ICIMOD

MOUNTAIN INFRASTRUCTURE AND TECHNOLOGY

Discussion Paper Series

ENERGY PLANNING AND MANAGEMENT IN SWAT DISTRICT, PAKISTAN

A CASE STUDY

Aslam Khan

MIT Series No. 6

1991

INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT

ENERGY PLANNING AND MANAGEMENT IN SWAT DISTRICT, PAKISTAN

A CASE STUDY

MIT Series No. 6

Aslam Khan was associated with the Department of Geography, Peshawar University, Pakistan, and is currently working for ESCAP, Environmental Division, Bangkok.

September, 1991

International Centre for Integrated Mountain Development (ICIMOD)

Kathmandu, Nepal

CONTENTS

LIST OF ABBREVIATIONS

Union Council	=	The lowest tier of local government in the district
Bokhara	=	Local stove
District Council	=	A tier above the union council in the local government

Energy Content and Conversion Factors

	Natural Units	kcal ('000)	TCE	TOE	Others
Non-commercial					
Fuelwood	ton	4,000	0.57	0.39	1.43 m^3
	m^3	2,800	0.40	0.27	700 kg
Dried Dungcake	ton	2,600	0.37	0.25	--
Agricultural Residues	ton	3,000	0.43	0.29	--
Commercial Fuels					
Diesel					
	kl	9,080	1.29	0.88	0.826 ton
	ton	10,960	1.57	1.07	1,210 litre
Light Diesel Oil	kl	9,350	1.34	0.91	0.853 ton
	ton	10,960	1.57	1.07	1,172 litre
Petrol	kl	8,000	1.14	0.78	0.709 ton
	ton	11,290	1.61	1.10	1,411 litre
Kerosene	kl	8,660	1.24	0.84	0.778 ton
	ton	11,130	1.59	1.08	1,285 litre
Liquefied Petroleum Gas	ton	11,760	1.68	1.14	--
Coal	ton	6,000	0.86	0.59	--
Electricity	MWh	860	0.12286	0.083576	--
Other Conversion Factors					
1 TCE			1.00	0.680272	
1 TOE			1.47	1.00	

Heat Content of Different Fuel Types

1 kg wood	=	15 Megajoules (MJ)
1 kg coal	=	26.5 MJ
1 litre of kerosene	=	43.6 MJ
1 kWh of electricity	=	3.57 MJ

INTRODUCTION

Background

The severity of the energy problem in the villages of the mountainous areas of Pakistan has increased over time, despite the Government's efforts to improve the availability of energy through numerous means. The extension of the grid to rural areas and the introduction of new technologies for both energy production and use has brought a new dimension to energy development in the mountains of Pakistan, but the benefits of the improved technologies have remained limited both in terms of the target population and area coverage. Further, with the increasing mountain population, the pressure on traditional forms of energy, particularly fuelwood, has assumed crisis proportions with major economic, social, and ecological consequences. The depletion of forests caused by reckless exploitation has led to an increase in the market prices of fuelwood and is causing greater hardships, forcing the village population to travel greater distances to obtain wood.

The realisation of the necessity for taking energy needs into account in rural development planning at national and international levels during the last few years. However, the importance of the planning and management of energy at regional or district level and its integration with rural development has emerged only recently. A pilot project to address these aspects was initiated by the International Centre for Integrated Mountain Development (ICIMOD) in April 1987. The project conducted case studies in five countries: China, India, Nepal, Bhutan, and Pakistan. This case study on Rural Energy Planning in the Swat District of Pakistan was a part of that project.

Objectives of the Study

The overall objectives of the study were to analyse the energy situation in the Swat District of Pakistan and to assess the extent of community participation in energy conservation and planning. The specific objectives are stated below.

- To assess the energy situation in Swat District.
- To analyse the consumption pattern of both traditional and commercial sources of energy.
- To determine the current demand and project future demand for different types of energy.
- To examine the supply situation under various scenarios.
- To analyse the importance of community participation in energy conservation and planning and identify measures to enhance the level of participation.
- To recommend an institutional framework for energy planning and development in light of the lessons learned in Swat District.

Methodology

Database Generation

A number of surveys were conducted during the course of this study to generate an energy data base. These surveys included the topics discussed below.

<u>Union Council Energy Survey</u>. A survey of all union councils (69), consisting of 537 electoral wards, was conducted with the help of the Department of Local Government of the North West Frontier Province

(NWFP) in Swat District to assess the energy supply pattern along with the potential for future development in each electoral ward. In addition to this survey, the energy supply potential of the district was also assessed from the data obtained from secondary sources such as the Department of Forests and from previous government reports on hydroelectric potential.

Household Energy Survey. A household energy survey was conducted in five villages located at three different altitudes, i.e., high altitude (above 9,000 ft), medium altitude (5,000 ft to 9,000 ft), and low altitude (below 5,000 ft). The five villages also had varied energy characteristics, i.e., two of these had no electricity connections and were not accessible by all-weather roads. Among the remaining three villages, two had grid electricity while the third had a micro-hydel plant. These three villages were accessible by all-weather roads.

The survey was conducted in two stages. During the first stage a rapid appraisal was made of the socioeconomic status of the households in these villages. The households were then classified into three groups, i.e., high income, medium income, and low income. From each of these three strata, 20 per cent of the households were selected by random sampling for administration of the questionnaire.

Electricity Consumption Data. Electricity consumption data in the district, by sector, was collected from the Water and Power Development Authority (WAPDA). The data on grid stations and villages electrified were also obtained from the same source. Similarly, the data on micro-hydels were obtained from relevant government organisations, including the Pakistan Council for Appropriate Technology (PCAT) and the Small Hydel Development Organisation (SHYDO).

Petrol/Diesel Consumption Data. A survey of filling stations was carried out in the district to find out the total petrol/diesel sale. The survey was deemed essential because this information could not be obtained from the household survey which had covered only the resident population and had omitted outside consumers passing through the district.

Survey of Energy Use in Small Industries. A rapid appraisal of small industries, which are major consumers of energy, was made to assess their energy consumption pattern in the district.

Energy Marketing Survey. A rapid appraisal was carried out to obtain details of the commercial energy supply system in the district, and this formed the basis for estimating the current demand as well as the present and future supply of energy sources in the district.

Survey of a Community's Felt Energy Needs. A community felt needs' survey was conducted in one of the local government units to demonstrate a methodology that could be used not only to assess the community's felt needs for the development of energy but also to involve the community in the energy planning and management process. The unit selected for the study was a union council (Charbagh Union Council), the lowest tier of local government in the district.

Application of an Econometric Model for Demand-Supply Balancing in the Energy Sector. An econometric model was applied to estimate energy needs, by sector, in the rural areas of Swat District. The following is the equation used:

$$Qj(t) = Qj(o) \times \left(1 + \frac{\text{Price variation}}{100}\right)^{P.E.} \times \left(1 + \frac{\text{Sectoral growth in GDP}}{100} \Big/ 1 + \frac{\text{Population growth}}{100}\right)^{I.E.}$$

Where, Qj(t) = The demand for fuel j at time t

Qj(o) = The demand for fuel j in the base year

P.E. = Price Elasticity

I.E. = Income Elasticity

The population growth rate, sectoral growth rates, and the increase in energy price are assumed to follow historical trends. In addition, government policies also affect energy price. Price and income elasticities in the future will reflect past trends. The software package used for the analysis was Lotus 123 on an IBM PC. The conceptual framework for the case study is shown in the flow chart in Figure 1.

Organisation of the Report

The study is divided into three main parts. The first part outlines the objectives and methodology of the study, describes the organisation of the report, and gives a description of the project area. The second part analyses the use pattern of energy resources which, for the purpose of discussion, has been classified into three major groups, i.e., biomass, electricity, and fossil fuel. The current energy demand as discerned from the use pattern, has then been projected for the next five years (Seventh Five Year Plan period: 1988-93) in the third part of this study. The projected demand thus obtained has been balanced against the various supply options. The account of the demand/supply scenario in the district has been followed by a section on demand/supply management. This section covers important aspects of community participation and institutional arrangements which play a crucial role in the development and management of energy at the district level.

Major Features of Charbagh Union Council (Swat)

Swat District is situated in Northern Pakistan, within the western-most reaches of the Himalayas. The district extends from 34° 10' to 35° 56' north latitude and from 72° 07' to 73° 0' east longitude. The total area of Swat District is 8,788 km^2.

The microclimate of the district varies considerably depending upon slope, altitude, aspect, and local winds. The district has cold winters which are more severe in the uplands. Summers range from hot in the lower southern portion of the district to cool at higher elevations.

