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Pakistan's Perspective on Energy for the 1990s

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ABSTRACT

Inspite of its very low level of per capita commercial energy consumption, Pakistan is heavily dependent on imported energy resulting in serious balance of payment difficulties. This paper reviews historical evolution of energy supply and demand in the country and analyses the potential of indigenous energy resources. The on-going efforts on the development of indigenous energy resources and promotion of energy conservation are discussed. Based on these efforts, the prospects of energy demand and supply over the next ten years are presented and the corresponding investment and financing issues analysed.

INTRODUCTION

Pakistan is a low income developing country which is facing serious energy supply difficulties due to rapidly growing energy demand, poor energy resource base, high cost of energy imports and shortage of capital for energy investments. The present per capita primary commercial energy consumption is only 0.26 TOE, which is about one-half the average for developing countries, one-seventh of the world average and one-twentieth of the average for industrialized countries. Inspite of this low level of energy consumption, Pakistan is unable to meet its energy requirements from indigenous resources and has to rely on imports to cover about one-third of its commercial energy needs. The oil import bill is a major strain on the country's hard earned foreign exchange; it averaged to about 25% of the export earnings over the 3 years preceding the Gulf war. The oil price hikes caused by the Gulf war increased the country's oil import bill during 1990-91 by about 55% (Pakistan Economic Survey, 1990-91), thereby adding to the balance of payment difficulties. To make things still worse, the peak electricity demand has been exceeding the supply capability of the national grid by some 10- 25% over the last five years, necessitating load shedding upto 1500 MW. These power shortages, in addition to causing inconvenience to the general public, are estimated to be resulting in a reduction of annual GDP by about 2%, with a loss of over 8% in industrial value added and a reduction of over 4% in the export of manufactured goods (Khan and Alauddin, 1990).

The planning for energy sector in Pakistan is carried out as an integral part of the overall national development planning effort. The on-going Seventh Five Year Plan (1988-93) and the Perspective Plan (1988-2003) formulated by the Planning Commission in 1988 have laid particular emphasis on elimination through rapid exploration and development of indigenous energy resources and adoption of energy conservation measures. Before discussing the on-going developmental effort in these areas and the related financing and environmental issues etc., it would be appropriate to briefly review the historical evolution of energy and electricity demand and supply in Pakistan and the supply potential of various energy resources available to the country.

HISTORICAL EVOLUTION OF ENERGY DEMAND AND SUPPLY

Energy Demand

The consumption of energy in Pakistan at present comprises about two thirds in commercial and one third in non-commercial forms. The primary commercial energy consumption amounts to about 29 million TOE per annum (oil: 39%, gas: 39%, coal: 7%, hydro: 15% and nuclear:0.3%) (Pakistan Economic Survey, 1990-91; Energy Year Books, 1981-89). The non-commercial energy (fuelwood, dung and agricultural wastes) is used mainly as cooking fuel by the rural population and the urban poor at an efficiency of only 5-10% as against 30-60% typical of fossil fuels.

The demand for commercial energy in Pakistan has been increasing rapidly as a result of developments in industry and transportation, mechanization of agriculture, improvements in social services, rural electrification and shift away from non-commercial fuels; it increased from 1.4 million TOE in 1950 to 28.8 million TOE in 1990, i.e. by a factor of 20 during the last 40 years. During the same period the demand for electricity increased even faster--from 0.26 to 40 billion KWH i.e. by a factor of about 150. The corresponding improvements in the per capita levels of commercial energy and electricity consumption are by factors of 7 and 52 respectively (Table 1).

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Table 1. Total and per capita consumption of primary commercial energy and electricity (Source: Energy Year Books, 1981-89; Khan et al., 1990)

Year	Total Consumption		Percapita Consumption	
	Energy (10^6TOE)	Electricity (10^3GWH)	Energy (TOE)	Electricity (KWH)
1950-51	1.41	0.26	0.04	7
1960-61	3.09	1.30	0.07	28
1970-71	7.52	7.20	0.12	117
1980-81	15.19	16.06	0.18	195
1989-90	28.80	40.00	0.26	365

Energy Supply

The pattern of commercial energy supply in Pakistan has undergone considerable change during the last four decades (Energy Year Books, 1981-89; Khan et al, 1990). The shares of different energy sources (coal, oil, gas, hydro and nuclear) in the primary energy mix in selected years between 1950-51 and 1988-89 are shown in Table 2. Also shown in parentheses in the same table are the shares of imported fuels in total commercial energy. It is worth noting that oil and coal were the only fossil fuels used in the country in the early 1950s and they together accounted for 99% of the primary energy supplied, of which 80% was imported energy. Following the development of natural gas reserves at Sui in the mid-1950s, gas has gradually substituted for coal and oil and now meets about 39% of the energy requirements. Further, the construction of two large dams at Mangla and Tarbela has led to increasing the share of hydro from a meager 1% in the early 1950s to around 15% now. Thus, through recourse to indigenous resources of gas and hydro, Pakistan has succeeded in reducing its energy import dependence from nearly 80% in the early 1950s to about 32% now.

