UNCLASSIFIED

AGENCY FOR INTERNATIONAL DEVELOPMENT

WASHINGTON, D.C. 20523

PROJECT PAPER

ENERGY PLANNING AND DEVELOPMENT PROJECT

391-0478

JULY 1983

UNCLASSIFIED

UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D C 20523

PROJECT AUTHORIZATION

PAKISTAN

Energy Planning and Development
Project No. 391-0478

1. Pursuant to Section 531 of the Foreign Assistance Act of 1961, as amended (the Act), I hereby authorize the Energy Planning and Development Project for the Islamic Republic of Pakistan (Cooperating Country) involving planned obligations of not to exceed Thirty Million United States Dollars ($30,000,000) in grant funds over a four (4) year period from the date of authorization, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the project. The planned life of the project is five years from the date of initial obligation.

2. The project is designed to increase Pakistan's energy self-sufficiency by assisting the Cooperating Country to formulate and implement plans and programs to assess, develop and use indigenous energy resources and to increase the efficiency of energy use. This will be accomplished by, among other things, strengthening the capability of the Cooperating Country to: (a) undertake effective integrated and sectoral analyses of energy development strategies in order to support financially sound energy policy and development planning; (b) develop programs in coal assessment, mining, and utilization; and, (c) adopt energy conservation and renewable energy technologies.

3. The Project Agreement(s) which may be negotiated and executed by the officer(s) to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority shall be subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

a. Source and Origin of Commodities and Nationality of Services

Commodities financed by A.I.D. under this project shall have their source and origin in the Cooperating Country or in the United States, except as A.I.D. may otherwise

agree in writing. Except for ocean shipping, the suppliers of commodities or services shall have the Cooperating Country or the United States as their place of nationality, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the project shall, except as A.I.D. may otherwise agree in writing, be financed only on flag vessels of the United States or the Cooperating Country.

b. Condition Precedent to the Selected Disbursement of Funds under the Energy Analysis and Manpower Development Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement of funds under this project, or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made, for the long-term general technical assistance contract, participant training and special studies under the energy analysis and manpower development component of this project, the Cooperating Country, acting through its Planning and Development Division, Ministry of Planning and Development, shall furnish to A.I.D., in form and substance satisfactory to A.I.D., documentary evidence that:

i. an administrative unit within the Planning and Development Division has been authorized and established to assume responsibility for energy analysis and manpower development activities and is being organized, staffed, and equipped; and,

ii. a Participating Agency Project Implementation Coordinating Committee has been authorized and established, its duties and responsibilities have been defined, and the Committee is being organized, staffed, and equipped.

c. Condition Precedent to the Selected Disbursement of Funds for Activities under the Coal Mine and Coal-Fired Power Generation Development Sub-Component of the Coal Resource Assessment and Development Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement of funds under this project, or to the issuance by A.I.D. of documentation pursuant to which disbursement will be made, for the coal mine and coal-fired power generation development technical assistance contract under the coal resource assessment and development component of this project, the Cooperating Country, acting

through its Planning and Development Division, Ministry of Planning and Development, shall furnish to A.I.D., in form and substance satisfactory to A.I.D., documentary evidence that:

i. a Coal Projects Department has been authorized and established to promote, plan, and manage the development and implementation of coal mine and coal-fired power generation projects within WAPDA and adequate funds have been made available for its operation;

ii. the authority, duties and responsibilities of the overall manager and the coal mine and power section managers of the Department have been adequately defined; and,

iii. an adequately trained and experienced overall manager of the Department has been appointed and persons to fill the other two managerial positions have been identified.