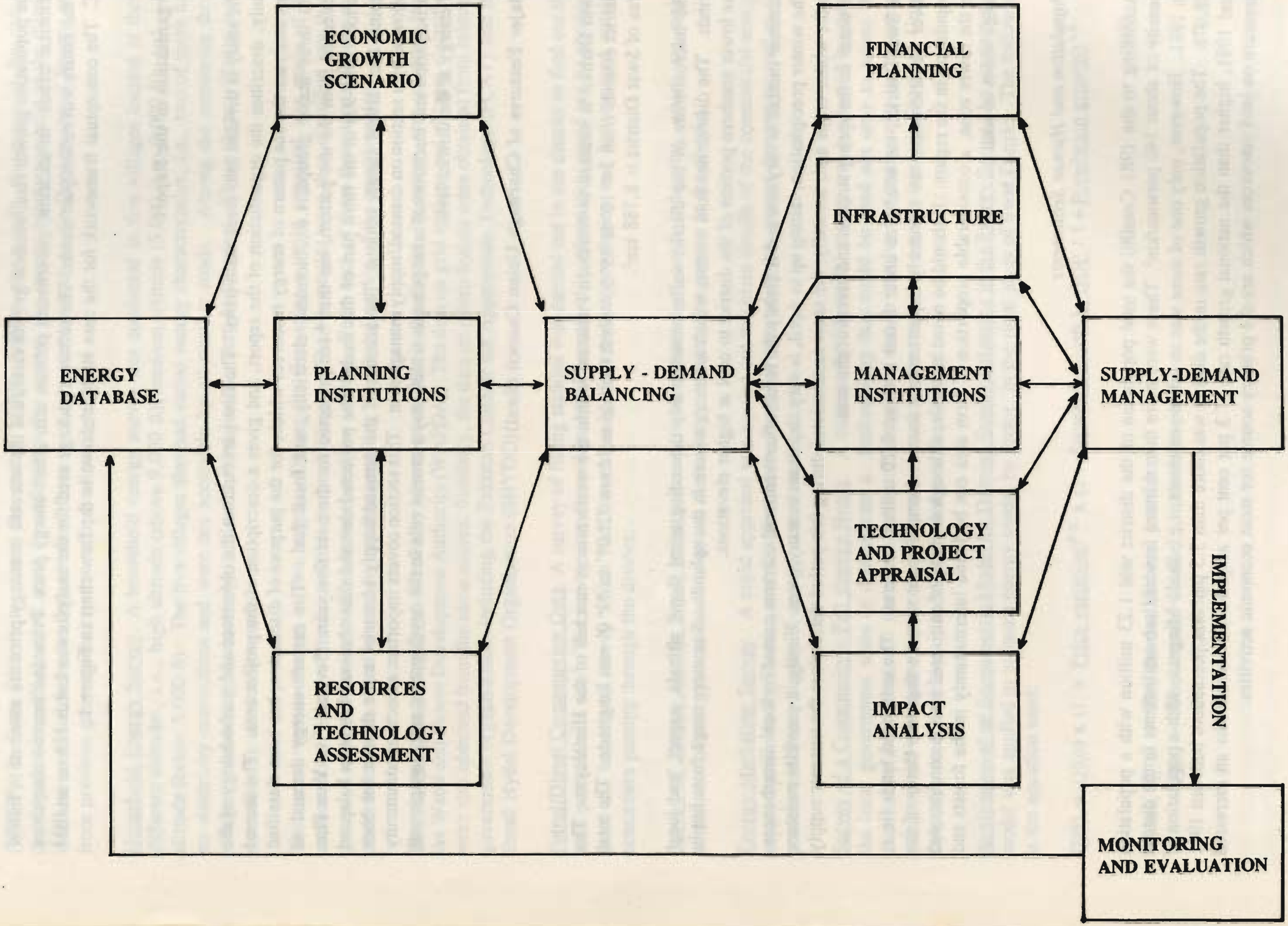
Summer rainfall is very low and is mainly the result of conventional currents caused by local disturbances. The winter precipitation, lasting up to April, is very important in many ways. Firstly, it provides moisture to the winter crops and, secondly, the snow accumulated during this period determines the summer supply of water in the spring streams and rivers of the area.

In Swat District, the total area under forest is about 0.20 million hectares. The cultivated lands lie at lower elevations and are extremely important as a source of employment to more than two-thirds of the population in the region. It should be noted here that, although the bulk of cultivated land is concentrated in the lower zone, a considerable proportion of farm area can be found intermittently in the forests and range zones as well.

Population and Human Settlements

According to the 1981 Census, the total population of the district was 1.23 million with a population density of about 140 persons/km^2. There were more than thirteen hundred sub-settlements in the district in 1981. However, only one of these was an urban settlement, i.e., Saidu-Mingora, with a population of 88,078. The population growth rate in the district was more than 3.5 per cent per annum between 1961 and 1981, higher than the national growth rate of 3 per cent per annum. The result was an increased pressure on land resources which are the primary source for most economic activities.

FIG. 1. DISTIRCT RURAL ENERGY PLANNING PROCESS



The growth rate of the urban population in the valley was extremely high. Saidu-Mingora reported a growth rate of almost 10 per cent per annum between 1972 and 1981. The rural population in the same period had grown at a rate of 3.26 per cent per annum. In 1981 it was 1.15 million and it is currently estimated at 1.39 million. The rural population is dispersed throughout 1,208 villages. Nineteen of these had a population of more than 5,000 each. However, the majority of these villages were small with more than half (624) having a population of less than 500. The district now has two urban settlements and 1,316 rural settlements.

Economy

According to the 1981 Census (GOP 1981), the labour force (both those working and looking for work) constituted 27.5 per cent of the total population in Swat District. The labour force participation rate was higher for rural areas (27.5%) than for urban areas (24.1%). The open unemployment rate was also low for the rural areas and was only 4.2 per cent as opposed to 9.6 per cent in the urban areas. More than 77 per cent of the working population of the district are engaged in agriculture, forestry, hunting, and fishing.

The other important economic activities are "community, social, and personal services", "wholesale and retail trade", and "restaurants and hotels", which employ 8.5 per cent and 4.7 per cent of the total working population of the district respectively. Manufacturing is another non-farm sector that offers employment to a large number of people.

The number of industrial units in Swat District are 46, out of which 2 are pharmaceutical units (NESPAK 1984), 39 are silk mills, and 5 are miscellaneous industrial units. These 46 industries constitute 20.08 per cent of the total number of registered units in the NWFP.

Bee-keeping is the biggest cottage industry in the district. More than 6,000 rural families are engaged in producing about 200,000 pounds of honey and beeswax annually.

Communication and Transportation

Swat has a very good network of roads. Even the remotest areas are connected by roads. The total length of the roads in the district is 542 miles, out of which these 242 miles of good quality roads and 300 miles of inferior quality roads (GOP 1981).

Telecommunication services are available in the important villages and towns. Currently, there are 83 post offices and 23 telegraph offices in the district. There is no railway network but a regular air service operates between Mingora and Peshawar.

Energy Sources for Domestic Use

According to the household census of 1980, three-quarters of the households used kerosene, one-fifth used electricity, and the remainder used unspecified sources for lighting. Within the urban areas, 71 per cent of the housing units used electricity and 29 per cent kerosene for lighting. In the rural areas, 78 per cent of the housing units used kerosene, 17 per cent electricity, while the remaining 5 per cent used unspecified sources for lighting. Regarding cooking fuels, wood/brushwood was used by 94 per cent of the housing units, 4 per cent used dungcakes, and only 1 per cent used kerosene. Among the rural dwellers, 95 per cent used wood/brushwood, 4 per cent depended upon electricity, and only 1 per cent on other fuels. In the urban areas, 71 per cent of the people used wood/brushwood; however, the percentage of urban dwellers using kerosene for fuel was comparatively high (21%).

ENERGY RESOURCES IN SWAT DISTRICT

Biomass Energy

Biomass is a very important source of energy for the people of Swat. Fuelwood currently accounts for more than 92 per cent of the total energy consumed in various activities (Table 1). Fuelwood is mostly obtained from the forests within the district but trees are also grown at the sides of fields. Besides fuelwood, crop residue and cow dung are other sources of biomass energy, albeit comparatively on a much smaller scale.

Table 1: Energy Supply from Different Sources in Swat, Pakistan (in tons of oil equivalent, 1987)

Energy Source	Energy Supplied in TOE	%
Fuelwood	969	92
Others	84	8
- Petroleum Products	34	3
- Coal	27	3
- Other Biomass	15	1
- Hydropower	8	1

Source: Water and Power Development Authority (WAPDA), Swat.

The total area under forests, along with the growing stock and yield, is given in Table 2. It can be classified into the following types:

- o scrub forests,
- o chir *(Pinus roxburghii)* forests,
- o deodar *(Cedrus deodara)* forests, deodar
- o blue pine *(Pinus wallichiana)* forests
- o silver fir *(Abies pindrow and Abies webbiana)* forests,
- o alpine pastures,
- o oak forests, and
- o cultivated trees or plantations.

The scrub forests lying between 2,500 to 3,000 feet have almost disappeared on account of extensive clearance for cultivation and the reckless cutting of trees to meet the timber and fuelwood demand of the population. Thick groves found in the graveyards are the remnants of what must have been the tree cover at these elevations. The main species are *phulai (Acacia modesta), Kao (Olea cuspidata), and Khair (Acacia catechu)* etc.

The other forests (besides alpine pastures or plantations) are basically timber forests and should only be considered as fuelwood sources to the extent of 15 to 17 per cent of the yield which is made available by thinning the trees. However, due to reckless cutting of these forests to obtain fuelwood, and, because of other malpractices, extensive damage has occurred to the forests leading, in places, to disastrous consequences.

Table 2: Forest Area with Growing Stock in Swat District, 1987

Name of Forests	Area (ha)	Growing Stock (1,000 m^3)	Yield (1,000 m^3)
Kalam Forest	24405	2,656	159.7
Swat & Swat Kohistan Forest	95477	22,765	335.6
Alppuri Forest	44405	2,797	550.0
Buner Forest	41040	2,002	800.6
Total	205327	30,220	1,845.9

Source: Aerial Inventory Section, Forest Department, Government of the NWFP.

The Union Council Survey carried out in this study reported an overall decrease in forest density. The only addition to the existing stock of trees was by their cultivation around farms, water courses, etc or in limited areas which fell within watershed management projects. Population growth leading to the heavy demand for fuelwood has been pointed out as the main reason for extensive lopping. Generally, conifers are lopped for fuelwood while broad-leaved species are lopped to augment the fodder supply. These practices are leading to the rapid extinction of forests near the villages. Illicit felling is also becoming serious. About one third of the union councils in the district reported the illicit felling and smuggling of timber to other areas.

Grazing and browsing have also been responsible for substantial damage to the forests. Large areas of pasture exist above the forest belts and flocks of cattle, sheep, and goats pass through them twice a year.

