ENERGY DEMAND AND SUPPLY UNDER DIFFERENT SCENARIOS

Very often the energy mix and energy quantity demanded change due to the ongoing changes in the structure of economic activities within the rural economy. The demand for energy is a function of parameters such as population increase, increase in number of households, prices, income, and tax and subsidy.

The rural energy supply analysis is based on the examination of district resource potential, particularly the availability of biomass (tree biomass, crop residue, and animal dung), fossil fuel (oil, LPG and mineral coal), and electricity (grid and micro-hydro), and other non-conventional energy sources (wind, solar, etc). The rural energy supply from these sources is influenced by economic factors such as policy, prices, cost, and taxes/subsidies as well as ecological factors.

Demand Projections

Demand for different energy/fuel types has been projected on the basis of the future number of consumers (population, household), growth of economic activities, increase or decrease in the use of particular energy forms, and rise or fall in income and prices due to market forces or government policy decisions on tariff increase. The projections cover the Seventh Five Year Plan period (1988-1993).

(i)   The demand for each fuel/energy type is converted into tons of oil equivalent (TOE).

(ii)   Various supply options on the basis of energy resources in the district are matched with the demand. Different scenarios are built to present energy mixes and options.

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Sectoral Growth Rates

The likely annual growth rate in the GDP and its important sectors in Swat District during the Seventh Five Year Plan period (1988-93), along with the population growth rate, is given in Table 6. It can be seen that the overall GDP is expected to grow at about twice the growth rate of the district population. Among individual sectors, the services/commercial sector has the highest growth rate of 6.50 per cent per year, followed by the transport sector. Agricultural and manufacturing sectors are likely to grow at the rate of 4.40 and 3.00 per cent per annum respectively.

Table 6: Target Growth Rates in GDP and Important Sectors in Swat District During the Seventh Five Year Plan (1988-1993)

Sectors	1988/89	1989/90	1990/91	1991/92	1992/93
			(in percentage)		
GDP	6.00	6.00	6.00	6.00	6.00
Population	3.30	3.28	3.26	3.24	3.22
Manufacturing	3.00	3.00	3.00	3.00	3.00
Agriculture	4.40	4.40	4.40	4.40	4.40
Services/Commercial/Community	6.50	6.50	6.50	6.50	6.50
Transport	6.20	6.20	6.20	6.20	6.20

Electricity Demand

The current sale of electricity without conservation and projected sales up to 1992/93 are given in Annex Table 1. Domestic use has been projected taking into account the following functions:

o increase in the number of households,

o growth of domestic connections has been envisaged to increase at the annual rate of 12 per cent according to the Government's current policy, and

o government tariff policy (the electricity generation and distribution is totally in the public sector).

The Water and Power Development Authority's tariff increase (Annex Table 1) for the plan period was calculated by taking out inflationary effects (calculated by dividing the nominal tariff increase by inflationary rates).

The current use of electricity, as obtained from WAPDA for various sectors - domestic, agricultural, industrial, and services, was projected using the econometric approach. For the domestic sector, the total current consumption was used to calculate the average consumption of one household. This was projected for each year to calculate increased total domestic demand on the basis of consumer increase (household increase weighted by per cent connections' increase) as well as the value of income/price elasticity.

The projected sales of electricity with conservation up to 1992/93 are given in Annex Table 2. Conservation efficiency is considered by taking into account changes in the efficiency of devices such as *"Chulha"* etc. The effect of conservation through pricing is not considered, but the basic econometric approach incorporated within the model takes this factor into consideration.

The sale of electricity is projected to increase at an annual compound growth rate of 11.12 per cent. The per capita consumption of electricity and the population served and not served are shown in Annex Table

3. It may be noted that in 1987/88, 27.5 per cent of the population was served with electricity and it is expected that 41.3 per cent of the population will be served by the year 1992/93.

LPG Demand

The study envisages an increase in domestic consumption of LPG at the rate of 8 per cent per annum. Taking this into account, the use of LPG has been projected using the econometric approach (Annex Table 4). The use of LPG in restaurants and other related economic activities has also been taken into account. The total tonnage of LPG for the domestic, restaurant, and other sectors was then added to give the total LPG demand.