d. Condition Precedent to the Selected Disbursement of Funds under the Conservation and Renewable Energy Technologies Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement of funds under the conservation and renewable energy technologies component of this project, or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made, except for vehicles and household/office furniture and equipment, the Cooperating Country, acting through its Directorate General for Energy Resources (DGER) of the Ministry of Petroleum and Natural Resources and its Planning and Development Division of the Ministry of Planning and Development shall furnish to A.I.D., in form and substance satisfactory to A.I.D., documentary evidence that:

i. an adequately staffed administrative unit has been authorized and established within the DGER to manage all component activities; the authorities, duties and responsibilities of the overall manager and the conservation and renewable energy managers in the administrative unit have been adequately defined; and, an adequately trained and experienced overall manager of the administrative unit has been appointed; and,

ii. a National Renewable Energy Activities Coordinating Committee has been authorized and established and its duties and responsibilities as well as those of both its public and private sector members have been adequately defined.

e. Covenant as to Participant Training

The Cooperating Country, acting through its Planning and Development Division, Ministry of Planning and Development, and each of the participating agencies in the project, shall make every reasonable effort to require that each person trained under this project works in energy sector activities in Pakistan for not less than three times the length of time of his or her training program provided, however, that in no event shall the individual be allowed to work in energy sector activities for less than one year nor be required to work in energy sector activities for more than five years from the date of the individual's completion of training.

f. Covenant as to Activity Reports

The Cooperating Country shall furnish to A.I.D., in form and substance satisfactory to A.I.D., periodic activity reports, the requirements of which shall be set forth from time to time by A.I.D. in Project Implementation Letters. The requirements may include, but shall not be limited to providing information concerning:

i progress of each of the implementing agencies in organization, staffing and training;

ii. progress of each of the long-term technical assistance contractor teams with respect to meeting established targets in the schedules and workplans of individual advisors; effecting commodity procurements; scheduling, implementing and evaluating training programs and demonstrations; and, preparing required reports and other project documents; and,

iii. a combined summary report for the entire project.

g. Covenant as to External Evaluation

The Cooperating Country shall participate in periodic external project evaluations by assigning senior representatives of participating ministries and agencies to joint A.I.D.-Cooperating Country Evaluation Teams. Participants in project evaluations are to be individuals who are familiar with the project but who are not directly involved in its implementation.

4. Based upon the justification set forth in Annex F of the Project Paper, I hereby

(a) find that special circumstances exist to waive, and do hereby waive, the requirements of Section 636(i) of the Act;

(b) approve a source/origin/nationality waiver from Code 000 (U.S. only) to Code 935 (Free World) to permit the procurement of ten (10) right-hand drive vehicles; and

(c) certify that the exclusion of procurement of these vehicles from Free World countries other than the Cooperating Country and countries included in Code 941 would seriously impede attainment of foreign policy objectives and the objectives of the foreign assistance program.

Signature _____
M. Peter McPherson
Administrator

July 13, 1983
Date

Clearance:	Date	Initial
Charles W. Greenleaf, AA/ASIA	7/5/83	
John R. Bolton, AA/PPC	7/11/83	
Richard A. Derham, GC	7/	

SMT
GC/Asia:STisa:hp:6/22/83

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: Pakistan

3. PROJECT NUMBER: 391-0478

4. BUREAU/OFFICE: Asia — 04

5. PROJECT TITLE (maximum 40 characters): Energy Planning and Development

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 07 DD 31 YY 88

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)

A. Initial FY 83 B. Quarter 4 C. Final FY 86

8. COSTS ($000 OR EQUIVALENT $1 = Rs 13.00)

A. FUNDING SOURCE	FIRST FY 83 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	10,600	2,400	13,000	24,527	5,473	30,000
(Grant)	(10,600)	(2,400)	(13,000)	(24,527)	(5,473)	(30,000)
(Loan)	(-)	(-)	(-)	(-)	(-)	(-)
Other U.S. 1.						
Other U.S. 2.						
Host Country	-	1,075	1,075	-	6,295	6,295
Other Donor(s)						
TOTALS	10,600	3,475	14,075	24,527	11,768	36,295

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) ESF	740	878	-	-	-	30,000	-	30,000	-
(2)									
(3)									
(4)									
TOTALS				-	-	30,000	-	30,000	-

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 871 | 872 | 873 | 874 | 875 | 876

11. SECONDARY PURPOSE CODE: 752

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code: TECH

B. Amount:

13. PROJECT PURPOSE (maximum 480 characters)

To assist the Government of Pakistan to formulate and implement plans and programs to assess, develop, and use Pakistan's indigenous energy resources and increase the efficiency of energy use.

