Chapter 5
Review on Policies and Their Implications on Renewable Energy Technologies in the Context of the HKH Region of Pakistan

by Tajammul Hussain[1]

5.1 Background

Most of the population of the mountain region in Pakistan live below the poverty line. Not surprisingly, the energy consumption is very low, with biomass fuel (firewood, dung, crop residue, etc) accounting for about 80 per cent of it. Most of this is consumed by households, since no significant industries exist.

The Hindu Kush-Himalayan (HKH) Region in Pakistan includes the Northern Mountains and the dry Western Mountains. The Northern Mountains take in the Northwest Frontier Province (NWFP), Federally Administered Tribal Areas (FATA), Azad Jammu and Kashmir (AJK), and the Northern Areas. This territory has a population of 22.937 million and covers an area of 174,572sq.km. (Abdullah 1997). Most of the land is used for farming, livestock breeding, grazing, or forestry, depending upon altitude, climate, and socioeconomic conditions. Most of it, too, is steeply mountainous, with only a very small amount of flat area available for cultivation; otherwise it generally supports only natural vegetation. The pastures are grazed at higher elevations, between 1,500 to 3,300m, in the summer only, but they are grazed throughout the year at lower levels. In the winter, animals are fed on hay made from grasses cut in the area. Most of the population are subsistence farmers who manage to meet only the bare minimum needs of food and fodder for their households.

The Western Mountains include Balochistan Province, with a total estimated population of 6.738 million. The total land area of the region amounts to 302,454sq.km., and most of the land is arid (Abdullah 1997). The main economic activity revolves round the livestock industry (one third of the land is used as rangeland), less than three per cent of the area being exploited for fruits and vegetables by using scarce groundwater resources. The export trade from the province is in coal, gas, mutton, hides, and temperate fruits and vegetables.

1 Director, Commission on Science and Technology for Sustainable Development in the South (COMSATS), Islamabad, Pakistan

5.2 Energy Supply Potentials and Consumption Patterns

There is no production of oil in mountain areas, and a uniform fixed price prevails for oil products. Indeed, the availability of oil in substantial quantities in the far-flung mountain area could cause problems. The main gas fields in the Western Mountains are located in Sui, Pirkoh, and Loti. The annual production of gas from these fields has remained nearly constant, at 325,000 to 350,000 million cu.ft., during the last five years. The balance of recoverable reserves of gas in Balochistan amounts to 4.1 trillion cu.ft. and there is a 5,293km gas distribution pipeline in the mountain areas (60% in the Northern and 40% in Western mountains). For the FY 1994/95, the production of coal amounted to 1.6 million tonnes in the mountains, 97.4 per cent of which was produced in Balochistan. The total estimated reserves of coal in mountain areas amount to 54 million tonnes.

The Northern Mountains are rich in hydropower resources. According to some estimates these areas have a potential of 30,000MW. At present, the installed capacity of hydropower amounts to 4,726MW—generating 22,858 GWh in NWFP, of which it consumes 8,245 GWh, thus making the provinces net exporters of electricity to other provinces (Sharma et al. 1997). The Master Plan for the development of small hydropower identified 116 sites with a total potential of 400MW as feasible. At the same time, the identified potential of medium hydel schemes is 770MW, ranging from 10MW to 150MW.

Public forest areas in the mountains (76% of the total forest area in Pakistan), including coniferous forests (58%), scrub (33%), riverine forests (1%), farmland trees (4%), and irrigated and linear plantations (4%), provide most of the wood required for domestic and industrial purposes within both the mountains and plains in Pakistan. About 14 per cent of the Northern Mountains is covered by forest, though a significant variation in forest cover, from 15 to 60 per cent, is observed if an analysis is made at the district level. The Northern and Western Mountains contribute 82 per cent and 18 per cent respectively of the total forest area in the mountains. The Northern Mountains are dominated by coniferous forest area (70%) and scrub (21%); the Western Mountains by scrub forest (85%). One estimate of supply potential indicates that coniferous forest contributes almost 51 per cent, farmland 25 per cent, and scrub forest nine per cent of the annual sustainable yield in the mountains (GOP 1992).

The use of other biomass resources (namely, agricultural residue and animal dung) is increasing in mountain areas due to growing deficits of wood. The exact amount of biomass residue available is not known, but various studies have indicated that these resources are also used as fuel, fodder, and fertilizer. The tendency to divert these residues to cooking and heating needs, instead of using them as fodder and fertilizer, is a great concern in the mountain areas of Pakistan.

In FY 1994/95, the per capita final energy consumption in the mountains of Pakistan amounted to 11.6 GJ (10.5 GJ in the Northern Mountains and 15.1 GJ in the Western Mountains). The share of various forms of energy varies between the Northern and Western Mountains. Table 5.1 compares the per capita final energy use pattern between the Northern and Western mountains of Pakistan. For example, the share of fuelwood in the total final energy amounts to 46 per cent in the Northern, while it is 66 per cent in the Western Mountains. The contribution of 'other' biomass (i.e., agricultural residue and animal dung) to total biomass fuels in the Northern Mountains is 26 per cent, and 10 per cent in the Western Mountains. This is indicative of the high biomass fuel consumption in the Western compared to the Northern Mountains. The harsh climatic conditions of the Western Mountains combined with the scarcity of fuelwood, forces the area to depend primarily on imports from outside Balochistan Province. Also, there is a high demand for fuelwood from the Northern Mountains from the adjoining plains where it fetches a good price, so local residents are tempted to save fuelwood in order to earn cash.