Kerosene Demand

The domestic consumption of kerosene is likely to grow at a rate of 8 per cent per annum. Domestic use is projected through 1992/93 using the econometric approach (Annex Table 5). It has been assumed that only the domestic sector will use kerosene.

Animal Dung Demand

It is expected that the number of households using animal dung will remain constant through the plan period and also that the domestic use per household per month will remain the same. Annex Table 6 shows a demand projection up to 1992/93.

Fuelwood Demand

The number of households using fuelwood has been projected to increase at an annual rate of 3 per cent, taking into account the population growth rate. Annex Table 7 shows the demand for fuelwood for 1987/88 to 1992/93.

Demand for Charcoal and Coal Briquettes

It is expected that the charcoal and coal briquettes consumption in Swat District will remain constant during the plan period and the share of the household and other sectors will remain at 20 per cent and 80 per cent respectively (Annex Table 8).

Demand for Crop Residues, Sawdust, and Bagasse

It is expected that the number of households using crop residues will remain constant during the plan period and the domestic usage per household per month will decrease at an annual rate of 7 per cent. Annex Table 9 shows the optimal production of crop residue in order to substitute other energy sources for the other high-value requirements of crop residue.

Demand for Petrol/Diesel

The sale of petrol according to the figures obtained from a survey of filling stations was projected using the econometric approach in Annex Table 10. A summary of demand projections for various energy sources is given in Table 7.

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Table 7: Demand Projection for Various Energy Sources in Swat District, 1988/89 to 1992/93

	1988/89	1989/90	1990/91	1991/92	1992/93
Electricity (MWH)	102437	113478	126196	140864	157804
LPG (tons)	1689	1877	2086	2319	2579
Kerosene (tons)	5207	5752	6357	7027	7770
Cow Dung (tons)	14795	14795	14795	14795	14795
Fuelwood (tons)	2764885	2878486	2996906	3120355	3249051
Charcoal & Coal Briquettes (tons)	2880	2880	2880	2880	2880
Crop Residues (tons)	23035	21423	19924	18529	17235
Petrol/Diesel (ltrs)	29072	31061	33186	35457	37883

Energy Use in Important Industries

The total quantity of wood, mineral, coal, and bagasse used in tobacco, brick kiln, and *gur* manufacturing industries is given in Annex Table 11. The wood used in the tobacco industry is assumed to remain constant. Similarly, wood used per day in brick kilns has been kept constant, but one new kiln has been added every year in the total calculations for the district. It has been assumed that mineral coal usage per kiln will also remain constant.

Supply Projections

Electricity

The per capita consumption of electricity, total electricity supply, and the population served and not served in Swat District are shown in Annex Table 3. Since the expected supply from the national grid will not be able to meet the requirement, it is planned to meet the deficit through renewable energy sources such as small hydel, solar, and biogas plants.

Other Sources

Supply of other energy sources for the projected period are given in Annex Table 12.

Balancing Demand and Supply under Different Scenarios

The projected demand for and supply of energy sources are given Annex Table 12. The total energy demand in the next five years will be increasing gradually from 10.5 million TOE in the base year (1988) to 12.9 million TOE in 1993. This demand can be met by different mixes of energy supply. The present study gives four different supply scenarios; in each, varied ratios of energy forms/types have been used. The first scenario is Business As Usual (BAU) or continuation of current situation of energy supply-demand into the future. Demand equals supply in the BAU scenario.

The second scenario is a slight modification of the BAU scenario which differs only in the supply of fuelwood and crop residue and tries to reduce their demand through price mechanisms. This kind of optimisation for high-value biomass is necessary but, unfortunately, does not appear to be feasible in view of the fact that much of the fuelwood and crop residue is obtained free of charge by the households.

In the third and fourth scenarios, energy substitutions have been made to reduce the fuelwood component in order to arrest the high growth of fuelwood usage. These scenarios are based on possible combinations of the following options:

i. increased supply of LPG,
ii. increased supply of kerosene,
iii. extensive installation of micro/mini-hydel, solar panels, windmills, biogas, biomass, gasification, and
iv. smokeless coal briquettes.

An efficient plan for the supply of various types of fuels can only be achieved if further detailed studies are carried out to determine the economic/ecological costs of the above four options. The analysis here is done with the assumption that fuelwood replacement is of the highest necessity and the above options can be adopted from the point of view of infrastructure.