Oil Imports

The weakest link in the energy supply system of Pakistan has been the supply of oil from indigenous resources. The share of indigenous oil in total oil consumption of the country remained in the range of 10-15 percent until early 1980s. However, this share has now increased to a level of nearly 25% owing to a much increased petroleum exploration and development activity during the 6th and 7th Five Year Plan periods (1983-88, 1988-93). Still, the oil import bill is a major strain on Pakistan's economy and has been syphoning off a large portion of its export earnings (Table 3), thereby causing serious balance of payment difficulties. The softening of oil prices in the international market since 1986 had provided some relief but the recent events in the Persian Gulf have made the Oil market, once again, highly uncertain.

Power Sector

As for the electric sector, the present installed power generation capacity is about 8900 MW, consisting of 32% hydro, 66% thermal based on oil and gas, 0.2% coal-fired and 1.5% nuclear. This installed capacity is insufficient to meet the peak demand as the hydro generation capability undergoes large seasonal variations and reduces considerably when the reservoir water levels get low. Still, the share of hydro in total power generation is close to one-half, while the other half is generated essentially all by thermal plants. The country has only one nuclear power plant of 125 MW capacity, whose

Table 2. Primary commercial energy consumption and shares of energy sources (Source: Energy Year Books, 1981-89., Khan et al., 1990)

	1950-51	1960-61	1970-71	1980-81	1989-90
Primary Energy (10^6TOE)					
	1.41	3.09	7.52	15.19	28.80
Share of Energy Sources (%)					
Coal	43.5 (28.3)	24.6 (11.9)	8.1 (0.5)	6.0 (1.4)	6.9 (2.2)
Oil	54.3 (47.1)	50.2 (40.9)	45.4 (39.3)	36.5 (33.3)	39.2 (29.4)
Gas	0	20.3	35.6	43.2	39.1
Hydro	2.2 (1.3)*	5.0	10.9	14.2	14.7
Nuclear	0	0	0	0.3	0.3
	100 (76.7)	100 (52.8)	100 (39.8)	100 (34.7)	100 (31.6)

Note: Figures in parentheses represent shares of imported fuels.

* Imported electricity from India.

Table 3. Quantity of oil imports and oil import bill of Pakistan (Source: Pakistan Economic Survey 1990-91; Energy Year Books, 1981-89).

Fiscal Year	Oil Imports (10^6 TOE)	Oil Imports Bill ($10^6$$)	% of Export Earnings Spent on Oil Imports
1972-73	3.7	62	8
1973-74	4.1	152	15
1974-75	4.0	337	33
1975-76	4.0	378	33
1976-77	4.1	413	36
1977-78	4.7	497	38
1978-79	5.1	530	31
1979-80	5.6	1079	46
1980-81	5.8	1535	52
1981-82	6.2	1710	69
1982-83	6.3	1616	60
1983-84	6.7	1421	51
1984-85	6.5	1435	57
1985-86	6.5	1039	34
1986-87	7.1	814	22
1987-88	7.8	1047	23
1988-89	8.0	963	21
1989-90	8.4	1163	23
1990-91	8.7	1800	32

Table 4. Electricity generation mix of Pakistan (% shares) (Source: Energy Year Books, 1981-89).

Year	Hydro	Oil	Gas	Coal	Nuclear
1950-51	28.4	71.6	-	-	-
1955-56	57.6	42.4	-	-	-
1960-61	49.7	9.7	40.6	-	-
1965-66	38.5	5.4	51.3	4.8	-
1970-71	47.9	2.9	46.4	2.8	-
1975-76	52.7	4.8	36.0	0.6	5.9
1980-81	56.3	3.5	39.0	0.3	0.9
1985-86	53.9	13.9	30.3	0.2	1.7
1989-90	45.0	20.6	33.5	0.1	0.8

contribution to present electricity generation is less than 1%. Table 4 shows the changes in the pattern of fuel mix for power generation during the last four decades. The share of oil, which dominated the power generation activity in the 1950s, decreased to a level of 3-4% in the 1970s, mainly because of rapid hydro development and use of natural gas for power generation. However, it has since been increasing again, partly due to slowing down of hydro development and delays in construction of nuclear power plants and partly because shortage of natural gas supplies has forced switching over of some of the gas-fired plants to furnace oil and diesel in addition to building of new oil based plants during the last 10 years.