Table 5.1: Per Capita Final Energy Consumption Pattern in the Mountains of Pakistan, FY 1994/95

Descriptions	Western Mountains		Northern Mountains		Mountain Total
	MJ/Capita	Per cent	MJ/Capita	Per cent	'000 GJ
By sector					
Rural households	12,024	65	7,028	56	204,884
Urban households	11,835	14	7,024	11	37,087
Comm/institutional	222	1	268	2	7,639
Industrial	1,350	9	1,648	16	46,886
Agriculture	202	2	236	2	6,785
Transport	1,393	9	1,335	13	40,019
Total	15,186	100	10,515	100	343,550
By fuel type					
Fuelwood	10,094	66	4,864	46	179,573
Other biomass	1,003	7	1,697	16	45,687
Coal	585	4	59	1	5,304
Petroleum fuels	2,102	14	1,923	18	58,271
Natural gas	421	3	871	8	21,570
Electricity	982	6	1,157	11	33,146
Total	15,186	100	10,515	100	343,550
Total population (thousands)	6,738		22,937		29,675
Rural	5,526		19,699		25,225
Urban	1,212		3,238		4,450

Source: Abdullah (1997); Rijal (1997)

The share of commercial fuels in terms of total final energy amounts to about 34 per cent in the mountains, with a variation in the share of commercial fuels (i.e., 38% in the Northern and 27% in the Western Mountains), but the per capita consumption remains almost the same. Among the commercial fuels, petroleum fuels contribute about 49 per cent, electricity 28 per cent, natural gas 18 per cent, and coal five per cent in the mountains. The share of petroleum fuels and electricity remains almost the same in both mountain areas, while the share of natural gas is dominant in the Northern Mountains (per capita natural gas consumption is almost double), and coal dominates the energy scene in the Western Mountains (per capita coal consumption is almost 10 times more), reflecting the accessibility of these fuels as well as the types of industries that are operational there.

The rural domestic sector primarily depends on biomass fuels (98% in the Western and 92% in the Northern Mountains), while such dependence is much less in the urban domestic sector (50-55%), because of the patterns of energy supply and demand infrastructure. The urban domestic sector of the Northern Mountains is dominated by natural gas (70%) and electricity (22%) and that of the Western Mountains by electricity (51%) and natural gas (33%). This is due to the higher per capita electricity consumption in the urban domestic sector of the Western Mountains (almost four times more than the Northern Mountains), despite the per capita total electricity consumption in the Northern Mountains being 1.2 times more than in the Western Mountains.

The industrial sector of the mountain economy of Pakistan is dominated by the supply of commercial fuels (70-80%). The industrial sector of the Western Mountains is dominated by coal (54%) and the Northern Mountains by natural gas and electricity (69%). However, industries in the Northern Mountains consume more in terms of per capita energy. This is because of the location and the types of industry that prevail in these mountain areas. The agricultural sector of the Northern Mountains consumes more electricity (168 MJ per capita) than the Western Mountains (111 MJ per capita), which reflects the agricultural mechanisation as well as availability of electricity within the former.

More than 90 per cent of all biomass fuel is consumed by the domestic sector in the Western Mountains, while seven per cent of it is required by the industrial sector. A similar pattern of consumption is observed in the Northern Mountains. The sectoral consumption pattern of commercial fuel shows that 24 per cent of it is required in the domestic sector, 34 per cent in transport, 27 per cent in industry, eight per cent in commerce, and seven per cent in agriculture in the mountains of Pakistan, with minor variations over time. The biggest consumers of electricity are the domestic (40%) and industrial (35%) sectors in the Eastern Mountains, and the same is true of the Western Mountains, though these industries (45%) consume more than the domestic sector (35%).

In absolute terms, the Western Mountains consume almost 1.5 times more energy than the Northern Mountains, though the per capita commercial energy consumption is higher in the Northern Mountains. Other striking differences are that: a) the household sector in the Western Mountains consumes about 80 per cent of the total final energy and in the Northern Mountains less than 70 per cent; b) the final energy consumed in the industrial and transport sectors of the Northern Mountains is higher than in these sectors in the Western Mountains; and c) the commercial fuel consumed in the Northern Mountains is higher than in the Western Mountains. The energy consumption trend reflects the inadequacy of the commercial energy supply infrastructure in the Western Mountains, as well as the low level of industrial development and transport infrastructure.

5.2.1 The Present Status of Renewable Energy Technologies

The development of renewable sources of energy opens up the prospect of increasing the indigenous energy supply and thereby contributing to greater self-sufficiency. The development of renewable energy also creates new options for responding to the energy requirements of the rural domestic sector. The role of renewable energy technology should be perceived as a dynamic interaction between resources, technologies, and the present and future energy requirements for the social and economic uplift of the region. Recent studies have shown that hydroelectricity has been the cheapest source of renewable energy. However, biomass, wind energy, and direct solar energy have already been installed. Wind energy is the second cheapest option of renewable energy available, while solar thermal energy offers another option which can be used for space and water heating.

The government of Pakistan has made the following renewable energy programmes a national high priority (UNESCO 1996).

- The installation of a 1MW solar thermal power plant in the desert area of Pakistan
- Model houses self-sufficient in terms of energy
- PV telecommunications' systems for rural areas
- Biomass plants using agricultural and municipal wastes
- Solar desalination pilot project
- Community solar driers for drying grains, fruits, vegetables, etc
- Biogas plants to meet the domestic fuel needs of rural areas.

Micro- and Mini-Hydropower Plants

The HKH Region in Pakistan, especially the NWFP, enjoys high rainfall and possesses numerous snow-peak mountains, making it rich in water resources with vast hydropower potential. Most of the large rivers of Pakistan originate in these mountain ranges, which have been blessed with good forests and minerals. There is an abundance of perennial streams and waterfalls that can be successfully exploited to generate electricity and motive power by means of micro- and mini-hydropower (MMHP) plants. These plants have several advantages over other conventional energy systems, including large hydropower. These power plants can be installed near the village where it is needed by the user community. It is a fairly simple technology with low capital investment.

It may be noted that the recoverable potential of hydroelectric power in Pakistan has been estimated to be nearly 35,000MW, only 3,330MW of which have so far been exploited — which is only 14 per cent of the total energy from commercial fuel (HDIP 1995 and 1996).

The main government agency in Pakistan, Water and Power Development Authority (WAPDA), has found it difficult to implement and run projects of below five MW in capacity. Therefore, power plants installed below this capacity range have been handed over to the Irrigation Department of the NWFP. Other organizations have also been created or upgraded to undertake the installation and maintenance of MMHP plants. In the northern areas (Gilgit and Baltistan), the task of MMHP plant construction and operation has been assigned to the Northern Area Public Works' Department (NAPWD) in the NWFP and Sarhad Hydel Development Organization (SHYDO), a provincial organization of the NWFP.

