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# OPPORTUNITIES FOR PRIVATE SECTOR POWER GENERATION IN PAKISTAN

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and

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TABLE OF CONTENTS


| | Page Number |
|---|---|
| 1.0 BACKGROUND | 1-1 |
| 1.1 RATIONALE FOR PRIVATE-SECTOR INVOLVEMENT | 1-2 |
| 1.2 CURRENT PRIVATE- AND PUBLIC-SECTOR ACTIVITIES | 1-2 |
| 1.3 BACKGROUND OF ANALYSES/APPROACH | 1-3 |
| 1.4 OBJECTIVES OF THIS REPORT | 1-4 |
| 2.0 THE GOP PRIVATE SECTOR POWER POLICY | 2-1 |
| 3.0 POTENTIAL FOR PRIVATE SECTOR POWER GENERATION | 3-1 |
| 3.1 DIESEL POWER/HUB-CHOWKI PROJECT | 3-1 |
| 3.2 POTENTIAL FROM NON-PIPELINE GAS | 3-4 |
| 3.3 POTENTIAL FROM SMALL-SCALE COAL | 3-7 |
| 3.4 POTENTIAL FROM SMALL-SCALE HYDRY POWER | 3-9 |
| 3.5 POTENTIAL FROM RENEWABLE ENERGY SYSTEMS | 3-12 |
| 3.6 TOTAL POTENTIAL FOR PRIVATE-SECTOR POWER GENERATION/CAPITAL NEED | 3-18 |
| 4.0 POLICY IMPLEMENTATION ISSUES | 4-1 |
| 4.1 UTILITY PURCHASE PRICE | 4-2 |
| 4.2 IMPLEMENTING ORGANIZATION | 4-2 |
| 4.3 LONG TERM STRATEGY | 4-4 |
| 4.4 DORMANT GAS | 4-4 |
| 4.5 POLICY EXPANSION | 4-5 |
| 4.6 CAPITAL RESOURCES/AVAILABILITY | 4-5 |
| 5.0 CONCLUSIONS/RECOMMENDATIONS | 5-1 |
| 5.1 CONCLUSIONS | 5-1 |
| 5.2 RECOMMENDATIONS | 5-1 |

TABLE OF CONTENTS (continued)


| | |
|---|---|
| APPENDIX A | PRIVATE-SECTOR POWER GENERATION POLICY DOCUMENT |
| APPENDIX B | THE HUB CHOWKI PROJECT |
| APPENDIX C | DORMANT GAS FIELDS |
| APPENDIX D | LIST OF CONTACTS |
| APPENDIX E | PUBLIC ANNOUNCEMENT - PRIVATE SECTOR POWER POLICY/ HUB CHOWKI PROJECT |

LIST OF EXHIBITS


| | TITLE | PAGE |
|---|---|---|
| Exhibit 3.1 | Cost of Power for Medium-speed Diesel Power system | 3-2 |
| Exhibit 3.2 | Potential Power Generation at Dormant Gas Fields | 3-5 |
| Exhibit 3.3 | Cost of Power Estimates - Gas Turbines | 3-6 |
| Exhibit 3.4 | Power Generation Potential from Coal | 3-8 |
| Exhibit 3.5 | Power Cost Estimates - Small Coal-Fired Power Plants | 3-10 |
| Exhibit 3.6 | Power Cost Estimates - Small-Scale Hydro | 3-13 |
| Exhibit 3.7 | Estimate of Yield of Crop Residues in Pakistan | 3-15 |
| Exhibit 3.8 | Power Cost Estimates - Biomass-Fired Power system | 3-17 |
| Exhibit 3.9 | Cost of Electricity from Private Sector Power Generation Options | 3-19 |
| Exhibit 3.10 | Capital Investment Requirements - Independent Power Production Options | 3-21 |
| Exhibit 3.11 | Private-sector Power Generation - Preliminary Estimate of Economic Potential and Possible Development | 3-22 |
| Exhibit 4.1 | Actual Load Shedding on WAPDA Power System (1981 - 1985) | 4-3 |

## 1.0 BACKGROUND

For the last 10 years, the economy of Pakistan has grown at an average rate of about 6 percent per year. Growth has been particularly robust in the manufacturing sector (7.7 percent average annual rate) and in the public sector, which includes the electricity and gas subsectors (9.2 percent). This growth has been fueled by large increases in power generation, distribution, and consumption. National electric generation capacity, for example, has grown from 2,200 MW in 1975 to 5,500 MW today, an average rate of close to 10 percent per year.

The growth in electricity consumption has been both intensive and extensive. The intensive growth stems from an increase in the number of customers in already electrified areas and from higher consumption by existing customers. For example, recent growth in urban domestic consumption has averaged 21 percent per year. And in the last 10 years alone, 2.7 million new customers have been added in already electrified areas, approximately 77 percent of whom are in urban areas. The extensive growth has come from the extension of service to new areas. For example, over the last 24 years some 17,500 villages have been electrified.

However, the increase in the quantity of electricity consumed and the increasing number of customers served, together with the spatial spread of the customers to which electricity is delivered, have led to problems. There has been a deterioration in the quality of electric service, measured both in frequency and duration of outages and in voltage instability. Load shedding has become a necessity, often for periods of hours, and the situation is getting worse.

The provision of electricity to a growing number of people reflects recent political objectives of the GOP. These objectives are explicitly embodied in the general targets of the Sixth Five-Year Plan and in decisions on relative power infrastructure budgets and pricing decisions. The emphasis on growth has led not only to outages and voltage instability, but to distribution expansion budgets that are larger in relation to generation or rehabilitation budgets than those in other developing countries. Moreover, most small urban and rural customers do not pay the economic cost of the power or energy that they consume. As a result, the utilities must pay for the shortfall, using funds that would otherwise be available for needed system improvements and expansion.

In the most recent estimate, the electric power capacity deficit was put at about 1,500 MW or approximately 38 percent of peak demand, and is expected to be more than 3,000 MW, or almost 40 percent of peak demand, by 1993. Even if WAPDA and KESC succeed in installing 500 MW of capacity every year for the foreseeable future, as they intend, a deficit of 1,000-1,500 MW will remain. This deficit will exist even if the aggressive generation, distribution, and load management programs currently undertaken are successful.

It should be noted that the capacity shortfall problem tends to be a seasonal one which in normal years peaks during the 5-7 months (late

December through May) when reservoir levels of the large hydropower facilities are low. The seasonal nature of the major deficits complicates utility planning, in general, and will impact on how the GOP might contract with private sector power sources.

## 1.1 RATIONALE FOR PRIVATE-SECTOR INVOLVEMENT

The private sector can play an important role in reducing the electric power capacity deficit in Pakistan, for several reasons.

First, it is directly affected by the power shortage situation. In many countries, production losses owing to lack of power are estimated to be one order of magnitude higher than the actual cost of power; Pakistan is no exception.

Second, the private sector has the ability to enter the power generation field because it can attract technical and managerial resources and mobilize financial resources.

Third, the private sector is interested in entering the power generation field, as reflected in specific proposals to generate power for sale to utilities.

Fourth, the private sector can deal with a diversity of smaller power units based on such energy sources as small scale hydro, biomass and smaller Diesel power plants in rural areas which would unwisely divert the utilities' management from large projects.

Fifth, timing is critical, and the private sector can install large quantities of power generation significantly faster than WAPDA and KESC, because it is less subject to bureaucratic constraints, and it can mobilize capital faster.

## 1.2 CURRENT PRIVATE- AND PUBLIC-SECTOR ACTIVITIES

A number of private industries, in order to protect themselves from load-shedding and to meet new power requirements that cannot be provided by the grid, have been importing and installing on-site small-scale diesel generators. While these generators may be the only short- term solution for individual companies, they are much less efficient than cogeneration systems. In addition, the use of small diesel units will increase the country's volume of oil imports and will contribute to a more inefficient national power system over the long term.

Several private parties have submitted proposals for power generation projects to the Ministry of Water and Power. The proposals range from simple letters to detailed feasibility studies of projects between 25 and 500 MW using oil, coal, gas and hydro and are intended solely for producing electricity to be sold to WAPDA or KESC.

As described in section 2.0, the GOP has responded to this private-sector

interest by preparing a policy document intended to be used as a guide by utilities in purchasing bulk power from independent producers. The most important part of the document is the section dealing with the mechanism to be used to determine the purchase price of bulk power. According to the draft document, "...the Ministry of Water and Power will calculate the bulk purchase price of electricity for a power station, at a specific location, on the basis of the cost of production if the investment were to be made by WAPDA or KESC." The document also contains provisions that allow the private investor to make a fair return on equity and present desired operational arrangements.

Pakistan is in the forefront of developing countries in establishing a policy to encourage private-sector participation in power generation. This policy can easily embrace small- and medium-sized power generation facilities, including cogeneration units and renewable resources such as hydro, biomass, wind, and solar.

Of particular interest to Pakistan is the case of the United States, which enacted the Public Utility Regulatory Policies Act of 1978 (PURPA) to promote the development of cogeneration and small power production. PURPA mandates U.S. electric utilities to purchase power from cogenerators and small power producers that use energy sources other than oil and gas at the utilities "avoided cost," independent of the cogenerator's or small power producer's cost. The avoided cost, intended to be a reflection of the true value of the power to the utility, is established on the basis of utility marginal costs. The experience with U.S. PURPA regulations is useful background in identifying policy issues and developing general crieria for encouraging private sector participation in expanding generating capacity in Pakistan.

## 1.3 BACKGROUND OF ANALYSIS/APPROACH

The USAID Bureau for Asia and Near East (ANE) has initiated country-specific examinations of the potential for, and impediments to, private-sector power generation. This activity is part of a broader AID effort to promote the privatization of energy systems in Asia and is supported by the USAID Bureau of Science and Technology, Office of Energy. The ANE initiative coincides with the initiative taken by the Government of Pakistan to formulate a policy facilitating private-sector participation in power generation. The analysis leading to this report was carried out in Pakistan by a team of senior consultants of Hagler, Bailly & Company and Arthur D. Little, October 12-31, 1985.

This study included consideration of both on-site power (cogeneration and dedicated power plants) by industry for internal use and grid connected private sector power. Only the latter option which is the focus of the recently enunciated GOP Private Sector Power Policy is discussed in this report. The on-site power options are discussed in sister reports[1] and will be considered as part of energy conservation strategies within the ENERCON project.

## 1.4 OBJECTIVES OF THIS REPORT

The study team had several objectives:

(1) Preliminary identification of the technical and economic potential for using private-sector resources for installing and operating grid connected power generation systems, with emphasis on renewable and indigenous energy resources (particularly coal and gas).

(2) Identification of the policy, regulatory, institutional, and other impediments to private-sector power generation for sale to the grid.

(3) Development of recommendations to be considered by the GOP and USAID for programs to strengthen support and accelerate the introduction of private sector power generation in Pakistan consistent with the intent of the new policy statement enunciated by the GOP.

## 2.0 THE GOP PRIVATE SECTOR POWER POLICY

The GOP is very concerned about the impacts of land shedding on economic growth and the strain on government finances associated with addressing the situation solely via government financed capacity expansion. During the last four or five years the private sector has shown via proposals to and discussions with the GOP an interest in helping to alleviate capacity shortfalls by installing and operating power units to sell electricity into the national grid. As a result of the growing impact of capacity shortfalls and the expressed interest of the private investors in participating in the power sector, there have been a series of discussions at high levels within the government on the possibility of encouraging the mobilization of private capital for installing generating capacity to supplement that of WAPDA and KESC. This effort, which culminated in a policy document prepared by a specially appointed Committee on Private-Sector Power Generation for the Economic Coordination Committee, provides a framework for the development of privately owned, utility-scale power plants designed to sell power to WAPDA or KESC. The document outlines the general provisions of a policy whereby private sector organizations can build power plants which tie in with the utility grid. This policy statement, provided in Appendix A, is intended to provide the basis of a dialogue between the GOP and private organizations and will be expanded and modified based on experience, more detailed analyses, and changing national needs.

It should be noted that the policy statement is consistent with a more general GOP policy to expand the role of the private sector in economic growth, in general, and within the energy sector, in particular. The new policy places the power sector in the forefront of this effort to increase the role of the private sector in the national economy.

Currently, the policy statement does not apply to the full range of private sector power generation options of potential interest in Pakistan. For example, it applies only to plants using oil or coal. Although the policy does not explicitly refer to small-scale systems, many of the principles and guidelines could apply to such systems. The main elements of the policy are:

1. Location and Capacity

   (a) The Ministry of Water and Power will determine, in the context of agreed medium-and long-term plans, the location and capacities for thermal generation suitable to system conditions, and invite the private sector to install and operate them.