They generally start the uphill sojourn in the months of April and May and return in September. During this nomadic activity, they spend about two months in the forests and cause heavy damage to the conifers and broad-leaved species. In addition the soil is trampled hampering the regeneration of pastureland (Khan 1965). Grass cutting is also practised extensively in autumn for stall-feeding during winters. In this practice, hundreds of *chir*, *kail*, and *deodar* seedlings are cut every year, sometimes deliberately to check the reestablishment of tree growth. Torchwood extraction and forest fires are other reasons for damage to standing forests in the district.

People in Swat District have begun to show concern regarding the deterioration of the forests. They now plant some useful trees along water channels, *nullahs*, and fields and vigilantly conserve them to supplement their income and to meet their domestic fuel requirements.

Consumption of Firewood and Sources of Supply

Household sector surveys on firewood consumption show disturbing pictures. Kalam Integrated Forest Development Project conducted a survey that estimated the average per capita firewood consumption in Kalam at 3.68 kg per day in summer and 9.69 kg per day in winters (KIFDP 1984). Household surveys of five sample villages in the study area revealed that the average per capita consumption per day is 5 kg. This gives a monthly consumption rate of 1,256 kg per household, bringing a total annual consumption in the household or domestic sector of the district to 2.65 million tons. With the current population growth rate and the present annual demand, the consumption is likely to increase to 3.2 million tons.

The survey data in this study show that an average household in the hilly areas of Swat District consumes much more energy than an average household in the country. The higher energy consumption is obviously in end uses such as cooking, space and water heating, and to some extent in lighting. Table 3 gives the end uses of firewood in the five sample villages, by income groups. The average breakup shows that most of the firewood (56%) is consumed in space and water heating during the prolonged cold winters. Approximately 42 per cent of the wood is used for cooking and only about 2 per cent is used as torchwood or for lighting (Table 3). The fuelwood consumption in the winter months is more than double the amount used in summers because of space and water heating, which is done using stoves locally known as '*Bokharas*'. These stoves are kept burning the whole day throughout the winter months.

Table 3: End Uses of Firewood in the Household Sector in Sample Villages of Swat District, 1987

(in percentages)

Income Group by Village	Cooking	Heating	Lighting	Total
<u>Village 1</u>				
Low Income	42.1	55.3	2.6	100.0
Medium Income	47.8	50.8	1.4	100.0
High Income	48.2	51.8	0.0	100.0
<u>Village 2</u>				
Low Income	36.7	63.3	0.0	100.0
Medium Income	47.5	52.5	0.0	100.0
High Income	46.7	53.3	0.0	100.0
<u>Village 3</u>				
Low Income	49.4	50.6	0.0	100.0
Medium Income	53.3	46.7	0.0	100.0
High Income	48.3	51.7	0.0	100.0
<u>Village 4</u>				
Low Income	32.4	64.8	2.8	100.0
Medium Income	30.5	63.3	6.2	100.0
High Income	34.9	65.1	0.0	100.0
<u>Village 5</u>				
Low Income	41.8	48.2	10.0	100.0
Medium Income	44.6	48.5	7.1	100.0
High Income	47.2	52.8	0.0	100.0
<u>All Villages</u>				
Low Income	39.7	57.9	2.4	100.0
Medium Income	44.4	53.3	2.3	100.0
High Income	45.1	54.9	0.0	100.0
<u>Average</u>				
(All villages and all incomes)	42.1	56.2	1.7	100.0

Source: Primary Survey.

Fuelwood Supply

Fuelwood is supplied in the district through commercial as well as informal marketing systems. In a large part of the district it is gathered for personal use. Fuelwood is sold in firewood depots and in ordinary grocery shops in the villages.

The informal system of fuelwood use in the district is based on the right of the population to collect fallen dry twigs from the forest area and even to lop upto one-third of the trees in certain areas for their own consumption. For daily use, firewood is collected from the nearest forests by women, men, or children. For winter use, particularly at higher altitudes, firewood is collected from nearby forests or far away timber harvesting places and transported by rented trucks or pack animals to the village residents. Wood deposited by rivers and avalanches are also collected.

The poor economic level of the rural population and the scarcity of fuel has promoted the sale of collected dry twigs and firewood to inhabitants of large settlements and towns. Collection of fuelwood is usually restricted to forest areas alloted to the village. In those villages where fuelwood is brought from long distances, many buyers wait halfway along the route to purchase the bundles at cheaper rates. The dealers/shopkeepers also purchase wood from individual collectors and then resell it at higher prices. However, most of the fuelwood consumed is obtained free through collection or illegal lopping.

Tobacco curing, *gur*-making and brick kilns are the three important local industries which used considerable amount of biomass/firewood. There are about 350 tobacco-curing ovens and 33 brick kilns in the district which together use about 3,300 tons of wood annually. However, about 900 tons of wood are also used in making unrefined sugar or *gur*. The same industry also uses bagasse as fuel, amounting to about 2,070 tons per year.

Other Biomass

The other forms of biomass which help to meet the energy demand of the district include animal dung, charcoal, and agricultural residues. Surveys during this study revealed that about 15,000 tons of animal dung are being burned every year as fuel, which otherwise could be used to increase soil fertility. Bio-conversion of animal dung to biogas plants can yield methane gas for burning and sludge for manure, thus providing a renewable source of energy and fertiliser. Rough estimates show that one ton of dry organic matter can be converted into energy which is roughly equivalent to two barrels of oil or about 280 cubic metres of gas and 0.73 tons of fertiliser. Although a beginning has been made in Swat with about a dozen plants, their performance is not very satisfactory due to cold weather and also due to technical deficiencies.

Agricultural crop residues constitute another source of biomass fuel. However, crop residues are also habitually used as animal feed, manure and roofing, and construction material in Swat District. Among the major crops of the district, only maize and sugarcane residues are used as fuel. Dried cobs and sticks of maize are used by households for cooking and heating in ordinary domestic stoves and in open fire places while leaves and green stalks are fed to animals. Likewise, use of bagasse as fuel energy is common practice in the unrefined sugar or *gur*-making industries of the district. There are about 300 such factories in the district. Wheat and paddy straw and rice husks serve mainly as animal feed and also as thatching material or are mixed with mud in making walls of the houses.

Another source of biomass energy in the district is sawdust which is a by-product obtained from the saw industries. This is used mainly by the household sector for space heating in winters.

ELECTRICITY CONSUMPTION AND SUPPLY

Grid System

The main feeder to Swat District is a 132 kV transmission line from Dargai via Chakdara to Saidu. Another 66 kV transmission line extends to Dagger. There are grid stations at Saidu and Daggar. The Saidu Station has four transformers with a total capacity of 11,645 MWh, while the Daggar Station has only one transformer with a capacity of 1,655 MWH. There is no generation capacity in the grid system. Overall, there are 1,317 villages/*mauzas* in Swat District (excluding 109 uninhabited *mauzas*/villages) out of which only 246 (19%) are electrified by the grid system.

The sectoral electricity consumption and the total connections in the rural and urban areas of the district are shown in Table 3.1. The major consumer of electricity in the rural areas is the household sector that uses two-thirds of the total consumption. It is followed by the industrial sector which uses about a quarter of the share. The agricultural sector uses only 4 per cent of the total consumption, primarily for tubewells and lift irrigation.

By the end of 1987, the rural areas of Swat had 44,878 electricity connections from the grid, out of which almost 92 per cent were domestic (Table 4). Despite this, the domestic connections covered only about a fourth of the rural households. Commercial connections were second in number but they consisted mostly of small consumers such as shopkeepers. The agricultural connections surpassed industrial connections in rural areas and their share in electricity consumption was six times that of industrial consumers.

Supplying electricity from the grid poses a number of problems to a hill district like Swat. In many cases the remoteness of villages, small populations, and the lack of income-generating activities contributed to making rural electrification through grid extension uneconomical. The cost of electrifying a village in the hilly areas through the main grid is around Rs 800,000. Maintenance of the lines and wiring on the consumer's premises is also very difficult because of the lack of trained manpower willing to serve in the remote areas. Non-availability of components and parts adds to the maintenance problem.

Decentralised System

Besides grid electricity, another source for providing electricity to rural areas in Swat District has been small hydropower plants. Currently three such plants are functioning at Kalam (200 kW) in Swat Sub-division and Damori (100 kW) and Karora (200 kW) in Alpuri Sub-division. A fourth small hydel scheme of 400 kW is being implemented at Ushoran in Swat Sub-division and this will be completed by the end of 1988. All these projects were undertaken by the Irrigation Department of the Government of the North West Frontier Province (NWFP). The department has recently established a Small Hydel Development Organisation (SHYDO) to promote small hydel schemes in hill districts where potential hydropower can be used quite extensively. In Swat District alone, seventeen projects have already been identified with a total energy potential of more than 100 Giga Watt hours annually.

In addition to small hydels, the Irrigation Department of the Government of the NWFP has also installed eight micro-hydel plants in collaboration with the University of Engineering of the NWFP, and these range from 15 to 20 kW in installed capacity.

FOSSIL FUEL

The fossil fuels, i.e., oil, gas, and mineral coal are supplied from sources external to the district.