There are a total of 64 MMHP plants with a total capacity of 17MW operated by these government agencies. Other organizations engaged in the promotion of micro-hydropower (MHP) plants (up to 100kW in capacity) are the Pakistan Council of Appropriate Technology (PCAT) and the Aga Khan Rural Support Development Programmes (AKRSP). Both these organizations have installed MHP stand-alone plants of lower capacity, owned by the local communities or individuals, with a total capacity of 2,334kW from 181 units. A detailed account of the MMHP plants installed by various agencies as of June 1997 is given in Table 5.2.

Table 5.2: The Number of MMHP Installations in Mountain Areas of Pakistan

Area	Number of plants	Total Capacity (kW)	Average Capacity (kW)	Implementing Agency
Northern Areas	77	14,633		
Government-owned	47	13,940	297	NA-PWD
Community-owned	30	693	23	AKRSP/PCAT
NWFP	163	4,342		
Government-owned	12	2,700	225	SHYDO (Government)
Community-owned	151	1,642	11	PCAT
AJK	5	574		
Government-owned	5	574	95	AJK-PWD
Community-owned				
Total	245	19,549		
Government-owned	64	17,214	267	
Community-owned	181	2,335	13	

Source: PCAT, SHYDO, NA-PWD and AJK-PWD.

Problems with MMHP Installations

The challenge of planning and providing rural electrification has not been satisfactorily met in Pakistan. All aspects of rural life from food processing to factories, from enterprise to entertainment, suffer from a lack of available and reliable electricity. Though modest progress has been made, there is little evidence of well-established sustainable systems serving rural areas. Quite often, rural electrification is based on subsidies that are justified by political priorities exempted from the economic, ecological, and social criteria of socioeconomic development. This has been particularly true for the MMHP schemes in the NWFP and the Northern Areas. Many plants installed by the government agencies have ceased operations or remained inoperative for a major part of the year. Far from demonstrating sustainable development, most have failed to demonstrate even institutional and operational stability. The following are the main causes responsible for this situation (SHYDO, undated, Siraj 1995): a) mismatch between plant capacity and energy demand; b) inappropriate equipment, most of which is imported; c) lack of trained personnel; d) repair and maintenance performed as in other routine government departments, through tendering, etc; e) failure to identify the local energy market; and f) limited private sector involvement.

Except in the case of the AKRSP and PCAT, which work in close collaboration with the local communities, all other MMHP plants installed in Pakistan are operated and maintained by public sector organizations, which act more or less like power utility companies. This results in a heavy bureaucratic organizational structure which makes the operation of the system more complicated. In case of any breakdown in the plant, which is quite frequent in MMHP schemes, the repair is made according to normal government procedures involving tendering, etc. This takes a long time, sometimes more than a year. During this period, the local people use diesel generators to meet their power demands. Customers have to make a great effort to get a power connection. These departments are not geared to carry out their own research and development activities, so their staff are unable to undertake any innovations, and, in case of major breakdowns, assistance is sought from overseas' equipment manufacturers at very high costs. The power supply from these plants is not too reliable, particularly from MMHP plants, and is often erratic.

Biogas Plants

Biogas is a clean and cheap fuel. About 60 per cent of it is inflammable methane gas; the rest of the constituents are carbon dioxide (30-35%), hydrogen sulphide, carbon monoxide in traces, and water vapour. This gas can be used for cooking and lighting. Biogas is produced from cattle dung in a biogas plant through a process called digestion.

There are about 30 million cows and buffaloes in Pakistan. The total dung available per day in the country works out to between 300 and 450 million kg, assuming that each animal daily produces 10-15kg of droppings. The total number of biogas plants that can be installed in Pakistan may well exceed one million (Sarhandi, no date). In addition to producing gas, efficient biogas plants also provide nitrogenous fertilizer. This bio-fertilizer is highly suitable for the land, being better than many chemical fertilizers. The suitability of biogas plants for mountain areas is constrained by the low temperatures.

PCAT was established in 1974 and biogas plant designs were procured through the Intermediate Technology Development Group (ITDG), London. These designs were tried out in some places, but with little success. In 1976, the Appropriate Technology Development Organization (ATDO, later renamed PCAT) obtained the design of Chinese biogas plants through the Chinese Embassy in Pakistan, and these were installed in different places. Twenty-one such plants were erected throughout the country in sizes of 10, 20, and 50 cubic metres. These designs consisted of a dome-shaped reinforced concrete (RCC) roof and brick masonry. Some problems encountered in the Chinese design were: a) gas pressure was not constant, and this affected the burning efficiency; b) difficulty in the construction of a good quality dome by local masons; and c) the use of costly forms of work and associated transport. Afterwards, an Indian design was adopted, with some modifications according to local needs, to reduce costs. The modifications made were: a) the central partition wall was removed; b) slide supports were provided for the gas holder instead of a central guide; c) the thickness of the wall of the fermentation chamber was reduced from 9" to 4 ½"; d) the outlet pipe was removed and the digested slurry was allowed to drain from the top of the fermentation chamber (Shehryar 1995).

There are altogether 1,134 biogas units installed in the NWFP and Balochistan Province (HDIP 1996). Most of these plants belong to individuals who have paid the entire cost of construction, through PCAT may have provided technical assistance and supervisory services during their installation.

Solar Energy Technologies

The mountain areas of Pakistan are blessed with plenty of sunshine. The daily average solar radiation is four to six kWh/sq.m. in the HKH Region (Sheikh, no date, Raza et al. 1995). People are beginning to use solar enerty for a large number of applications.

<u>Solar Thermal Technologies</u> - This technology has been successfully developed in Pakistan for water heating and space heating, and is now being commercialised. An average family-size solar water heater of 30 gallons costs PRs 13,000, and space heating systems cost PRs 7/cu.ft. In view of the low per capita income of the HKH Region, it is difficult to commercialise. However, NGOs and government agencies are installing such systems in schools and community service centres. At the same time, NGOs are active in promoting solar driers for drying fruit in mountain areas in order to develop this as a cottage industry. Solar cookers have been developed by PCAT, PCSIR, and NIST but have not been disseminated in rural areas due to economic and social factors.