POTENTIAL OF INDIGENOUS ENERGY RESOURCES

Fossil Fuels

The current remaining proven fossil fuel reserves of Pakistan are:

Gas:	26 TCF	= 530 million TOE
Oil:	225 million barrels	= 30 million TOE
Coal:	490 million tons	= 163 million TOE
	Total	= 723 million TOE

How meager are these reserves can be judged from the fact that if only these were to meet the entire commercial energy demand of the country, they will all be exhausted completely within a matter of next 10 years. As for the overall fossil fuel resource potential of the country, the situation is as follows:

Oil and Gas.— About 800,000 square kilometers area in Pakistan consists of sedimentary basins (onshore: 600,000 sq.km., offshore: 200,000 sq.km.). The speculative ultimately recoverable petroleum resource potential of this area, as estimated (Raza and Ahmed, 1990) corresponds to 40 billion barrels (6 billion TOE) of oil and about 200 TCF (4 billion TOE) of gas. The oil and gas reserves discovered so far correspond to less than 1% of the above estimated oil potential and about 15% of the gas potential. The relatively high size of gas resource discovery is due mainly to three major fields Sui: (192 million TOE), Mari (70 million TOE) and Pirkoh (81 million TOE) which were discovered in 1952, 1957 and 1977 respectively. Of a total of about 300 exploratory wells drilled so far in Pakistan, some 125 were drilled by 1978, while 100 wells were drilled over the next 10 years. The now on- going 7th Five Year Development Plan(1988-93) envisages drilling of 125 exploratory wells during the plan period. In the first three years of the plan period 64 exploratory wells were drilled.

Coal.— According to the latest available information, the total geological resources of coal in Pakistan amount to 9.3 billion tons (equivalent to 3.1 billion TOE) of which only

5.3% correspond to proven reserves and the rest consist of indicated, inferred and hypothetical resources. Huge capital expenditure extending over a long period of time will have to be incurred in order to prove the above resources and develop the necessary mining infrastructure. It may be pointed out here that the type of coal found in Pakistan is very poor; it has very high sulphur, ash and moisture content, which makes its use unsuitable for domestic and most of the industrial applications. However, it can be used for power generation based on advanced technologies e.g. flue gas desulphurisation(FGD), fluidised bed combustion(FBC), provided large scale economical mines may be developed for the purpose.

Hydro Power.— Pakistan has an identified hydro power potential of about 30,000 MW of which some 3,000 MW has already been developed, while an additional 6,000 MW is under development or in advanced planning stages. It is expected that the hydro capacity will reach a level of 7,000 MW by the turn of the century and 12,000 MW by the year 2010. There will be considerable difficulties in further expansion of hydropower. This is because the most attractive sites have already been developed and the cost of construction of new dams is increasing with increasing complexity of dams at less favorable sites. Further, in most cases new sites are far away from demand centers, thereby necessitating huge additional investment in transmission lines and, still having their generated electricity subject to substantial transmission losses. In view of these and other constraints (e.g. dislocation of people, submergence of agricultural land etc.), it would be unrealistic to assume that much more than half of the remaining hydro potential in the country will be exploited over the next several decades.

FUTURE ENERGY REQUIREMENTS AND PLANS FOR SUPPLY

The experience of the last thirty years shows that the commercial energy consumption in Pakistan has been increasing at about 8% per annum as against the growth of gross domestic product (GDP) at about 6% per annum, resulting in an income elasticity[1] of 1.3. The growth rate of electricity demand had been even higher; 18.7% per annum during 1960s, 8.4% during 1970s and 9.5% p.a. during the 1980s. The income elasticity of electricity demand averaged about 1.6 during the last 20 years. This trend of significantly higher growth in energy and electricity consumption compared to the growth in GDP is expected to continue for some time in view of the present energy-intensive phase of our development.

It is, however, to be expected that, over the coming years, the income elasticity will gradually reduce as a result of higher energy/electricity prices and the conservation measures now being introduced by the government. In-depth studies of the country's energy/electricity requirements over the next 5-15 years were carried out by the Planning Commission in connection with preparation of the Seventh Five year Plan (1988-93) and Perspective Plan (1988-2003). It has been projected that for a 6.5% p.a. GDP growth target, the primary commercial energy requirements will increase from 24.6 million TOE in 1987-88 to 37.6 million TOE in 1992-93 and 84.2 million TOE in 2002-03. Simultaneously, the use of noncommercial fuels is estimated to increase from 11.5 million TOE in 1988 to 13.7 and 14.8 million TOE by the years 1992-93 and 2002-03 respectively. The overall energy supply mix envisaged by the Planning Commission in these years is given in Table 5.