Table 4: Electricity Consumption and Connections by Different Sectors in Rural and Urban Areas of Swat District, 1986-87

Sector	Urban Consumption		Rural Consumption		Total Consumption		Rural Connection		Urban Connection		Total Connection	
	Unit (MWH)	Share (%)	Unit (MWH)	Share (%)	Unit (MWH)	Share (%)	No	%	No	%	No	%
Domestic	14224.68	47.51	39131.38	66.17	53356.07	59.9	41079	91.53	9357	69.24	30936	86.16
Commercial	3429.52	11.46	1774.07	3	5203.59	5.84	2469	5.5	3941	22.68	6410	10.84
Industrial	11346.59	37.9	15128.23	25.58	26474.82	29.72	631	1.41	392	2.75	1023	1.73
Bulk	-	-	530.39	0.9	530.39	0.6	5	0.01	-	-	5	0.01
Agricultural	23.59	0.08	2561.08	4.33	2584.67	2.9	693	1.55	19	10.13	712	1.21
Public Lighting	912.47	3.05	10.38	0.02	922.85	1.04	1	0	22	0.2	29	0.05
	29936.95	100	59135.53	100	89072.29	100	44878	100	14307	95	59115	100

Kerosene

Kerosene is mostly used for domestic lighting and to some extent for cooking. It is supplied by tankers through two different routes and is distributed to various dealers throughout the district. The agencies (major dealers) supplying kerosene are located in four places and more than a dozen sub-agents in the district sell kerosene to retailers.

From the major depots, kerosene is transported to small shops in all the major villages of Swat. The shopkeepers usually sell kerosene from drums or cans using the bottle as a unit. The price of kerosene in the district varies from Rs 3.30 per litre to Rs 5.00 per litre, depending upon the accessibility of the place and the amount purchased. Kerosene is primarily used for lighting. The average consumption per household in the area is about four litres/month/household. This means that the total rural household monthly consumption in the district is about 4,862 tons of oil equivalent (TOE) per year. The end use consumption of kerosene is given in Table 5.

Investigation on the availability of kerosene revealed that 70 per cent of the households obtained it from a distance of within one mile. Of the remaining households 20 per cent, got it from within a radius of 1 to 2 miles and only 10 per cent of households had to travel more than 2 miles to procure kerosene. The people who suffered most in this respect were the ones living in the high altitude areas. Thus, almost half of the population living in the high altitude villages surveyed in this study had to travel a distance of 4 miles or more to procure kerosene. It is also a problem for scattered settlements at medium and low altitude.

Table 5: Kerosene Consumption by Households with Different Income Levels in Sample Villages of Swat District, 1987

Village	Monthly Consumption	(Litres)
Low Altitude with Electricity	Low Income	2.9
	Medium Income	2.6
	High Income	2.4
Low Altitude without Electricity	Low Income	4.4
	Medium Income	4.7
	High Income	5.0
Middle Altitude with Grid Electricity	Low Income	3.8
	Medium Income	2.8
	High Income	2.0
Middle Altitude without Grid Electricity but with Micro-hydel	Low Income	4.3
	Medium Income	4.9
High Income	5.6	
High Altitude without Electricity	Low Income	3.7
	Medium Income	3.9
	High Income	4.2

Source: Primary Survey

Mineral Coal

Coal is transported to the district from Baluchistan either by trucks or through railways up to Dargai and from there by trucks to Swat. It is used mainly by brick kilns which consume about 60,000 tons of coal annually.

Petrol/Diesel

Petrol/diesel is mainly used for transport vehicles. However, diesel is also used for running agricultural machinery, i.e., tractors, threshers, tube wells, etc as well as for operating diesel generators and industrial machinery such as saw machines. Like kerosene, petrol/diesel is supplied through tankers. There are a number of filling stations in the district located at different places. Besides filling stations, petrol/diesel is also sold in cans at roadside shops in the major villages.

Liquified Petroleum Gas (LPG)

Liquified petroleum gas (LPG) is used mainly for cooking. It is supplied to the district by trucks from Rawalpindi. Each truck has the capacity of about 252 cylinders. There are many agencies of LPG in Swat District. LPG use has been reported in almost 40 per cent of the Union Councils of the district. LPG is commonly available in those villages having relatively better accessibility. It is used only by medium or higher income households. Among the study samples, none of the low income households used LPG. In certain cases, it was found that people travelled up to as much as 40 miles to obtain LPG from Mingora, where the headquarters of the district are situated. On an average, one cylinder was used per month by user households, and these totalled about 9,300. However, when both user and non-user groups of households are combined, the average reduces to 0.04 cylinders per month per household. At this rate, the total amount of gas used monthly by the household sector is about 110 tons. The restaurants in the commercial sector also use gas up to about 17 tons per month. The total consumption of gas per year in the district, therefore, is about 1,500 tons or approximately 1,700 TOE per year.

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.

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.

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.

COMMUNITY PARTICIPATION IN ENERGY PLANNING

Soliciting Participation and Identification of Felt Needs

The involvement of the community in energy planning and management can be achieved by associating individuals and voluntary workers, traditional village organisations, e.g., farmers' associations, cooperatives or tribal groups, associating non-government organisations and the local government.

This study uses the current set-up of the local government in Swat District to evolve a methodology to enlist the participation of the community in energy planning and management at the local level. The exercise was carried out as a case study in one of the largest union councils in the district with about 15,000 people living in 7 electoral wards. This was an attempt to construct a model community participation approach which could be used in the planning, implementation, and monitoring of energy development activities in the union councils of the district.

Under the current local government system, Swat District is divided into 537 electoral wards. Each electoral ward has about 250 to 300 households with an average of 8 members. All the 537 electoral wards are grouped into 69 union councils. Each union council elects one member from each ward. The total membership varies from 5 to 12 depending upon the population and size of the union council. The members of a union council elect their own Chairman. The tier above the union council in the local government is the district council, and it has 33 elected members in Swat. The district council also has its own chairman elected by the members.

The analysis of data collected, regarding the felt needs for energy, showed that the community in Charbagh Union Council gives top priority to the use of fuelwood as a source of domestic energy. The assessment of felt needs and their prioratisation are given in Annex Table 13. These needs were prioritised by households on the basis of a system of scoring. The scores allocated depended upon the importance attached to the form of energy, its possible availability in the area, and resources available (funds, labour, tools, land, etc) for obtaining it through programme execution. Each of these three aspects had a positive or negative rating. Each positive answer was rated as 1 while each negative answer was rated as 0. The selection of form of energy in the priority list was therefore linked with a positive rating from all three aspects (importance, possibility, and resource contribution).

The questionnaire was administrated to about 1,800 households. The scores allocated to each form of energy by individual households were aggregated to identify the priority and felt needs for the whole Union Council. The results, thus, obtained, are given in Table 8. It is apparent that given the choice, the local people first prefer to go for energy plantation and they are willing to contribute resources generously to promote energy plantation. About 41 per cent of the households prefer to promote other traditional energy resources, e.g., fossil fuels and electricity. Among these, LPG received the maximum weightage. A positive aspect revealed by this study was that 9 per cent of the households preferred to go for some form of renewable energy resource. Among these, solar energy appeared to be the most popular. Another form of energy technology that came into the priority list was diesel generators.

Table 8: People's Response on Sources of Energy they Would Like to Promote in Charbagh Union Council, Swat, 1987

Energy Source	% of Residents
Energy Plantation	43.2
Cylinder Gas	14.2
Other Fossil Fuels	13.7
Grid Electricity	12.8
Renewables	9.0
Others	7.0

Once identified, the felt needs of the local people can be used effectively to prepare a plan of action. For example, the wasteland in Charbagh Union Council is estimated to be about 2,000 acres. As expressed in their felt needs, the local people would like to use this land for energy plantation. The people are willing to participate in the development and management of renewable energy resources. However, there is a need to identify feasible projects and implement these through community participation.

Using the technique described above it would be possible to prepare an energy plan of action for Charbagh Union Council. Once approved, the plan can be implemented through the active support and participation of the Charbagh community.

This process of planning with the involvement of community participation can be extended to all union councils in Swat District. Once the action plans for all 69 union councils become available the same can be consolidated into a district plan of action. The criteria for the consolidation of the plan of action (projects) at different levels may be based on people's priority needs, self-reliance, magnitude of affected population, and linkages with other projects/programmes.