<u>Solar Photovoltaic</u> - About seven solar stations have been installed in various parts of the Northern Areas and Balochistan, with a total capacity of 234kW (HDIP 1996). These systems, installed by various donor agencies during the late 1980s for village lighting, are not in operation because of maintenance problems.

Wind Energy

Wind can be used to produce useful work for a variety of applications, such as pumping water, grinding food, or producing electricity. However, Pakistan has made very little headway in tapping this resource. DGNRER initiated a programme during the late 1980s to install a few wind generators and wind pumps. For example, one unit with a capacity of 20kW installed in Khurkhera, Lesbella District, Balochistan, is currently not in operation. The plight of wind pumps installed in Balochistan (per comm. DGNRER) is similar.

In 1985, with a budget of PRs 2.8 million, PCAT undertook to gain experience in the design and operation of wind technologies. However, no significant progress has been made so far. The council installed a few wind-measuring devices in Balochistan, but it is not clear to what extent the information on wind velocity has strengthened Pakistan's knowledge about the potential of wind resources in the country (PCAT 1992; Shehryar 1995). All wind data are received through the Pakistan Meteorological Department, but they do not seem to be reliable.

Improved Biomass Stoves

Most of the energy consumption takes place in the household for cooking, lighting, and water and space heating. More than 60 per cent of such needs in the NWFP and 80 per cent in Balochistan are met by fuelwood, and five to 10 per cent by dung cakes. The government's major emphasis on plantations has led the Forest Department and NGOs to launch afforestation programmes. About 90,000 acres of forest land have been leased for afforestation (GOP 1993). Social forestry has been encouraged and incentives, such as the selling of saplings at subsidised rates, have been provided.

Besides these efforts, energy-efficient cooking stoves have been designed by PCSIR and PCAT, and an improved design of the traditional stove has increased its use from 43 to 50 per cent and resulted in a 50 per cent saving of firewood. The front baffle controls availability of oxygen to the firewood, and the rate of burning, thus economising on firewood. The cavities around the cooling surfaces diminish heat loss, while the baffle at the outlet, i.e. near the chimney, traps the residual heat for subsidiary uses when the cooking stove is not in use. The chimney is cheaply made by recycling vegetable ghee tins. The stoves are made of traditional and easily available local materials, and the cost per stove is between PRs 50 and 80. The simplicity of design renders it very easy to construct in the remote mountains. So far 68,000 stoves have been distributed in rural areas of the NWFP and Balochistan by PCAT&DGNRER (Sarhandi 1996).

PCAT started the Fuel-efficient Cooking Technology (FECT) project in collaboration with GTZ to achieve fuel savings of up to 25-40 per cent in 150,000 households from 1990 to 1993 (Sarhandi 1996). This involved disseminating improved cooking/heating stoves and establishing bakeries as part of a viable system leading to the commercial dissemination of improved cooking devices through the private sector. The training and transfer of technology is carried out through five centres in the NWFP and four in Balochistan.

More than half the population of the country are women, the majority of them living in rural areas. Plagued by illiteracy, rural women face great hardships associated with motherhood, poor health conditions, and social constraints in their daily life. With this in mind, a pilot project was prepared in consultation with the International Labour Organization (ILO). The UNDP provided financial assistance, and PCAT implemented the project primarily for women; this involved the training in and dissemination of techniques for constructing cooking stoves.

Efficient Electrical Devices

Lighting Fixtures: When fluorescent tubes are fitted with an electronic choke electricity consumption is saved by up to 70 per cent. The private sector introduced this high-performance light fixture. The government has announced duty exemptions for its electronic components which will drastically reduce the price of the electronic chock (Maher, no date).

Main Findings

Poverty is one of the major obstacles in the adoption of RETs. Government efforts to introduce micro- and mini-hydelpower through NGOs like the Aga Khan Rural Development Board and international agencies (GTZ) have been successful.

Generally, RETs are capital-intensive. The private sector is not capable of investing in RET development. However, experience has shown that RETs can be successfully managed and maintained by local communities. Mountain communities should be encouraged to exploit the locally available resources to meet their growing energy needs, since sufficient potential exists.

5.2.2 Institutional Bodies for the Implementation of RET Programmes

Currently, several organizations are involved in various aspects of RET. The **Ministry of Science and Technology** (MOST) organizes various RET-related activities through the following institutions which are under its administrative control.

The **National Institute of Silicon Technology (NIST)** is an R&D institute created to develop solar photovoltaic technology. Solar cells have been developed by the institute. A 100-watt PV system was installed in 1994 at the Edhi Trust Medical Post in Islamabad.

The **Pakistan Council for Appropriate Technology (PCAT)**, previously ATDO, an administrative unit under MOST, has introduced different programmes to promote technologies that use the available resources of particular areas for the welfare of the people. The programmes include renewable energy, food processing and preservation, and water and sanitation in order of priority. Some work has also been planned to address environmental issues, housing, and income-generating technologies.

The PCAT has had reasonable success in the dissemination of micro-hydropower plants, having installed 200 units. In addition, 40 more potential sites have been identified, and work on these sites is in different stages of development. Similar progress has been achieved in the energy conservation and wind turbine programmes. The PCAT intends to augment its role in the design, fabrication, and development of energy-efficient appliances that increase self-reliance.

The **Pakistan Council for Scientific and Industrial Research (PCSIR)** has offices in Peshawar (NWFP) and Quetta (Balochistan), in addition to Karachi, Lahore, and Islamabad. The council is engaged in research and development of solar thermal technologies.

The **Solar Energy Centre (Hyderabad)** promotes solar thermal technologies. This centre has installed a solar desalination plant to make potable water from the Indian Ocean Gawadar Beach area, in Balochistan. Windmill and solar thermal programmes are in progress.