Table 5. Primary energy supply by source (Source: 7th Five Year Plan, 1988-93 and Perspective Plan, 1988-2003).

	million TOE		
	1987-88	1992-93	2002-03
Oil	9.9	15.0	36.5
Gas	9.1	15.2	15.9
Coal	2.3	3.6	19.3
Hydro	3.2	3.7	10.0
Nuclear	0.1	0.1	1.8
Others	-	-	0.7
Total Commercial Energy	24.6	37.6	84.2
Non-commercial Fuels	11.5	13.7	14.8

Consistent with the Energy Sector Plan's objective of achieving a high degree of self-reliance in energy, efforts are now under way:

a) to increase the supply of gas from the existing fields and develop new fields. (The Seventh Plan envisaged that the supply of gas would increase from 1200 MMCFD in 1987-88 to 2095 MMCFD by the year 1992- 93.)

b) to make effective use of the hitherto under utilised large resource of coal. (Three 50 MW size of power plants

[1] Defined as the ratio of growth rate of energy consumption to growth rate

based on FBC technology are being set-up near the Lakhra coal field with proven reserves of 187 million tons.)

c) to accelerate the petroleum exploration and development effort. (A number of incentives have already been offered to the oil companies in the new petroleum policy.)

d) to increase hydro power generation through extension of existing hydro plants and construction of new ones. (In this respect effort is being made (i) to overcome certain socio- political problems hindering the construction of new large dams, and (ii) to carry out detailed investigations for various hydro projects at perspective sites.)

e) to increase contribution of nuclear power. (Negotiations with Peoples Republic of China and France are in progress to build two plants of 300 MW and 900 MW capacity before the turn of the century.)

As for the power sector, the Planning Commission expects the demand for electricity to grow at about 10% p.a. during the perspective Plan period (1988-2003). The peak demand has been estimated to increase from 5674 MW in 1987-88 to 8900 MW by 1992-93. The corresponding extension of installed power generation capacity is planned to be from 6824 MW in 1988 to 12245 MW by 1993 with the additions of 1928 MW hydro and 3493 MW thermal plants. According to the recent projections (WAPDA, 1990) by the main utility, Water and Power Development Authority (WAPDA), the requirements of installed power capacity in year 2002-03 will be 27,915 MW which is proposed to be based on the following mix: Hydro: 11520 MW; Gas: 2500 MW; Oil: 8470 MW; Indigenous Coal: 1400 MW; Imported Coal: 1800 MW; Nuclear: 2225 MW).

ENERGY SECTOR INVESTMENTS AND FINANCING

In line with the government's policy of increasing energy self- reliance, the energy sector has been receiving increasing emphasis in the national developmental effort since the mid 1970s. The energy sector investments corresponded to about 15% of the total public sector development expenditure in the early 1970s. This share has substantial increased over the last 15 years: The share increased to 25.4% and 31.7% of during the Fifth and Sixth Five Year Plan periods (1978-83, 1983-88) respectively and is planned to reach a level of 35.5% under the on-going Seventh Five Year Plan. The share of power sector in the total development expenditure also increased from 18.4% during the Fifth Plan period to 21.8% during the Sixth Plan period, and is now expected to increase further to 25.8% during the Seventh Plan period. This increasingly higher emphasis is a consequence of the basic strategy embodied in the Sixth and Seventh Plans calling sharp increase in the allocations for the power sector to achieve the twin objectives of reduction in load shedding and rapid electrification of rural areas. The share of fuel sector (i.e. energy sector minus power sector; almost 95% of the fuel sector is accounted for by oil and gas) in total public sector development expenditure also increased from 7.0% during the Fifth Plan to 9.9% during the Sixth Plan period; it is stipulated to be 9.7% in the Seventh Plan allocations and will amount to about $400 million investment per year on the average. A marked increase has been noticed in oil exploration activity recently: 30 concessions have been granted over the last two years, mostly to foreign private sector, envisaging an investment of risk capital of about $150 million over the next 2 to 3 years. New incentives now being offered by the government to the foreign private investment in oil and gas exploration and development are expected to further increase this activity.