14. SCHEDULED EVALUATIONS

Interim MM 02 YY 85 | MM 08 YY 86 | Final MM 06 YY 88

15. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [X] Local [ ] Other (Specify)

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment.)

17. APPROVED BY

Signature: Donor M. Lion

Title: Director, USAID/Pakistan

Date Signed: MM 05 DD 23 YY 83

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

AID 1330-4 (9-79)

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ENERGY PLANNING AND DEVELOPMENT

391-0478

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
ADBP	Agricultural Development Bank of Pakistan
ATDO	Appropriate Technology Development Organization
BTU	British thermal unit, a measure of heat energy
CIDA	Canadian International Development Agency
DGER	Directorate General of Energy Resources
EAG	Energy Analysis Group
ECC	Economic Coordination Committee
ECNEC	Executive Committee of the National Economic Council
FAC	Transenerg - France (French Foreign Assistance Agency)
GDP	Gross Domestic Product
GNP	Gross National Product
GSP	Geological Survey of Pakistan
HDIP	Hydrocarbon Development Institute of Pakistan
IBRD	International Bank for Reconstruction and Development (World Bank)
IDA	International Development Agency
IDB	Industrial Development Bank of Pakistan
IEDC	International Energy Development Consultants
IMF	International Monetary Fund
IQC	Indefinite Quantity Contract
JICA	Japan International Cooperation Agency
KESC	Karachi Electric Supply Corporation
KFW	Kreditanstalt fur Weideraufbau (German Foreign Assistance Agency)

KW	Kilowatt, 1000 watts
LPG	Liquified Petroleum Gas
MCF	Million cubic feet
MW	Megawatt, 1 million watts
NEPC	National Energy Policy Committee
ODA	Overseas Development Agency
OGDC	Oil and Gas Development Corporation
PASA	Participating Agency Services Agreement
PCSIR	Pakistan Council for Scientific & Industrial Research
PICIC	Pakistan Industrial Credit & Investment Corporation
PMDC	Pakistan Mineral Development Corporation
PSC	Personal Services Contract
REC	Regional Energy Center
REP	Rural Electrification Project
RES	Reference Energy System
TCF	Trillion cubic feet
TOE	Ton (metric) of oil equivalent
UETP	University of Engineering & Technology, Peshawar
UNDP	United Nations Development Program
USGS	United States Geological Survey
WAPDA	Water and Power Development Authority

GLOSSARY OF TERMS

Biogas	- gas, mostly methane, produced when animal or other biological material decomposes in the absence of air.
Biogas Digester	- a mechanism by which biological material is converted into biogas.
Biomass	- any material produced by living matter.
Commercial Fuels	- oil, gas, coal and other fuels which are normally produced and marketed either commercially or by government agencies. Non-commercial fuels include wood, cow dung and other materials not normally produced or sold in the marketplace.
Core Drill	- a drill used in geological work which extracts samples from coal strata as the hole is drilled.
Firm Capacity	- the sum of all generating plant capacity less the value for de-rating units to take into account unit age, deterioration, low reservoir levels, units under maintenance plus the amount of the largest generator in case it might fail during operation with the expectation that not more than one unit not scheduled for maintenance would fail at a given time.
Geophysical Logging	- geophysical exploration using a technique of electrimically measuring properties such as radioactivity, density and electrical resistivity.
Installed Capacity	- the sum of all "name plate" or nominal ratings of all power generating equipment installed.
Kilowatt-Hour	- a unit of energy equivalent to using 1000 watts of power for one hour.
Lignite	- imperfectly formed coal often having a woody texture.

