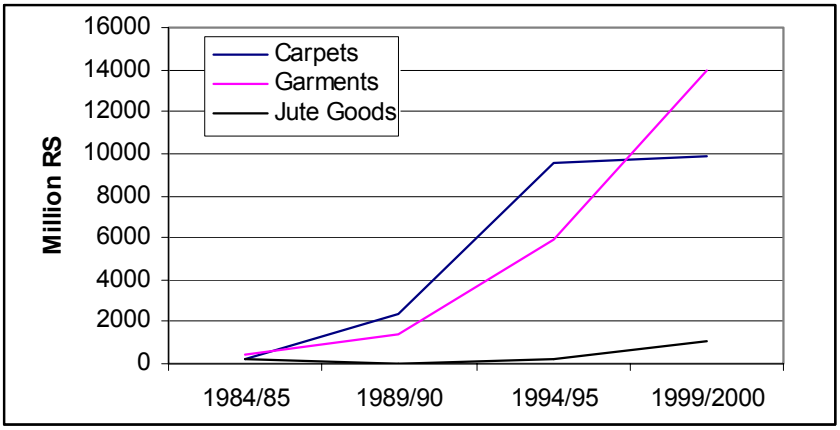


Source: Economic Survey, HMG/N, 2001

Woolen carpets and readymade garments have been occupying major place in exports to countries other than India since last few years. As compared with the FY 1998/99, export of readymade garments in the FY 1999/2000 rose by 43.5% totaling RS13,924.90 million, while that of woolen carpets increased marginally by 0.4% totaling RS 9,841.9 million.

In exports to India, jute goods occupied the major share and jute goods of RS 1,103.8 million were exported in 1999/2000

Figure 3: Exports to India

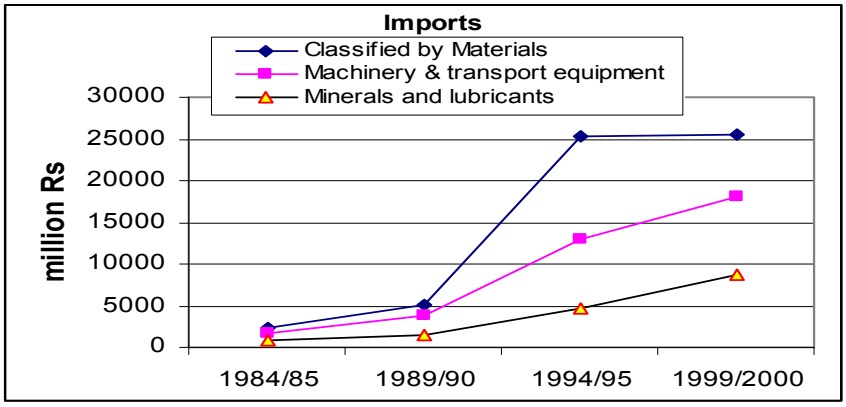


Source: Economic Survey, HMG/N, 2001

Among the imported items, classified finished products, transport and mechanical equipment, mineral fuels, food items, and chemicals and medicines had a share of 83.2% of the total imports of RS 106,966.8 million in FY 1999/2000. Compared with imports of classified finished

products in 1989/99, imports of these products increased slightly by 1.3% in 1999/2000, whereas in the case of transport and mechanical equipment and mineral fuels, imports increased by 38.7% and 85.2% respectively.

Figure 4: Imports



Source: Economic Survey, HMG/N, 2001

The main trading partners of Nepal are India, Germany, USA and Japan. Since 1991, Nepal has undertaken economic liberalization policy and several policy measures have been taken under the structural adjustment programs of the World Bank and the IMF. Nepal is under the process for the membership to the WTO.

Energy in Nepal's Economy

Though Nepal is one of the countries with the highest potential of hydropower energy, but this potential has not been utilized fully for the economic development of the country. Per Capita consumption of energy of 2.109 MBtu in 2000 is quite low, even compared with neighboring countries in SAARC region. Energy consumptions in 1999/2000, both primary and final, had increased by 11% and 6% to 52,919 GBtu and 46,298 GBtu respectively, compared with consumptions in 1998/1999.

Table 5: Macro Energy - Economy Indicators

Particulars	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Population (million Persons)	18	18.49	18.94	19.39	19.86	20.34	20.83	21.33	21.84	22.37	22.9
GDP in current market prices (million Rs)	120370	149487	171474	199272	219175	248913	280513	300845	341978	383553	414469
GDP in current market prices (million $)	3344	3497	3992	4042	4389	4522		4897	5007	5560	5624
Primary Energy Consumption (GBtu)	17061	20013	25294	27035	28676	31996	35898	39417	43512	47833	52919
Final Energy Consumption (GBtu)	14665	17390	22381	23970	25330	28404	32184	35552	39629	43561	46298
Per Capita GDP (current $)	182.70	187.18	208.72	206.40	218.85	220.21	234.17	227.47	227.17	246.34	243.38
Per Capita Energy Consumption (MBtu)	0.815	0.924	1.182	1.236	1.275	1.397	1.545	1.667	1.815	1.947	2.109
Urbanization Ratio (%)	9.6	10.1	10.5	11.0	11.5	12.0	12.6	13.2	13.8	14.4	15.1
Industrialization Ratio (%)	7.0	9.1	9.1	9.5	9.4	9.6	9.4	9.5	9.4	9.7	9.8
Implicit GDP Deflator (1985=100)	194	232	256	275	292	315	338	352	383	406	414

Foreign Exchange Rate (Rs/$)	36.00	42.75	42.95	49.3	49.94	55.05	56.98	61.44	68.3	68.98	73.7
Energy Intensity (MBtu per Thousand $)	8.508	11.338	14.353	16.308	16.852	19.786	22.097	25.555	30.313		35.554
Oil Intensity (MBtu per Thousand $)	4.681	5.566	8.445	10.364	10.755	13.015	14.465	16.478	19.644		21.729
National Energy Conversion Loss (%)	14.0	13.3	11.5	11.3	11.7	11.2	10.3	9.8	8.9		8.7
Electricity Share in Primary Energy (%)	50.1	48.0	40.6	38.6	38.9	37.4	36.4	35.8	33.3		33.2
Net Energy Import Dependency (%)	51.2	48.2	56.6	62.3	62.8	64.5	62.8	65.1	69.2		68.7
Net Oil Import Dependency (%)	47.3	43.4	52.1	56.3	56.4	58.4	58.7	58.2	59.0		55.8

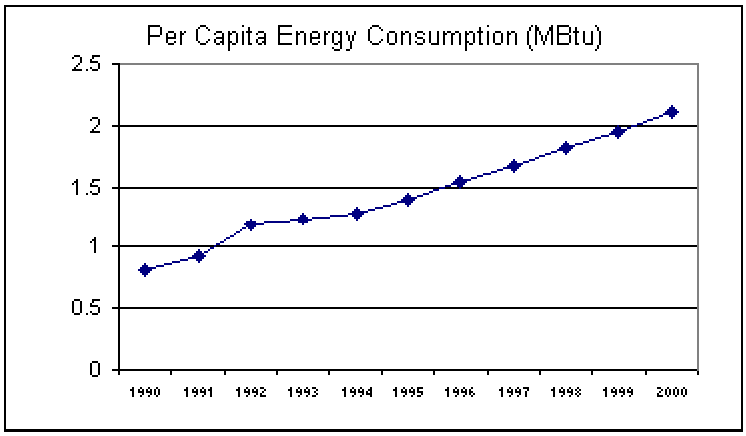
Source: Water Energy Commission (WEC), 2001

Notes:
1. Industrialization Ratio refers to share of value added of manufacturing and mining sectors to GDP at current market prices
2. Foreign Exchange rate is average of Period
3. Energy /Oil intensity is measured by primary energy /oil consumption per thousand US$ of real GDP at 1985 constant market prices
4. National Energy Conversion Losses are computed by using the formula : 1-(final energy Consumption/primary Energy Consumption)

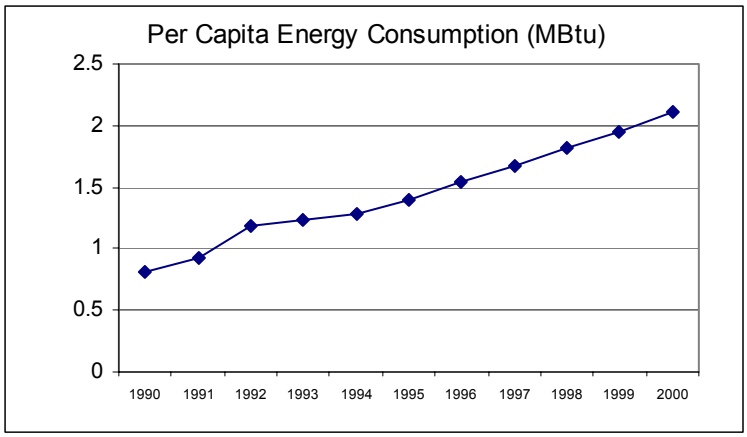
Table 5 on Macro-energy and energy indicators shed ample light on the energy development taking place in Nepal from 1990 to 2000. Net Energy import dependency has decreased by almost 3% in 2000 compared with that of 1999, whereas net oil import dependency has decreased by 5%. Electricity share in primary energy has increased by 2%, and national energy conversion loss has decreased by 2% in 2000

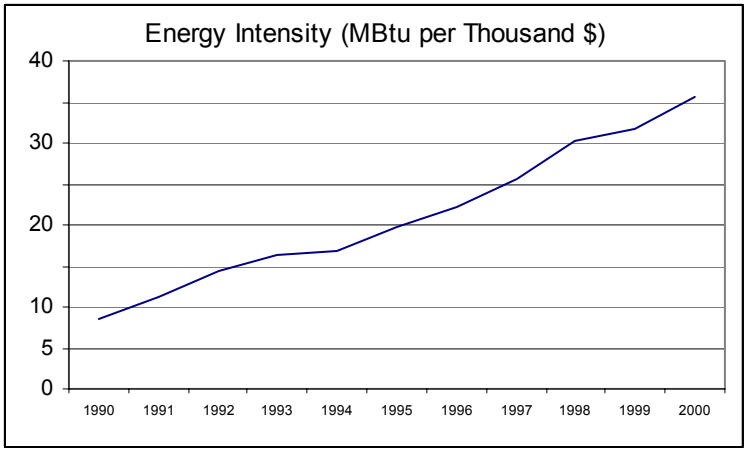
If we compare per capita consumption in Nepal, it is one of the lowest in the world. The average growth rate of per capita energy consumption from 1990 to 2000 is 9.97%, which is one of the highest in the world. In 2000, the per capita energy consumption is 2.109 MBtu.