   (b) The Minstry of Water and Power may also entertain proposals made by private enterprises, on their own initiative, and consider them in the context of the agreed medium-and long-term plans.

2. Bulk Price

(a) The Ministry of Water and Power will calculate the bulk purchase price of electricity for a power station, at a specified location, on the basis of the cost of production if the investment were made by WAPDA or KESC.

(b) In determining the bulk price, a suitable return on equity will be taken into consideration. The rate of return on equity will be fixed in consultation with the Ministry of Finance.

(c) Only the price and quantity of energy to be purchased, not a fixed return, will be guaranteed to the private entrepreneur.

(d) If the station is located at a distance from the transmission system, a suitable discount for transmission costs may be provided.

(e) The bulk tariff will be worked out on the basis of a 60 percent annual plant capacity factor. A purchase at this capacity factor would be guaranteed by WAPDA/KESC. A suitable penalty clause applicable to both the purchaser and the supplier of electricity will be incorporated in the contract to ensure that the purchases and sales do not fall below the minimum, except by mutual consent.

(f) WAPDA/KESC would have the right to purchase power, over and above the 60 percent annual plant capacity factor, at the agreed price, and the private operator could not unreasonably withhold the supply.

(g) The bulk purchase price may be in two parts:

(i) The base price for energy

(ii) The cost of fuel

(h) A suitable escalation will be provided for the basic price of energy, taking into consideration key inputs only, e.g., labor. The fuel component will be directly linked to the cost of fuel, which will be the prevalent competitive market price. A formula for this linkage, assuming a certain plant efficiency, would be worked out.

This policy is to be extended later to fuels other than oil and domestic coal.

The above policy is a very constructive base for initiating discussions with interested private sector investors in power generation capacity. It incorporates some of the general principles associated with the U.S. PURPA regulations which have helped accelerate independent power production in the U.S. For example:



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(a) The rate at which power is purchased by the utility is, in effect, related to the marginal cost of power since it will be related to the cost of new capacity if it were being installed by WAPDA or KESC.

(b) Provisions are made to increase buyback rates consistent with overall cost escalations associated with power generation inputs, which would also be experienced by government operated facilities such as fuel and labor.

(c) Subject to the above, the independent power producer will be offered a fixed buyback rate and not guaranteed a rate of return. Consequently, the independent power generators will have financial incentives to operate efficiently in order to maximize profits.

(d) As indicated in later sections, however, the effectiveness of the policy will depend critically on how it is interpreted by the GOP in establishing the buyback rate from private sector generators. Furthermore, the policy will require significant expansion along with supporting analyses so it can deal effectively with the complex issues of the highly seasonal nature of capacity shortfalls, the inclusion of power units using energy sources other than oil or coal, the regional variations in power needs and transmission losses, and the changing value of incremental power additions over time as the nature of the overall national grid changes.

## 3.0 POTENTIAL FOR PRIVATE SECTOR POWER GENERATION

The private sector has already indicated its interest in investing in dedicated power units and selling the output to the utility grid. The power generating options being considered by private sector interests include:

- Oil-fired diesel
- Non-pipeline gas/gas turbines
- Small-scale coal boilers/steam turbines
- Small-scale hydro
- Renewables (solar, wind, biomass)

The initial cost and economics of these power options vary widely, which influences their potential for implementation by the private sector.

In the following sections, the potential impact of power from each of these power generating options is estimated, taking into account resource availability, technology status, and economics. Some resource-specific considerations affecting the potential estimate are also discussed.

### 3.1 Diesel Power/Hub Chowki Project

a. General

There are several technical options for using petroleum products to generate power, including gas turbines, high- speed diesel engines, medium- and low-speed diesel engines, and steam turbine systems. Gas turbines and high-speed diesels usually have to use distillate fuels, which are expensive. Medium and low-speed diesels can use furnace oil, which in Pakistan is currently about half the price of diesel oil. The private sector in Pakistan has already installed over 50 MW of diesel generation capacity in industry and has indicated an interest in installing dedicated 100-MW to 200-MW power plants to generate electricity for sale to the national grid. The advantages of medium- speed diesels include:

- Modularity, which allows capacity to be installed in increments as low as 1 MW and as high as 20 MW

- High thermal efficiency (over 40 percent), leading to low fuel consumption

- Short lead time, allowing construction in as little as 1-2 years.

The cost of electricity generated by a diesel power system is shown in Exhibit 3.1, assuming two prices of fuel oil -- Rs. 1,720/tonne ($108/tonne), which corresponds to the purchase price by KESC, and Rs. 2,288/tonne ($143/tonne), which corresponds to the current imported fuel oil price. The cost of electricity is about 88 Ps./kWh (5.5¢/kWh) for the higher priced fuel. As indicated subsequently, this range is in line with recent proposals from the private sector -- the Hub Chowki project, for example.

Exhibit 3.1

COST OR POWER FOR MEDIUM SPEED DIESEL POWER SYSTEM
(1985)

| Fuel Cost | Large System Ps./kWh | (¢/kWh) | Small System Ps./kWh | (¢/kWh) |
|---|---|---|---|---|
| 1,720 Rs./tonne ($100/tonne) | 88 | (5.5) | 96 | (6.0) |
| 2,300 Rs./tonne ($143/tonne) | 104 | (6.5) | 112 | (7.0) |

Asssumptions:

Large system (20 MW) Cost - $650/kW
Small system (4 MW) Cost - $800/kW

Capital recovery factor - 0.2
Capacity factor - 60%

Consumable Costs - 10% of fuel

Source: Arthur D. Little

The cost of oil fired power is also highly competitive with the utilities' own marginal power costs. It should thus be consistent with rates offered by the utility to the private sector under the new policy, thereby ensuring interest by the private sector in oil fired diesel power systems. There is no basic resource constraint on the potential for private sector power from this option, but other types of constraints exist, including:

- Government policies that limit the growth in fuel oil generating capacity to as low a level as possible, given the associated long-term (balance of payment) ramifications of relying too heavily on oil-based power generation

- Other options such as low-Btu gas fields and hydropower that may produce lower cost power than oil fired units

- Possible accelerated drilling programs by the government and private sector, which could result in large increases in natural gas reserves.

As a result of these constraints, the team assumed that oil fired diesel power represents a short-term solution to capacity shortfall problems. The economic potential is not estimated because any large-scale plant would be cost competitive with the utilities own new oil or coal fired generating capacity.

b. Hub-Chowki Project:

Appendix B summarizes the results of a specific Diesel power project which has been proposed to KESC by Packland Cement Company. The project is for 120 MW of medium speed Diesel engine capacity at a site about 50 miles West of Karachi in Baluchistan, called Hub Chowki.

The proposed system would have a total cost of $78,000,000 or roughly $650 per rated kW. The estimated probable selling price of power by the private sector was 87 ps per kWh. The team reviewed the cost and financial figures and estimated costs of 77 ps to 90 ps per kWh depending on assumptions relative to taxes and assuming a capacity factor of 60% per the Policy Statement. The assumed after tax return on equity was 20% which is a minimum requirement to attract private capital for projects of this type. The capitalization assumed was 30% equity and 70% debt. The price which would have to be offered the private investors consistent with the intent of the Policy Statement is well above the KESC and WPDA service area average cost of power which is a source of concern to WAPDA and KESC officials. The range is, however, consistent with the cost of power from new oil fired facilities being installed by KESC and WAPDA.

The Policy Statement itself specifies that the price to be paid to the private sector investors will be "based on the cost of production if the investment is made by WAPDA or KESC". Consistent with this statement KESC made estimates of power costs by a Diesel Power Unit of Hub Chowki using basic cost figures provided by a Japanese consultant group. These cost estimates were on the order of 60-70 Rs/kWh with the lower cost being the result primarily of lower assumed finance charges on the foreign exchange portion of debt (less than 10% as compared to 14% by Packland) and lower maintenance costs. This exemplifies the importance of ensuring that the Policy Statement is interpreted in a constructive manner and does not

assume preferential access to capital or other inputs by the GOP as compared to the private sector.

Notwithstanding the above concern, the initial experience of Hub Chowki in applying the new Policy Statement would result in capacity being installed by the private sector and selling into the grid at costs comparable to those from new generating capacity installed by the utilities. This should help mitigate concerns by some in the government that inclusion of private sector power in the generating mix will increase the overall cost structure.

### 3.2 Potential from Non-pipeline Gas

The GOP has drastically curtailed the use of pipeline natural gas for use in new power generation facilities. However, two sources of gas are not or may not be so restricted:

1) "Dormant gas fields." These eight gas fields identified over the last 30 years, contain low-quality gas that cannot economically be used in pipelines but could be used for power generation (see Appendix C).

2) The associated and non-associated gas recently identified at oil drilling concessions by Union- Texas, Occidental, and OGDC. This gas is often found in modest quantities, has a short life and is not near the pipeline, so its most effective use, in many cases, would be for power generation.

Both types of gas supply could, in some cases, be developed fairly rapidly and used for relatively low- cost power production. However, currently the private sector does not have access to the "dormant" gas fields and there continues to be issues relating to the pricing and definitions of associated gas which must be resolved before this option can be pursued by the private sector.

**Potential**

Three gas fields have the greatest potential for development by the private sector because of their size and availability. The power generation potential of these fields is shown in Exhibit 3.2.

If reserve estimates are verified by more detailed field appraisals, the potential for these three fields would be over 1,000 MW.

However, Uch, Zin, and Kairpur have not been appraised for over 25 years and all estimates of gas reserves must be treated cautiously. Needed drilling and seismic appraisal activity would take 12-36 months, and could result in changes, upward and downward, of field potential. Several industry observers believe that reserves at Uch, in particular, might be conservatively estimated.

No estimates have yet been made of gas reserves (associated and otherwise) at the oil concessionary fields in Sind and the Potwar region, operated by Union Texas and Occidental.

Exhibit 3.2

POTENTIAL POWER GENERATION AT THE DORMANT GAS FIELDS

| Field | Reserves (TCF) | Energy (Btu/Ft) | Power Potential (MW) |
|---|---|---|---|
| ZIN | 0.1 | 460 | 60 - 80 |
| UCH | 2.5 | 270 | 850 - 1,150 |
| Kairpur | 1.0 | 120 | 150 - 200 |
| | | TOTAL | 1,060 - 1,430 |

Assumptions:

- Plant life = 15 years
- Capacity factor = 0.6
- Power cycle efficiency range from 30% (simple cycle turbine) to 40% (combined cycle)

Source: Arthur D. Little



12

Exhibit 3.3

COST OF POWER ESTIMATES - GAS TURBINES

System Type: Simple Cycle Gas Turbines

GAS PRICE

| | Current Market Price Rs. 18.7($1.17)/mmBtu | | Two-thirds of imported Fuel Oil Price Rs. 37.5($2.34)/mmBtu | | Equal to Imported Fuel Oil Price Rs. 56.0($3.51)/mmBtu | |
|---|---|---|---|---|---|---|
| 50 MW | 37 | (2.3) | 72 | (4.3) | 94 | (5.9) |
| 20 MW | 64 | (4) | 85 | (5.3) | 107 | (6.7) |
| 5 MW | 85 | (5.3) | 105 | (6.6) | 128 | (8) |

Ps./kWh, Numbers in parenthesis are in ¢/kWh

Assumptions:

a. System Type: Simple Cycle Gas Turbines
b. Effiency: 30%
c. Capital Costs:

50 MW: $350/kW
20 MW: $500/kW
5 MW: $800/kW

d. Capital Recovery Factor = 0.2
e. Capacity Factor = 0.6

Source: Arthur D. Little

In Sind there are over 15 wells containing cap gas and associated gas, with associated gas at one site being flared. Industry experts are confident that additional gas will be found as more wells are drilled. Although much of this gas is pipeline quality, many of the wells might be more economically dedicated to power generation using skid-mounted turbines, given the high pipeline costs associated with connections into a multiplicity of modest-sized reserves.

Economics

Non-pipeline gas is most likely to be converted to power using gas turbines. Preliminary cost of power estimates, assuming private-sector financing, are shown in Exhibit 3.3 for different gas prices. The gas price range reflects the uncertainty in government policies. A cost of Rs. 37.5 ($2.34)/mmBtu is consistent with two- thirds of imported fuel oil prices, while a gas price of Rs. 18.7 ($1.17)/mmBtu corresponds to the current market price.