Role of Private Sector

The Seventh Plan puts heavy emphasis on promotion of private sector activity through further deregulation of the economy in order to transfer bulk of the financial burden from the government's budgetary resources to the private sector's own resources. Accordingly, it is envisaged that the share of private sector in total fixed investment during the Seventh Plan period will be 44.3% as compared to 41.2% during the Sixth Plan period. Within the energy sector, the share of private sector investments in total energy sector investments is expected to increase from about 12% during the Sixth Plan to about 21% during the current plan period. Further, in addition to its participation in traditional areas related to production, transportation, distribution, etc. of oil, gas and coal, the private sector, for the first time, is being involved in power generation activities. To promote private sector investment in the power generation, a private sector fund of about US $ 600 million has been created to provide loans to potential investors up to 30% of the project cost. Resources for this fund have been contributed by the World Bank, USAID and other bilateral and multilateral agencies.

To achieve this level of private investment in power sector, the Government is offering the private sector a number of incentives. An 18% return on equity is being allowed, corporate tax has been waived for the sponsors, foreign lenders have been exempted from tax on their profits arising out of loans and, in some cases, customs duties have also been waived. Initially, the private sector was restricted to thermal power plants based on oil and indigenous coal. Subsequently, the policy was extended to include thermal power stations using low calorific value gas, imported coal and also hydroelectric stations. In principle, the government will give consideration to the use of any fuel for power generation, having regard to both economy and

diversity. The response from the private sector has been very encouraging and a number of power projects in private sector corresponding to a total capacity of some 5000 MW, are now under consideration of the government. The government has created a Private Power Cell in the ministry of Water and Power for speedy negotiations and implementation of these projects.

ENERGY CONSERVATION AND EFFICIENCY IMPROVEMENT PROGRAMME

In 1986, Pakistan took a major initiative in this respect by establishing ENERCON, the National Energy Conservation Centre, which is responsible for planning and coordination of activities related to energy conservation and improvement of energy efficiency in all sectors of the national economy. The main thrust of ENERCON's effort is directed towards providing technical support to various energy consumers, manufacturers, public agencies etc., in the form of energy audits, demonstration programmes, feasibility studies or simply expert advice on energy conservation. The specific measures envisaged in different sectors of consumption are as follows:

Industry.— (1) Technical services comprising (a) boiler/ furnace tune-up (b) steam system survey and (c) electrical system survey, each leading to an average efficiency improvement of 5-8%. (2) Demonstration project to illustrate energy savings attainable through the use of electronic combustion analysis technology, waste heat recovery system, burner control system, energy accounting system etc.

Buildings.— (1)Retrofitting of existing buildings.(2) Improving the design of new buildings. In this respect, a National Energy Conservation Building Code, which includes recommended specifications, both for design of buildings and the use of equipment to heat, cool and light the buildings, has been approved by the government for adoption on a voluntary basis.

Agriculture.— (1) Retrofitting of tube-wells (2) Efficiency improvement of tractors through dissemination of proper information to the farmers.

Transport.— (1) Auto-engine tune-ups with the help of electronic engine analyzers. (2) Use of CNG as a motor fuel.

Power.— (1) Reduction of transmission and distribution losses through the rehabilitation of equipment and improved load management measures. (2) Appropriate tariff and non-tariff measures leading to overall energy conservation in the power sector and reduction of peak demand.

ENVIRONMENTAL ISSUES

The major energy-related environmental concerns in Pakistan are:

1. Degradation of the environment in major cities due to increasing emission of pollutants (SO_2, NO_x, CO etc.) from large industries, transport vehicles, etc.

2. Use of outdated technology and lack of pollution control devices in major energy consuming facilities.

3. General adverse environmental impacts (e.g. submergence of land, dislocation of population etc.) associated with the development of large hydro projects.

4. Deforestation and loss of soil fertility due to large scale use of fuelwood and other noncommercial fuels.

5. Coastal pollution around port areas due to increasing oil leakages from ships and tankers.

6. Environmental degradation likely to result from the expected large-scale future use of indigenous poor quality coal with high sulphur content.

Pakistan fully shares the world-wide concern for global warming resulting from CO_2 emissions of continued heavy reliance on fossil fuels. However, due to its very low level of per capita energy consumption, Pakistan is not a significant contributor to the global CO2 emissions. As such, there is no specific planning effort in the country to reduce the emission of CO_2.

CONCLUSION

Pakistan's immediate concern is to provide adequate energy to meet its socio-economic development requirements and to achieve a high level of energy self-sufficiency. With only minor contribution expected from nuclear power and renewable sources of energy by the turn of century, the country will have to follow for the 1990s an energy strategy involving an appropriate mix of hydropower and domestic and imported fossil fuels in an environmentally acceptable manner, together with strong energy conservation efforts aimed at slowing down the growth rate of energy demand, thereby leading to reduction in energy import dependence.

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