Figure 5: Per Capita Energy



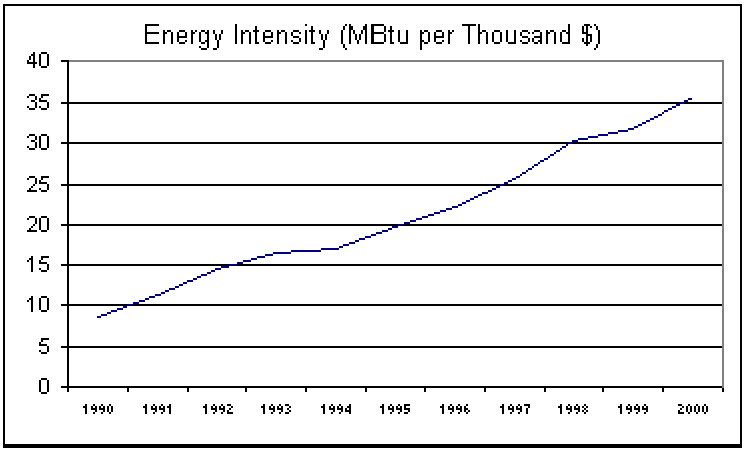
Source: WECS 2001





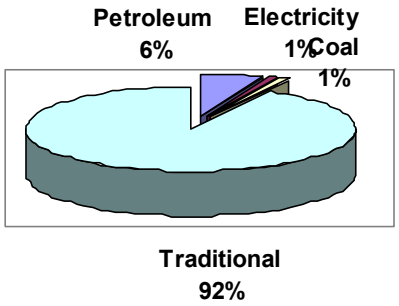
The energy intensity in 2000 has increased 12% to 35.554 MBtu/$1,000, compared with that of 1999. The average annual growth rate in energy intensity is 15.374% in a span of ten years. It means that more energy is being used in every $1,000 of the GDP.

Figure 6: Energy Intensity



Of the total primary energy consumption of 31,996 GBtu in 1995, the traditional fuel wood and animal waste occupied 92%. Whereas Commercial energy made 8% only. Petroleum products occupied 6%, electricity 1%, and coal 1% respectively.

Figure 7: Energy Consumption Pattern in 1995

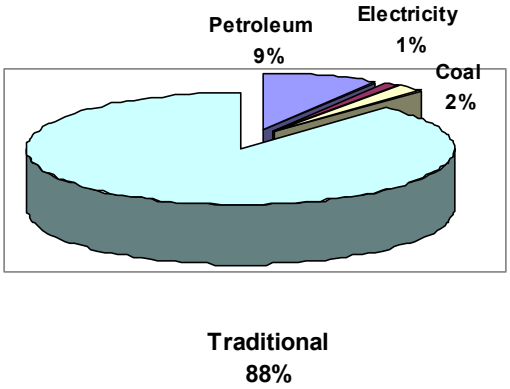


Source:IMF, 2000

If we see the energy consumption pattern in 2000, tradition fuels have declined to 88%, but petroleum products have increased by 50%. Nepal is becoming more dependent on imported energy sources, which can have an adverse on Nepal's balance of payment, if this trend continues in future.

Petroleum products occupied 9%, and coal 2% of the total energy consumption in 2000. Electricity remained the same with 1% of the total consumption.

Figure 8: Energy Consumption Pattern in 2000



Source:IMF, 2000

Nepal's Energy Balance

In year 2000, 5385 GBtu of coal, 28999 GBtu of petroleum products and 13464 GBtu of electricity were consumed by all the various sectors. Industry sector consumed the highest amount of the total energy, while agriculture sector consumed the least. The various energy consumption of each energy product is shown in Table 6 below.

Table 6: Energy Balance: Nepal, 2000 (GBtu)

Energy Type	Coal	Petroleum Products	Electricity	Total
Primary Products	419	-	15509	15928
Import	5416	29518	1424	36358
Export	-	-	-	-
Bunkers	-	-	-	-
Stock Change	-	-	-	-
Primary Consumption	5835	29518	16933	52286
Refineries	-	-	-	-
Power Plants	-	-519	633	114
Self Consumption, and Losses	-	-	-4102	-4102
Final consumption of which:	5835	28999	13464	48298
Industry	4934	6344	5897	17175
Transport	184	11755		11939

Residential	16	8237	5169	13422
Commercial	701	1837	1944	4482
Agriculture	-	407	81	488
Others	-	419	373	792

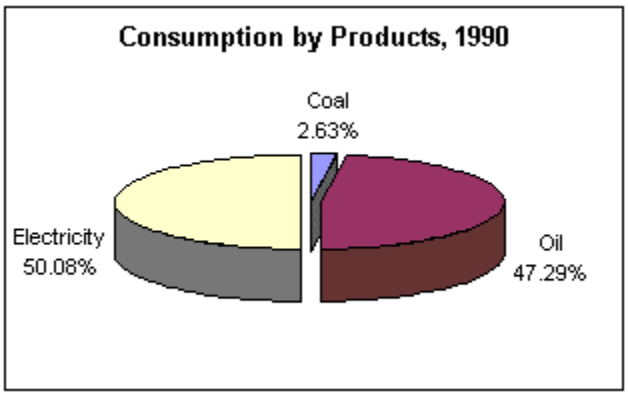
Nepal's Energy Production

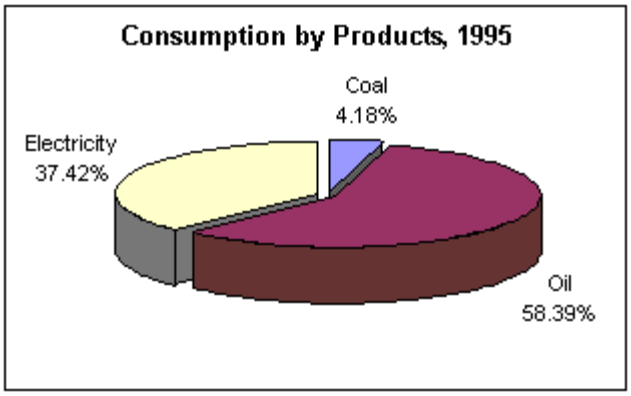
Primary energy production as well as imports for each product from 1990 to 2000 is given in the table below. In year 2000, oil consumption is highest, being 56 percent, with electricity 33 percent and coal only 11 percent of total energy.

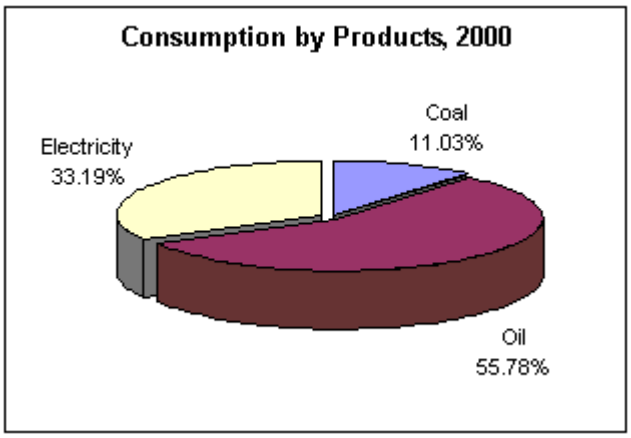
Table 7: Primary Energy

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Production by Products (GBtu)											
Electricity: Hydro	8140	9960	10251	9577	9972	10394	12817	13140	11985	12633	15509
Electricity: Thermal	9	8	341	495	640	811	383	393	1018	1108	633
Coal	186	247	381	121	52	144	160	213	384	269	419
Total	8335	10215	10973	10193	10664	11349	13360	13746	13387	14010	16561
Net Imports by Products (GBtu)											
Coal	263	1607	1464	1235	1305	1194	1615	2186	2958	4002	5416
Oil	8068	8690	13169	15233	16166	18684	21069	22924	25681	28075	29518
Electricity	395	499	312	374	541	769	146	561	1486	1746	1424
Total	8726	10796	14945	16842	18012	20647	22830	25671	30125	33823	36358
Consumption by Products (GBtu)											
Coal	449	1854.00	1845	1356	1357	1338	1775	2399	3342	4271	5835
Oil	8068	8390.00	13169	15233	16166	18684	21069	22924	25681	28075	29518
Electricity	8544	9469.00	10280	10446	11153	11974	13054	14094	14489	15487	17566
Total	17061	19713	23449	27035	28676	31996	35898	39417	43512	47833	52919

Figure 9: Primary Energy Consumption by Products







Nepal's Energy Consumption

Table 8: Final Energy Consumption (GBtu)

Total	**14665**	**17090**	**25381**	**23970**	**25330**	**28404**	**32184**	**35552**	**39629**	**43561**	**48298**
Transportation Losses (GBtu)											
Oil to Electricity	7	7	279	405	525	664	313	321	834	907	519
Electricity Losses	2389	2616.00	2634	2660	2821	2928	3401	3544	3049	3365	4102
Consumption by Products											
Coal	3.06%	10.85%	19.09%	5.66%	5.36%	4.71%	5.52%	6.75%	8.43%	9.80%	12.08%
Oil	54.97%	49.05%	50.79%	61.86%	61.75%	63.44%	64.49%	63.58%	62.70%	62.37%	60.04%
Electricity	41.97%	40.10%	30.12%	32.48%	32.89%	31.85%	29.99%	29.67%	28.87%	27.83%	27.88%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Consumption by Sectors											
Industry	20.16%	21.70%	23.24%	24.78%	26.32%	27.86%	29.40%	30.94%	32.48%	34.02%	35.56
Transport	36.99%	35.76%	34.53%	33.30%	32.07%	30.84%	29.61%	28.38%	27.18%	25.95%	24.72
Residential	29.38%	29.22%	29.06%	28.90%	28.74%	28.58%	28.42%	28.26%	28.11%	27.94%	27.79
Commercial	9.81%	9.76%	9.70%	9.65%	9.60%	9.55%	9.49%	9.44%	9.39%	9.33%	9.28
Agriculture	3.45%	3.21%	2.96%	2.72%	2.47%	2.23%	1.99%	1.74%	1.50%	1.26%	1.01
Others	0.21%	0.35%	0.51%	0.65%	0.80%	0.94%	1.09%	1.24%	1.34%	1.50%	1.64
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	10000.00%

Source: ADB, 1991;
WECS, 2001

Final energy consumption by each product as well as by each of the sectors is given in the table below. In year 2000, oil products is 60 percent of total final energy consumed, with electricity 28 percent and coal 12 percent. In the same year, industry sector consumed almost 36 percent of total energy. Transport sector consumed 25 percent and residential sector consumed about 28 percent. Agriculture sector consumed only about 1 percent of total energy and has been decreasing since 1990, when it was almost 4 percent of final energy consumed.

Nepal's Energy Consumption by Sector

In 2000, about 48,300 GBtu (Giga British Thermal Units) of commercial energy was consumed by various sectors as discussed below. The energy consumption is growing by almost 13 percent each year.

1.1. Residential Sector

In 2000, about 28 percent of total commercial energy is consumed in residential sector. Of total residential energy needs, almost 80 percent is met by fuelwood alone and mainly for cooking. Rural population comprises of over 80 % of total population, who do not have access and affordability to commercial fuels such as kerosene and LPG.

1.2. Industrial Sector

The energy consumed by the industrial sector was about 17200 GBtu in 2000. Petroleum products, coal and electricity are the major energy sources. In terms of end-uses, the consumption for motive power and process heat was almost 60 %.

1.3. Commercial Sector

In 2000, the energy consumption in commercial activities was about 4500 GBtu of which 80% was used for cooking and heating and about 10% for lighting and appliances. In terms of fuel use, almost 70 percent of energy needs was provided by petroleum products, electricity and coal and the rest by biomass.