The **National Institute of Power (NIP)** has been engaged in the development of micro-hydropower plants in the mountainous areas of the NWFP. Recently this organization was closed by the government.

The **Energy Wing of the Ministry of Planning and Development** has been responsible for the overall planning and coordination of energy sector activities, while the Planning Commission undertakes studies on remote power generation, energy conservation, and renewable energy technologies.

The Directorate General of New and Renewable Energy Resources (DGNRER) under the administrative control of the Ministry of Petroleum and Natural Resources had installed several photovoltaic power systems (12 stations) in primarily rural, mountainous areas. Several biogas plants have been installed, but most of them are not functioning properly. Recently, this organization has merged with WAPDA.

SHYDO is a provincial (NWFP) organization and is responsible for power generation. With German Technical Assistance (GTZ), it has installed a number of mini-hydelpower plants in the province.

The **Northern Area - Pakistan Works' Department (NA - PWD)** carries out activities in developing mini-hydropower plants in the Northern Areas (NWFP). A number of power plants has already been installed, and those are being maintained by local communities.

The **National Energy Conservation Centre (ENERCON)** has initiated many studies in order to collect basic information, mainly on questions of commercial energy, which will serve as a benchmark in the planning and development process and, in particular, be used to work out options for the development of various forms of energy, including biomass.

5.2.3 A Review of Renewable Energy Policies and Programmes

The federal government is giving priority to developing RETs in Pakistan through the private and public sectors. The National Technology Policy has advocated that the renewable energy resources be exploited. The Eighth Five Year Plan (1993 - 98) clearly stated that the demonstration and promotion of renewable energy technologies are the primary responsibility of the organizations concerned (GOP 1994). Pilot systems were to be established in far-flung areas.

The government has an energy policy which also covers RETs in general but lacks political will and commitment. The provincial policies generally take the federal lead, the result being that very little has been done at the provincial level except in the field of micro-hydro power. There is no integrated plan for the development of RETs in the country, in general, and in the HKH Region in particular. Most institutions are working in isolation without any major impact.

Legislation and Regulatory Mechanisms

The government has legislation regulating the cutting of trees in order to prevent deforestation. This law is being implemented by the Forest Department through regular monitoring. In case of violations, strong action is taken by the concerned government agencies. On the other hand, due to poverty, the population is compelled to resort to cutting trees for their day-to-day fuel requirements. In addition, wood contractors also indulge in unlawful activities and take away trees to sell on the market or use for buildings.

A law has been promulgated to allow water in the rivers to be used for generating power. At the provincial level, the sites for micro- and mini-powerhydel plants have been allocated to the public sector. The government has encouraged this by decreasing the import duty on turbines that are not manufactured locally.

No standard has yet been devised on RET equipment at the national or provincial levels. It may be noted that the Institute of Standards has the needed authority, but no work has been carried out on this by them.

Economic Incentives

The price of conventional fossil fuels is to be gradually brought in line with international tariffs by phasing out the subsidy available on the import of oil. The government provides a subsidy on the price of kerosene and LPG within the HKH Region (Sharma et al. 1997). If the price of conventional fuel is not subsidised there is a possibility that mountain communities will slowly shift to RETs.

The government provides concessions on import duties for RETs, and a tax holiday of five years has been given for setting up industries based on solar energy technology in the country. Also, the import duty has been reduced (20%) on the import of turbines. No soft loans are available for RETs. However, loans for setting up cottage industries are available, and they can be used for the manufacture of RETs.

Rural Electrification Policy

The rural electrification programme is an integral part of the programme to uplift the socioeconomic conditions, living standards, and productive capacity of 70 per cent of the rural population. WAPDA, SHYDO, NA-PWD and PCAT are engaged in village electrification, having provided electricity to 60,144 villages in Pakistan during the period from 1985 to 1996, including the Northern Areas. The supply of electricity is erratic, and most of the areas suffer frequent load-shedding (WAPDA 1996 and 1997).

Afforestation Programme Policies

The total area under forests has been estimated at 4.20 million hectares or 4.8 per cent of the total geographical area of the country. This is inadequate to meet the growing demand for timber and wood, and at the same time to conserve and protect the environment. The existing forests are classified as 42.8 per cent coniferous, 37.6 per cent scrub, 7.6 per cent mangrove, and 6.5 per cent riverain. Irrigated forests account for 5.1 per cent and linear plantations for 0.4 per cent of the area. A long-term goal of the forest policy is to increase the forest area from the current level of 4.8 per cent to 10 per cent in the next fifteen years (GOP 1992 and 1993).

During the Eighth Plan (GOP 1994), high priority has been accorded to the development of forestry, watershed, and rangelands. Intensive forest management was carried out on government forests, and farm forestry promoted on private land to meet the growing demand for timber and firewood. The degradation of the watershed was arrested through afforestation, soil conservation, and proper management practices. In the case of rangelands, programmes for reseeding depleted areas with nutritious, high-yielding grasses and planting of fodder trees were promoted to meet the feed requirements of livestock.

The productivity of forests has been low. Some of the important factors for low productivity include poor regeneration and the low stocking of coniferous forests, faulty logging practices, deterioration of soil fertility, inadequate irrigation, poor quality of planting material, overgrazing, and demand for arable land for crop cultivation (GOP 1993).

The public sector organizations have also chalked out a plan to acquire 90,000 acres of vacant farmland on lease for afforestation (GOP 1993; Sharma et al. 1997). Progress in increasing forest area has been limited due mainly to financial and social constraints. Social forestry programmes have been started to involve peasants in tree-growing campaigns. These efforts have resulted in an area covering up to 47,000 hectares of farmland annually coming under various social forestry and watershed management programmes.

Private Sector Hydropower Generation Policy

Private investors are free to propose the implementation of a hydropower project at any location and opt for any type of equipment. Current policy covers all feasible hydropower plants with capacities of up to 300MW either the run-of-the-river type or the type with nominal absorption of daily flow fluctuations. A feasibility study needs to be prepared within the private sector in accordance with the criteria laid down by the World Bank or Asian Development Bank. Private power generation companies have been exempted from corporate tax on income earned from the sale of electricity. Companies are allowed to import all types of plants and equipment for generation, transmission, and distribution without payment of any sales' tax, flood relief, and other surcharges, and the import license fee. Only a customs' duty of two per cent on imported machinery needs to be paid (GOP 1996).