ENERGY PLANNING AND MANAGEMENT FOR DISTRICT DEVELOPMENT

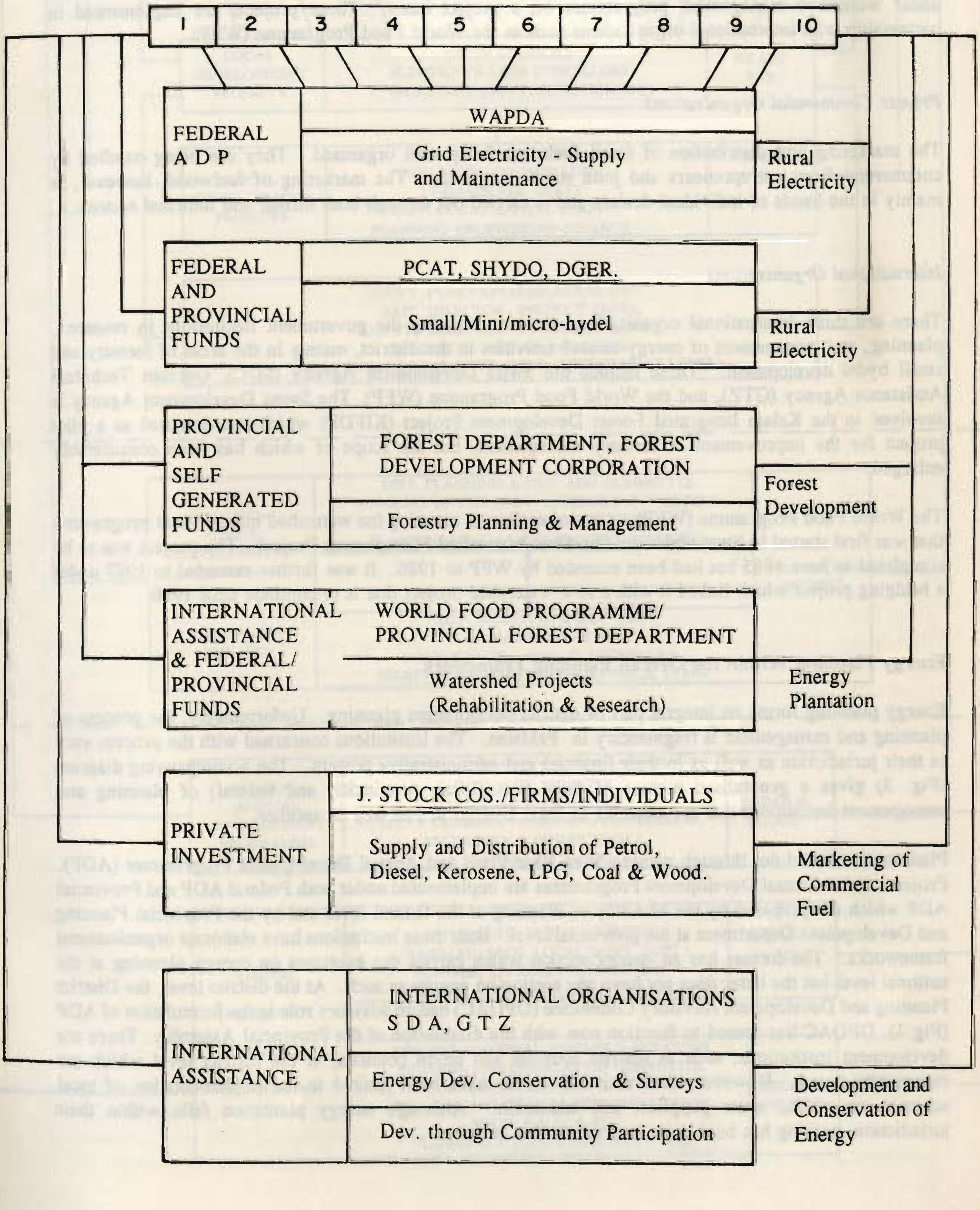
Energy Institutions

Currently, there are three types of institution in the district that play important roles in energy planning and development (Fig 2). These include government institutions, commercial organisations, and international organisations.

Government Institutions

The government institutions are concerned with the planning and management of two forms of energy, i.e., electricity and biomass. The Water and Power Development Authority (WAPDA) deals with rural electrification through the grid. However, efforts have also been made in recent years to reinforce grid electrification through the provision of micro-hydels. Two solar energy plants and about a dozen biogas plants have also been installed in the area.

FIG. 2 : INSTITUTIONS CONCERNED WITH ENERGY PLANNING AND MANAGEMENT IN DISTRICT SWAT



The Pakistan Council for Appropriate Technology (PCAT), Islamabad, the Small Hydel Development Organisation (SHYDO), and the Directorate General of Energy Resources (DGER) have been active in this sector. The biomass energy (forestry sector) is under the control of the Forest Department for planning and management purposes. The research and rehabilitation work in forestry is being undertaken under watershed management programmes on a project basis. These projects are implemented in partnership with international organisations such as the World Food Programme (WFP).

Private Commercial Organisations

The marketing and distribution of fossil fuels are fairly well organised. They are being handled by commercial firms/entrepreneurs and joint stock companies. The marketing of fuelwood, however, is mainly in the hands of individual dealers and is carried out through both formal and informal sectors.

International Organisations

There are three international organisations that are assisting the government institutions in research, planning, and management of energy-related activities in the district, mainly in the areas of forestry and small hydel development. These include the Swiss Development Agency (SDC), German Technical Assistance Agency (GTZ), and the World Food Programme (WFP). The Swiss Development Agency is involved in the Kalam Integrated Forest Development Project (KIFDP) which was initiated as a pilot project for the improvement of forestry management, but the scope of which has been considerably enlarged.

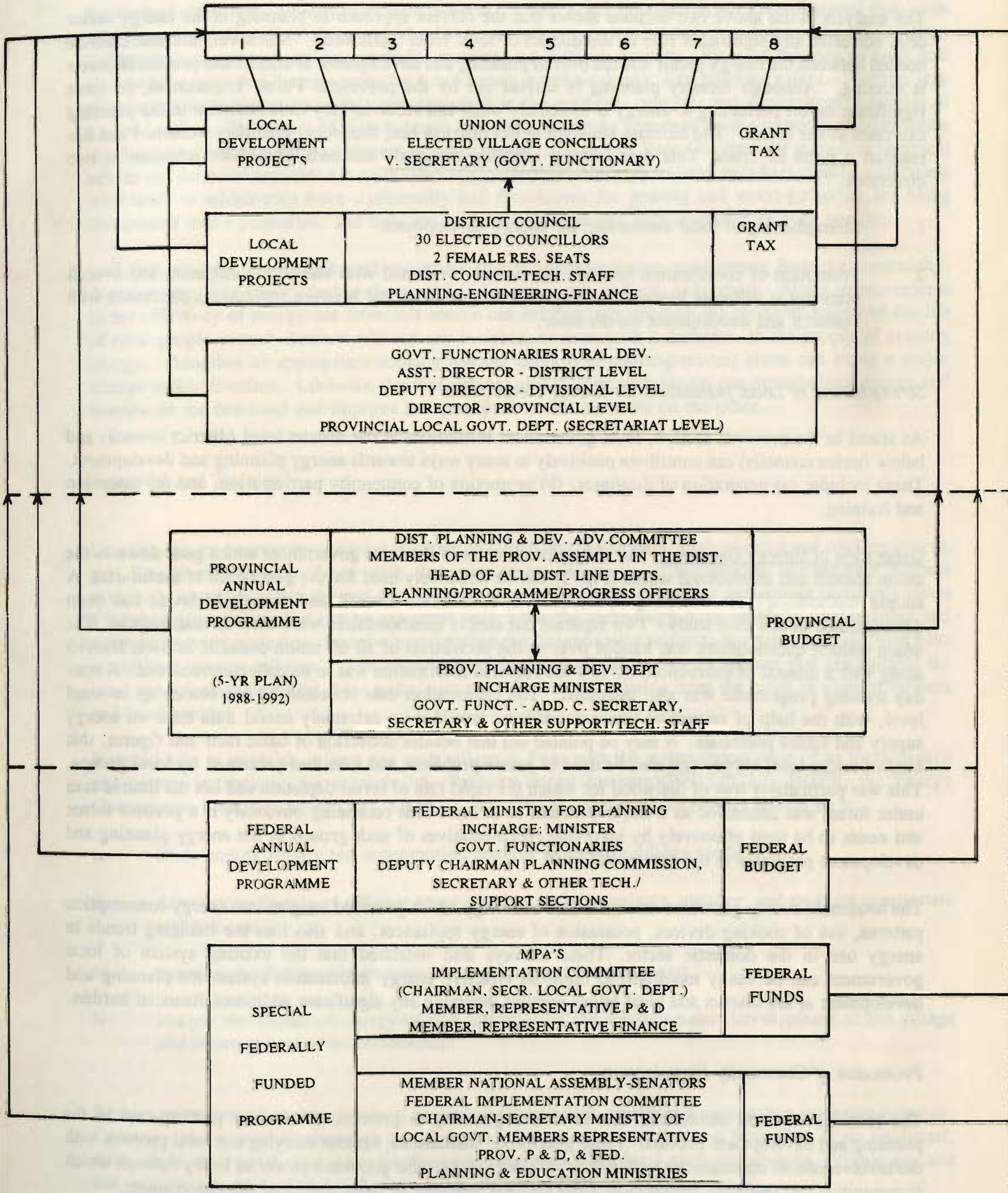
The World Food Programme (WFP), as stated earlier, is assisting the watershed management programme that was first started in Swat under the Dir-Swat Watershed Management Project. The project was to be completed in June 1985 but had been extended by WFP to 1986. It was further extended to 1987 under a bridging project which linked it with a new watershed project that is to continue until 1990.

Energy Planning Within the Overall Planning Framework

Energy planning forms an integral part of district development planning. Unfortunately, the process of planning and management is fragmentary in Pakistan. The institutions concerned with the process vary in their jurisdiction as well as in their financial and administrative powers. The accompanying diagram (Fig. 3) gives a generalised picture of three tiers (local, provincial, and federal) of planning and management institutions that are effective in Swat District in one way or another.

Planning is carried out through national Five Year Plans and Annual Development Programmes (ADP). Projects under Annual Development Programmes are implemented under both Federal ADP and Provincial ADP which are prepared by the Ministry of Planning at the federal level and by the Provincial Planning and Development Department at the provincial level. Both these institutions have elaborate organisational frameworks. The former has an energy section which carries out exercises on energy planning at the national level but the latter does not have any section on energy as such. At the district level, the District Planning and Development Advisory Committee (DPDAC) had an advisory role in the formulation of ADP (Fig 3). DPDAC has ceased to function now with the dissolution of the Provincial Assembly. There are development institutions, such as district councils and union councils, at the district level which are community based. However, their activities so far have been limited to the implementation of local schemes on roads, water supplies, and education. Although energy plantation falls within their jurisdiction, nothing has been done to promote this activity.

FIG. 3 : INSTITUTIONS INFLUENCING OVERALL PLANNING PROCESS AT DISTRICT LEVEL



Crucial Aspects of Energy Planning

The analysis in the above two sections shows that the current approach to planning in the energy sector does not offer any significant role to the district or local level institutions. Moreover, the coordination needed between the energy sector and the overall planning and development at district and provincial levels is missing. Although forestry planning is carried out by the provincial Forest Department, its most significant aspect pertaining to energy is extremely weak and receives very little attention in the planning exercises of the sector. The biomass situation in hill districts has, therefore, gradually worsened and has reached a point of crisis. This deteriorating situation obviously demands immediate attention in two directions.