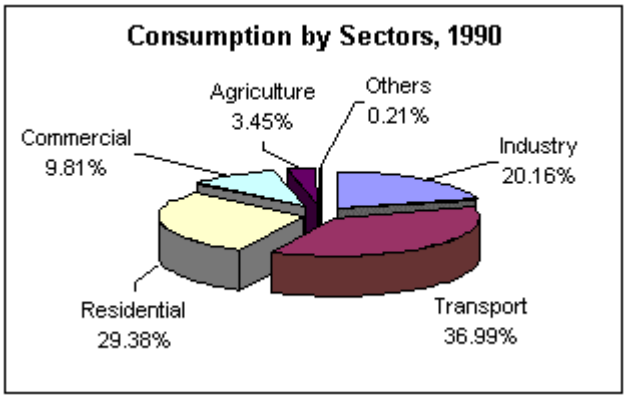
1.4. Transport Sector

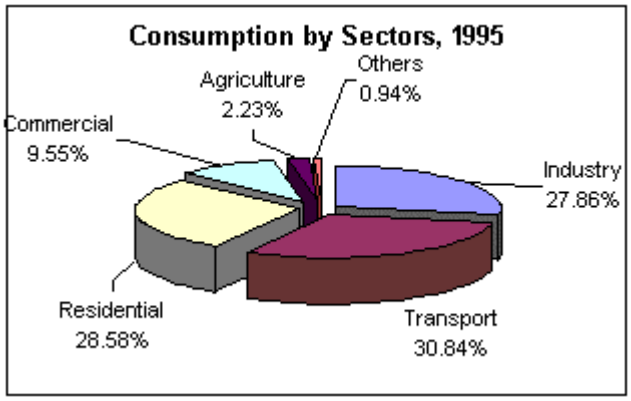
Tax liberalization, push for global concept on economy has led to an increase in transport activities. Between 1986 and 2000, the energy consumption in transport sector has increased by almost eight folds, mainly because of increases in road and rail services. Of about 12000 GBtu of energy consumed in 2000, almost 84% was consumed in road and 15% in air transport. Among fuels, diesel (67 %) and motor spirit (16 %) where the major supplies.

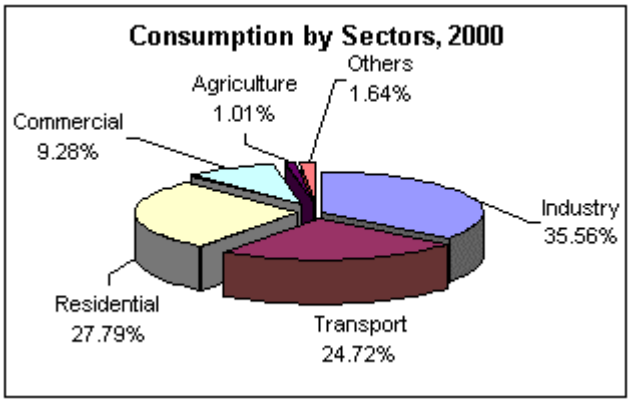
1.5. Agriculture Sector

Water pumping for irrigation, land preparation for cultivation and harvesting are direct energy consuming agricultural activities. The use of animate energy for agricultural activities has not been considered here. In 2000, the total energy consumption in the agriculture sector is about 500 GBtu, of which almost half is used for pump and another half for land preparation and other activities.

Figure 10: Final Energy Consumption by sector:







Challenges for the Future

Sustainable electricity development in Nepal would have to be achieved by relying on the indigenous hydropower, because in case of Nepal the viability of electricity generation from other sources has not been established yet. Because of extremely uneven distribution of water resources (which is available in the country in form of rain fall during certain months of a year only), construction of high dams to regulate the flow are essential. This is necessary in order that wet season surplus energy could be stored in the reservoirs for meeting the energy demand of the dry season. Due to weak geological conditions, steeper topography, intense rainfall during monsoon season and frequent glacier lake outburst events, the rivers are laden with heavy sediment load particularly in monsoon season. Hence, for creation of effective flow regulation for longer period, comparatively higher dams are required. This is an unavoidable problem associated with natural condition of the country. Very large scale projects with large high dams like Karnali, Pancheswor and Kosi are not suitable for Nepalese consumption for a foreseeable future. Unfortunately a moderate scale storage project which has already been studied to the feasibility level study and could be developed in a staged manner to suit the Nepalese power system, has already been licensed for dedicated export. Due attention has not been given to storage projects of medium size projects such as Sharda, Andhi Khola, which are of immediate importance for operating efficiently the power system of Nepal. On the other hand, policy thrust is always for larger projects leading to a situation that all the larger storage projects will be filled almost completely with silt at the time when Nepal will require electrical energy from these projects. Such policy thrust will create a situation making electricity supply for Nepal unsustainable in a longer term and incompatible approach of the development in the shorter term.

The quantity of the known fossil fuel mineral resources (coal and natural biogenic gas) in the country is not large to meet the demand in the national scenario. Whatever identified so far are of small nature which is good only for energy substitution locally so thinking of using available fossil fuel mineral resources as a sustainable energy source will be practicably of not much sense. In the present context, the important fact that should be happened is to confirm or establish whether there exist or not any fossil fuel mineral resources showing significance for development as energy source in the country.

In recognition of the high risk environment in petroleum exploration and the underdeveloped infrastructure situation in the country, His Majesty's Government of Nepal has designed a production sharing contract with attractive fiscal conditions which are favorable than most of the countries in the world.

Though much emphasis were given towards attracting the foreign capital through provision of different incentives such as exemption from all taxes and fees, foreign currency repatriation facilities, inclusion of "seismic options' in place of mandatory exploratory drilling", "no ring fencing" for exploration cost recovery etc. the response of the private investors is not much appreciable as anticipated. An example for this is the past case that only one company entered into petroleum agreement for the two of the available ten blocks after the four consecutive bid in 1989, 1990, 1995 and 1997. There is a tendency among the foreign investor to propose for more and more incentives even such as rate reduction in the present 12% royalty and 50% tax on net profit after recovery of the investment which are the only income that government will take from the petroleum

operators on the basis of petroleum sold or disposed and net income or profit earned. The foreign investors try to justify such proposals categorizing the petroleum exploration in Nepal of great risk than in those counties where the petroleum have been already discovered. The other obstacles impeding progress in petroleum exploration are tendency of holding or blocking the exploration blocks than actual implementation of the exploration commitments outlined in the agreement.

Energy Structure

Key Players In Nepal Energy Sector

Electricity Sub-Sector

His Majesty's Government of Nepal has established a number of Councils and Commissions of umbrella nature to bring coordination among sectoral plans and to ensure sectoral policies are consistent with the government's broader development and investment policies. The commissions and councils having relevance with electricity sector include National Development Council (NDC), Water Resources Council (WRC), Environment Protection Council (EPC), National Planning Commission (NPC) and Water and Energy Commission (WEC).

The Councils and NPC are an integral part of government itself and play a role in establishing consensus on major policies and strategies, which also influence power sector development. Policy advice arising from such Councils! Commissions is now embodied in policy documents and legislation. The Water and Energy Commission Secretariat (WECS) undertakes studies on water and energy sectors to arrive at appropriate policy recommendations. These recommendations are discussed in WEC and, for the government approvals, the recommendations of WEC are channelized through Ministry of Water Resource. Thus, although in WEC are representations from various ministries and private sector, WEC/WECS is just an apex body to The Ministry for Water Resources (MWR) having stronger linkage with it. Following are the line agencies directly responsible for power sector.

Ministry of Water Resources: MWR is the line Ministry with primary jurisdiction over the power sector. MWR is responsible for framing legislation that will be submitted to Cabinet and parliament, and has regulatory oversight for power generation, transmission and distribution licenses for NEA and private entities operating under the Electricity Act. These regulations are administered through the Electricity Development Department.

Electricity Development Department (EDD): Electricity Development Department (EDD) which is formerly known as Electricity Development Center, was created by the Electricity Act. It was upgraded in year 2000 as a HMG/N department similar to other departments like Irrigation, etc. It currently has three- part mandate acting on behalf of MWR and the legislative authority provided by H MG/N. This includes:

- Electricity Industry Regulatory Function: Under the framework of the enabling legislation, EDD is to provide theperational capacity for HMG to implement economic, technical and safety regulations for the power industry for duly registered public and private companies and entities;
- Private Power Development Promotion and Facilitation Function: promote private investment in generation, transmission and distribution by developing programs and approaches to actively solicit private investment in Nepal; and act as the designated "one

window facility" for private developer contact with government for development and operation of power supply facilities;

- MWR Technical Support Function: undertakes national level power planning activities; basin studies and establishment of hydro project inventories; and project-specific investigations, surveys and studies for multi-purpose projects for both domestic and bi national and regional development aims; and provision of technical backup to M0WR for Bilateral and Multilateral talks and negotiations on technical matters, agreements and financing arrangements when requested.

The Tariff Fixation Commission is new and was established under the Electricity Act, 1992. This commission has a direct relevance with electricity sector. The Commission consists of at least five persons from among HMG service and the professional community. At present the Commission has a full time Commissioner and a technical assistant. As a temporary measure EDD is providing technical support for the Commission. In future the Commission may establish a small cadre of core professional staff and utilize technical services from the professional community such as accountants, economists and tariff analysts when required. The function of the Commission is primarily to review and approve retail electricity tariff structures. The Act provides the basis on which tariffs will be established including levels required to ensure the financial viability of NEA such as reflecting depreciation, profit, and mode of operation of the plant in the system, royalties, taxes and other fees for electrical service at the consumer level. NEA is required to make an application for tariff increases to the Commission. The Commission is required to review the application and is given sole authority on deciding the tariff levels, balancing the commercial and financial viability of NEA with social considerations. The Act does not specifically require the Tariff Fixation Commission to review and approve tariffs for bulk power sales, such as from independent generators to NEA, or for export sales.

Nepal Electricity Authority (NEA): HMG/N has established in August 1985 a national power utility, the Nepal Electricity Authority (NEA) by combining various small electricity entities existing at that time. NEA has multiple responsibilities on its own as a public utility and is a dominant player in the development and operation of generation, transmission and distribution of electricity in the country and in negotiating and working with private power companies. NEA's multiple roles include:

- System planning: as an autonomous public corporation, NEA is responsible for planning required to meet the load in its service area and to specify the quantum and timing of power required from independent generation to complement NEA financed generation.
- Power purchaser: as a power purchaser, NEA will negotiate and enter into a PPA with the private developers. Similarly NEA would enter into supply agreements with independent transmission companies and distribution companies.
- Integrated grid maintenance and development: NEA is responsible for operating, maintenance and development of the integrated transmission grid.
- Scheduling and Dispatch: or the integrated operation, private generation will be subject to scheduling and dispatching from the control center of NEA.

NEA remains and will remain a dominant player in the development of hydropower in Nepal and operator of National Electricity System. It has an integral role to play in transmission, possibly wheeling of power, and in distribution and sale of the final product "electricity". NEA's viability affects the evolution and viability of the whole Nepal's power sector. Historically NEA has relied on traditional concessionary sources of debt financing which involve long lead times for HMG negotiation with Multilateral and Bilateral sources, and HMG on-lending to NEA at commercial

rates. Long delays in public sector financing will have spill over effects on private power development. NEA's ability to arrange timely construction of transmission connection to individual projects which generally involve take or pay contract arrangements is a more immediate and specific type of such concern. Failure to be ready when specified in the PPA agreement (often written many years earlier), will lead to financial loss to NEA.