The cost of power ranges between 48 Ps./kWh (3¢/kWh) within this gas cost range. This range is competitive with the cost of power generated by the utility. As a result, the range might be useful in defining utility purchase provisions that are attractive to both the GOP and private-sector investors.

Economic Potential

Pakistan's non-pipeline natural gas resources have an estimated economic potential of 530-715 MW. This is half their technical potential.

## 3.3 Potential from Small-scale Coal

There are over 2,000 coal mines in Pakistan, with centers of production located in the Quetta area of Baluchistan, the Lakhra area of Sind, and in various locations in Punjab. Current production is about 2.5 million tonnes. Within this highly fragmented industry, there are roughly 20 mining groups that account for the majority of the production.

Several of the larger firms have assessed the prospects for installing small (10-50 MW) coal-fired power plants using coal from their own mines, possibly supplemented by coal from nearby smaller mining operations. This approach has the advantage of reducing (or eliminating) transportation costs.

Possibly the largest single barrier to a large near- term contribution from small-scale coal-fired generation is the fragmented nature of current coal production. With production scattered among many smaller mines, it is difficult to assemble sufficient coal in one area to fire coal plants of economical size. For example, a 25-MW power plant would use between 120,000 and 250,000 of coal per year, depending on coal quality and power plant efficiency.

The power production potential of coal, assuming the use of 10 percent, 25 percent and 50 percent of current nationwide production, is shown in Exhibit 3.4. The potential is likely to be in the lower end of this range,

Exhibit 3.4

POWER GENERATION POTENTIAL FROM COAL*

| % of Coal Produced | Tonnes/Yr | Power Potential (MW) |
|---|---|---|
| 10 | 250,000 | 40-60 |
| 25 | 625,000 | 110-140 |
| 50 | 1,250,000 | 200-300 |

*Based on current annual production levels estimated at about 2.5 million tonnes.

Source: Arthur D. Little

Exhibit 3.5

POWER COST ESTIMATES - SMALL COAL-FIRED POWER PLANTS

| Coal Price Rs./tonne | ($/tonne) | Energy Cost Ps./kWh (¢/kWh) (CR = 0.2) | | Energy Cost Ps./kWh (¢/kWh) (CR = 0.12) | |
|---|---|---|---|---|---|
| 320 | (20) | 131 | (8.2) | 94 | (5.9) |
| 480 | (30) | 144 | (9.0) | 107 | (6.7) |
| 640 | (40) | 155 | (9.7) | 118 | (7.4) |

Assumptions:

- Capital Cost = $1,500/kW fully installed
- O&M Cost = 16 Ps./kWh (1 ¢/kWh)
- Capacity Factor = 60%
- Capital Recovery Factor = 0.2 and 0.12
- Plant Efficiency = 25% (Overall)

Source: Arthur D. Little, Inc. estimates.



15

given the need for significant volumes of coal in a rather limited area to control transportation costs and the need for relative stability in current coal markets. Over the long term, mine modernization could result in increase in production levels and a resulting higher power production potential.

Economics

Recent designs for small wood- and lignite-fired units, together with engineering studies in support of private-sector mine operators in Pakistan, indicate that the capital cost of small coal-fired power plants would range between $1,200 and $1,800/kW, on an installed basis (turnkey).

Equipment represents about 60 percent of these costs, because oversized stoker-boiler systems are needed to handle the relatively low-grade coal. Associated coal and ash handling equipment is also required. However, small units based on pre-engineered subsystems can probably be installed in 2-3 years, which would greatly reduce finance charges and control the escalation of costs during construction compared with large central plants.

The economics of coal-fired power generation depend on local coal costs. Power costs as a function of delivered coal prices ranging from Rs. 320 ($20)/tonne to Rs. 640 ($40)/tonne are shown in Exhibit 3.5. The lower figure corresponds to a mine-mouth operation with minimal coal transportation or handling charges, and the higher figure corresponds to a plant with substantial delivery charges.

On the basis of these coal costs the cost of power ranges from about 131 Ps./kWh (8.2¢/kWh) to 155 ps/kWh (9.7¢/kWh). Up to 65 percent of the power cost is associated with finance and capital charges in these power units, which makes the analyses particularly sensitive to financial assumptions. Several private sector investors have indicated that they might have access to highly favorable financing terms for pre-engineered coal fired power plants. The impact of more favorable financing terms are indicated in column B of Exhibit 3.5 which assumes a capital recovery factor of 0.12 (corresponding roughly to having a major portion of equipment cost financed at 8% over a period of 10 years). This reduces power costs to the 94 ps/kWh (5.9¢/kWh) to 118 ps/kWh (7.4¢/kWh) range. This is consistent with the range of power costs being proposed by potential private investors using indigenous coal resources for smaller (25 - 50 MW) power units.

Economic Potential

The capital costs of small coal fired power plants are relatively high so that favorable financial terms will have a greater impact on this option than those with power cost equipment. Also, near term potential will be limited by mining capacity. As a result of these two efforts the economic potential of this option in the near term (less than 5 years) is estimated at 50 - 100 MW. This potential could, however, expand significantly if government policy gives preference to those power plants using indigenous resources thereby providing incentives to increase mining capacity.

## 3.4 Potential from Small-Scale Hydro Power

The small-scale hydropower sites in Pakistan can be divided into four categories:

1) Barrages: the heads created by existing dams on the irrigation network could be used to generate power in the 5 MW to 200 MW range

2) Canals: small dams can be created on the irrigation canals for hydro power generation in increments of capacity at (50 kW to 5 MW)

3) Small rivers: dams can be placed in smaller rivers of the North West Frontier Province (NWFP) and Punjab for hydropower generation of 100 kW to 100 MW per station

4) Mountain streams: specially designed turbines use the low flows and high heads in mountain streams for micro hydropower production (1 kW to 50 kW per station).

The last category will occur primarily in remote northern areas that are usually isolated from the grid. The power so generated may be important on a local basis to satisfy important socioeconomic needs. The gross potential is, however, modest (2 MW) and is thus not considered further here.

Barrages. Studies undertaken jointly by WAPDA and GTZ contractors have identified a number of sites on barrages that have good potential for hydropower generation. The overall potential of these sites is in excess of 300 MW, with individual power units ranging from 5 MW to 200 MW. As the result of a recent study, four sites have been identified for development, probably by WAPDA itself:

| | | |
|---|---|---|
| Chasma | - | 200 MW |
| Jinnah | - | 120 MW |
| Jaunsa | - | 120 MW |
| Guddu | - | 50 MW |
| Total | | 490 MW |

WAPDA is currently undertaking a detailed feasibility study for Chasma and may issue tender documents for this project, assuming installation by WAPDA.

The barrage sites have the potential to attract private-sector development, but the government is currently reluctant to allow private operation of them since the barrages are considered to be strategic locations and are referred to as "key points".

There is increasing interest in using small hydro sites for generation of power in both the autonomous and grid-connected modes. Examples of this interest include:

- A recent "agreement" between the Punjab Irrigation Department and a private party for the development of a 2.8 MW unit on link No. 2 of the DGK Canal. The Irrigation Department is also negotiating an agreement with a private party for a 3.8 MW site in upper Punjab.

- Proposals received by WAPDA from Electra Power Corporation (Palo Alto, CA) for development of small hydro sites. WAPDA provided Electra with two specific locations for detailed consideration:

- a site in Gilgit with 4 MW of potential
- two locations on the B.S. link in Punjab, one with 6 MW of potential and the other with 9 MW.

In addition to these specific proposals, several private- sector organizations indicated that they would be

interested in developing hydropower sites if government policy made such development more attractive.

Canals. Pakistan has the largest irrigation canal network in the world. In Punjab alone there are about 23,000 miles of canals. Based on surveys undertaken by the Punjab Irrigation and Water Department over the past few years, there are about 230 sites that might be favorable for small-scale hydro power. Of these, 60 have the potential for more than 50 kW of output; together they have a potential of 92 MW.

Five of the more favorable sites have been selected for feasibility studies. They have a power potential of 1.5 MW to 5 MW, 5 ft. to 11 ft. heads, and flow rates of 4,000 cubic feet/sec to 11,000 cubic feet/sec.

If the projects are feasible, the government of Punjab plans to install and operate the facilities, which will not be connected to WAPDA and will serve only nearby tubewell pumps and villages. Nevertheless, their presence could reduce future power demands on WAPDA as the rural electrification program expands. Punjab Province probably has the bulk of small hydro sites on canals in Pakistan, both because of the very large canal infrastructure and the relatively hilly topography.

Small Rivers. The Ministry of Water and Power has identified numerous sites on about 12 of the smaller rivers flowing in the northern regions (Swat, Gilgit, Chitral) with good potential for small-scale hydro power generation. These sites have individual power potentials of 1 MW to 100 MW; many are reasonably close to the WAPDA distribution system and, if developed, would become grid-connected.

The potential for small-scale hydropower in Pakistan, based on information made available to the study team, is shown in the table below. The overall potential is estimated to be between 1,400 MW and 2,850 MW. Of this potential, however, about 300 MW-600 MW (21 percent) is on the barrages, where private parties may not be allowed to operate.

| | | |
|---|---|---|
| Barrages & Link Canals | | |
| Canals | 300 - 600 | |
| Small Rivers | 100 - 150 | |
| | 1,000 - 2,000 | |
| | TOTAL | 1,400 - 2,850 |

The cost of implementing a small-scale hydro project depends on site conditions, location, system size, and heads. Pre-packaged small hydro

turbine-generation- control units are becoming increasingly available as the result of worldwide interest in small-scale hydropower. The availability of such units will help reduce cost uncertainties and shorten implementation schedules. In making preliminary cost estimates, the study team divided the systems into two categories:

1. Barrages: The barrages themselves function as the dam, which significantly reduces civil works requirements.

2. Canals and rivers: These sites will require dam structures and other civil works, which increase costs.

For larger systems on the barrages, installation costs are estimated to be $600 to $1,200 per kW. The costs for smaller units on the canals and small rivers are estimated to be $1,000 to $2,000 per kW.

Operations and maintenance costs should be uniformly low, ranging from 6.4 Ps./KWh (0.4¢/kWh).

Preliminary estimates of power costs from small hydro sites are shown in Exhibit 3.6. The power costs of the barrage units would range from 38 Ps./kWh (2.4¢/kWh), depending on size and financing terms. The smaller canal and river sytems would have significantly higher power costs ranging from 73 Ps./kWh (4.6¢/kWh), owing to higher capital costs and generally lower capacity factors.

Economic Potential

Based on the information presented above, the team estimates the economic potential for small-scale hydro to be in the 400 MW-700 MW range.

## 3.5 Potential from Renewable Energy Systems

The renewable energy sources addressed are solar, wind, and small-scale biomass. In the United States and elsewhere there has been a great deal of activity in developing systems to use such renewable energy resources. As a result, these resources have been used in small remote applications as well as small utility (1- 50 MW) applications.

Pakistan has been a leader in applying these technologies, on an experimental basis as exemplified by the installation in the last few years of a large number of digester systems and solar village units based on photovoltaics. Moreover, several private-sector ventures for the production of photovoltaic and wind turbine systems are currently being formulated.

There is, therefore, a technological base being established in Pakistan for the application of these technologies, by both government and private sector organizations. However, solar and wind systems will most likely be used initially to serve small loads in remote areas that cannot economically be served by conventional means (grid extensions, diesel generators).

The lack of biomass resources (e.g., bagasse, cotton stalks, rice hulls) in sufficient concentrations for use in power plants will probably limit their

Exhibit 3.6

POWER COST ESTIMATES - SMALL SCALE HYDRO

a. Barrages:

| Capital Cost Rs./kW | ($/kW) | Energy Cost Ps./kWh | (¢/kWh) |
|---|---|---|---|
| 9,600 | (600) | 38 | (2.4) |
| 12,800 | (800) | 48 | (3.0) |
| 16,000 | (1000) | 59 | (3.7) |
| 19,200 | (1200) | 69 | (4.3) |

b. Rivers and Canals:

| Capital Cost Rs./kW | ($/kW) | Energy Cost Ps./kWh | (¢/kWh) |
|---|---|---|---|
| 16,000 | (1000) | 73 | (4.6) |
| 19,200 | (1200) | 86 | (5.4) |
| 24,000 | (1500) | 105 | (6.6) |
| 32,000 | (2000) | 137 | (8.6) |

Assumptions:

- Capital Recovery Factor = 0.2
- Capacity factor on barrages = 0.6
- Capacity factor on canals = 0.5

Source: Arthur D. Little



20

potential. The potential for power generation from each type of resource is presented below.