1. Strengthening of local institutions for energy development.

2. Promotion of coordination between institutions concerned with energy development and overall planning at different hierarchical levels on the one hand and between institutions concerned with research and development on the other.

Strengthening of Local Institutions for Energy Development

As stated in the previous section, local government institutions at the district level (district council) and below (union councils) can contribute positively in many ways towards energy planning and development. These include: (a) generation of databases, (b) promotion of community participation, and (c) extension and training.

Generation of Energy Databases. The elaborate structure of the local government which goes down to the union council and its electoral wards (Fig. 3) can be effectively used for the generation of useful data. A simple methodology for obtaining information at both union council and household levels has been demonstrated in this case study. Two separate but simple questionnaires were used for the purpose. The union council questionnaire was handed over to the secretaries of all 69 union councils in Swat District along with a manual of instructions on how the required information was to be collected/recorded. A one-day training programme was also instituted. The information thus collected by secretaries up to ward level, with the help of respective union councilors, provided an extremely useful data bank on energy supply and future potentials. It may be pointed out that besides collection of basic facts and figures, this kind of micro-level survey can also be used to assess problems and solutions perceived by local groups. This was particularly true of fuelwood for which the rapid rate of forest depletion and not the limited area under forest was conceived as a major problem or stress. This reckoning obviously is a positive factor and needs to be used effectively by involving representatives of such groups in the energy planning and development processes at the grassroots' level.

The household survey generated extensive data on energy which provided insights into energy consumption patterns, use of cooking devices, possession of energy appliances, and also into the changing trends in energy use in the domestic sector. These surveys also indicated that the existing system of local government can be easily mobilised to build an effective energy information system for planning and development at the district and local levels without incurring any significant additional financial burden.

Promotion of Community Participation

The local government institutions also need strengthening to promote community participation in the planning and development process. These grassroots' institutions, besides carrying out local projects with the involvement of communities within their jurisdiction, can also provide a powerful lobby through which communities can negotiate for services from sectoral agencies or departments of the Government.

Unfortunately, the role of Local Councils in development efforts has mostly been underrated by planners, and is quite often overlooked in the implementation of energy projects, resulting in their failure to achieve the desired objectives. Energy plantation projects provide a case in point. It has been observed that, even when the political will is there and the funds are allocated, implementing a large-scale afforestation (plantation) campaign is an unexpectedly complex and difficult process. Planting millions of trees and successfully nurturing them to maturity is not purely a technical task, like building a dam. Further, tree planting projects almost invariably get enmeshed in the political, cultural, and administrative tangles of a rural locality. The nature of their success, therefore, is largely governed by the intensity of community involvement through local government or other means. Central or State Government stimuli in technical advice and financial assistance in such cases are ineffective unless community members clearly understand why lands to which they have traditionally had free access for grazing and wood-gathering are being demarcated into a plantation, and they are apt to view the project with suspicion or even hostility.

Last, but not least, conservation efforts cannot succeed without strong commitment from the community. A major source of energy fuel in the rural hill districts, such as Swat, is biomass. Slight improvements in the efficiency of energy use from this source can substantially improve the physical quality of the life of rural people in such districts without any increase, or even with a decrease, in the supply of primary energy. Adoption of appropriate cooking devices (improved cooking-stoves) alone can bring a major change in this direction. Likewise, the replacement of dung fuel with biogas can provide both energy and manure on the one hand and improve the quality of the environment on the other.

Extension and Training

Usually, energy programmes require a system by which end use devices, such as improved cooking-stoves, are disseminated in accordance with the programme objectives. Dissemination mechanisms become extremely important when the end use device is new to the user. Unfamiliar technology obviously raises a number of questions that can be answered only when the technology is successfully implemented and comprehensively evaluated. In order to strengthen the dissemination process, countries such as China have established 'energy villages'. The purpose is to demonstrate the energy techniques that are suitable for local conditions and see that these techniques are practical and reliable from the point of view of farmers and local people.

It would help to establish at least one such village in Swat with the active cooperation of its local council and energy institutions, for example, the Pakistan Forest Institute (PFI), PCAT, DGER, the Energy Conservation Centre (ENERCON), SHYDO, etc. The objectives of the project should be to:

i. study energy supply and consumption patterns to identify village needs;

ii. demonstrate the use of efficient energy devices and disseminate, monitor, and evaluate appropriate technologies;

iii. augment the fuel supply situation through energy plantation; and

iv. analyse the impact of energy-related activities on the socioeconomic development of the village and improvement of its environment.

Besides promotion of energy, the local councils by themselves constitute a very strong extension network. Currently, the energy development agencies at the federal or provincial level have little or no field staff. As a result, their rural energy programmes have suffered. The local councils can help fill this gap and can provide valuable assistance through quick dissemination and extension work.

Institutional Coordination and Energy Development Strategy

The implementation of rural energy programmes requires the involvement of a large number of official agencies working under different departments, private and public manufacturers, voluntary agencies, artisans, R&D institutions, village communities, social organisations, and private individuals. This requires a considerable degree of coordination at the federal, provincial, and district levels. At the federal and provincial levels this coordination should be maintained by the Federal Planning Commission and the Provincial Planning and Development Department respectively.

The Federal Planning Commission has an energy wing for this purpose, but the provincial Planning and Development Department needs strengthening in this respect by creating an energy planning section within it. At the district level, this function should be performed by the District Planning Officer who can also assist as a district level project implementation officer. Besides coordination among the different tiers of planning institutions, there is a great need for networking R&D institutions, manufacturers and other concerned groups, e.g., community organisations and NGOs involved in rural energy planning and implementation.

Finally, the success or failure of rural energy programmes/projects in a district will also be determined by strategies adopted and logistics provided. After a rural energy technology has been field-tested and found suitable for large-scale implementation in a district, the major task for its implementation will involve formulation of strategies on the following:

i. speed or pace of programme implementation;

ii. provision of funds and procedures for disbursing loans and subsidies;

iii. making raw materials available for installation of energy transmitting devices;

iv. creation of infrastructure for manufacturing energy equipment (it has also to be decided whether the public organisations should manufacture it or whether private entrepreneurs should be encouraged by providing incentives);

v. R & D and maintenance network to promote the design of energy equipment, training of artisans and mechanics for fabrication, and installation as well as maintenance; and

vi. monitoring and evaluation to facilitate timely feedback and to assess the success of the programme.

SUMMARY AND CONCLUSIONS

Currently, wood is the single most important source of energy in Swat District and it meets more than 90 per cent of the total energy needs. The overuse of forest wood is creating serious ecological problems for the district in the form of deforestation, soil erosion, mass movement, and increased sedimentation.

According to present estimates, about 52 per cent of the public sector expenditure and approximately a third of the GDP in Pakistan is spent on the energy sector. The process of energy planning, however, is a highly centralised activity and district and local level institutions are not playing any significant role in the process. As a result, the energy crisis in rural areas, and particularly in mountainous areas like Swat, is not adequately reflected in national level planning.

In addition, energy development and conservation programmes are not being effectively implemented. This applies to a wide spectrum of programmes, ranging from the enhancement of social forestry to the introduction of energy-saving devices, e.g., improved cooking-stoves.

This study has shown that the objective of effective implementation of energy planning cannot be achieved without decentralisation and community involvement. The country is fortunate that it has a wide network of local government institutions at the district and lower levels. However, the system can be effective only if these institutions are assigned their due role.

The existing energy planning capability of the district is very weak. It is extremely important to amend this state of affairs by strengthening the energy planning and management capabilities of district level institutions. This case study has suggested some measures that can be adopted by existing institutions to generate an adequate database. This information can be used for effective energy planning. The study also showed that community participation, generated through union council involvement, can produce feasible projects within the broad goals set by district planning.

The concept of an energy village is a possible approach the union council can take in exercising its role at a local level for project formulation through community participation. The model energy village is used here as a case to study the community mobilisation process in energy development activities, such as afforestation, energy plantation, establishment of micro-hydels, etc. It can also serve as a social laboratory for the investigation of social barriers and the attitudes of the local population which are preventing the adoption of improved energy devices and alternative forms of energy.

Annex Table 1

Projected Sales of Electricity without Conservation (kWH) in Swat District, 1987/88 to 1992/93

Sector	i-elast[1]	p-elast[2]	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)[3]	Share 1992/93
Domestic Connection										
Urban Domestic Connections			9857	11040	12365	13848	15510	17371	12.00	
Rural Domestic Connections			41079	46008	51529	57713	64639	72395	12.00	
Total Domestic Connections			50936	57048	63894	71561	80149	89767	12.00	
g-rate %				12.0	12.0	12.0	12.0	12.0		
Domestic kWH/HH/yr	1.67	0.20	1048	1085	1125	1167	1211	1256	3.70	
g-rate %				3.63	3.67	3.70	3.73	3.77		
DOMESTIC TOTAL (MWH)			53356	61929	71904	83512	97025	112761	16.14	71.5
g-rate %				16.07	16.11	16.14	16.18	16.22		
Industrial	1.38	-0.29	29475	29910	30351	30799	31254	31715	1.48	20.1
Agriculture 1.58	-0.20	3352	3562	3784	4021	4272	4539	6.25	2.9	
Comm/Bulk/Pub.light	1.47	-0.41	6656	7037	7439	7864	8314	8790	5.72	5.6
TOTAL ELECTRICITY (MWH)			92839	102437	113478	126196	140864	157804	11.19	100.0
g-rate %				10.34	10.78	11.21	11.62	12.03		