Private sector participation is being pursued through the regulatory framework that HMG has established, with EDD taking the key promotion role on behalf of MWR. Since the passage of the Electricity Act, 1992 a number of survey licenses (or equivalent MOU's) have been issued for private supply to interconnected grid, totaling about 273 MW of nominal capacity. NEA's total installed capacity is now 425.95 MW as of Feb. 2000. 113.4 MW (Andhi Khola, Jhimruk, Khimti I and Upper Bhote Koshi) of generation capacity of four power stations connected to the grid is licensed to private companies, although BPC(Andhi Khola, Jhimruk) cannot be considered as a totally private company due to the fact that majority of the shares of BPC belongs to HMG/N. In the past two years HMG/N is pursuing to sell 75% of its shares in BPC to private owners and tenders for this have been issued and evaluation process is going. NEA has obtained survey and production licenses for a number of hydro projects for interconnected system supply from EDD including Kali Gandaki A (144 MW) which is under construction with the financial assistance provided by ADB and OECF of Japan. Decisions are still pending on larger public sector hydropower projects to be pursued by NEA.

A survey license for West Seti (360 MW) has been issued for private sector development for export of power to India.

Existing Legislative and Regulatory Framework

Major revisions to HMG/N's foreign investment policy, and the legislative and regulatory framework for the power sector were completed between 1992 and 1993.

The key Acts and Regulations which set out the legal and regulatory framework governing public and local and foreign private sector participation in power sector development include:

- Hydropower Development Policy, 1992
- Electricity Act, 1992
- Electricity Regulations, 1993

A number of other Acts and legislation govern activities which indirectly affect the power industry include the following:

- Water Resources Act, 1992.
- Industrial Policy (1992)
- Foreign Investment and Technology Transfer Act (1993)
- Environment Protection Act (pending)

- Company Law

In addition to the main legal instruments that are applicable, there are also numerous district-level, local and municipal level regulations, which must be observed by public and private entities involved in energy supply activities in such locations.

Issues Affecting Electricity Sector

Institutional/Policy Issues:

- Policy thrust on export oriented hydropower development is obvious as evidenced by Ninth Plan Document. However, these ambiguous plans have neither been supported by investment programs, nor by commitments in specific requirements of institutional capacity building for handling mega-multipurpose projects.
- Competition among private developers is not the mandatory requirement by Electricity Act, instead a provision has been made for the government to enter into a contract with any person or corporate body even through by passing the Act (Ref. Clause -35 of Electricity Act just by including specific terms and conditions in the contract). Besides, no cost control mechanism is stipulated in the Act. This has encouraged adhoc decision making process affecting on NEA's commercial viability.
- Instead sufficient policy support by way of creating a separate department for rural electrification, the government has loaded its social responsibility of rural electrification to a commercial entity like NEA.

Economic I Financial Issues:

- Tariff Fixation commission becomes active, only when it receives the proposal for tariff increase. No mechanism has been incorporated in the Electricity Act for cost control.
- Inability to attract domestic finance for hydropower development.
- Need of regular tariff adjustments based on reevaluated assets.
- Neglect of national capacity building in hydropower development has led to higher development cost.
- Technical Issues:
- System fit consideration is grossly overlooked, while issuing licenses for hydropower development.
- Inadequate investment in transmission/ distribution sector than for generation is the root cause for high technical losses.

Environmental Issues:

- Resettlement and rehabilitation of the people in the construction sites and project as a whole area.
- Protection of forest as well as aquatic resources.

Availability of Resources:

- Among the resources available indigenously for electricity generation, the only promising resource is hydropower, but due to uneven distribution of this resource in terms of time

and location, its development is location specific and requires high dams for seasonal flow regulation and for optimum use of the available potential.

Petroleum and Coal Sub-sectors

A number of the councils and commissions formed by His Majesty's Government of Nepal are existent in the country with an objectives to bring the coordination among the sectoral plan and to ensure that the activity are undertaken in consistent with the broader perspective of the government on development and policies. Relevant councils and commission with fossil fuel energy resources development are National Development Council (NDC), Environment Protection Council (EPC) and National Planning Commission (NPC).

The commissions and councils, being integral part of the government itself, play a pivotal role in attaining consensus on overall policies and strategies of mineral resources development including that of fossil fuel resources. Policy matters arising from such commission! councils appear as policy documents and legislation. These policies are implemented by line ministries and departments. The following are the line agencies under which fossil fuels are administered.

Ministry of Industry, Commerce and Supplies

The Ministry of Industry, Commerce and Supplies is the line ministry for formulation of legislation for the exploration and development of fossil fuel resources, as well as for the marketing and distribution of their products. The Ministry administers the regulation approved from the cabinet and parliament through the different government departments and corporation including Department of Mines and Geology, Department of Commerce, and Nepal Oil Corporation responsible, among others, for fossil fuels.

Department of Mines and Geology (DMG)

The Department of Mines and Geology created in 1976 to avoid overlapping activities between Bureau of Mines and Nepal Geological Survey was given a mandate to undertake mainly the following main aspects in the exploration and development of the minerals.

- To provide the basic geo-scientific information and expert services to mineral resources exploration and development entrepreneurs and institutions.
- To promote the development of mineral industries.
- To manage the government investment in mineral exploration, development and production, and also in related mineral based industries. Currently the activities of the department in respect of fossil fuel mineral resources development cover exploration, evaluation and promotion of coal, natural biogenic gas, petroleum and related natural gas.

Petroleum Exploration Promotion Project (PEPP)

His Majesty's Government of Nepal formed the Petroleum Exploration Promotion Project as the independent unit under the umbrella of the Department of Mines and Geology to ensure that the petroleum exploration promotion activities were undertaken effectively and systematically. The PEPP in its capacity acts as the facilitator in negotiation and granting petroleum agreement to private investors in conformity with the procedural arrangement as defined in the petroleum Act and Regulations.

Nepal Oil Corporation (NOC)

The Nepal Oil Corporation established as a regulated public enterprises by HMG/N in 1971 currently operates under the Ministry of Industry, Commerce and Supplies after amalgamation of the three Ministries namely Industry, Commerce and Supplies. Its primary functions are to arrange (i) import of petroleum and oil product (POL), (ii) storage of strategic POL product and (iii) distribution of POL product throughout the country. The Ministry of Industry, Commerce and Supplies is authoritative in fixation of the prices of petrol, diesel and kerosene however the NOC Board can finalize prices of other unregulated prices. Import of POL are exclusively through India mainly in the form of procurement by NOC from one of six major Indian Oil Company (IOC) depots located close to the Nepal-India border. Payment to lOC is processed through various swap mechanism as agreed upon between the governments of Nepal and India. Accordingly NOC will provide IOC with POL products from the international markets at Indian port location for its (IOC) general uses. NOC authorizes contractors to transport fuel between IOC and NOC depots, as well as between NOC and local wholesale and retail dealers. Existing regulation permits private dealers in Nepal to import the POL products from third country under the procedure defined by the Departments of Industry and Commerce. Currently import of Liquefiable Petroleum Gas (LPG) is taken care by the private sector as well.

Nepal Coal Limited and Private Sector Coal Importers

Till 1992, the Nepal Coal Limited (NCL) established as a public corporation with exclusive right for import of coal from India was the only agency engaged in necessary coal supplies through agreement with the Coal India Limited (CIL). In 1993, twelve private enterprises were emerged to share hands in coal import business. The new arrangement provides the individual private enterprises the right to make own agreement and fix price with Coal India Limited. NCL is not existent today by decision of the HMG/ N to dissolve it. Currently the private sector is engaged in import and distribution of coal throughout the country. The Nepal Coal Limited was dissolved in view of providing a competitive forum totally for the private enterprises.

Existing Legislative and Regulatory Framework

Two separate Acts and corresponding Regulations exist to deal with different fossil fuel minerals, categorized into two groups, namely:

a. All mineral resources (including coal and natural biogenic gas), and

b. Petroleum and related gas only.

The Act and Regulations relating directly to coal, biogenic natural gas and petroleum hydro-carbon minerals exploration and development by the local and foreign investors are as follows:

- Mines and Mineral Act, 2042 (1985) with First Amendment, 2050 (1993).
- Mines and Mineral Regulation, 2056 (1999).
- Nepal Petroleum Act, 2040 (1983).
- Petroleum Regulation, 2041 (1985) with First Amendment, 2046 (1989) and Second Amendment 2051 (1994).
- Petroleum Industry (Income Tax) Regulation, 2041 (1985).

A number of other Acts and Regulations which govern and affect the activities on fossil fuel mineral based. industries include the following:

- Industrial Policy, 1992.
- Foreign Investment and Technology Transfer Act, 1992 with First Amendment 1996.
- Industrial Enterprises Act, 1992 with First Amendment 1997.
- Environmental Protection Act, 2053 (1996).
- Environmental Protection Regulation, 2054 (1997) with First Amendment, 2055 (1998).
- Company Act, 1997.
- Income Tax Act, 1974.

Provisions in Laws Affecting Petroleum and Coal Resources Development

The prevailing Acts and Regulations provide basic statutory to deal with fossil fuel minerals categorized into (i) Coal, (ii) Natural biogenic gas, and (iii) Petroleum and related natural gas.

The Mines and Mineral Act (1985) with First Amendment (1993), and Mines and Mineral Regulation (1999) addresses the following main provisions for participation of private investors in prospecting, exploration and development of (i) Coal, and (ii) natural biogenic gas:

- His Majesty's Government bears right to participate in the coal, natural biogenic gas and other mineral development activity as a partner in terms of capital or any other form of contribution,
- Facility for joint venture or 100% local or foreign investment,
- Provision to obtain a prospecting /exploration license over not more than 250 sq. km area for an initial 2-4 years period and additional 2 years extension,
- Entitlement of acquiring mining right up to (I) an area of 25 sq. km and (ii) 30 years in consideration of the size of mining operation,
- Right to sale and export the products of mining activities,
- Facility to import machinery and equipment for mining activities,
- Royalty recovered based on production, and
- Nominal cost involvement (Rs. 2000-8000) for obtaining mining license.

The Petroleum Act 2040 (1983), Petroleum Regulation 2041 (1985) with First Amendment 2046 (1989) and Second Amendment, 2051 (1994) and Petroleum Industry (Income Tax) Regulation, 2041 (1985) outline the following legal and regulatory features for exploration, development and production of the petroleum resources and related natural gas. The Act and Regulations offer attractive and competitive incentives for potential investors both from within and outside the country.

- HMG/N may carry out petroleum exploration, development and production by itself or through agreement with the contractor/Investor;
- Provision for a joint venture or 100% local or foreign investment;
- Right to export entitlement of petroleum;
- Exemption from all tax and fees except a royalty of not less than 12.5% to be prescribed on the value of petroleum sold or disposed of;
- Income tax of 50% on net income or profit from petroleum operation;

- Annual surface rentals for the areas other than those under production at rate of US$ 10.00 to 40.00 per sq. km and for the area under production at the rate of US$ 500 sq. km;
- Nominal miscellaneous I fees which include land tax, registration and forestry fees, and charges of general application;
- Exemption from custom duties on imported goods;
- Foreign currency facility and right to repatriate funds; and
- Right to employ foreign nationals.

The Petroleum Regulation providing specifically the procedural arrangement for bidding, evaluation of bids, negotiation and granting of petroleum arrangement to conduct petroleum exploration and operations through employment of a contractor or a company possessing specified capital, technical competence and professional skills outline the following features.

- Contracting a qualified oil company through an international bidding with notice of not less than 60 days for exploration in blocks each of approximately 5000 sq. km;
- Contract may hold generally up to two blocks in a petroleum agreement;
- Four years as the initial exploration period with 2 optional extensions of two years each. After expiry of exploration period, additional extension may be granted to complete drilling and testing of a well in progress.

"Seismic Option" is applicable for the initial four year turn without the inclusion of a drilling commitment.

- "No ring Fencing" applies regarding the recovery of the exploration cost involved in the blocks.
- Production period ends at thirty years from the date of agreement with an option of five years extension.
- Requirement of data package purchasing pertinent to the respective acreage block.