Solar and Wind

Solar availability in most of Pakistan compares favorably with the very best regions of the United States. Wind resources, although poorly defined at this time, are probably marginally attractive in many coastal and mountain regions. If economics were not a constraint, either of these resources could easily satisfy all of Pakistan's energy needs. As a result, technical potential based on resource availability is not meaningful when discussing these energy sources.

Biomass

Preliminary estimates of biomass availability in Pakistan are presented in Exhibit 3.7. Biomass resources are restricted to crop and animal wastes, since wood is already in short supply because it is used by rural populations for cooking. The crop wastes associated with sugar production are already heavily used for industry power and

steam needs. The most underused crop waste is cotton stalks. The annual yield is about 3.6 million tonnes, which could produce up to 800 MW of power at a 60 percent capacity factor. The stalks could be converted to power using prepackaged boiler-steam turbine systems (1-50 MW) similar to those used to burn wood wastes in the United States and elsewhere.

Detailed field surveys of the distribution and current disposal of cotton stalks are not readily available. Even a modest availability of 10-20 percent of the total yield could produce 80 MW to 160 MW.

Bagasse is the largest source of biomass currently used in Pakistan and studies recently conducted by the GOP have concluded that up to 60 MW of additional power could be generated through more efficient use of the sugar mill power plants. Unfortunately most sugar mills are not connected to the grid and the use of bagasse would not be economically justified if it had to be transported over distances greater than 30 miles.

Economics of Solar Power Generation

Solar power systems include major subsystems of photovoltaic (PV) arrays. Base prices for the PV panels alone currently range from $5,000 to $7,000 per kW in the United States. System costs, including controls, battery storage, and installation, are usually $15,000 to $25,000 per peak kW. However, total system costs, not including storage, have been as low as $10,000 per kW. Several of the PV systems that have been installed in Pakistan for village electrification have approached these lower cost figures.

Although much progress has been made in recent years to rapidly decrease PV costs, further cost reductions are expected to occur slowly. By the early 1990s, installed costs (including mounting, cells, protection equipment, wiring, and power conditioning) are expected to be about $5,000 per kW.

Exhibit 3.7

ESTIMATE OF YIELD OF CROP RESIDUES IN PAKISTAN
1978-1979

| Residue origin | Thousands Tonnes |
|---|---|
| Wheat (straw) | 13,023 |
| Rice (straw) | 3,400 |
| Maize | 1,053 |
| Millet | 562 |
| Sorghum | 596 |
| Barley (straw) | 154 |
| Oats (straw) | 1,218 |
| Food grains subtotal: | 20,006 |
| Sugar Cane | 4,349 |
| Tops and Leaves | 4,349 |
| Bagasse | 2,810 |
| Molasses | 366 |
| Cotton | 3,586 |
| Other | 1,929 |
| Cash crops subtotals: | 13,040 |
| TOTAL CROP RESIDUES | 33,046 |

Source: Adapted from Muller (1980)

The capacity factor of PV systems, even in sunny regions, is only about 20-30 percent (without storage). With current system costs at about $12,000/kW, energy costs are over Rs. 9.6/kWh (60¢/kWh). Therefore, PV systems will continue to be used primarily for remote power markets where the costs of running distribution lines or operating small engine generators are prohibitively high.

Economics of Wind Turbine Power Turbines

Altamount Pass in California is one of the largest windfarm developments in the world. The installed wind turbine (WT) capacity in this 18-square-mile area is 360 MW, with 4,087 WTs installed as of January 1985. A typical WT rated at 100 kW would cost approximately $150,000 installed. Average power ratings range from 70 kW to 100 kW and cost between $90,000 and $150,000, for an average of about $1,500 per rated kW.

The available energy is proportional to the cube of the wind velocity. However, only a small fraction of the energy in the area swept by the blades of a WT is extracted as mechanical energy. A typical annual energy output for a 100 kW WT in California, in areas with wind regimes averaging greater than 14 mph, is approximately 210-240 kWh. The capacity factor for WTs on average is between 15 and 25 percent, owing to variations in wind velocities. With installed costs of WTs at approximately $1,500/kW, the cost of energy is around 192 Ps./kWh (12¢/kWh).

Discussions with WT manufacturers and utility operators have indicated steadily increasing WT reliability and modest reduction in cost. By 1990, the cost of energy for WTs is expected to be reduced to 160-176 Ps./kWh (10-11¢/kWh).

Economics of Biomass

The most straightforward approach to using biomass resources for power generation is to burn them in a boiler to drive small steam turbines. According to discussions with one manufacturer of prepackaged units, capital costs for installed capacities below 10 MW would be $1,400/kW-$2,000/kW.

The economic value of agricultural wastes is difficult to estimate. Where the power unit performs a much needed disposal function, the cost of the wastes may be zero (and a credit can even be obtained in some extreme cases). If additional collection and transportation of wastes are required to allow their use in a power system, the cost would reflect this effort.

Power cost estimates for a biomass-fired system are shown in Exhibit 3.8, assuming two cases: zero value of biomass, and a value of $25/tonne. Resultant power costs would range from 108.8 Ps./kWh (6.8¢/kWh), with the lower cost quite attractive. A survey is thus warranted to determine whether cotton stalk wastes or excess bagasse are available in sufficient concentrations to be used in small-power generating units.

Economic Potential

Because of the lack of data on most resources, the economic potential is arbitrarily estimated at 50-100 MW, most of it from biomass (cotton wastes and bagasse).

Exhibit 3.8

POWER COST ESTIMATES - BIOMASS-FIRED POWER SYSTEM

Unit Type: Prepackaged Steam Power System

Efficiency: 25%

| | Case A No Fuel Charge Ps./kWh | (¢kWh) | Case B With Fuel Charge Ps./kWh | (¢kWh) |
|---|---|---|---|---|
| 10 MW | 108.8 | (6.8) | 157 | (9.8) |
| 5 MW | 132.8 | (8.3) | 180 | (11.3) |
| 1 MW | 170 | (10.6) | 218 | (13.6) |

Assumption:

A. Costs

| | Installed Rs./kW | ($/kW) | O & M Ps./kWh | (¢/kWh) |
|---|---|---|---|---|
| 10 MW | 22,400 | (1,400) | 12.8 | (0.8) |
| 5 MW | 25,600 | (1,600) | 16.0 | (1.0) |
| 1 MW | 32,000 | (2,000) | 24.0 | (1.5) |

B. Capacity Factor = 0.5 to reflect seasonal variations in waste availability

C. Capital Recovery Factor = 0.2

D. Fuel Charge = Rs.37/mmBtu ($2.30/mmBtu)

Source: Arthur D. Little

## 3.6 TOTAL POTENTIAL FOR PRIVATE-SECTOR POWER GENERATION/CAPITAL NEED/

Exhibit 3.9 summarizes the estimated power costs from the different technology options. Low-Btu gas-fired turbines, small- scale hydro, and biomass-fired power units also have power costs of under 60 Ps./kWh (3.8¢/kWh) in some cases.

The cost of power from diesel power units using heavy oil ranges from 75 Ps./kWh (4.7¢/kWh) to about 120 Ps./kWh (7.5¢/kWh) in capacities over 5 MW. This range is consistent with what is probably the true marginal cost of thermal power from the utilities themselves. The coal-fired units produce the most costly power -- Ps. 100/kWh (6.3 c(RB)//KWh)in lower capacities. This high cost of power is the result of relatively high capital and operating costs for small coal power units, even those without pollution control.

For comparison purposes, WAPDA's average sale price of power to industry ranges from 72 Ps./kWh (4.5¢/kWh), to 80 Ps./kWh (5.0¢/kWh), including fuel adjustments cost (FAC).

Cogeneration, some hydro sites and gas turbines operating with low-cost gas could compete with the average range of electricity retail prices.

The marginal cost of power to WAPDA for oil-fired thermal power stations is 93 Ps./kWh (5.8c(RB)//kWh), depending on fuel oil price and capital cost assumptions. If price policies on purchases from the private sector are related to these marginal costs, all the power options except coal, wind, and solar become economically attractive.

### Likely Market Penetration

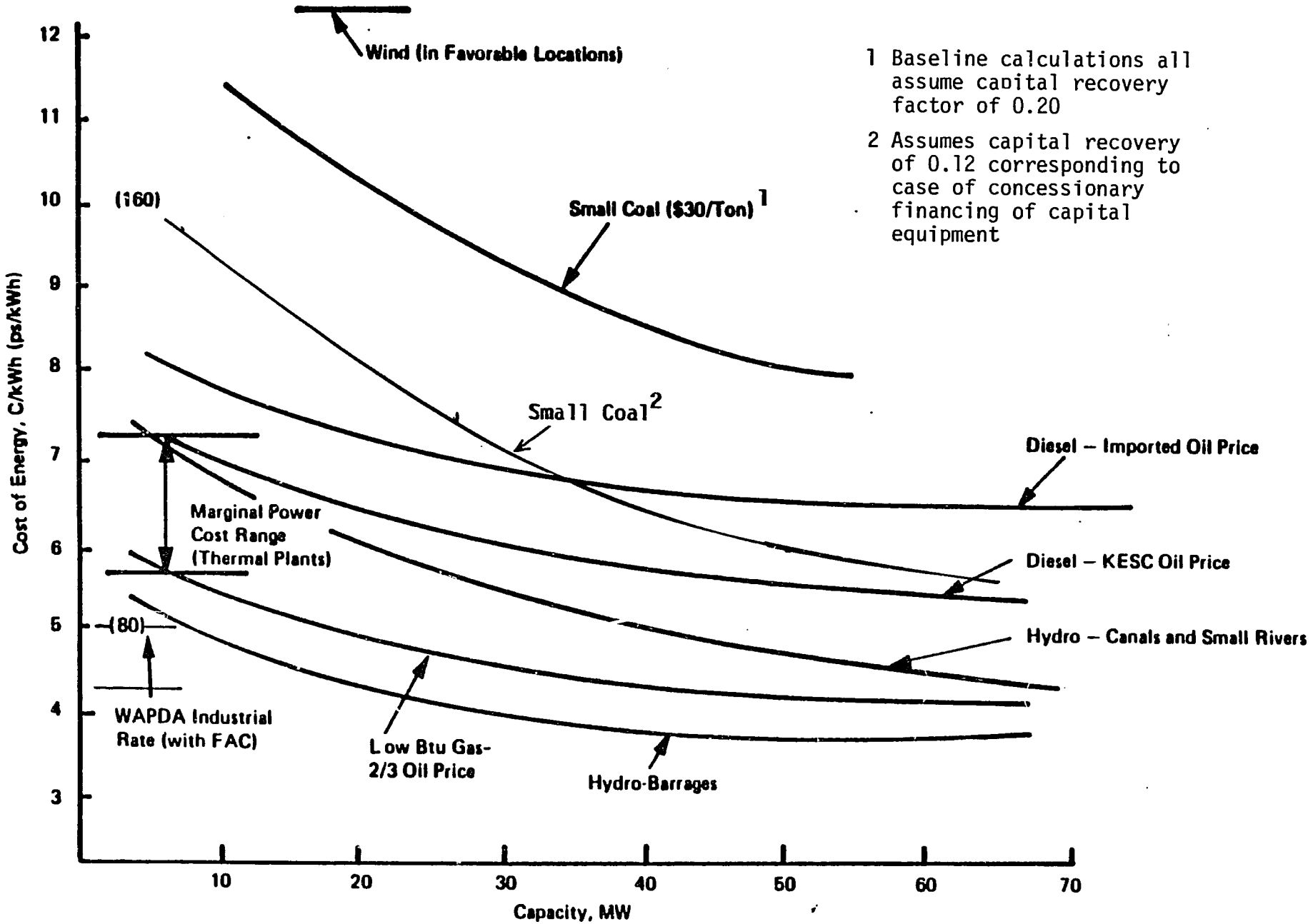
Estimating the implementation rate of relatively unfamiliar technologies is always subject to a high level of uncertainty, even where market response data are well documented, as in the United States. Furthermore, the relationship between economics and market penetration depends on the market segment being considered.

For larger independent power projects that have a financial structure similar to that of a utility, the economic criterion for significant levels of implementation is a 20% return on equity (after taxes).

Estimating realistic implementation rates for independent power generation in Pakistan is complicated by several factors:

- A lack of experience and information in industry and the financial community on the application and economic potential of the various technologies for independent power generation.

- Government policies on dormant gas and associated gas that inhibit (or prohibit) their use by the private sector which could delay the use of this major energy source.