WAPDA TARIFF INCREASE FOR PLAN PERIOD

	Real % (After taking out Inflationary Effects)						
Domestic	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Industrial	9.43	9.43	9.43	9.43	9.43	9.43	9.43
Agriculture	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Others	9.43	9.43	9.43	9.43	9.43	9.43	9.43
Average	6.60	5.66	5.66	5.66	5.66	5.66	5.66
	Nominals % (After taking in Inflationary Effects)						
Domestic	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Industrial	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Agriculture	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Other	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Average	13.00	12.00	12.00	12.00	12.00	12.00	12.00
Inflation	6.00	6.00	6.00	6.00	6.00	6.00	6.00

Source: WAPDA

Note:

[1] income elasticity

[2] price elasticity

[3] annual compound growth rate

Annex Table 2

Projected Sales of Electricity with Conservation (MWH) in Swat District, 1987/88 to 1992/93

Sector		1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR (Plan)	Share 1992/93
TECHNOLOGICAL CONSERVATION (MWH)									
Domestic	(MWH)	0	100	110	110	130			
Industrial	(MWH)	0	100	100	120	140	170		
Agriculture	(MWH)	0	20	40	40	60	80		
Others	(MWH)	0	25	50	70	80	110		
Total	(MWH)	0	245	310	340	390	490		
g-rate	%		26.53	9.68	14.71	25.64			
TECHNOLOGICAL CONSERVATION (%)									
Domestic	(%)	0	0.16	0.15	0.13	0.11	0.12		
Industrial	(%)	0	0.33	0.36	0.39	0.45	0.54		
Agriculture	(%)	0	0.56	1.06	0.39	1.40	1.76		
Others	(%)	0	0.36	0.67	0.89	0.96	1.25		
Total	(%)	0	0.24	0.27	0.27	0.28	0.31		
SALES OF ELECTRICITY WITH CONSERVATION									
Domestic	(MWH)	53356	61829	71794	83402	96915	112631	16.12	71.6
Industrial	(MWH)	29475	29810	30241	30679	31114	31545	1.37	20.1
Agriculture	(MWH)	3352	3542	3744	3981	4212	4459	5.87	2.8
Others	(MWH)	6656	7012	7389	7794	8234	8680	5.45	5.5
Total	(MWH)	92839	102192	113168	125856	140474	157314	11.12	100.0
g-rate	%	10.07	10.74	11.21	11.62	11.99			

Source: WAPDA

Annex Table 3

Per Capita Electricity Consumption, Population Served and Total Supply of Electricity in Swat District, 1987/88 to 1992/93

Indicators		1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)	
POPULATION	('000)	1495.73	1545.09	1595.77	1647.79	1701.18	1755.95	3.26	
G-RATE	%	3.30	3.28	3.26	3.24	3.22			
Households @ 8.0766	('000)	185	191	198	204	211	217	3.26	
Persons per HH		3.30	3.28	3.26	3.24	3.22			
Sales Per Capita	MWH	92839	102192	113168	125856	140474	157314	11.12	
Consumption Per Year	kWH	62	66	71	76	83	90	7.62	
g-rate	%			6.56	7.22	7.70	8.11	8.49	
Domestic Connections		50936	57048	63894	71561	80149	89767	12.00	
Population Served @ 8.0766 per HH		411390	460756	516047	577973	647330	725009	12.00	
Population Served	%	27.50	29.82	32.34	35.08	38.05	41.29	8.46	
Population Not Served		1084341	1084334	1079722	1069818	1053850	1030948	-1.00	
Population Not Served	%	72.50	70.18	67.66	64.92	61.95	58.71	-4.13	
SUPPLY OF ELECTRICITY									
Sales	MWH	92839	102192	113168	125856	140474	157314	11.12	
				10.07	10.74	11.21	11.62	11.99	
National Grid	MWH	89072	97550	107649	119461	133203	149167	10.86	
Increase y1-y0	MWH		8477	10100	11812	13743	15964		
Surplus/Deficit	MWH	-3767	-4643	-5519	-6395	-7271	-8147	16.68	
Small Hydel+Solar + Biogas	kW (Power)	860	860	1060	1260	1460	1660	14.06	
Capacity Added Locally	kW (Power)	0	200	200	200	200	200		
Small Hydel+Solar	MWH	3767	4643	5519	6395	7271	8147	16.68	at 50% capacity
Net Surplus/Deficit	MWH	0	0	0	0	0	0		

Source: WAPDA, PCAT, and SHYDO

Annex Table 4

Demand for LPG (Cylinder Gas) in Swat District, 1987/88 to 1992/93

Sector		i-elast	p-elast	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)	
Domestic Connections		1.5	-0.15	9260	10000	10800	11655	12598	13605	8.00	1 cylinder = 11.5 kg.
g-rate					8.00	8.00	8.00	8.00	8.00		
Domestic use per HH/month	cylinder/month		1.00	1.35	1.39	1.44	1.48	1.53	8.89		
Domestic per HH/year	Tons/Year		0.14	0.15 3.09	0.15 3.12	0.16 3.15	0.16 3.18	0.17 3.21	3.15		
Domestic Total	Tons/Year		1311	1460 11.34	1626 11.37	1811 11.40	2018 11.44	2250 11.47	11.40		
Restaurants and others	Tons/Year	1.60	-0.20	210	230	251	275	301	329	9.39	
Total LPG	Tons/Year			1521	1589	1877	2086	2319	2579	11.13	
Total LPG	TOE/Year			1634	1882	2091	2324	2583	2872	11.13	
Price increase for plan period				REAL %							
LPG				5.66	5.66	5.66	5.66	5.66	5.66	0.00	
				NOMINALS %							
LPG				12.00	12.00	12.00	12.00	12.00	12.00	0.00	

Annex Table 5

Demand for Superior Kerosene in Swat District, 1987/88 to 1992/93

Sector	i-elast	p-elast	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR (Plan)
Domestic Connections	1.4	-0.2	120400	130032	140435	151669	163803	176907	8.00
g-rate			8.00	8.00	8.00	8.00	8.00		
Domestic use per HH/month	lit/month		4.00	4.09	4.18	4.28	4.38	4.49	2.33
Domestic per HH/year	Tons/Year		0.0392 2.27	0.0400 2.30	0.0410 2.33	0.0419 2.35	0.0429 2.38	0.0439	2.33
Domestic Total	Tons/Year		4714 10.45	5207 10.48	5752 10.51	6357 10.54	7027 10.57	7770	10.51
Domestic Total	TOE/Year		4862	5370	5933	6557	7248	8014	10.51
Price increase for plan period					REAL %				
Kerosene				7.08	7.08	7.08	7.08	7.08	0.00
					NOMINALS %				
Kerosene				13.50	13.50	13.50	13.50	13.50	0.00

Annex Table 6

Demand for Animal Dung in Swat District, 1987/88 to 1992/93

Sector	i-elast	p-elast	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR (Plan)
Domestic Connections	1.02	-0.03	9632	9632	9632	9632	9632	9632	0.00
g-rate				0.00	0.00	0.00	0.00	0.00	
Domestic use per HH/month	kg/mo/HH		128	128	128	128	128	128	0.00
Domestic per HH/year	Tons/Year		1.54	1.54 0.00	1.54 0.00	1.54 0.00	1.54 0.00	1.54 0.00	0.00
Domestic Total	Tons/Year		14795	14795 0.00	14795 0.00	14795 0.00	14795 0.00	14795 0.00	0.00
Domestic Total	TOE/Year		4734	4734	4734	4734	4734	4734	0.00
g-rate	%			0.00	0.00	0.00	0.00	0.00	

Annex Table 7

Demand for Fuelwood in Swat District, 1987/88 to 1992/93

Demand/Supply		i-elast	p-elast	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR (Plan)
Domestic (HH Nos)		1.25	-0.3	175933	181739	187700	193819	200099	206542	3.26
g-rate					3.00	3.00	3.00	3.00	3.00	
Domestic Use Per HH	kg/Month			1256	1266	1276	1287	1298	1309	0.83
Domestic Per HH	Tons/Year			15.072	15.19	15.31	15.44	15.57	15.71	0.83
					0:78	0.81	0.83	0.86	0.88	
Domestic Total	Tons/Year			2651670	2760636	2874218	2992619	3116048	3244726	4.12
g-rate	%				4.11	4.11	4.12	4.12	4.13	
Others	Tons/Year			4230	4249	4268	4287	4306	4325	0.45
g-rate	%				0.45	0.45	0.45	0.44	0.44	
Total Gross Wood	Tons/Year			2655900	2764885	2878486	2996906	3120355	3249051	4.11
g-rate	%				4.10	4.11	4.11	4.12	4.12	
Volume	m^3/Year			3160521	3290213	3425399	3566319	3713222	3866371	4.11
Optimal Production	Tons/Year			0	0	0	0	0	0	
g-rate	%			0.00	0.00	0.00	0.00	0.00	0.00	
Surplus/Deficit	Tons/Year			-2655900	-2764885	-2878486	-2996906	-3120355	-3249051	4.11
Total Adj. Wood	TOE/Year			-969403	-1009183	-1050648	-1093871	-1138929	-1185904	4.11
g-rate	%				4.10	4.11	4.11	14.12	4.12	Adjustent means demand after deducting the economic use of Forest wood
Substitute -----------										
LPG	Tons/Year			0	0	0	0	0	0	
Energy Plantation				0	0	0	0	0	0	
Net Surplus Deficit	TOE			-969403	-1009183	-1050648	-1093871	-1138929	-1185904	4.11

Market price increase + induced price increase to promote substitution for higher value wood (currently used as firewood)

REAL %							
Wood	8.49	8.49	8.49	8.49	8.49	8.49	0.00
NOMINALS %							
Wood	15.00	15.00	15.00	15.00	15.00	15.00	0.00