Policies on RETs

MMHP: The government of Pakistan attaches high priority to development of indigenous energy resources. The policy focusess on increasing the availability of electrical energy to all villages. In this context, the government has identified 100 feasible sites for micro-hydropower plants (<100kW) with a total capacity of 1,213kW and 89 feasible sites for mini- and small-hydropower (>100 and <15MW) with a total capacity of 350MW in the northern mountain areas.

Biogas Plants: The government has recently approved the installation of 20,000 biogas plants by PCAT in the rural areas with the help of an international agency. COMSATS is also going to install community biogas plants in about 50 houses with the help of UNESCO. This project has already been approved and will be implemented during 1997-98.

Financing and Private Sector Initiatives in the Energy Sector

Policy and Strategy: Participation of the private sector in power generation was finally permitted in 1985. However, physical progress remained slow. Except for the identification, documentation, and processing of projects with donor agencies, no significant progress was achieved during the Seventh Plan. The Eighth Plan (GOP 1994) envisaged that the private sector would play a key role in investment, production, distribution, research and development, human resource development, and the generation and mobilisation of resources. The main elements of the strategy to support this role would be the following:

- adoption of appropriate fiscal, monetary, trade, exchange rate, industrial, and other policies to attract private investment (domestic and foreign);
- expanding infrastructural facilities in the public sector, with the participation of the private sector;
- developing human resources;
- ensuring macroeconomic stability;
- maintaining law and order; and
- effectively using the exchange rate to sustain the competitive position of Pakistan without triggering a decline in productivity.

As a measure of financial support for the energy sector, where the private sector is relatively cautious because of the nature of the projects, the government has set up a Private Sector Energy Development Fund (PSEDF).

Indigenisation in Manufacturing: Maximum emphasis is to be laid on manufacturing energy sector equipment in Pakistan. The following measures are proposed.

- Efforts will be made to standardise the design and size of suitable power plants, and the participation of local industries in manufacturing them (partially or wholly) will be promoted. WAPDA will adopt the standardised designs of the plants and make them publicly known to promote indigenous manufacturing.
- WAPDA would maximise indigenous content in power plants. Further, special advantages will be given to the local components of manufacturers.
- NDFC will finance facilities and equipment manufactured locally. Similarly, other financial support will be organized to assist the local manufacturing industry.
- Joint ventures with foreign companies will be encouraged.
- Import of turn-key projects will not be ordinarily allowed.

Due to government policy, micro- and mini-hydropower plants are being installed by NGOs. The private sector has acquired some potential sites for MMHP plants. The Aga Khan Board for Rural Development has already installed MMHP plants.

5.2.4 Policy Issues Affecting RET Development

It is evident from the discussions that Pakistan in general has a poor record in this field, very little having been done so far to accelerate the development and commercialisation of renewable energy technologies in the country. A host of factors has impeded renewable energy technologies from making any meaningful contribution to alleviating the country's perennial energy problems. However, the following six factors stand out.

a) The nation has lacked a clear-cut and comprehensive national policy at the top for the development of RETs.
b) The high initial costs of most RETs have made them beyond the reach of most individual consumers or private enterprises.
c) Market distortions and imperfections have made energy from renewable sources appear more expensive than from non-renewable energy resources.
d) Suitable financial mechanisms and incentives have not been devised to promote pre-competitive but highly promising RETs.
e) The country has lacked the institutional capacity for indigenous planning and development of more challenging RETs.
f) Old planning tools and decision-making practices have not been conducive to fair competition between renewable energy sources and conventional fossil fuel options.

First and foremost, there is a need for a comprehensive national and provincial RET plan to strategically guide the development and deployment of renewable energy technologies in applications in which they can more realistically compete with conventional energy conversion technologies and by which their superior features can be exploited to the nation's best advantage. Since such a plan does not exist, most efforts made to make use of RETs have remained at best piecemeal and incoherent and thus have not led to the creation of sustainable markets for them. No special policies have been devised to ease the diffusion of renewable technologies into society, which is essential for commercialising these pre-competitive technologies. In the absence of interest and a clear-cut programme from the government, the systems that were installed have not been able to deliver the services for which they were designed, to the disillusionment of the owners and the detriment (i.e., eventual abandoning) of the projects.

Second, a major hurdle to RETs gaining a wider commercial acceptance has been their high initial costs which have placed them beyond the reach of even the most well-to-do energy consumers. This was true not only of renewable technologies designed for electricity production but other less sophisticated, direct energy conversion systems such as the passive solar heating of buildings, solar water heating, 'daylighting', and industrial heat production from biomass and solar thermal processes.

Third, the fuel and electricity market in the country has also remained distorted during the past few decades, and made the cost differential between renewable technologies and the alternatives to them based on conventional fuel appear much wider than it would have been otherwise. Production and consumption subsidies have kept the prices of competing fossil fuels for power production rather low, while electricity tariffs have been kept below their long-range marginal costs (LMRC) and, since fossil fuel prices do not fully reflect their relative environmental costs, the technologies based on them have looked deceptively good compared to RETs. Subsidies on diesel and kerosene fuels have compelled consumers to ignore energy-producing possibilities on remote sites from renewables such as solar, wind, or biomass, while artificially low prices for natural gas do not encourage consumers to search for alternative means to fulfill their heating needs from solar options.

Fourth, investment in capital-intensive and commercially untested renewable technologies have been beyond the reach of individual consumers, and, for most, private enterprises represent high-risk capital ventures. Suitable financing mechanisms are needed from the government to give a boost to young but upcoming renewable technologies. No such incentives have been considered necessary or have been devised to facilitate consumers in bearing the high initial costs of RETs. Even the small subsidy provided by the government on the installation of biogas units was later withdrawn, and the technical support from the government for proper upkeep of these units has not kept up with the demand placed on it. MMHP plants in the region can attract private investment if the national grid is extended to the Northern Areas and WAPDA signs an agreement on the purchase of electricity. The potential hydel power can be exploited as a cooperative effort between private and government agencies.