1 Baseline calculations all assume capital recovery factor of 0.20

2 Assumes capital recovery of 0.12 corresponding to case of concessionary financing of capital equipment

Exhibit 3.9 COST OF ELECTRICITY FROM PRIVATE SECTOR POWER GENERATION OPTIONS

Source: Arthur D. Little

- Questions on the amount of private sector capital that is realistically available for power projects, particularly if a 20 to 30-percent return on equity is required. The total investment required to realize the economic potential is estimated to be in excess of $2 billion (see Exhibit 3.10), of which roughly 45 percent would be needed as equity from the private sector. Over a 10 year period this averages about $200 million annually which would have to be provided via private capital markets.

- Continuing uncertainty in the private sector on the status of government policies - particularly those pertaining to buyback rates from private power generators.

- The current lack of an infrastructure which can effectively implement the intent of the private sector policy and expand it to include the full range of power options which would likely be of interest to the private sector.

- The installation of power systems by industry to avoid disruptions caused by load shedding; the decision to install such a system is based on economic factors that are not directly related to utility tariffs or potentital buyback provisions

The study team estimates that 330 MW to 510 MW of private-sector power generation, using energy sources other than oil, could be developed by 1990 and could increase to over 1,000 MW by 1995 (See Exhibit 3.11). The inclusion of oil fired facilities, such as the proposed Hub Chowki project, could significantly increase this total.

The levels of implementation indicated are a modest 300 - 600 MW with most of this occuring in the earlier years to rapidly address near term power shortages while the private sector policy is adopted to facilitate the use of indigenous resources. This corresponds to 3 to 6 projects the size of the proposed Hub Chowki facility.

Independent power generation via the private sector could, therefore, eliminate or at least, greatly reduce, the projected power deficit with associated major benefits to the economy. With appropriate policies most of this benefit could derive from power sources using indigenous energy resources.

Exhibit 3.10

CAPITAL INVESTMENT REQUIREMENT - INDEPENDENT POWER PRODUCTION OPTIONS

| Technology | Additional Capacity (MW) | Range of Cost ($/kW) | Capital Requirements ($, million) Total | Domestic | Foreign |
|---|---|---|---|---|---|
| A. NON-OIL POWER OPTIONS | | | | | |
| Non-pipeline gas/gas turbine | 625 | 350-800 | 220-500 | 100-230 | 120-270 |
| Small-scale hydro | 550 | 900-2,000 | 500-1,100 | 275-605 | 230-490 |
| Small-scale coal | 35 | 1,200-1,800 | 40-60 | 20-30 | 20-30 |
| Biomass | 100 | 1,400-1,200 | 100-150 | 50-80 | 50-70 |
| TOTAL | 1,300 | | 860-1,810 | 440-940 | 420-860 |
| B. OIL FIRED SYSTEMS | | | | | |
| Diesel Generators | 500 | 750-1,200 | 370-600 | 130-200 | 240-400 |

Exhibit 3.11

PRIVATE SECTOR POWER GENERATION
PRELIMINARY ESTIMATE OF ECONOMIC POTENTIAL AND
POSSIBLE DEVELOPMENT (MW)

| | ECONOMIC POTENTIAL | POSSIBLE DEVELOPMENT by 1990 | POSSIBLE DEVELOPMENT 1991-1995 |
|---|---|---|---|
| A. NON-OIL POWER OPTIONS | | | |
| - Gas | 530 - 715 | 185 - 250 (35%)** | 370 - 500 (70%) |
| - Coal | 25 - 50 | 13 - 25 (50%) | 25 - 50 (100%) |
| - Hydro | 400 - 700 | 120 - 210 (30%) | 280 - 480 (60%) |
| - Other Renewable | 50 - 100 | 12 - 25 (25%) | 25 - 50 (50%) |
| TOTAL: (rounded) | 1,000 - 1,570 | 330 - 510 | 700 - 1,080 |
| B. OIL FIRED FACILITIES | | | |
| | 300 - 600 | 200 - 400 | 100 - 200 |

**Estimated market penetration rate.

## 4.0 POLICY IMPLEMENTATION ISSUES

The Policy Statement provides a basis for a dialog between the GOP and private investors for installing generating capacity. Moreover, Section 3 indicates that there are several power generating options which could show good economic potential assuming a constructive interpretation of the policy document.

Additionally, the GOP has adopted other policies which are directly or indirectly supportive of private sector power generation including:

Input Duty Elimination:

The Ministry of Finance is exempting most electricity generating equipment from import duties which should significantly lower the cost of installing power generation systems by private sector investors. (Import duties on industrial equipment car be as high as 40%).

Modifications in Regulations for Public Companies:

The GOP has recently modified regulations which govern the formation and operation of private sector companies which raise capital via public stock offerings. These changes facilitate this process and increase the accountability of company management to reduce the possibility for unethical behavior. Industry participants believe that these changes should increase public confidence in public companies and facilitate raising capital for private sector power projects by being able to draw on the resources of many investors - particularly the substantial financial resources available to workers returning from the Middle East. Discussions with private sector interests indicate that as a result of the new regulations, most power generation projects would be implemented as public limited companies where half the equity capital is raised via public stock offerings.

Self-financing requirements for WAPDA: WAPDA is committed to self-finance its investment program at a 40 percent level. Current investments are around Rs. 10 billion ($630 million)/year. The practical impact of this policy is to require significant increases (no less than 10% per year is forecast as being required) in electric tariffs to increase internally generated cash. These tariff increases should facilitate implementing a realistic utility buyback policy from private generators based on the cost of power from new, higher cost facilities since these higher costs are similar to those of the utilities themselves and must increasingly be reflected in the rate structure.

The issues directly affecting the potential for significant flows of private capital into power generation include:

(1) Utility purchase prices as interpreted by the policy statement.

(2) Organization and implementation of the private sector policy

(3) Long Range Policy Definition

(4) Expansion of the policy to include gas fired, hydro, and other energy sources

(5) Access of private sector to dormant gas fields, associated gas, and hydro-electric sites.

(6) Availability of Capital Resources.

Each of these issues is discussed briefly below:

## 4.1 UTILITY PURCHASE PRICE:

Discussions with potential private investors indicate that the single most important factor which will determine the level of private sector participation in power generation will be the rate structure offered by the GOP to the private generation facilities. The policy statement offers a potentially constructive approach to this issue since it calls for a price to the power producer related directly to the cost of power from similar facilities erected by the government itself. This, in effect, constitutes the marginal cost of power from new facilities. It will be important that the interpretation of this provision be done with realistic assumptions relative to such factors as capital costs, financing costs, fuel cost, O&M requirements, efficiency and availability so that purchase provisions are not biased against the private operators.

Specifically, there should be no assumptions implying preferential access of government installed facilities to capital resources, fuel, or other inputs in estimating a fair purchase price to private operators.

Seasonal Pricing:

As indicated by Exhibit 4.1, the major power shortfalls in Pakistan occur during the months of December to May when hydropower resources are at their lowest levels*. The general policy guidelines do not yet call for buyback rate provisions based on seasonal or time of day provisions. Similarly, neither WAPDA nor KESC have seasonal pricing policies. Strong consideration should be given to buyback rates which include a premium for power made available during the critical power shortage months (or conversely have penalties if power is not available for key periods during this period.) This policy would be further supported if the GOP implemented seasonal electric rates to reduce demand during power shortage months.

## 4.2 IMPLEMENTING ORGANIZATION

The policy guidelines were prepared by a high level committee within the GOP with major inputs from the Minister of Water and Power. They serve to provide the initial basis for dialog on proposals submitted

* In recent years serious power shortages have occurred almost year round due to lower than normal water levels in the reservoirs.

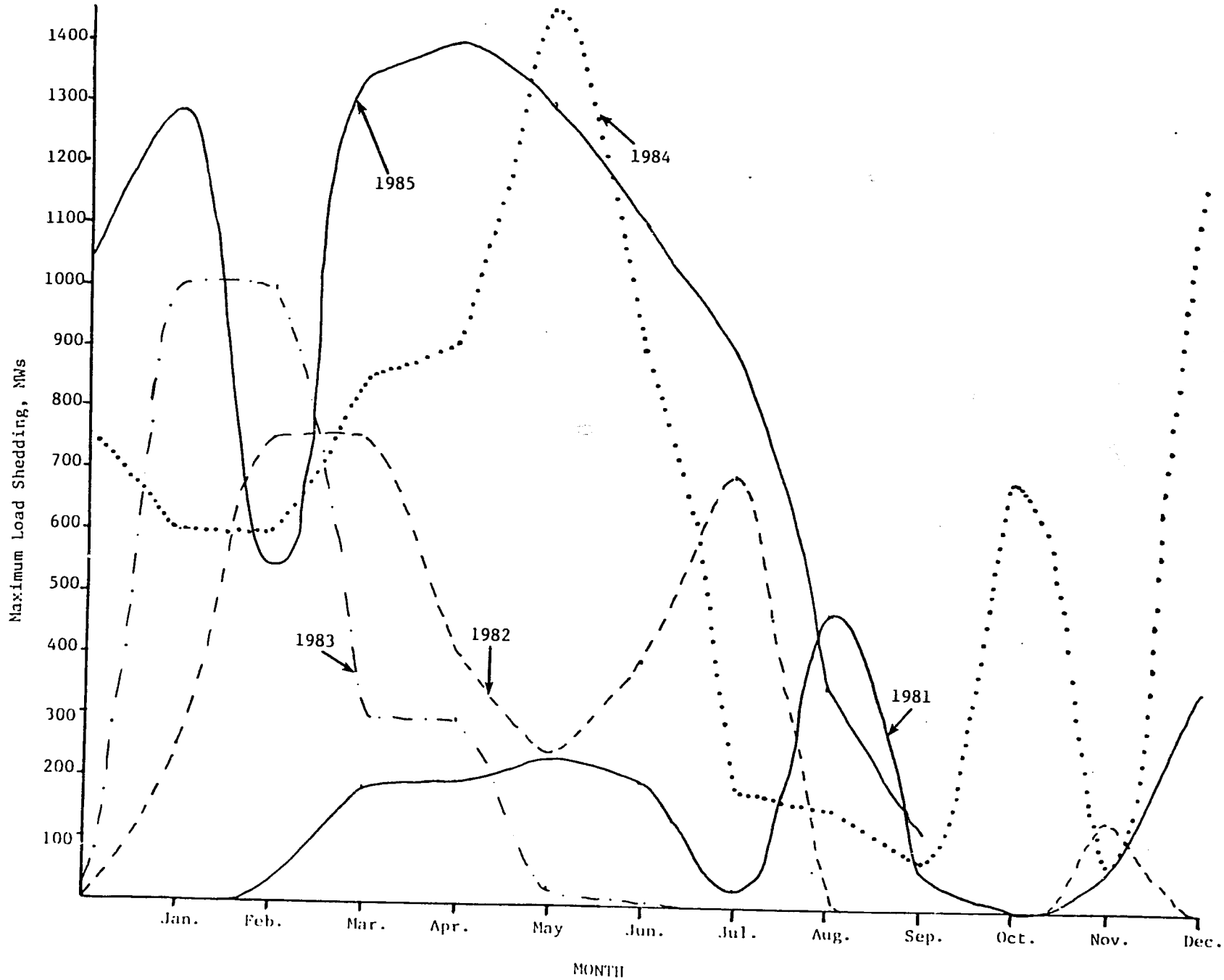



Exhibit 4.1 Actual Load Shedding on Water Power System

by the private sector. However, implementing and expanding the policy will require establishing a staff organization which can

- o undertake analyses in order to establish specific buyback provisions which account for such factors as:
  - seasonal availability of power
  - annual capacity factor
  - geographical location
  - fuel/energy source
  - timing of implementation

- o assess longer term utility capacity needs, expansion plans, and demand growth in order to define rationale long term strategies for the role of the private sector generators.

- o define technical interconnect requirements which ensure the safety at utility maintenance personnel and the integrity of the quality of utility power.

The organizational aspects of implementing the policy will be absolutely critical to encouraging timely responses by the private sector. Long delays in responding in a constructive manner to proposals due to inadequate staffing and lack of policy direction will discourage private initiative and delay the installation of systems important for reducing power generations shortfalls.

## 4.3 LONG TERM STRATEGY

Related to the above, the economics of power generation and use in Pakistan are quite complicated and will change over time as both demand and generator capacity increases. The power shortage is so large near term that any and all power sources brought on by the private sector would be important contributions. However, the GOP will need to quantitatively address longer terms role of private sector power in the generating mix and how this role might change in time as capacity needs change. It is likely, for example, that capacity brought on line early while capacity shortfall, are very large will have more value than capacity brought on line at a latter date. Utility buyback rates should reflect this possibility in order to accelerate early entry by the private sector.