As arrangement made in the Act, the Department of Mines and Geology on behalf of HMG/N administers the application for and negotiation of petroleum agreement. One other institution constituted under this Act named, "the Petroleum Advisory Board" delivers advice to HMG/N on matters relating to petroleum operations. Its main functions are to advice HMG/N on:

- Selection of contractor to carry out petroleum operations.
- Amendment and termination of petroleum agreements.
- Joint venture arrangement and participation by HMG in petroleum operations.
- Arbitration.

Table 9: A Quick Snapshot of Nepal's Oil and Gas Industry (In barrels per day)

Imports	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	253	297	461	515	535	602	710	773	809	861	958	1,021
Diesel	1,779	1,834	2,870	3100	3,378	3,915	4,316	4,432	5,180	5,441	5,351	5,618
Kerosene	1,649	1,309	2,110	2571	2,793	3,111	3,596	4,187	4,860	5,083	5706	5,452
Aviation Turbine Fuel	161	285	428	503	521	647	700	822	866	957	980	1088
Other products		270	402	564	471	622	710	701	495	1026	1062	420
Total	3,842	3,995	6271	7254	7,691	8,897	10033	10,916	12,269	13369	14,056	13599

In year 2001, the other products do not contain LPG.

Source: Nepal Oil Corporation Ltd. and Ministry of Finance, HMG/N, 2001

Details About Oil and Gas in Nepal

Petroleum Sub-sector

Of the total commercial energy, petroleum sub-sector occupies 75%, electricity 8%, and coal 17%. Till today, exploration and development activities have not brought any fruitful result. The demand for petroleum products is totally met by 100% imports. The demand for petroleum products is increasing on average 12/13% annually. The major petroleum products used are diesel, kerosene, gasoline, aviation fuel, LPG, fuel oil and other refined products.

Due to the September 11 event, Nepal's economy is badly shaken and the consumption of diesel in the first 6 months (fiscal 2001/2002) has decreased by 11.67% to 5,295 barrels per day. Tourism industry is also in doldrums and as a result, domestic airlines are also facing a tough time. Adverse situation in the tourism sector has caused aviation fuel consumption to be declined by 25% to 895 barrels per day. Despite all these scenarios, gasoline sales have increased by 5.9% to 1,067 barrels per day. Sales of Kerosene and Liquefied Petroleum Gas (LPG), which are mainly used for cooking purposes, have increased by16% to 6,187 barrels per day and by 23% to 18,778 MT respectively.

Upstream Petroleum Activities

Petroleum is categorized as the national priority commodity for exploration and development. The Petroleum Exploration Promotion Project (PEPP) was established in 1982 to promote petroleum exploration and development activities in the country.

The Southern Terai Plains and adjoining Siwalik Range have been divided into ten different blocks, each of 5,000 sq km for exploration and development. A considerable amount of geological and geo-physical data of different studies such as geological section measurement (850 km), petrochemical

sampling (1,100 sites), photo geology (60,000 sq km), aero-magnetic survey (24,145 line km covering 48,000 sq km), seismic survey (5,294 km, and gravity survey (21,000 sq km) and drilling 3,520 km). Royal Dutch Shell and its partner Triton Energy of the US had drilled to the depth of 3,520 km at one site near Biratnagar, but could not find out any oil.

Texana Resources of the US has recently obtained the right to carry out seismic and geological studies at Nepalgunj and Chitwan areas.

Downstream Sector

Nepal Oil Corporation Ltd. (NOC) was established in 1971 by His Majesty's Government of Nepal (HMG/N). Its primary objectives are to import petroleum products and distribute throughout the Kingdom of Nepal at the most reasonable prices. It operates under the Ministry of Industry, Commerce and Supplies. The prices of gasoline, diesel, kerosene and LPG are administered by HMG/N, and the domestic prices of other products are fixed by the NOC Board of Directors.

Petroleum consumption

If we observe the per-capita consumption of petroleum products in the developed countries and our neighbors, our consumption is dismally poor. Petroleum consumption is usually considered as one of the main indicators of the economic development of the country. Nepal's consumption is just 35 Kg per capita, which is twice below India's, and more than four times below that of China. There is virtually no point in comparing with the consumption in the developed countries.

Table 10: Petroleum Consumption per Head

Country	Consumption
USA	3,170 Kg
Canada	2,835 Kg
Japan	2,185 Kg
Great Britain	1,480 Kg
China	170 Kg
India	82 Kg
Nepal	35 Kg

Source: Energy Statistics Sourcebook, 1995

The ten years' sales figures (from 1990 to 2000) of the following petroleum products shed ample light on the alarming growth rate, and this is a serious thing and needs focused attention from the HMG/N. Otherwise, supply crisis may occur at any time. For the past five years, The Compounded Annual Growth Rate (CAGR) of petroleum sales is 13.85%. If we consider the Perspective Energy Plan (PEP) prepared by the National Planning Commission in 1995 for 20 years' projection from 1992 to 2018, the annual demand growth for petroleum products will be in the range of 7.5% to 10.2%.

Table 11: Petroleum product Consumption (In barrels Per day)

Imports	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	253	297	461	515	535	602	710	773	809	861	958	1,021
Diesel	1,779	1,834	2,870	3100	3,378	3,915	4,316	4,432	5,180	5,441	5,351	5,618
Kerosene	1,649	1,309	2,110	2571	2,793	3,111	3,596	4,187	4,860	5,083	5706	5,452
Aviation Turbine Fuel	161	285	428	503	521	647	700	822	866	957	980	1088
Other products		270	402	564	471	622	710	701	495	1026	1062	420
Total	3,842	3,995	6271	7254	7,691	8,897	10033	10,916	12,269	13369	14,056	13599

In year 2001, the other products do not contain LPG.

Source: Nepal Oil Corporation Ltd. and Ministry of Finance, HMG/N, 2001

NOC and Indian Oil Corporation Ltd. (IOC) have an agreement of supply of petroleum products on product exchange basis. Under the agreement, NOC imports usually diesel (gasoil) and kerosene from the international market and hands them over to IOC. In exchange, NOC uplifts various petroleum products from IOC's depots nearest to Nepal Border. The accounts are settled on quarterly basis.

The current agreement is valid till June, 2002. Under the present agreement, NOC has to provide crude oil to India instead of refined petroleum products such as gasoil and kerosene.

In year 2001, the other products do not contain LPG.

Table 12: Import of Petroleum products from India (In barrels per day)

Imports	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	253	297	461	498	542	604	719	800	819	889	1,009	1,045
Diesel	1,779	1,834	2,815	3,055	3,368	3,923	4,382	4,457	5,205	5,499	5,642	5,752
Kerosene	1,597	1,309	2,109	2,474	2,795	3,045	3,685	4,201	4,956	5,141	6,034	5,603
Other products	161	285	419	495	524	653	1,023	1,216	1,286	1,396	1,546	421

Total	3,790	3,725	5,803	6,522	7,230	8,224	9,809	10,675	12,265	12,925	14,232	12,821

Source: Nepal Oil Corporation Ltd. and Ministry of Finance, HMG/N, 2001

Petroleum Prices

Though dependent on import, petroleum products are the cheapest sources of energy for Nepalese. Kerosene is almost 3.5 times, LPG more than two times cheaper than electricity. Though not expensive, fuel-wood has almost become unavailable in urban areas. The following table for producing 1 MJ (Mega-Joule) of heat energy shows why petroleum products have become the main source of energy for Nepalese. (The table is based on current prices of the energy sources).

Table 13: Comparison of Energy Sources

Source of energy	Cost/ 1MJ of heat energy
Electricity	RS 2.21
LPG*	RS 0.83
Kerosene*	RS 0.62
Fuel-wood	RS 0.15

(LPG and kerosene prices are based on the price revision of NOC on 13th Oct, 2000.)

Especially kerosene has become the principal source of cooking energy for the urban poor. It has been supplied below its economic cost for the past several years. When a product is provided below its real value, there are a lot of chances that the product will not be used efficiently. There are cases of widespread adulteration of diesel and gasoline with kerosene due to the wider price differences. Subsidy is also provided in the LPG.

The prices of some of the major petroleum products are as follows.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline NC RS	19.00	20.00	25.00	29.00	29.00	29.00	31.00	34.00	39.00	40.00	40.00	46.00
Diesel NC RS	9.10	10.00	10.00	11.50	12.00	12.00	13.50	14.00	15.50	15.50	23.00	27.00
Kerosene NC RS	6.90	8.50	8.00	9.75	9.75	8.50	9.50	9.50	10.50	10.50	13.00	17.00

Table 14: Petroleum Product Prices - (per liter, annual average) (In 2001, US$1.00 = NC RS 77)
Source: Economic Survey, HMG/N, Ministry of Finance, 2001

Current Storage Facilities

The current growth rate in consumption of petroleum products in the country asks for strategically planned way of expansion of storage facilities, which it seems NOC has not been able to do so yet. The existing storage facilities of 31,790KL and the addition of facilities of almost 39,010KL constructed with the assistance from the Asian Development Bank, and NOC's internal accruals, can meet around 30 days' current demand only.

Table 15: Current Storage Facilities at Different Locations

Locations	Storage Facilities in kL
Kathmandu	23,100
Amlekhgunj	23,630
Biratnagar	12,320
Bhaiahawa	3,620
Pokhara	3,420
Nepalgunj	2,010
Dhangadi	2,580
Surkhet and Dipayal	120
Total	70,800

Source: NOC

For a land-locked country, though a Commission set up in 2054 to give report on inclusion of private sector in the supply and distribution of petroleum products suggested a storage facilities for 45 days, Nepal needs minimum storage facilities for meeting almost 90 days' consumption. The reasons are the topography and current inadequate other means of transport infrastructure, and road being principal mode of transportation in the country. To have storage facilities of 90 days' demand, will NOC be able to construct additional storage facilities of around 110,000 KL, which requires an investment of almost RS 100 crores (based on figures in 1993)? Infrastructure development at NOC is very poor, and hence, there always looms the specter of supply crises at any time.

As per the international Energy Program (IEP) contained in the International Energy Agency's (IEA) governing treaty, a member country has to have emergency reserves equivalent to at least 90 days net of oil imports. If we look into the current strategic reserves of the OECD countries, the average reserves are sufficient for 90 days' forward demand. For land-locked country like Switzerland, the reserve is still higher and covers for more than 120 days' forward demand.

Problems and barriers in sustainable development of petroleum resources

The exploration and development of petroleum involve not only high risk and uncertainty but also much more huge investment than in the case of other mineral exploration activities. The potential geological features considered to be favorable for the localization of petroleum lie at considerably deep condition, three to four kilometers deep in our context. Deep exploration cost increases the cost significantly.

The present political situation in the country will hardly be conducive for attracting any foreign investment.

Some Challenges Ahead

Although efforts are being made in exploration, these efforts are limited due to limited domestic financial resources and high risk of deep exploration. Till now, only one hole is drilled to the depth of 3,520 m, and it also was found dry.

Demand for petroleum products is increasing at a rapid rate and it requires adequate storage facilities for security purposes, for Nepal is a land-locked country. His Majesty's Government of Nepal (HMG/N) has not paid required attention in expanding storage facilities with respect to increase in consumption.