Fifth, since most RETs use resources that are diffuse, site-specific, and slated for distribution, they have therefore entailed much more detailed and rigorous site and resource analyses than are commonly required for conventional energy systems. Data on resource availability and the temporal variation in it, and the institutional capacity needed to match resource and technology to local needs, are not available. RETs are based on intermittent sources like the sun, wind, or rainfall and, therefore, entail some form of storage or back-up system to ensure uninterrupted supply, which adds considerably to their already high capital costs. The country needs indigenous R&D to search for cheaper storage or back-up for these systems and innovative ways to lessen the associated cost burdens. This capacity does not exist, and its lack is to the disadvantage of RETs.

The scientific and technological infrastructure required for undertaking R&D on RETs does not adequately exist. The poor institutional set-up does not allow for experimenting with new and innovative uses of renewable technologies in search of applications for which the labour-intensive nature of RETs could have been exploited to the region's advantage. At the same time, human resource development in the context of RETs is not significant. The development of the craftsmanship necessary to construct and maintain RETs is essential for the sustainability of the RET programme.

Sixth, energy planning in Pakistan is carried out by using tools that were developed by international lenders and development assistance agencies for comparing more established and centralized energy supply alternatives. The old rules established for comparing power generation alternatives have not been conducive to technologies, such as the renewables, the unique features of which (such as environmental soundness, modularity, lack of fuel dependence, and supply diversification) are not easily comparable using conventional planning tools. Those beholden to these rules thus were biased towards conventional fuel options when making decisions. Further, funding from international agencies has also been more easily available for less risky and more established energy schemes built around conventional fuels.

In general, power utilities are much better placed to experiment with these new and capital-intensive energy technologies in their systems. However, they have lacked the internal R&D capability for tackling unfamiliar technologies such as RETs. Despite their better position vis-à-vis this responsibility, they are simply not interested in what they do not consider to be part of their mission. They remain more preoccupied with issues of more immediate concern, such as operational and financial problems, than with developing, acquiring, or maintaining unfamiliar renewable technologies.

5.3 Conclusion and Recommendations

RETs contribute practically nothing to the HKH Region's energy supply, if the contribution made by large-scale hydropower is excluded from consideration. Most of the biogas plants installed as demonstration projects are non-functional today, owing to the lack of adequate maintenance and management. No assessment has been made by planners and decision-makers of ways to develop RETs in the region. No visionary RET policy exists at national or provincial levels, and hence no integrated plan has been devised to support it. The following conclusions bring together various recommendations to promote the development of RETs, particularly in the HKH Region of Pakistan.

The Need for Policies and Plans for RETs

There should be clear-cut policies on the various RETs. These should be drawn from an integrated plan to develop RETs in the country in general and in the HKH Region of Pakistan in particular. The plan should include an assessment of energy needs and yearly development targets. These targets should be clearly assigned to the organizations concerned. The Ministry of Planning, in association with other ministries, should develop such a plan and ensure its implementation through the responsible ministry.

Development of Institutional Capability for RET Promotion

Currently, various institutions are involved in the development, promotion, and demonstration of RETs in the HKH Region without any collaboration. Research and development do not provide an adequate base from which to produce or adopt RETs in accordance with the local environment. This is due to a lack of interest or motivation on the part of researchers and managers. The major obstacle is scarcity of funds.

There is a lack of initiative in the development of human resources among personnel working in the field of renewable energy technologies. There is a need for grassroots' level institutions within the region, and locally available manpower should be trained to produce and manufacture RET products such as cooking stoves, solar cookers, and solar water heaters.

Implementation and Monitoring of the RET Programme

The RET programme should be implemented by the assigned agency in collaboration with the local community. Various programmes related to RETs were and are being implemented, but they are not properly monitored. This has resulted in breakdowns and the loss or abandoning of various hydro, biogas, windmill, and solar photovoltaic (SPV) plants. It is, therefore, proposed that a local agency (with the participation of beneficiaries) should be established to manage and maintain RET projects. Traditional local social systems can also be used for this purpose so as to reduce management costs and deliver affordable energy. Innovation may also be encouraged in order to develop and improve the performance of the RET programme. The government should finance such development ventures.

Financial and Economic Incentives

Since RET programmes are capital-intensive (except afforestation, for which free saplings are provided), the prevailing low-income pattern of the mountains makes it mandatory that the government finance RET programmes, i.e., MMHP, biogas, and solar energy. International agencies may also be approached for funding in pursuance of a global environmental policy. This is only achievable if the government is willing to allocate reasonable funds for RET development.

Market reforms are also desirable in order to reduce the cost of RET-based products and industries. The government has announced the tax-free import of solar energy-based products, and this should be extended to all RETs. Similarly, the five-year tax holiday announced for the solar energy field should be extended to other RET equipment as well.

Economic incentives, such as soft loans, should be provided to entrepreneurs willing to establish an industry within the region, as the cost of transporting raw material is quite high under the prevailing mountain conditions. Legislative protection is needed to motivate potential private concerns to invest in the HKH Region.

Poverty Alleviation — Essential for RET Deployment

The main obstacle to the implementation and use of RETs in the HKH Region is the fact that commercialisation of RETs will only be possible when the prevailing patterns of poverty are eliminated. This can occur if production is increased through the deployment of various energy technologies that exploit the available resources within the region. The role of RETs for the alleviation of poverty in mountain communities is both feasible and desirable. A few examples are cited below.

Traditional farming has to be overhauled. Value-added crops could be sown for marketing in the plains for better returns and fruits conserved (dried). Crop residue needs to be preserved for winter use as livestock feed. In addition, there are a number of fast-growing tree species available to provide income from the sale of fuelwood. All of these requirements can be met with the judicious application of RETs.

Trained manpower (craftsmanship) should be motivated to develop a cottage industry for the manufacture of the basic tools of agriculture (in line with appropriate technology), energy-efficient devices, and other local goods (beekeeping and silkworm production) according to the potential of particular locations within the region. The government should provide soft loans to establish small cottage industries or businesses that employ RETs.