## 4.4 DORMANT GAS

As indicated in Section 3, one of the largest potential sources of power generation could be that associated with the use of the low Btu gas in the "dormant" gas held to gas turbine generating facilities. These gas fields are under the control of the OGDC and, to date, the private sector has not had access to the fields for development purposes. This reflects both the reluctance of the OGDC to provide concessions to the private sector for these resources and the heretofore lack of specific interest by the private sector in their development since the gas has limited economic value except for use in power generation.

Significant policy changes will be required to accelerate the development of this resource by the private sector for power generation:

- The GOP will have to develop concession policies for the fields which reflect the value of gas for power generation which still result in attractive terms for both the government and private investors.

- The Private Sector Power Policy will have to be expanded to include power generation from low Btu gas.

## 4.5 POLICY EXPANSION

The current policy statement specifically refers to oil and coal based power generation. This reflects the perception that power facilities using the fuels can be implemented in a relatively short period of time in large increments (50 MW+) and thereby significantly mitigate the pressing power shortage problems.

As noted in section 3, however, substantial potential for privately financed power also exists with low Btu gas, biomass resources and hydropower in the near term and possibly renewable in the longer term. Furthermore, these energy sources are indigenous and their use should be encouraged preferentially as compared to imported oil. Also, the economic analyses of Section 3 indicates that their economics may in many cases be more favorable than oil fired facilities which would provide additional incentives to private capital.

It is important that the stated intent of the GOP to expand the policy to other energy sources be followed up in a timely manner so that private ventures can proceed to assess and plan projects using the full range of energy resources with a high degree of confidence.

The current policy also emphasizes an approach where the GOP specifies locations , capacities, and fuel types for those power plants for which private sector proposals are solicited. This approach may be appropriate in some cases for larger facilities where utility system balance, access to high voltage transmission lines, and/or regional power needs are impacted. It is probably too prescriptive, however, to encourage a broad range of private sector responses to the policy. The policy should, therefore, be modified, at least for smaller capacity units, to actively encourage proposals at sites and using technologies which are selected by the private sector for economic reasons.

## 4.6 CAPITAL RESOURCES/AVAILABILITY:

As indicated in Section 3, the cost of installing up to 2,000 MW of private sector capacity over the next 5 - 10 years could be in excess of $2 Billion or approximately $260 million on an annual basis. Roughly 30 - 40% of this would be in the form of equity capital with the remainder debt financing.

Discussions with private sector organizations which have submitted power proposals and financial organizations (development banks, etc.) indicate that sufficient capital is probably available for several hundred MW of capacity using some combination of internal company resources, vendor financing of equipment, capital raised via public stock offerings, and the banking system. For example, none of the current major proposals, such as those for Hub-Chowki, are contingent upon financial resources not already available to the proposing parties.

It appears, therefore, that implementation of early projects up to several hundred MW of capacity per year can be done with available capital resources.

It is not clear, however, that sufficient capital would be available for a vigorous, near term, expansion of private sector power generation under terms (interest rates, loan durations, etc.) which could realistically lead to attractive business opportunities. For example, the lower cost financing available through such mechanisms as vendor credits is often of relatively short duration (5 - 8 years) which is inconsistent with the capital needs of power sector projects. The issue of capital availability and its terms of availability requires an in depth review.

## 5.0 CONCLUSIONS/RECOMMENDATIONS

### 5.1 CONCLUSIONS

The prospects for mobilizing private capital for the construction and operation of power plants in Pakistan appears very promising given the policy orientation of the GOP to encourage such developments. For this potential to be realized, it will be necessary to:

- Establish an institutional capability to implement the private sector power policy expeditiously and to expand its range of applicability.

- Interpret the policy constructively so that the rates offered private investors are realistic while still protecting the interests of the GOP and the public.

In addition to the above, it may be necessary to establish a "financial window" which will allow the private sector to readily access foreign exchange and finance projects on terms as favorable as those available to the GOP itself. The need for the financial window is not well quantified and a significant level of private sector participation can probably be expected based on available financial resources assuming the other conditions are satisfied.

The privately funded power systems which appear to be most likely to be financially attractive are:

- Diesel power units (using lower cost heavy fuels)
- Gas turbines based in the use of the low Btu gas fields (UCH, etc.)
- Small scale hydro units
- Biomass fired steam units

Small coal fired plants are also of interest - particularly to the existing coal mining industry. However, small coal fired facilities would probably have higher generating costs than the above options and would, therefore, require higher utility buyback rates to be financially attractive.

The use of the low BTU gas fields offers the most potential based on the use of indigenous energy resources with an installed capacity of over 1000 MW possible based on what many in the industry feel is a relatively conservative estimate of gas reserves. The timely expansion of the policy to facilitate private sector access of the dormant gas fields to the private sector for power generation purposes is, therefore, an important element in expanding power capacity.

Donor support in accelerating on updated definition of gas held reserves could help support such a policy environment.

### 5.2 RECOMMENDATIONS

The GOP with donor support should move expeditiously to implement the intent of the Private Sector Policy Statment so that additional power generation

capacity can be added to the system using private capital. The program should include both short term actions to implement early projects and longer term programs to develop appropriate implementing organization and more detailed policy guidelines so that potential private sector investors can operate within a predictable and constructive framework.

Specific action steps which should be considered include:

1. Hub Chowki Support

An acid test of the GOP commitment to the Private Sector Policy Statement will be how it responds to the existing and likely subsequent proposals for a power plant at Hub-Chowki. It is important that the response to these proposals install a sense of confidence in the private sector that proposals will be dealt with expeditiously and that reasonable utility buyback provision will be offered. Consequently, the GOP with appropriate donor support should move quickly to implement the Hub Chowki power project within the guidelines set forth in the policy statement.

2. Organizational Development

The implantation and expansion of the private sector power policy will require establishing an organization which can analyze utility expansion plans, establish buyback provisions consistent with national needs, and expand the policy to deal with various energy sources. The GOP with donor support should move to establish such an infrastructure such that decision making responsibility is at a level where an appropriate balance of the interests of the private sector investors, national utilities, and the public can be established.

3. Dormant Gas Fields Associated Gas Potential

The "dormant" gas fields and to a lesser degree associated gas represent a major opportunity for expanded power generation using indigenous resources. Consequently, accelerating the use of these resources is a high priority project which calls for technical support to the GOP in assessing the potential for the low BTU gas for power generation and defining program options for involving private capital in their development. Subsequent donor support could include helping to verify field reserves to facilitate establishing concessional agreements between the GOP and private investors.

4. Long Term Policy Definition

The initial policy statement provides general guidance on the GOP approach to encouraging private sector participation in power generation. In parallel with Item 2 above, this policy should be expanded to apply to other energy sources (other than oil and coal as is now the case) and, with appropriate analytical backup, provide more quantitative detail on buyback provisions in order to establish a predictable environment for potential private sector investors. During the period when the GOP infrastructure is being developed, donor organization should assist the GOP in establishing a longer range policy for private sector power based on detailed analyses of power needs, and their seasonal and regional variations.

**GOVERNMENT OF PAKISTAN**
**PLANNING AND DEVELOPMENT DIVISION**
**SUMMARY FOR ECONOMIC COORDINATION COMMITTEE**

Subject - Private Sector Induction in the Power Generation

1. On a Summary submitted by the Ministry of Water and Power, the ECC decided to constitute a Committee to resolve the basic issues involved in the induction of private sector in power generation.

2. A meeting of Committee was held on 14th July, 1985 (list of participants attached).

3. Before setting out the recommendations of the Committee, it might be useful to consider the rationale of private sector participation in power generation.

Firstly, inadequate investment in power has been the principal reason for recent power shortages. As funds for public sector investment will continue to be less than the requirements in the forseeable future, it appears desirable to mobilize private resources for development of the power network.

Secondly, WAPDA is burdended with manifold responsibilities and is examining ways of decentralization. Privately operated generation units will relieve WAPDA of some of its future day to day responsibilities.

Thirdly, power generation is a convenient point for inducting private participation. In the light of experience gained, the role of private enterprise in the development of the power system could be enlarged.

4. It was agreed to recommend the following procedure for induction of private enterprise in bulk power generation:

I. Location and Capacity

(a) The Ministry of Water and Power will determine, in the context of agreed medium and long-term plans, the location and capacities for thermal generation suitable to system conditions, and invite private sector to install and operate them.

(b) The Ministry of Water and Power may also entertain proposals made by private enterprise, on their own initiative, and consider them in the context of the agreed medium and long-term plans.

II. Bulk Price

(a) The Ministry of Water and Power will calculate the bulk purchase price of electricity for a Power Station, at a specified location, on the basis of the cost of production, if the investment were to be made by WAPDA or KESC.

(b) In determining the bulk price, a suitable return on equity will be taken into consideration. The rate of return on equity, would be fixed in consultation with Finance.

(c) No fixed return will be guaranteed to the private entrepreneur. The guarantee will be only for price and quantity of energy to be purchased.

(d) Where the station is located at a distance from the transmission system, a suitable discount for transmission costs may be provided.

(e) The bulk tariff will be worked out on the basis of 60 percent annual plant factor. A purchase at 60 percent annual plant factor would be guaranteed by WAPDA/KESC. Suitable

penalty clause applicable to both the purchaser as well as to the supplier of electricity will be incorporated in the contract to ensure that the purchases and sales do not fall below the minimum, except by mutual consent.

(f) WAPDA/KESC would have the right to purchase power, over and above the 60 percent annual plant factor, at the agreed price, and the private operator would not unreasonably withhold the supply.

(g) The bulk purchase price may be in two parts:

(i) The base price for energy.

(ii) The cost of fuel.

(h) A suitable escalation will be provided for the basic price of energy, taking into consideration key inputs only e.g., labour. The fuel component will be directly linked with the cost of fuel which will be the prevalent competitive market price. A formula for this linkage, assuming certain plant efficiency, would be worked out.

III. Inviting of bids and acceptance of offers

(a) Private entrepreneurs will submit bids for the capacity and location, in term of bulk price of power desired by them. Where the bulk price offered by the entrepreneur is lower or equal to the price, computed in accordance with para (II) above, the Ministry of Water and Power may accept the offer. Where the price bid is higher than the bulk price computed under para (II) above, the Ministry of Water and Power may either reject the offer or seek sanction of ECC, giving reasons for accepting the higher price.



40

(b) Since timely installation and proper operation of the plant is of importance, a bank guarantee will be taken from the private entrepreneur to ensure recovery of penalty in case of default.

(c) The financial position, experience and other credentials of the applicant will be examined while considering his offer.

(d) Bids will be invited by WAPDA/KESC under the aegis of Ministry of Water and Power. The agreement with the private sector will be at two levels i.e., between WAPDA/KESC and private sector party and between GOP and private sector with GOP as underwriter.

IV. Tax and Fiscal Status:

(a) The power station would be treated, as an industrial establishment, for purposes of tax, and other fiscal regulations.

(b) Concessions available for large scale industry in specified areas will be available to the power plant as well, and will be reflected in the determination of the bulk rate.

(c) The entrepreneur may raise local and foreign finance in accordance with regulations applicable to industry, in general.

V. Labour Laws - The consensus was that the essential services Act may be made applicable to the labour working in the privately owned power house, since the same is applicable to the Government owned power house. The Ministry of Labour, however, was not in favour of this proposal and they advocated that the existing laws applicable



41

to industry should be applied to the privately operated power house as well.

VI. Fuels- Entrepreneurs should be restricted to two specified fuels, namely oil and indigenous coal. Other fuels may be added later. Bids can be invited for plants based on specific fuel/fuels (HSD, F.O., LDO or Coal) depending upon location and available time for construction. Infrastructure requirements for fuel transportation will be kept in view while evaluating bids.

VII. Inspection and Monitoring- In order to ensure that power plant is being properly maintained/renovated and proper standards are being observed, periodic inspection and monitoring be ensured in the contract.

5. The Summary has been prepared in consultation with Ministries of Finance, Water and Power, Petroleum and Natural Resources and Labour, Manpower and Overseas Pakistanis.

6. The proposals made in paragraph 4 are submitted for approval.

7. The submission of the Summary has been authorized by the Minister of Planning and Development.

V.A. JAFAREY,
Secretary General

Islamabad, the 22 August, 1985.