Table 16: A Quick Snapshot of Nepal's Electric Power Industry

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Installed generating Capacity (GW)	0.219	0.254	0.269	0.267	0.288	0.304	0.310	0.328	0.328	0.328	0.400
Total Generation (bk Wh)	0.784	0.959	1.019	0.969	1.021	1.078	1.27	1.302	1.251	1.322	1.553
Coal Generation (%)											
Petroleum Generation (%)	0.110	0.080	3.220	4.910	6.030	7.240	2.900	2.900	7.830	8.060	3.920

Natural gas Generation (%)											
Hydroelectric Generation	90.82	90.88	87.83	86.07	84.86	85.62	90.87	86.65	75.75	75.44	82.50
Other Generation (Micro Hydro)	9.07	9.04	8.95	9.02	9.11	7.14	6.23	10.45	16.42	16.50	13.58
Transmission Losses (%)	29.20	26.16	24.87	26.38	26.58	26.14	25.75	26.15	23.45	24.48	25.40
Imports (bk Wh)	0.061	0.033	0.055	0.082	0.103	0.114	0.073	0.154	0.210	0.232	0.232
Exports (bk Wh)	0.023	0.018	0.085	0.046	0.051	0.040	0.087	0.100	0.067	0.064	0.095

Table 17: Long Term Electricity Consumption Forecast

	2005	2010	2015	2020
Total Electricity Consumption (bk wh)	2.598	30855	5.456	7.668
Total Electricity Consumption (GW)	0.57	0.846	1.198	1.683

Electricity consumption in various sectors is given in the table below. The consumption of electricity is gradually growing from 36 percent in 1990 to 44 percent in 2000. Consumption in commercial sector is almost constant at about 14 percent. Consumption in residential sector is 38 percent in 2000.

Table 18: Electricity

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Electricity Generation (bkwh)	0.784	0.959	1.09	0.969	1.021	1.078	1.27	1.302	1.251	1.322	1.533
Generation by Source %											
Hydro	99.84	99.82	96.78	95.09	93.97	92.76	97.10	97.10	92.17	91.94	96.08
Thermal	0.16	0.18	3.22	4.91	6.03	7.24	2.90	2.90	7.83	8.06	3.92
Total	100	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Net Imports (bkwh)	0.11	0.08	3.22	4.91	6.03	7.24	2.9	2.9	7.83	8.06	3.92
Final Electricity Consumption (bkwh)	0.038	-0.048	-0.03	0.036	0.052	0.074	-0.014	0.054	0.143	0.168	0.137

Comsumption by Sector %											
Industry	35.69	36.23	36.83	37.37	38.08	38.83	39.65	40.57	41.44	42.55	43.80
Transport											
Residential	42.9	42.62	42.33	41.89	41.55	41.15	40.72	40.27	39.61	39.02	38.39
Commercial	14.28	14.29	14.27	14.33	14.32	14.34	14.36	14.34	15.07	14.45	14.44
Agriculture	4.78	4.5	4.18	3.93	3.56	3.17	2.73	2.25	2.37	1.25	0.6
Others	2.35	2.36	2.39	2.48	2.49	2.61	2.54	2.57	1.51	2.73	2.77

Source: ADB, 1991; WECS, 2001, NEA 2001

Table 19: A Quick Snapshot of Nepal's Coal Industry **COAL (short tons)**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Anthracite Production	77	220	2090	1306	2094	6432	6577	8979	17347	12049	19283
Lignite Production	8589	11165	15488	4299	319	220	818	864	385	343	57
Total Consumption	8566	11385	17578	5605	2413	6652	7395	9843	17732	12392	19340
Imports	20705	85548	85153	62582	62641	61733	81931	110705	154218	197085	269266
Exports	12139	74163	67575	56977	60228	55081	74536	100862	136486	184693	249926
Net Imports/Exports	-	-	-	-	-	-	-	-	-	-	-
National Annual Average Price Per Short Ton	12139	74163	67575	56977	60228	55081	74536	100862	136486	184693	249926

Long Term Coal Production Forecast

	2005	2010	2015	2020
Total Coal Production	41,467	137,535	206,806	310,966

Long Term Coal Consumption Forecast

	2005	2010	2015	2020
Total Coal Consumption	365,868	530,140	827,224	1,243,864

Details About Coal in Nepal

Coal consumption is met mainly through imports, which amounts to about 250,000 short tons per year. There are few lignite occurrences in Nepal and the maximum production capacity of these mines is estimated at about 20,000 short tons per year at present.

Of the four spatially categorized coal resources known in Nepal namely (i) lignite of Kathmandu valley, (ii) sub-bituminous coal of Dang, Sallyan and Rolpa districts (iii) coal in Gondawana rocks of the Barakshetra area, and (iv) coal in Siwalik rock of the Churia range that occurred in the Dang-Sallyan-Rolpa districts bear an economic importance, and have been extensively explored and exploited these days. Presence of more than 5 million tons of coal resources containing a few cm to 2.5 m thick coal seams has been estimated for this category where possibility of identification of additional reserve is suggested on further exploration. Sub- surface exploration by drilling in the Tosh-Seuza area in Dang has specifically established existence of one million ton of proven coal reserve.

Occurrence of lignite resource known in the Kathmandu valley (Lukundol-Pharping-Dakshinkali area) were the only coal resources mined in the past to fulfill the local demand. Lignite production considerably declined in this area due to uncertainty of the reserve and water problems in underground workings. In a typical locality at Lukundol, out of the eight small lenticular seams representing I to 3 m thickness of very limited extension, only two seams were of some value.

Though lignite seams are observed over an area of 8 sq. km determination of actual lignite resources available at Lukundol area has not been practically possible due to small and irregular nature.

Coal occurrences representing other two categories namely that observed in the (i) Gondwana rock of the Barahakshetra and (ii) Siwalik rocks of the Churia range are commercially insignificant. In these regions sizeable coal seams, good for production, were not yet identified.

A Quick Snapshot of Nepal's Renewable Energy Industry

Solar PV

- About 1600 kWp of solar power has been installed in different parts of country covering rural telecommunication (more than 6.5%), centralized PV system, solar PV water pumping and stand alone solar home system in more than 60 districts;
- 14 recognized solar companies operating in Nepal

Microhydro

- More than 5 MW installed capacity in 941 microhydro installations of the country;
- 11 active manufacturers of microhydro turbines and accessories;

ICS

- More than 52,000 ICS have been installed;

Biogas

- More than 80,000 biogas plants have been installed by 2001;

Solar Thermal

- More than 17,000 solar water heaters have installed by 1998;
- Some solar cookers and solar dryers have been distributed as a trial basis in some districts

HMG/Nepal
Ninth Five Plan (1997-2002)
Development of Alternative Energy Goal

S/N	Description	Unit	054/55 97/98	055/56 98/99	056/57 99/2k	057/58 2k/01	058/59 01/02	Total
1.	**Micro – hydro**							
	a. micro-hydro installation	**kW**	**226**	**580**	**930**	**1530**	**1950**	**5216**
	b. mini-hydro installation	**kW**	**0**	**185**	**333**	**742**	**740**	**2000**
	c. micro-hydro inventory study	**District**	**3**	**3**	**3**	**3**	**3**	**15**
	d. feasibility study of micro-hydro	**Nos.**	**25**	**65**	**100**	**150**	**200**	**540**
		Rs in	**0**	**20**	**20**	**50**	**50**	**140**

	e. micro-hydro training **f. Rural Energy Development Program**	**Lakh** **kW**	**425**	**510**	**510**	**455**	**-**	**1900**
2.	Bio – Energy **a. Bio-gas installation** **b. ICS (Demo, Training, Development)**	 **Nos.** **District**	 **12 k** **0**	 **14.5 k** **5**	 **17.5 k** **10**	 **21 k** **15**	 **25 k** **15**	 **90 k** **45**
3.	Solar Energy **a. PV SHS (36/50Wp)** **b. Solar Dryer Installation(3m^2)** **c. Solar Energy Data Collection/Mapping** **d. Training/Demonstration/ Supervision/ Research & Development**	 **Nos.** **Nos.** **District** **District**	 **1.2 k** **30** **1** **4**	 **4.8 k** **60** **4** **6**	 **8 k** **60** **5** **8**	 **12 k** **60** **5** **10**	 **12 k** **90** **5** **12**	 **38 k** **300** **20** **40**
4.	Other Alternative Energy **a. Wind Data Collection/ Mapping** **b. Geo – thermal inventory study** **c. Geo – thermal Pilot Project**	 **District** **Nos.** **Nos.**	 **0** **0** **0**	 **0** **1** **0**	 **1** **1** **0**	 **2** **1** **1**	 **2** **0** **1**	 **5** **3** **2**
5.	Standardisation (Workshop/ Seminar / Research)	Nos.	0	2	2	2	2	8
6.	Rural Energy Development Fund	Rs in Lakh	0	25	25	25	25	100

Source: Ninth Five Year Plan, HMG/Nepal 562pp

Details About Renewable Energy Situation in Nepal

About 87 percent of the Nepal's populations live in rural areas and agricultural sector is the mainstay of the rural population. This sector contributes about 40% (1998/99) in the real Gross Domestic Products (GDP) and is in decreasing trend. However, this sector still provides employment to more than 80% of the economically active population. Industrial and service sectors (including tourism) are next major contributors in the national economy but their contribution to rural economy is very small.

Share of the rural areas in total energy consumption of the country is about 87%. Rural residential sector accounts for 89% of the total rural energy consumption. However, if only commercial energy (including new and renewable energy) is considered, then the rural areas consume only 30% of total commercial energy consumption (WECS, 1995).

From energy end-use perspective, residential cooking is a single activity that accounts for about 65 percents of total energy consumption. Level of electrification is very negligible. Kerosene lamps are the most common lighting appliances in rural areas which consumes about 1 percent of total rural energy consumption. The rural energy heavily relies upon animate and biomass energy for its energy requirements.

Rural Energy Supply:

Rural energy supplies can be broadly classified into, i) biomass, ii) electricity through rural electrification, iii) various renewable energy technologies, and iv) imported petroleum fuels.

1. Biomass

Biomass as a source of energy mainly consists of fuelwood, agricultural residue and animal dung. The biomass available for energy purpose on a sustainable basis is estimated to be about 23 million tonnes in the FY 1991/92 of which fuelwood from accessible forest was 33%, agricultural residue - 53% and animal dung - 14% (NPC/PEP 1995). Fuelwood and other biomass fuels are burnt in traditional stoves of various kinds for cooking and space heating. There have been some efforts to disseminate improved or more efficient stoves having energy conservation and health and sanitation benefits. There is a marked imbalance of sustainable supply of fuelwood and consumption at present (WECS, 1994). Agricultural residue, although can be converted to briquettes for more efficient use, is burnt as it is for energy purpose. Alternatively it can be converted to biogas without loosing nutrients that go to farm. Dung and agricultural residue, both have other important uses (fertilizer and fodder) which compete with their use as fuel.

2. Rural Electrification (RE)

Rural electrification alone does not spur the economic growth but it is a necessary adjunct to initiate industrial and other economic activities. The other reasons for rural electrification in Nepal are to improve the quality of rural life, expand rural employment opportunities, and reduce deforestation. Electricity has also been seen as a basic need for rural population. Although hydrological and topographical conditions provide Nepal with an immense potential to develop hydropower, the extent of rural electrification has been very small. It is estimated that out of 15% of the country's population having access to the electricity only about 5% is in rural areas.

Nepal's rural electrification can broadly be classified into Nepal Electricity Authority's (NEA) grid based rural electrification and isolated rural electrification. Isolated rural electrification can be further classified into NEA's isolated generation through small hydro and other facilities and the privately owned generation facilities like small and micro hydro, and other renewable energy (solar, wind, etc.) based electrification.