In view of the subsistence economy of the area, a cooperative system should be introduced at the community level, and loans should be granted to boost economic activities. Programmes to uplift women in rural areas by developing handicraft work should be implemented. Cooperative societies can initiate RET programmes at the community level, along with other development activities such as health care centres, telephone facilities, and the supply of potable drinking water. These activities should incorporate a conscious effort to use RETs rather than conventional fossil fuels.

5.3.1 A Proposed Policy for RET Development

The Government of Pakistan, in collaboration with the Government of NWFP and Balochistan, should formulate a policy for the development of renewable energy technologies in the region. An integrated renewable energy development plan should be framed, keeping in mind the HKH Region's needs. The proposed renewable energy policies should have the following features.

Continue Afforestation Efforts

a) New forestry areas would be earmarked, developed, and promoted on private lands to meet the growing demand for firewood. This should be done through economic and financial incentives provided by the government.

b) Improvement in the maintenance of forests by the government.

c) Improvement in the market structure for firewood and crop residue.

Encourage the Rational Use of Energy

The development and promotion of rational energy use require that efficient technologies for the production and consumption of energy be stimulated through economic incentives and tax rebates.

Encourage Commercialisation of RETs

a) **Micro- and mini-hydropower** plants should be encouraged in the private sector. This could be achieved if SHYDO, NA-PWD, and WAPDA ensure the purchase of power. This is possible if the national grid is extended to the HKH Region.

b) **Wind** surveys for the assessment of potential sites should be conducted.

c) **Wind and solar** electrification and water pumping demonstration units should be installed by the government agencies. Solar thermal technologies should be demonstrated initially by the government agencies at community centres and promoted so as to develop and commercialise RETs. Appropriate funds should be allocated.

d) **Biogas** plants should also be installed for demonstration purposes. Training should be imparted to the people so that the local community is able to build and operate biogas plants independently.

Provide Financial and Economic Incentives

a) Duty should be lifted from the import of RET equipment, and a tax holiday should be provided to set up RET-based industries.

b) Sales' tax and excise duty should be lifted from the sale of RET equipment.

Promote Institutional Development

a) Institutions should be established at the grass-roots' level.

b) Regular training programmes should be organized to upgrade the craftsmanship of local entrepreneurs.

SELECTED REFERENCES

Abdullah, M., 1997. 'Analysis of Present Energy Use Patterns in Rural and Urban Areas of the Hindu Kush - Himalayas in Pakistan', prepared for ICIMOD, Kathmandu.

GOP, 1992. *Forestry Sector Master Plan*. Vols. 1-7. Prepared by the Asian Development Bank and UNDP. Government of Pakistan in Collaboration with the Ministry of Food, Agriculture and Cooperatives by Reid, Collins and Associates.

GOP, 1993. *The Pakistan National Conservation Strategy, 1993*. Pakistan: Government of Pakistan, Pakistan Environment and Urban Affairs' Division and IUCN.

GOP, 1994. *Eighth Five Year Plan (1993-1998)*. Pakistan: Planning Commission, Government of Pakistan.

HDIP, 1995. *Pakistan Energy Year Book 1995*. Pakistan: Hydrocarbon Development Institute of Pakistan, Ministry of Petroleum and Natural Resources.

HDIP, 1996. *Pakistan Energy Year Book 1996*. Pakistan: Hydrocarbon Development Institute of Pakistan, Ministry of Petroleum and Natural Resources.

Maher, J., n.d. *Energy Conservation Technologies and Choices*. Islamabad, Pakistan.

PCAT, 1992. *PCAT: Annul Report*. Pakistan: Pakistan Council for Appropriate Technology.

Raza, H.A.; Ahmed, R.; and Sherer, H., 1995. *Energy Resources of Pakistan*. Tokyo: World Energy Council 16th Congress.

Rijal, K., 1997. 'Review on Energy Sector of the HKH Region: Bi-annual Update'. Kathmandu: ICIMOD.

Sarhandi, G.U., n.d. *Status of Biogas Energy in Pakistan*. Pakistan: Pakistan Council for Appropriate Technology.

Sarhandi, G.U., 1996. 'Stoves Used for Space Heating at Different Altitudes and/by Ethnic Groups in Pakistan'. Paper presented at *Regional Workshop on Stoves Used for Space Heating and Cooking at Different Altitudes and/by Ethnic Groups*, February 12-16, organised by RWEDP-FAO, Bangkok and ICIMOD.

Sharma, P.; Rijal, K.; Tulachan, P.; Miller, D.; and Malik, S.H., 1997. 'Sustainable Development in the Mountain Areas of Pakistan'. Report prepared for the Asian Development Bank, Kathmandu: ICIMOD.

SHYDO, n.d. *Hydropower Development in Mountain Areas of NWFP*. Pakistan: Sarhad Hydel Development Organization, GTZ and Government of the NWFP.

Siraj, U.W. (ed), 1995. *Proceedings of the Pakistan National Seminar on Mini and Micro-Hydropower Development in the Hindu Kush - Himalayan Region*. Kathmandu: ICIMOD.

Shehryar, K., 1995. 'Rural Energy Problems and Issues in Pakistan'. Paper presented in *Study Meeting on Appropriate Energy Sources for Rural Areas*, Islamabad. Pakistan: Pakistan Council for Appropriate Technology.

Sheikh, M., n.d. *Solar Energy in Pakistan*. Islamabad, Pakistan.

UNESCO, 1996. *High-Priority National Projects*. International Organizing Committee.

WAPDA, 1996. *Power Development Activities in Balochistan*.' Pakistan: Water and Power Development Authority.

WAPDA, 1997. *Power System Statistics : 1995-96*. Nineteenth and Twentieth Issue. Pakistan: Planning Department, Power Wing.

Plight of solar photovoltaic electrification scheme (30kW) due to lack of maintenance in the Northern Areas of Pakistan

Different types of improved biomass stoves demonstrated at an environmental fair in Peshawar, Pakistan