.42

## LIST OF PARTICIPANTS

**Planning and Development Division**

1. Mr. V.A. Jafarey,
   Secretary General.

2. Dr. Ghulam Rasul,
   Joint Chief Economist.

3. Mr. Ashfaq Mahmood,
   Chief.

4. Mr. Ghulam Haider,
   Deputy Chief

**Ministry of Water and Power**

5. Mr. Muhammad Akram Khan,
   Additional Secretary (Power).

**Ministry of Petroleum and Natural Resources**

6. Mr. Ashiq Ali,
   Director General.

7. Mr. Muhammad Iqbal Qureshi,
   Director.

**Ministry of Labour, Manpower and Overseas Pakistanis**

8. Mr. S.S. Huda,
   Joint Secretary.

**Enerplan Project**

9. Mr. Sadaqat Hasan Mir,
   Managing Director.

10. Mr. M. Izharhul Haque,
    Deputy Managing Director.

**Karachi Electric Supply Corporation**

11. Mr. S.M. Arshad Bokhari,
    Managing Director.

12. Mr. S. Hashim Abbas,
    Project Engineer.



43

In early 1985 the Karachi Electric Service Company (KESC) received a proposal from the Pakland Cement Company for a 120 MW oil-fired diesel engine power plant to be located at Hub Chowki. At a meeting in October 1985, the Secretary of Water and Power requested that the USAID mission team focus attention on the Hub Chowki Project. This project is of high priority to GOP. The USAID mission team was requested to provide the following specific inputs:

- A draft announcement for the Hub Chowki project soliciting expressions of interest from foreign and local private-sector organizations.
- A review of the feasibility studies and opinions on how the purchased power rates should be determined.
- Guidance on the process (e.g., schedule, steps) to stimulate the development of Hub Chowki by the private sector.

**Pakland Cement Company's Proposal**

In early 1985 the Pakland Cement Company submitted a proposal to KESC to construct and operate a central station power plant at Hub Chowki. The 120-MW power plant would consist of six 20-MW medium-speed diesel engines using furnace oil as fuel. The proposed power plant would operate in a baseload configuration, providing all generated electric power to KESC at a price that would allow Pakland Cement Company to achieve an acceptable return on its equity. The expected startup date for the diesel engine power plant was estimated at less than 2 years from the time that successful negotiations had been completed with KESC. The scope and nature of the proposed project from Pakland Cement Company had been in part dictated by an equivalent project successfully operating in Sri Lanka. This proposed project would represent a major step in the company's strategy to diversify into the energy field, while providing benefits to Pakistan.

## Project Evaluation

In conducting its evaluation of the proposed project, the team met with senior managers from both KESC and Pakland Cement Company to review the technical features and expected economic performance of the diesel engine power plant. However, the primary source for the evaluation was the proposal submitted by Pakland and the subsequent assessment conducted by KESC.

The Pakland Cement Company estimated a selling price for electricity generated by its proposed 120-MW diesel engine central station power plant of 87 Ps./kWh (or U.S. 5.5¢/kWh). This price is based on an assumed "tax free" return on equity of 20 percent and a 70/30 debt-to-equity ratio. In addition, Pakland assumed debt financing of 14 percent, which is consistent with normal commercial financing rates available to the industrial sector in Pakistan. The capital costs, non-fuel operating and maintenance costs, and efficiencies assumed by Pakland Cement Company in preparing its proposal appear reasonable ,based on comparisons with recent World Bank studies and discussions with a U.S. firm installing diesel engine power plants in the United States.

The baseline assumptions used in the evaluation are displayed in Exhibit B.1. Using these assumptions, the team determined the unit cost of electricity production in the first year of operation. In addition, it estimated how this cost would change with changes in two key parameters affecting the overall financial performance of the proposed project: income tax rate and annual capacity factor. The current tax laws in Pakistan provide the same types of deductions for determining taxable income as currently allowed under U.S. federal tax codes, i.e., depreciation and debt interest expenses. As shown in Exhibit B.2, the unit cost of electricity production varies between Rs. 0.78/kWh and Rs. 0.90/kWh and is greater when income taxes are included than not, despite the large deductions resulting from depreciation and debt interest. In contrast, increasing the annual capacity factor of the power plant results in a significant reduction of the unit production cost of electricity.

## Conclusions and Recommendations

Given the estimated marginal cost of electricity generation currently incurred by KESC of about Rs. 2/kWh, the potential

Exhibit B-1

## HUB CHOWKI

## BASIC ASSUMPTIONS

| | | |
|---|---|---|
| **A. Technical** | | |
| 1. | Plant gross output[1] (20 MW x 6) | 120 MW |
| 2. | Annual power generation[2], net | 630.72 GWh |
| 3. | Annual power generation[3], gross | 660.44 GWh |
| 4. | Specific fuel consumption, gross, furnance oil | 215 gr/kWh |
| 5. | Specific fuel consumption, diesel oil[4] | 185 gr/kWh |
| 6. | Specific lube oil consumption, gross | 2gr/kWh |
| **B. Economic** | | |
| 7. | Plant service life | 20 years |
| 8. | Capital costs, before duties [5] | Rs. 10,400/kW |
| 9. | Percent foreign exchange | 70 |
| 10. | Furnace oil Price | Rs. 1,415/Mtonne |
| 11. | Diesel oil price | Rs. 3,220/Mtonne |
| 12. | Lube oil price | Rs. 12,000/Mtonne |
| 13. | Consumption OEM[6] | Rs. 0.128/kWh |
| **C. Financial** | | |
| 14. | Depreciation | 20 years, S. Line |
| 15. | Interest or foreign debt | 11%, 20 years |
| 16. | Interest or local debt | 14%, 9 years |

Source: Pakland Cement

Notes:

1. i.e., before auxiliaries consumption
2. 120,000 X 8,700 X .6 (net capacity factor = 60%)
3. assuming 4.5% self consumption for auxiliaries
4. for start-up
5. construction period of 24 months, based on World Bank guidelines
6. includes G&A

Exhibit B-2

HUB CHOWKI PROJECT
Cost of Production in First
Year of Operation (Rs. million)

| Item | CF=60 % TR=0 % | CF=60% TR=40 % | CF=75 % TR=0 % | CF=75 % TR=40 % |
|---|---|---|---|---|
| Operating Expenses | | | | |
| Fuel Costs | | | | |
| Furnance Oil | 194.9 | 194.9 | 243.6 | 243.6 |
| Diesel Oil | 11.8 | 11.8 | 14.7 | 14.7 |
| Lubrication Oil Costs | 15.8 | 15.8 | 19.8 | 19.8 |
| Other Operating & Maintenance Costs | 84.5 | 84.5 | 84.5 | 84.5 |
| Depreciation Expenses | 62.4 | 62.4 | 62.4 | 62.4 |
| Interest Expenses | | | | |
| Foreign Debt Interest | 37.8 | 37.8 | 37.8 | 37.8 |
| Local Debt Interest | 20.7 | 20.7 | 20.7 | 20.7 |
| Total Expenses | 427.9 | 427.9 | 483.5 | 483.5 |
| Net Equity Investment | 312.0 | 312.0 | 312.0 | 312.0 |
| Returns on Equity (20% after tax) | 62.4 | 62.4 | 62.4 | 62.4 |
| Revenue Requirement | 490.3 | 570.9 | 545.9 | 626.5 |
| Electricity Sold (GWH) | 630.7 | 630.7 | 788.4 | 788.4 |
| Unit Production Cost (Ps/kWh) | 77.7 | 90.5 | 69.2 | 79.5 |

CF = Capacity Factor
TR = Tax Rate

Source: Hagler, Bailly & Company

benefits of the proposed Hub Chowki project or any other well-conceived private-sector power generation project to KESC and its customers could be dramatic. However, several major issues need to be reconciled:

- The preferential access of KESC (and WAPDA) to concessionary financing, which results in low "calculated" power generation costs against which the private sector must compete.
- The tax status of profits to the private sector from central station power generation investments. The private sector in Pakistan typically requires a minimum of 20-percent return on equity after taxes.
- The procedures in calculating a price for purchased power that incorporates the scheduled additions of Bin Qasim Units 3 and 4 beginning in 1989, and the highly seasonal variation in WAPDA's needs for purchases of excess electric power from KESC.

However, all of these issues are secondary to the key issue of deciding if the 120-MW Hub Chowki project is the "best" solution to the short-term need of KESC for additional electric power.

The GOP has drastically curtailed the use of pipeline natural gas for power generation. However, two sources of natural gas that do not fall under this policy include:

- "Dormant gas fields," that refer to eight gas fields identified over the last 30 years containing low-quality gas that cannot be used in pipelines.

- Both associated and non-associated gas recently identified at oil drilling concessions by Union-Texas, Occidental, and OGDC. These gas supplies are often found in modest quantities, have short lives and are not near the pipeline, so their most effective use would in many cases be for power generation.

## A. DORMANT GAS FIELDS DESCRIPTION

Eight gas fields in Pakistan are referred to as "dormant" since, until recently, nothing was done to develop them since their discovery in the 1950s and 1960s. These fields are currently held by the OGDC. Brief descriptions are presented below:

### i) ZIN

A small quantity of gas at low pressure was found in Sui Main Limestone at a depth of 2,973 feet in an exploratory well that was drilled by Pakistan Petroleum Limited (PPL) in 1953 on the basis of geologic survey. This field is located in Kohlu Agency, Baluchistan. It contains 46 percent methane, 8 percent Nitrogen, 45 percent carbon dioxide and traces of hydrogen sulfide gas. During testing the well gave an absolute open flow of 3 million cubic feet of gas per day (mmcfd) after acidization. The recoverable reserves reported by PPL on the basis of single well are 0.1 trillion cubic feet (tcf), with a reservoir pressure of 279 psig.

ii) UCH

The gas was discovered in Sui Main Limestone at a depth of 3,985 feet in an exploratory well drilled by PPL in 1954 on the basis of a geologic and seismic survey. The field is located in Nasirabad district, Kohlu Agency, Baluchistan. The gas contains 27 percent methane, 25 percent nitrogen, 46 percent carbon dioxide and traces of hydrogen sulfide gas. During testing, after acidization, the absolute open flow was about 140 mmcfd. The recoverable reserves estimated on the basis of a single well are 2.5 tcf with reservoir pressure of 2,016 psig.

iii) KOTHAR

This field is located in Dadu District, Sind. It is a surface anticline. An exploratory well was drilled by OGDC on the basis of geologic and seismic survey. The gas was discovered from Sandstone of Ranikot at a depth of 4,960 feet. On testing, the well showed an absolute open flow potential of 12 mmcfd. The estimated reserves are 0.025 tcf.

(iv) JANDRAN

This field is located in Kohlu Agency, Loralia District, Baluchistan. It is a surface anticline. An exploratory well was drilled by AMOCO on the basis of a geologic survey. The gas was discovered from Sandstone of Nispha formation of Cretaceous. The absolute open flow potential of four zones is about 14 mmcfd. The estimated recoverable reserves on a single well basis are 0.015 tcf. Jandran is located in a remote, sensitive area where security measures are not available; therefore, this field has remained unexplored.

v) LOTI

The Loti gasfield is located in Dera Gugti Agency, Baluchistan. The Loti structure is a large anticline spread over an area of 125 square kilometers. The structure was delineated after conducting an extensive geological and seismic survey. The well was drilled down to a depth of 2,252 meters. On production testing of the well, good quality gas in commerical quantity was encountered in Pab and Sui Limestone formations. The tests have established the well's producibility as 8-14 (mmcfd) with heating values ranging between 801 Btu/cf and 941 Btu/cf. On

completion of Phase I, the field will be capable of producing 30 mmcfd. The field is being appraised by OGDC.

vi) KHAIRPUR

The Khairpur gas field is located in Sind Province. The structure was established on the basis of a gravity and seismic survey. The gas is found in Sui Main Limestone at a depth of 2,020 feet with a reservoir pressure of 953 psig. The estimated recoverable reserves are 1.0 tcf. The gas contains 12 percent methane and 88 percent inert gases. Hydrocarbon Development Institute of Pakistan (HDIP) carried out a study of the Khairpur field through an RTM engineer, who has recommended that Khairpur gas may be used to generate electricity. The case is under submission to the Ministry of Water and Power for its consideration.

vii) PANJPIR

Panjpir gas field is located in Multan, Punjab Province. The structure measures about 20 square kilometers. Results of production testing carried out so far indicate that the discovery well can produce 14 mmcfd from three zones, and on completion of Phase I, the field will produce over 40 mmcfd.

viii) NANDPUR

This gas field is located in District Multan. The well was drilled to a depth of 2,100 meters. Upon testing of the well, gas in commercial quantity was found in Jurassic formation at interval 2,070-1,892 meters in the first zone, which produced gas at the rate of 10.00 mmcfd; the second and third zones in Cretaceous formation produced gas at the rate of 7.71 mmcfd and 8.3 mmcfd, respectively. Upon completion of the Nandpur Development project, production of 60 mmcfd with 40 percent combustible content is expected.