At present, both public and private sectors are involved in renewable energy. The Nepal Electricity Authority (NEA) is responsible for all aspects of public grid based rural electrification. Under NEA, a separate Directorate for Rural Electrification Programme with Small hydropower Department (SHPD) under it is responsible for renewable energy. Numbers of non-governmental organization (NGOs) are engaged in rural electrification in Nepal, as are various private firms through isolated systems.

In the Fifth and Sixth plans the stated objectives of rural electrification focused on two goals: to contribute to the development of rural industry and agriculture and to expand uses in the residential sector. The Seventh Plan dealt more extensively and stated goals for both small hydro and grid extensions to "develop and expand agriculture development and cottage and small scale industries." Irrigation potential from ground water was to be expanded with increased electricity access. Eighth Plan states that rural electrification programme will be carried out through the extension of the national grid as far as practical. It also states the formulation of a programme to support rural electrification in places as identified in Ten Year Rural Electrification Study. Under current government regulations, no license is required to operate hydroelectric projects with a capacity of up to 1000 kW (Water Resources Act, 1992). The Ninth Plan also emphasizes on need to continue the rural electrification as a driving wheel of rural development.

Rural electrification (RE), if properly planned and implemented, can be an important component of a comprehensive, planned development strategy such as Agriculture Perspective Plan. It will also assist the implementation of rural development programmes by meeting energy needs for the development activities and at the same time creating employment and economic activities in rural areas. It is, therefore, clear why the new and renewable energy supply options must be considered prior to grid extension.

3. Various Renewable Energy Resources:

a) Micro hydro

Traditional water wheel has been in use in rural Nepal for centuries. It is estimated that there are over 25,000 such units in operation meeting the agro-processing energy needs of the scattered villages in the hilly and mountainous regions. Compared to other countries in the region, Nepal has made significant progress in developing and utilizing its water resources for producing power particularly in the micro range (up to 100 kW) over the past three decades.

A good manufacturing base has already been developed in the country for micro hydro. The development and promotion of micro hydro are being conducted mainly in the private sector. At present, there are 11 active manufacturers of turbines and accessories, capable to manufacture turbine equipment up to 300 kW, located mainly in Kathmandu and Butwal. Some of them also have built-up capability to fabricate turbine casing, penstock pipes, electromechanical equipment and other accessories for hydropower plants up to 15 MW capacities. The total manufacturing capacity

of all the manufacturers in the micro-range is more than 2 MW per year. The factors that have contributed to bring the micro hydro technology in Nepal to the present stage are relatively low capital investment, short construction periods, and existence of large micro hydro potential. Other factors that have contributed in microhydro development are indigenous manufacturing capability, simple operation, government-incentives (loan and subsidy), and involvement and interest of many international agencies. De-licensing of plants up to 100 kW capacities by government in 1984 helped in its development in the private sector and the de-licensing of plants up to 1000 kW in 1992 has further encouraged the development. The government has been providing loans to potential entrepreneurs and a subsidy of 50-75% on the electrical component of the add-on or stand-alone electrification schemes through the Agriculture Development Bank of Nepal.

Currently, there are over 941 micro hydro installations in the private sector scattered in about 59 of the 75 districts of the country. The total installed capacity of these installations is more than 5 MW. The installed capacity of majority of micro hydro range from 1 kW (Peltric sets) to 50 kW is generating electricity for domestic lighting and limited industrial application. In addition, there are microhydro units that are used mainly for agro-processing purposes of which about 20% also have add-on electricity generation for domestic lighting. Estimated equivalent installed capacity of these turbine mills is about 5000 kW serving about 100 thousand households. The investment cost of micro hydro plants is very site-specific with the installation cost ranging from NRs. 100 to 200 thousand per kW. His Majesty's Government of Nepal provides 50 percent capital subsidy on electrical component of microhydro in hilly areas. The subsidy is 75 percent in remote areas. Similarly, peltric sets (a integrated turbine-generator unit) receives 50 and 75 percent of total cost that may include up to 100 meters of polythene pipes to be used as penstock in hilly and remote areas, respectively. The average operating and maintenance cost of micro hydro plant varies largely depending on the type of ownership (individual, group or community), location of the site, end-uses, and type of equipment used. Various studies show that the operating and maintenance cost varies from as low as 2-3% to as high as 50-60% of the total project cost.

Low load factor, no productive end-use, technical backstop, lack of entrepreneurship in owners, high transportation cost, no standardization of products etc. are some of the barriers of this technology.

b) Biomass Energy

The following biomass technologies are used in Nepal for conversion of biomass energy into more efficient and convenient energy forms: biogas, briquettes, gasifier, and improved cook stoves.

Biogas

The history of biogas development in Nepal began with the fabrication and installation of a prototype unit at Godavari in 1955. It was made using an old 200-litre oil drum and a gasholder made of mild steel sheet. No real interest in biogas was forthcoming until the fiscal year 1975/76, which was designated as the "Agriculture Year" to boost agricultural production. A special plan for biogas promotion was developed and various contractors built 199 plants with interest-free loans made available by ADB/N.

In 1977, the Gobar Gas Tatha Krishi Yantra Vikas Ltd. (Biogas and Agricultural Equipment Development Company) popularly known as the Gobar Gas Company (GGC) was established for the promotion of biogas technology as a joint venture investment of the ADB/N, the Development

and Consulting Services (DCS) of the United Mission to Nepal and the Fuel Corporation of Nepal (now merged with Timber Corporation of Nepal). The Biogas Company was backed by a Research and Fabrication Unit in Butwal and sales and services centers at strategic locations in the Terai and inner Terai regions. Due to the success of biogas development programmes and availability of government subsidy as well as the interest and involvement of a number of INGOs and donor agencies, private biogas companies started coming up after 1990. Biogas Support Programme (BSP) has been set up as a joint venture between ADB/N, recognized biogas companies and the Netherlands Development Organization (SNV-Nepal) to support the biogas programme through subsidy, quality control, training, etc. A third phase of the programme has been proposed for the time period 1996/97-2000/2002 with the target of installing 100,000 biogas plants. It has been estimated that a subsidy of NRs. 750 million and a loan investment of NRs. 1080 million will be required to achieve this target. As a result many new biogas companies have been established whose number at present exceeds 50.

At present the number of total biogas plants of different sizes has exceeded 60,000 units and has met the target of the Eighth Plan (1992-97). The biogas installation and subsidy programme is currently under direct monitoring of Biogas Support Programme (SNV/BSP), which is coordinated by the Alternative Energy Promotion Center. The programme provides subsidy to biogas plant installation at the rate of NRs. 7000 for 4 and 6 cu.m. plants and NRs. 7000 per plant up to 12 cu.m. size in Terai, NRs. 10,000 for 4 and 6 cu.m. plants and NRs. 9000 per plant up to 12 cu.m. size in the accessible hills and NRs. 12,000 for 4 and 6 cu.m. plants and NRs. 11000 per plant up to 12 cu.m. size plant in remote hills not connected by the roads.

In spite of the relatively successful implementation of biogas promotion and development programmes, there are still a number of technical, financial and institutional problems in the effective dissemination of the technology. Reduction in gas production during winter, high initial cost, lengthy procedures in obtaining information, loans and subsidy, lack of follow-up actions due to shortage of trained technicians for maintenance and repair of the plants are some of the problems.

Briquettes

It is estimated that about 150,000 metric tons of rice husk is produced annually in the Terai. The use of rice husk has been on the increase for industrial heating and process heating purposes. To reduce transportation and handling cost and to improve the heating value, rice husk is also used to make briquettes. These can be used for space heating and cooking activities in domestic and commercial sectors. They are also used by some industries for process heating purposes. According to various studies, the annual potential of briquette manufacturing is about 95,000 metric tons in the Terai region of Nepal alone. Due to rising cost of rice husk and electricity, the financial viability of such briquetting plants is now questionable.

Another form of briquette is bee-hive briquette made out of biomass char, such as wood, leaves, twigs, branches and any other kinds of agricultural and forestry residues. Biomass is converted into char by carbonizing in a charring drum, which a simple drum fitted with a conical is shaped grate, a chimney and a water seal arrangement. The biomass char is ground into powder and mixed with 20 to 30 percent by its weight bentonite clay by adding the required amount of water. The mixture is then filled compactly into the mould and made into briquettes. They are then dried in the sun for two or more days; and after this they are ready for use in briquette stoves.

The beehive briquette is very easy to ignite; and it does not produce much smoke in the stove or kitchen. This technology is simple, does not require sophisticated skill, even a rural layman can be trained to produce briquettes. In fact this technology could be very useful and appropriate in the rural and remote parts of Nepal as it also create rural employment opportunity.

Some of the problems faced in the promotion of briquetting technology in Nepal are high cost of collection of raw materials, wear and tear of screw and barrel, localized environmental impacts due to emission of CO, CO_2, SO_x, air pollution during production, lack of government commitment to technology, etc. In spite of these problems, the manufacturers claim that many of these problems can be solved and the use of briquettes is more economic and efficient than the uses of rice husk directly.

Gasifier

Although gasification is a promising technology that has been tried in India and other developing counties with a mixed result. In spite of technology being promising, the extent of work that has been carried out in this field in Nepal is limited to laboratory experiments at the Research Centre for Applied Science and Technology (RECAST) in early eighties.

Most recently, a renewed interest in biomass gasification has been demonstrated by a pilot project under UNDP-Nepal's Rural Energy Development Programme with a 5 horse power biomass gasification plant. The technical details and result of the pilot project are not available yet. However, scientists and technologists working in the pilot project revealed that technology has potential in Nepal and can prove to be a viable energy alternative for rural areas if it is disseminated in an integrated package such as agro-processing with proper arrangement for financing and training

The concept that technologies like charcoal making and gasification lead to mass forest deforestation has played negative role in the development and dissemination these technologies. However, with proper forest management, gasifier technology may be promoted as modern biomass technology that would enhance efficiency of biomass use.

Improved Cook Stoves (ICS)

Appreciating the usefulness of Improved Cook Stoves for rural development, various organizations have been promoting this simple and cheap technology for many years. Since 1980, ICS programme began in earnest; HMG/N had played an important role in promoting and disseminating it. The only large scale ICS programme carried out in Nepal was through the Community Forestry Development Division (CFDD), which was suspended in 1991.

Initially, the ceramic-insert-type stove was prefabricated and distributed to the users free of cost. The ceramic insert-type design was not suitable for many rural applications and because it was freely distributed to the users, its value was not appreciated. There were also many other socio-economic reasons and wrong program approach due to which the ICS programme was unsuccessful. About, 44,000 insert type stoves were distributed of which 35% are believed to be in operation (NPC, 1998). At present, the ceramic insert-type design has been abandoned in favor of stoves built on site using locally available materials and skills. A number of NGOs and INGOs have included ICS as an integral part of their overall development objectives and programmes. NGOs and INGOs working in the areas of literacy, health and sanitation, woman's development, energy and environment have been promoting and disseminating ICSs. Stressing user motivation and education, these

organizations are beginning to show success in their efforts to introduce improved stoves on a sustainable basis. During the last 5 years about 52,300 mud built stoves have been installed, of which more than 90% is believed to be in operation. Some of the problems in ICS dissemination are their inflexibility in use for diverse purposes, people's social and religious beliefs, and absence of strong promotional programmes by the government. In addition, lack of education and training of the users, availability of and accessibility to cost free biomass resources, lack of involvement of women in ICS programmes and lack of financial and institutional support to local NGOs and research institutions are the main hurdles in the promotion of this technology. In spite of these problems, the ICS development and promotion programme has been a relatively successful as a new and renewable energy promotion programme in Nepal and has a very high potential for reducing fuelwood consumption because of its simple and familiar technology.