Load Shedding	- the act of deliberately disconnecting the loads in a section of a power system to avoid over-loading power generators.
Megawatt	- one million watts. A watt is a unit of electrical power and measures energy used per unit of time.
Renewable Energy	- solar, hydro power, biogas, fuelwood and other forms of energy continually renewed by sunlight or other natural processes
Silicon Wafer Cells	- devices made from criptalline silicon and other materials which will produce electricity when exposed to sunlight.
Tons and Metric Tons	- "Tons" in this paper refers to short tons or 2000 pounds. "Metric Ton" or "in ton" refers to 1000 kilograms or approximately 2205 pounds.

I. SUMMARY AND RECOMMENDATIONS

A. Recommendations

1. Funding

USAID/Pakistan recommends that an ESF grant of $30.0 million be authorized for the Energy Planning and Development Project which has a Project Assistance Completion Date (PACD) of July 31, 1988.

2. Geographic Code

The project authorization should specify that, except as A.I.D. may otherwise agree in writing:

a. Goods and services financed by A.I.D. under this project shall have their source and origin in countries included in A.I.D. Geographic Code 000 or Pakistan; and,

b. Ocean shipping for all commodities financed by A.I.D. under this project shall be on flag vessels of the United States or Pakistan.

3. Waiver

It is recommended that a source/origin waiver from A.I.D. Geographic Code 000 to Code 935 be approved by the Assistant Administrator for Asia to permit the procurement of ten right-hand drive, 4-wheel drive vehicles. A copy of the waiver request is included as Annex F.

B. Summary Project Description

The goal of the Energy Planning and Development Project is to increase Pakistan's energy self-sufficiency and thereby improve the quality of life for its people. The purpose of the project is to assist the Government of Pakistan (GOP) to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and increase the efficiency of energy use. This will be achieved by strengthening the capability of the Government of Pakistan to: (1) undertake effective integrated and sectoral analyses of energy development strategies in order to support financially sound GOP energy policy and development planning: (2) develop programs in coal assessment, mining, and utilization; and, (3) adopt energy conservation and renewable energy technologies. The project is divided into three major components: (1) Energy Analysis and Manpower Development; (2) Coal Resource Assessment and Development; and, (3) Conservation and Renewable Energy Technologies.

The purpose of the Energy Analysis and Manpower Development component is to strengthen the capability of the GOP to collect and analyze data on energy resources, sectoral demand, and economic and social factors so that the financial implications of energy development options can be clearly understood by policy-making bodies in Pakistan. Technical assistance, training and commodities will be provided to the GOP Planning and Development Division in the Ministry of Planning and Development to support the development and management of an Energy Data System, the development of an Energy Analysis Group (EAG), and the implementation of a series of special energy studies and of a manpower assessment and development program. Assistance will be provided to enable the Energy Analysis Group to undertake integrated analyses in support of the GOP's annual, five-year and long-term planning cycles and to provide information required for investment planning and manpower development in the energy sector.

The Coal Resource Assessment and Development component will support GOP and private sector efforts to develop Pakistan's coal resources as an alternative to natural gas, imported oil and firewood. Under this component, technical assistance, training, and commodities will be provided to assist the GOP to assess and plan for the development of national coal reserves, prepare for the implementation of the country's first large scale coal mine and power generation project (Lakhra), define the private sector's role in coal mining, and introduce processed coal briquettes as an alternative to increasingly scarce and expensive fuelwood. A substantial amount of training of Pakistani professional personnel both on-the-job and in the U.S. and third countries is included under all three sub-components described below.

Assessment of coal reserves will be done by the Geological Survey of Pakistan (GSP) with the assistance of the U.S. Geological Survey (USGS). Activities under this sub-component will include coal exploratory drilling, coal analysis and testing, data management and geological studies.