Annex Table 8

Demand for Charcoal and Coal Briquettes in Swat District, 1987/88 to 1992/93

Demand For		1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)
Charcoal, Coal Briquettes	mounds/week	6000	6000	6000	6000	6000	6000	0.00
Total	tons/year	2880	2880	2880	2880	2880	2880	0.00
Total	TOE/yr	2218	2218	2218	2218	2218	2218	0.00
Restuarant + Others	Share 80%	2304	2304	2304	2304	2304	2304	0.00
HH	Share 20%	576	576	576	576	576	576	0.00

Annex Table 9

Demand for Crop Residue, Saw Dust, Bagasse etc in Swat District, 1987/88 to 1992/93

Demand/Supply	i-elast	p-elast	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)
Domestic HH	1.5	-0.15	34400	34400	34400	34400	34400	34400	0.00
g-rate				1.00	1.00	1.00	1.00	1.00	
Domestic use per HH	kg/Month		60	56	52	48	45	42	-7.00
Domestic use per HH	Tons/Year		0.72	0.67	0.62	0.58	0.54	0.50	-7.00
				-7.00	-7.00	-7.00	-7.00	-7.00	
Domestic Total	Tons/Year		24768	23035	21423	19924	18529	17233	-7.00
Others Cr/Sawdust/Bagasse	Tons/Year		822	825	827	830	833	836	0.33
Total Unadj.	Tons/Year		25590	23859	22250	20754	19362	18068	-6.72
Volume	m^3/Year		30964	28870	26923	25112	23428	21863	-6.72
Optimal Production	Tons/Year		0	0	0	0	0	0	
Surplus/Deficit	Tons/Year		-25590	-23859	-22250	-20754	-19362	-18068	-6.72
Total Adj.	TOE/Year		-7677	-7158	-6675	-6226	-5809	-5420	-6.72 Adjustment means demand after deducting the economic use of Crop
Substitute Residue									

LPG	Tons/Year		0	0	0	0	0	0	
Energy Plantation			0	0	0	0	0	0	
Net Surplus Deficit	TOE		-7677	-7158	-6675	-6226	-5809	-5420	-6.72

Market Price Increase + Induced Price Increase to Promote Substitution for Higher Value Wood (Currently Used as Firewood)

	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)
REAL %							
Saw Dust, Crop Residue, Bagasse, etc.	27.36	27.36	27.36	27.36	27.36	27.36	0.00
NOMINALS %							
Saw Dust, Crop Residue, Bagasse, etc.	35.00	35.00	35.00	35.00	35.00	35.00	0.00

Annex Table 10

Petrol/Diesel (Transportation) Demand in Swat District, 1987/88 to 1992/93

Supply	i-elast	p-elast	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR(Plan)
Sales	1.4	-0.2	27210	29072	31061	33186	35457	37883	6.84
			6.84	6.84	6.84	6.84	6.84	6.84	
TOE			27591	29479	31496	33651	35954	38414	6.84
			6.84	6.84	6.84	6.84	6.84	6.84	
Rate Increas for Plan Period									
					REAL %				
Petrol/Kerosene			9.43	9.43	9.43	9.43	9.43	9.43	0.00
					NOMINALS %				
Petrol/Kerosene			16.00	16.00	16.00	16.00	16.00	16.00	0.00

Annex Table 11

Energy Use in Important Industries in Swat District, 1987/88 to 1992/93

Industrial Sector		1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR (Plan)
Tobacco								
Wood	Mound/season/oven	200	200	200	200	200	200	0.00
Ovens	No.	350	350	350	350	350	350	0.00
Total wood in tobacco	Tons/Year	2800	2800	2800	2800	2800	2800	0.00
Total wood in tobacco	TOE/Year	697	697	697	697	697	697	0.00
BRICK KILN								
Wood	Maund/Day per kiln	1.1	1.1	1.1	1.1	1.1	1.1	0.00
Kilns	No.	33	34	35	36	37	38	2.86
Total wood in Brick Kiln	Tons/Year	530	546	562	578	594	610	2.86
			3.03%	2.94%	2.86%	2.78%	2.70%	
Total wood in Brick Kiln	TOE/Year	215	221	228	234	241	247	2.86
Mineral Coal	Tons/Day per kiln	5	5	5	5	5	5	0.00
Kilns	No.	33	34	35	36	37	38	2.86
Total Mineral Coal	Tons/Year	60225	62050	63875	65700	67525	69350	2.86
Total Mineral Coal	TOE/Year	26921	27736	28552	29368	30184	30999	2.86
GUR (UNREFINED SUGAR) MANUFACTURING								
Wood	kg/Day	100	100	100	100	100	100	0.00
Gur Units	No.	300	301	302	303	304	305	0.33
Total Wood	Tons/Year	900	903	906	909	912	915	0.33
Total Wood	TOE/year	365	366	367	369	370	371	0.33
g-rate	%		0.33	0.33	0.33	0.33	0.33	
Bagasse	kg/Day	230	230	230	230	230	230	0.00
Gur Units	No.	300	301	302	303	304	305	0.33
Total Bagasse	Tons/Year	2070	2077	2084	2091	2098	2105	0.33
g-rate	%		0.33	0.33	0.33	0.33	0.33	
Total Bagasse	TOE/Year	822	825	827	830	833	836	0.33
g-rate	%		0.33	0.33	0.33	0.33	0.33	

Annex Table 12

Energy Balance Sheet for Swat District, 1987/88 to 1992/93

Energy Demand/Supply		1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	ACGR	(Plan)
<u>Demand (Business as Usual)</u>									
Electricity	TOE	7561	8323	9216	10250	11440	12812	11.12	
LPG	TOE	1694	1882	2091	2324	2583	2872	11.13	
Kerosene	TOE	4862	5370	5933	6557	7248	8014	10.51	
Adj. Fuelwood	TOE	969403	1009183	1050648	1093871	1138929	1185904	4.11	Adjustment means demand after deducting the economic use of Forest Wood or Crop Residue
Adj. Crop Residue	TOE	7677	7158	6675	6226	5809	5420	-6.72	
Saw Dust, Bagasse, etc									
Cow Dung	TOE	4734	4734	4734	4734	4734	4734	0.00	
Petrol/Diesel	TOE	27591	29479	31496	33651	35954	38414	6.84	
Charcoal/Coal briquettes mineral coal	TOE	29138	29954	30770	31586	32401	33217	2.65	
Total Energy Demand		1052661	1096082	1141563	1189198	1239098	1291387	4.17	
<u>SUPPLY SCENARIO</u>									
Grid Electricity	TOE	7254	7944	8767	9729	10848	12148	10.86	
Small Hydel	TOE	307	378	449	521	592	663	16.68	
LPG	TOE	1694	1882	2091	2324	2583	2872	11.13	
Kerosene	TOE	4862	5370	5933	6557	7248	8014	10.51	
Adj Fuelwood	TOE	969403	1009183	1050648	1093871	1138929	1185904	4.11	
Adj. Crop Residue Saw Dust, Bagasse, etc	TOE	7677	7158	6675	6226	5809	5420	-6.72	
Cow Dung	TOE	4734	4734	4734	4734	4734	4734	0.00	
Petrol/Diesel	TOE	27591	29479	31496	33651	35954	38414	6.84	
Charcoal/coal Briquette/ Mineral Coal	TOE	29138	29954	30770	31586	32401	33217	2.65	
Total Energy Supply	TOE	1052661	1096082	1141563	1189198	1239098	1291387	4.17	
g-rate	%		4.12	4.15	4.17	4.20	4.22		
Per Capita (Swat)	KOE	703.78	709.40	715.37	721.69	728.38	735.43	0.88	
g-rate	%		0.80	0.84	0.88	0.93	0.97		
Pakistan Per Capita	KOE	277.00	283.31	289.76	296.35	303.10	310.00	2.28	

Assessment of Felt Needs and Their Prioratisation

Priority Ranks

Felt Needs	1	2	3	4	5	6	7	8	9	10	11
Plantation Around Farms	•										
Energy Plantation on Waste/ Vacant Lands.		•									
Supply of LPG			•								
Supply of Grid Electricity				•							
Supply of Kerosene Oil					•						
Development of Solar Energy						•					
Supply of Coal							•				
Supply of Petrol/Diesel								•			
Supply of Generators									•		
Wind Mill Installation										•	
Micro/Mini-hydel											•

REFERENCES

Government of Pakistan (GOP). "District Census Report of Swat". Islamabad: Population Census Organisation, 1981.

National Engineering Services of Pakistan (NESPAK). "Master Plan of Rural Electrification District Swat, NWFP". Lahore: NESPAK, 1984.

Khan, A.O. "Working Plan for the Forests of Swat and Swat Kolistan (1965-1980)". Peshawar: Forest Department, Government of Pakistan: 1965.

Kalam Integrated Forest Development Project (KIFDP). "Kalam on the Move". Kalam: KIFDP, 1984.

ICIMOD is the first international centre in the field of mountain development. Founded out of widespread recognition of environmental degradation of mountain habitats and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983, and commenced professional activities in 1984. Though international in its concerns, ICIMOD focuses on the specific, complex, and practical problems of the Hindu Kush-Himalayan region which covers all or part of eight Sovereign States.

ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

Mountain Infrastructure and Technology constitutes one of the four thematic research and development programmes at ICIMOD. The programme aims at achieving environmentally sound infrastructural development practices as well as the use of innovative technologies for alleviating drudgery and improving the living conditions of mountain inhabitants. This is carried out through state-of-the-art reviews, field studies, pilot training, and applied research. Currently, the main focus of the programme is on mountain risk engineering with special reference to hill road construction, decentralised district energy planning and management, as well as appropriate mountain technologies.

Director: Dr. E.F. Tacke Deputy Director: Dr. R.P. Yadav

International Centre for Integrated Mountain Development
G.P.O. Box 3226, Kathmandu, Nepal

Telex : 2439 ICIMOD NP
Telephone : (977-1) 525313
Cable : ICIMOD NEPAL
Fax : (977-1) 524509