Cogeneration

Cogeneration is the simultaneous production of electricity and heat, both of which are used. Cogeneration offers the chance for localized power generation, close to the point of use that can form a bridge to an energy economy with a much higher contribution from renewable fuel sources.

At present, Nepal has no experience in biomass cogeneration technology; whereas in neighboring India this technology is picking up fast. Given proper and adequate fiscal incentives, electric power generation in sugar mills of Nepal by cogeneration method using molasses/bagasse is a possible option.

Liquid Biofuel

The liquid biofuel energy, traditionally known as vegetable oil energy or plant oil energy, includes liquid fixed plant oil energy developed from the resins of different plant parts, seeds and nuts of trees, shrubs and cultivated plants. In most of the developed countries, liquid biofuel energy is developed from the cultivated energy crops like rape-seed oil and similar oilseed crops. In industrialized countries the use of liquid biofuel as bio-diesel is increasing significantly as a potential solution to some of the air pollution problems of urban areas and to fight global climate change. In the Nepalese context, bio-fuel from the seeds and nuts is a renewable and improved alternative fuel which reportedly can be used after simple blending with the kerosene oil (80 to 90% plant oil: 10 to 20% kerosene oil) in cooking stoves. Liquid biofuel production could be income-generating activities in rural areas to alleviate poverty. Moreover, rural health is improved, and bio-diversity will be conserved due to use of biofuel.

Liquid biofuel technology, thus, warrants further research and development.

b) Solar Energy

Although much of Nepal lies on the "Good" solar belt, a detailed radiation mapping is not available. On an average, there is more than 6.5 hours of sunshine per day in Nepal. As per World Meteorological Organization, the average insolation for Nepal lies between 4 – 5 kWh per square meter per day. Traditionally people are using solar energy without any technological intervention for domestic as well as industrial proposes. With the growing energy needs more efficient devices are being developed to utilize solar energy. There are mainly two methods of using solar energy: One is Solar Thermal and the other is Solar Photovoltaic.

Solar Thermal Energy

In this methods heat from solar energy is used directly by using efficient devices. There are also different technologies to use solar thermal energy.

- Solar water heater
- Solar dryer
- Solar cooker
- Solar passive building

a) Solar Water Heater

The history of the production of Solar Water Heater dates back to 1968 when first commercial solar water heater was produced. In 1974, the plumbing division of Balaju Yantra Shala started limited production of Solar Water Heaters.

It is estimated that there are about 120 manufacturers of SWH in Nepal. However, the number of manufacturers alone may give misleading information as none of the manufacturer mass-produces the SWHs, in an assembly line. Each SWH is individually produced. A significant use of solar energy has been in water heating in households as well as in hospitals, schools, hotels and lodges. Solar water heaters are produced and marketed commercially. Altogether, about 17,265 solar water heaters were estimated to be installed in 1997/98 (WECS, 1998).

The SWHs produced in Nepal are suitable for use in hilly and Terai region of Nepal. Although there is a large potential for use of SWHs in northern highlands, the locally manufactured SWHs, available in the local market are not suitable for regions where temperature reaches sub zero.

The most difficult aspect of the locally produced SWHs is the lack of technical information in terms of the standard parameters and the performance curves. One information, which is generally given to the buyers, is the maximum temperature. However, the maximum temperature figure alone, in the absence of other pertinent data such as water discharge rate, installation angles, etc. do not "tell" any substantive story about the product to the prospective user of SWH.

b) Solar Dryer

Solar dryers are used for drying agriculture products with the systematic use of solar thermal energy. Recently efforts have been made to develop solar dryers for large-scale crop drying. Major application is being developed primarily for drying of herbs and vegetables. There is no standard capacity range. There is no large-scale domestic use in Nepal due to lack of awareness and financial incentives. Different organizations have developed but no known commercial manufacturer specializes in dryers. It has not yet received wide commercial acceptance from likely users. If systematically designed and awareness is created for the industrial use by adopting favorable policies, a great amount of energy could be saved and income generation activities can be created in the rural areas.

With effective R&D efforts and proper dissemination approaches, solar dryers have potential to replace fuelwood and kerosene especially in rural households.

c) Solar Cooker

Another use of solar energy is in the field of cooking. This technology is being promoted in Nepal but not accepted widely due to traditional eating and cooking habits and lack of information dissemination. Attempts have also been made to develop solar cookers by few NGOs, private organizations/workshops and research institutions. With the creation of awareness and some incentives oriented policies this technology could be used as a secondary source of energy to save fuel wood and kerosene consumption in cooking. This technology also can generate employment and reduce health hazards from kitchen smoke for the women.

d) Solar Passive Building

Properly designed passive solar buildings with south facing help to keep the rooms relatively warm, which greatly reduces the daily precious consumption of firewood in mountainous areas. With small additional devices this design could also be used for cooling purposes in warmer areas like Terai. Systematically designed buildings with passive solar technology do not exist in Nepal. However, general mass would benefit, if buildings were built at least one each in different physiographic regions as demonstration by creating awareness of such designs. Construction of such solar passive buildings in the tourist areas of Nepal in mountain will definitely help to promote sustainable mountain tourism.

Solar Photovoltaic

Another important area of solar energy use has been electricity generation from solar photovoltaic (PV) system. Solar PV system has been extensively used in telecommunications services for more than 3000 locations. PV power installed as of December 2001 is 1600 kWp. In different parts of the country. Similarly, technical and economic viability of solar PV systems in water pumping for drip irrigation and drinking water is also being experimented in Nepal. 12,000 Solar Home Systems installed in more than 65 districts of Nepal and solar water pumping at 41 locations. The Nepal Electricity Authority has installed centralized PV power systems of 30-50 kW capacity in remote parts of the country like Simikot of Humla, Gamgadi of Mugu and Tatopani for rural electrification purposes. However, the performances of these PV systems have not been very satisfactory mainly due to their overly elaborate and expensive centralized design and lack of proper maintenance. Lately, private entrepreneurs and NGOs have been engaging in promotion and dissemination of solar PV home lighting systems. Private companies have started assembling, installing, promoting and providing services to household and community size PV system packages on commercial basis. With the development of proper institutional set up, effective dissemination approach and involvement of the government and donor agencies, solar PV technology can play and is playing a significant role in rural electrification within a short span of time.

At the moment, the involvement and commitment of the government is minimal in terms of infrastructure support in the solar PV development in Nepal. Government has been providing a subsidy of 50 % and 75% on solar PV home system and PV irrigation system, respectively, through the ADB/N. It is also learnt that the subsidy for irrigation has not been released so far. The global technological advancement in solar PV resulting in reduced cost of solar panel, solar potentiality of the country and the absence of other new and renewable sources of energy provide very conducive environment for the promotion of solar energy in Nepal. Solar energy could make significant contribution in meeting the rural as well as urban energy needs for decentralized rural electrification,

communication/information, preservation and storage of vital medicines in rural clinics and health posts and solar PV based drip irrigation. Similarly, PV integrated building designs, which is gaining popularity in developed countries, could be promoted in urban areas to augment/substitute grid electricity.

Some of the problems in this sector are related to lack of standardization of products, high initial cost, lack of sufficient funds for subsidy, lengthy procedures of acquiring loans, and lack of trained human resource in remote areas.

c) Wind Power

A potential of about 200 MW wind power in the 12 km corridor from Kagbeni to Chhusang generating about 500 GWh electricity annually has been identified so far in Nepal (Dangrid, 1992). Similarly, another study undertaken in Solukhumbu district in 1997 reveals that the average wind speed in the Khumbu region is 5m/s and is suitable for electricity generation. The potential, however, was not estimated. A preliminary survey of Department of Meteorology and Hydrology indicates that wind energy can be harvested in Nepal for generating electricity in the hills and pumping water in the Terai during dry season for irrigation.

The average installation cost per kW for wind energy has come down in the past two decades. The average cost in Europe is about US $ 1000 per installed kilowatt, and US$ 800 in India. The ex-factory price for Chinese made wind turbines generators (WTG) is about US $ 890 per kilowatt. With proper site selection, Nepal could also economically harness its wind potential.

Nepal's efforts to harness wind energy have resulted in series of failures. The first recorded failure to exploit wind energy in Nepal was made with the USAID support in the Agriculture Farm in Rampur, Chitwan in the early seventies. Similarly, an individual's effort to install a wind turbine for pumping water in Ramechap district in the late seventies also failed. RECAST bought two wind pumps from India for demonstration of this technology. Though both of these turbines functioned for sometime, the efforts fizzled out in the absence of continuity. Recently, Krishna Grill and Engineering Works (KGEW) in Biratnagar has fabricated and installed three wind pumps in the eastern Terai also met with similar destiny.

The most significant and systematic effort to harness wind energy in Nepal was undertaken by Nepal Electricity Authority in 1989. Two 10 kilowatts (kW) WTG were installed and operated in Kagbeni of Mustang district. The electricity generated from WTG was distributed to 60 houses in the village. These turbines broke down after two months of operation for technical reasons resulted from incomplete wind data.

More recently, an entrepreneur has installed a 900-watt wind solar hybrid system in a hotel resort in Kavre district.

The lesson learnt from these failures is that a proper wind data and analysis is necessary before a wind power project is undertaken. It is also important to ensure that the equipment selected has credible past performance in the past under similar circumstance. In addition, appropriate institutional arrangement is also required to study; design and implement wind power projects, and provide maintenance services, information dissemination, etc.

d) Geothermal

Geothermal energy, in the broadest sense, is the natural heat of the earth. Immense amounts of thermal energy are generated and stored in the earth's core, mantle and crust. At the base of the continental crust, temperatures are believed to range from 200ºC to 1000ºC. When the meteoric water passes into the crust of earth and comes in contact with hot fluid/rock, it heats up and comes out as thermal spring. Geothermal waters are broadly classified as high temperature (above 160ºC) and low-temperature (20ºC-140ºC) waters. Electricity generation involves the use of high temperature geothermal water above 150^0C while the low temperature water is used for a number of economically productive activities, e.g., hatching of fish, fish farming, swimming pools, biodegradation, fermentation, soil warming, mushroom growing, animal husbandry, greenhouses, irrigation, space heating, drying of stock fish, vegetables, and various farm products.

Geothermal energy has been tapped for large scale district heating schemes for over 60 years and producing electricity on the scale of hundreds of MW for over 30 years in other parts of the world. At present, more than 6000 MW electricity is being generated from geothermal energy in more than 21 countries and direct utilization of geothermal water is known in about 40 countries.

Efforts should be geared to tap geothermal energy as another important renewable energy resource in Nepal. This resource is not new in Nepal as many hot water springs are already in religious, health and tourist use.

Preliminary works to establish geothermal potential was started in the early 1980s in a limited scale and has identified about thirty-three geothermal springs in different parts of Nepal. The total potential of geothermal energy resource is not yet known in Nepal.

e) New and Modern form of RET

Apart from above-mentioned RETs, many new and modern forms of RETs are emerging. Most of them are in the stage of research and development although technology like dendro-thermal is almost ready for wide scale dissemination. Others like Hydrogen Energy, Fuel Cell etc. are emerging as feasible technologies. Nepal could also benefit from this new and modern RETs in future if they become financially and technically viable.

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