## B. FIELD STATUS

Based on recent discussions (October 1985) with the OGDC, these fields can be divided into four categories:

Group 1: Dedicated
Two of the fields, Kothar and Loti, have already been or are in the process of being developed and the gas dedicated to the pipeline.

Group 2: Remote
Two of the fields, Zin and Jandran, are located in remote regions that would make their appraisal and development a lengthy and costly process. Appraisal alone could take 2-3 years. Also, the remoteness of the locations complicates connection of power units to the grid.

Group 3: Committed to WAPDA
Over the past year the OGDC drilled two additional wells at Punjpir and Nandpur. At both sites there is sufficient gas to support about 25 MW of generating capacity. It has been decided by the GOP that WAPDA will have access to this gas.

The Planning Commission has asked for additional appraisal work at both these fields consisting of additional wells and seismic surveys. The new wells could be completed within 18 months and readily converted into production wells.

Funds for materials required by these wells is included in the World Bank Energy Sector Loan (ESL), which provides $52 million for 14 wells.

Group 4: Other
Two of the fields, Uch and Khairpur, are currently sitting idle and there are no firm plans for their development by OGDC or anybody else, despite their proximity to Karachi. Appraisal of these fields would only take 12-18 months. However, OGDC has no resources at present to undertake the necessary well drilling and seismic work.

## C. POTENTIAL AT UCH/PRIVATE-SECTOR PROPOSALS

Of the so-called dormant gas fields, Uch probably has the greatest potential and has elicited some interest in development by the private sector. This interest resulted in a preliminary proposal in 1984 from a firm called Petrocon Ltd of Lahore prepared by Mr. A.V. Loan, Managing Director.

This proposal, "Development of Uch Gas Field," describes the required field delineation and development work to deliver gas to a combined cycle power plant. It also includes above-ground gas treatment facilities for removing of some the carbon dioxide and hydrogen sulfide.

Main points raised in the proposal include:

- The gas reserve estimate of Uch, at 2.5 tcf, is probably conservative, possibly by a factor of 2.

- Using even very conservative estimates of gas reserves (2.5 tcf), the Uch field can support 300-700 MW of power generation over a period of 3 years.

- The estimated cost for the field development is about U.S. $126 million (in foreign currency) and Rs. 530 million (in local currency).

- The cost of gas over the first 10 years, when the loans are amortized, will be about Rs. 15.5 ($1.00) per mcf (roughly $2 per mmBtu based on the upgraded gas heat content).

- There is sufficient know-how, skilled labor, and capital in Pakistan to undertake the development work, particulary if it is done through joint ventures with foreign companies, several of which have shown an interest.

This proposal further reinforces the contention that a change in policies that would allow private-sector access to Uch is critical if private capital is to be used to significantly expand the country's power generating capacity.

# APPENDIX D LIST OF CONTACTS 1

## SUMMARY OF TEAM MEETINGS

| DATE | PERSON VISITED | RANK | ORGANIZATION |
|---|---|---|---|
| OCT.13 | MR. SADAQAT HASAN MIR | MANAGING DIRECTOR | ENERPLAN |
| | MR. M. IZHARHUL HAQUE | DEPUTY DIRECTOR | |
| OCT.14 | MR. J.G. FOSTER | FIRST SECRETARY (DEV). ENERGY SECTOR | CANADIAN EMBASSY, ISLAMABAD |
| | & MR. JOHN M. MUNDY | FIRST SECRETARY (COMMERCIAL) | -DO- |
| | MR. CHARLES MOSELEY | | USAID/ISLAMABAD |
| | MR. JAMES BEVER | | USAID/ISLAMABAD |
| | MR. JOHN MORGAN | | USAID/ISLAMABAD |
| OCT.15 | MR. AKRAM KHAN | SECRETARY FOR POWER | MINISTRY OF WATER (POWER), ISLAMABAD |
| | MR. GAUHAR ALI | ENERGY PROJECTS ADVISOR | WORLD BANK/ISLAMABAD |
| | MR. M.S. BUTT | ENGINEERING ADVISOR (POWER) | OFFICE OF THE CHIEF ENG. ADVISOR, ISLAMABAD |
| | | | MINISTRY OF WATER (POWER), ISLAMABAD |
| | MR. WAJAM HAIDER | CHIEF, CORPORATE PLANNING | OGDC |
| | MR. MIRZA | SECRETARY | MINISTRY OF PRODUCTION, ISLAMABAD |
| | MR. ASHFAQ MAHMOOD | HEAD, ENERGY | PLANNING COMMISSION |
| | DR. S.H.R. ZAIDI | SENIOR TECHNICAL MANAGER | FAUJE FERTILIZER CO., RAWALPINDI |
| OCT.16 | KHAWAJA DAWOOD | GENERAL MANAGER (GENERATION) | WATER & POWER DEVELOPMENT AUTH, ISLAMABAD |
| | MR. M. ARSHAD | CHIEF ENGINEER (PLANNING) | (WAPDA) LAHORE |
| | MR. SHAKOUR AHMAD | CHIEF ENGINEER GENERATION (THERMAL) | -DO- |
| | MR. JEHANGIR | DIRECTOR, TARRIFS | -DO- |
| | MR. JAFFERY | CHIEF ENGINEER (HYDEL) | -DO- |
| | MR. M. AMANULLAH | GENERAL MANAGER | DAOOD - HERCULES, LAHORE |
| | MR. R. ERNSTING | CONSERVATION SPECIALIST | EBASCO |
| OCT.17 | MR. RIAZ SAMEE | CHAIRMAN (POWER GROUP) | LAHORE CHAMBER OF COMMERCE & IND. |
| | MR. SHARIF | JOINT SECRETARY | -DO- |
| | MR. MIAN M. AKHTAR | SECRETARY IRRIGATION PUNJAB | GOVT. OF PUNJAB. DEPARTMENT OF |
| | | | IRRIGATION & POWER, LAHORE |
| | RAJA SAEED AKHTAR | GENERAL MANAGER DISTRIBUTION | WAPDA, LAHORE |
| | MR. ABDUL HAYEE | FINANCE MANAGER | RUPALI POLYESTER, LAHORE |
| | REPRESENTATIVES FROM | | ITTIHAD CHEMICAL INDUSTRY, LAHORE |
| | | | RAVI RAYON MILL, LAHORE |
| | MR. DON RUOTOLO | GENERAL MANAGER | EBASCS TEAM, LAHORE |
| | DR. Z. FIKRI | MANAGING DIRECTOR | FACE LTD, LAHORE |

## SUMMARY OF TEAM MEETINGS (CONTINUED)

| DATE | PERSON VISITED | RANK | ORGANIZATION |
|---|---|---|---|
| OCT.18 | DR. MASOOD AHMED | HEAD, ENERGY SYSTEMS DIVISION | ZELIN LTD, KARACHI |
| OCT.19 | MR. ARSHAD BOKHARI | MANAGING DIRECTOR | KESC, KARACHI |
| | MR. BASHIR A. CHOUDRY | CHIEF ENGINEER | KESC, KARACHI |
| | MR. HASHIM ABBASS | PROJECT ENGINEER | KESC, KARACHI |
| | MR. ASHRAF | CONTROLLER FINANCE | KESC, KARACHI |
| | MR. AKHTAR HUSSEIN | MANAGING DIRECTOR | PAKISTAN ENGINEERING SERVICES LTD, KARACHI |
| OCT.20 | MR. J.W.J. HARDY | VICE PRESIDENT | UNION TEXAS, KARACHI |
| | MR. KENNETH WHITE | V.P (COUNTRY MANAGER) | CHASE BANK, KARACHI |
| | MS. MARTHA CUSHING | PROGRAM ASST. | USAID, KARACHI |
| | DR. SHAHID K. HAK | PROGRAM MANAGER | ENAR PETRO TECH |
| | MR. M SIDDIQI | MANAGING DIRECTOR | PAKLAND CEMENT LTD, KARACHI |
| | MR. MUKHTAR BAIG | GENERAL MANAGER | HABIBULLAH MINES LTD., ISLAMABAD |
| OCT.21 | MR. ABDUL KARIM | PRESIDENT | KARACHI CHAMBER OF COMMERCE & IND |
| | MR. UNVER ISA | PRESIDENT | DARWAZA POWER PLANT |
| | MR. J. ABBAS ZAIDI | SENIOR VICE PRESIDENT | NATIONAL DEVELOPMENT LEASING CORPORATION, KARACHI |
| OCT.22 | MR. RIAZ SAMEE | CHAIRMAN, POWER SECTOR | LAHORE CHAMBER OF COMMERCE & IND., LAHORE |
| | MR. STUHLMAN | CHIEF CONSULTANT MANAGEMENT | EBASCO/AEPES/ITECO, LAHORE |
| OCT.23 | MR. CHAUDRI QASIM | CHIEF EXECUTIVE | CHAUDRI CABLES LTM, ISLAMABAD |
| | MR. THOMAS BRADY | PRESIDENT MANAGER | OCCIDENTAL OF PAKISTAN, ISLAMABAD |
| OCT.24 | MR. AKRAM KHAN | SECRETARY, POWER | MINISTRY OF WATER AND POWER, ISLAMABAD |
| | MR. EUGENE STAPLES | DIRECTOR | USAID, ISLAMABAD |
| | MR. ASHFAQ MAHMOOD | HEAD, ENERGY | PLANNING DIVISION, ISLAMABAD |
| | MR. M.S. BUTT | ENGINEERING ADVISOR | MINISTRY OF WATER AND POWER, ISLAMABAD |
| | MR. SADAQAT HASAN MIR | MANAGING DIRECTOR | ENERPLAN, ISLAMABAD |
| | MR. M. IZHARHUL HAQUE | DEPUTY MANAGING DIRECTOR | ENERPLAN, ISLAMABAD |

APPENDIX E:

PRIVATE SECTOR APPEARING IN POWER POLICY ANNOUNCEMENT

APPEARING IN

PAKISTAN TIMES SATURDAY, NOVEMBER 23, 1985

GOVERNMENT OF PAKISTAN

MINISTRY OF WASTE AND POWER

# A N N O U N C E M E N T

## PRIVATE SECTOR INDUCTION IN POWER GENERATION

To complement government resources and WAPDA and KESC efforts to provide adequate supply of power to the country, the Government has formulated a new policy to encourage private sector participation in power generation for sale of electricity to the national grid.

According to the policy the Government will determine in the context of agreed medium and long-term plans, the location and capacities for thermal generation plants suitable to system conditions, and invite bids from the private sector to install and operate them. Proposals made by private parties on their own initiative may also be entertained.

The general terms under which the Government will purchase power from private parties are summarized as follows.

(A) The Government will calculate the bulk purchase price of electricity for a power station, at a specified location, on the basis of the cost of production, as if the investment were to be made by WAPDA and KESC. In determining the bulk price, suitable return on equity to the private investor will be taken into consideration.

(B) The bulk tariff will be worked out on the basis of 60 per cent annual plant factor. The details will be negotiated at contract time and may include provisions for seasonal variations in capacity factor and

purchase price so that private sector power is preferentially generated to reduce those capacity shortfalls lending to load shedding. Private entrepreneur will have the choice of offering their own tariff proposal for bulk supply.

(C) A suitable escalation will be provided for the basic price of energy, taking into consideration key inputs only, E.G. Fuel, labour and spare parts.

The policy also contains provisions relative to such issues as non-performance penalty clauses applicable to both the supplier and purchasor and applying suitable discounts for transmission costs which will be applied on a project specific basis.

The general provisions relative to fiscal and tax treatment of private sector projects under this policy will be:

- The power station would be treated, as an industrial establishment, for purposes of tax, and other fiscal regulations.

- Concessions available for large scale industry in specified areas will be applicable tothe power plant as well, and will be reflected in the determination of the bulk rate.

- The private parties may raise local and foreign finance in accordance with regulations, applicable to industry in general.

This policy will initially be restricted to two specific fuels, namely Fuel Oil and Indigenous Coal. The policy may be expanded to include other energy sources at a later date.

The Government expects to announce applications of this policy through a series of specific proposal (the first of these will be for about 120 mw of capacity at a site near Karachi.