A high priority of the GOP as expressed in its Sixth Five-Year Plan is to substantially increase the use of indigenous coal by constructing a 300 MW coal-fired power generation station and developing a mine at Lakhra to provide the coal. This A.I.D. project will assist the Water and Power Development Authority (WAPDA) to undertake final exploratory and survey work at the Lakhra deposit so that engineering work, procurement and construction can proceed rapidly as soon as capital financing is available. A.I.D. may also finance,

through an amendment to this project in FY 1984, the front-end engineering work for the mine and power station, depending on the outcome of the additional feasibility work and the GOP's progress in securing financing from other donors for the construction phase of the Lakhra Project. A U.S. Consulting Engineering firm will assist WAPDA and the Pakistan Mineral Development Corporation (PMDC) in this work and will also assist in undertaking mine technology demonstration for the private sector.

A third important area of development for Pakistan's coal industry is the introduction of the use of processed coal for household use as a substitute for firewood. Under this project, a market survey and tests will be conducted, a pilot coal briquetting plant will be built, and a marketing system will be established to sell the briquettes to selected markets.

The Conservation and Renewable Energy Technologies component consists of two sub-components: an energy conservation program to increase the efficiency of industrial energy use; and, a program to assess and develop renewable energy technologies. Energy conservation is the most promising option available to Pakistan to deal with its near-term energy supply and demand imbalance. This project sub-component, which will be based on extensive U.S. experience in this field, will include the following activities: energy audits of specific industrial plants, industrial energy use data systems, training, and demonstrations. The overall objective is to develop a national industrial energy conservation program.

Under this project sub-component, U.S. technical advisors will work with GOP and private sector counterparts to identify industrial sectors and specific facilities within those sectors for the energy audit program. All audits will be undertaken jointly by U.S. experts and Pakistani counterparts (both public and private sector) so that the audit program has a strong "on-the-job" training impact. It is anticipated that up to 40 preliminary audits and 20 detailed audits will be executed over a two-year period. Each audit will result in a plan which can be used by plant managers to design and obtain financing for low-cost energy conservation measures. Funds are included to implement several demonstration conservation projects. Data compiled as a result of these and other energy audits will be used to establish an industrial energy use data system.

Under the renewable energy assessment and development sub-component, technical assistance, training, and demonstration

equipment will be provided to the Directorate General of Energy Resources (DGER) to develop a comprehensive national renewable energy assessment and development program which will delineate the long-term role and accelerate implementation of promising renewable energy technologies. Energy needs which can be met by renewable energy technologies will be identified and analyzed, and the technologies which are meeting or could meet these needs will be analyzed for specific applications. Pilot projects will be designed and carried out to demonstrate the feasibility and usefulness of the promising technologies. Activities will include a residential and small commercial energy needs survey and assessments and demonstrations of a number of specific applications and technologies, including solar heating and power, small hydro, energy-efficient wood stoves, and other biomass technologies.

The proposed allocation of A.I.D. funds is as follows:

Project Component	A.I.D. Funding (In $ Millions)
1. Energy Analysis and Manpower Development	5.3
2. Coal Resource Assessment and Development	16.2
3. Conservation and Renewable Energy Technologies	6.1
4. Evaluation	0.4
5. Contingency	2.0
Total	30.0

C. Summary Findings

This project is ready for implementation and is considered socially, financially, and economically sound, and administratively and technically feasible.

D. Project Checklists and Mission Director's Certifications

1. The project meets all applicable statutory criteria. Appropriate checklists are included in Annex B.

2. Two certifications signed by the USAID/Pakistan Mission Director are included in Annex C: (a) a FAA 611(e) certification which certifies that the GOP has the capability to implement and maintain the project; and, (b) a FAA 612(b) certification to permit the disbursement of dollars in lieu of U.S. owned rupees to finance local costs.

E. APAC Concerns and Design Guidelines

The concerns and design guidelines which were raised at the APAC review of the PID (See Annex A), and where they are addressed in the Project Paper are as follows:

1. Mission Workload

The APAC was concerned with the management requirements to implement this project, especially given Mission staffing constraints. Sections IV. B. of the Implementation Plan and V. B. of the Project Analyses include a detailed description of how the project will be managed. Section IV. B., in particular, estimates the amount of staff time each activity will require, describes how contractors will be utilized, and lists the options considered by the Mission for reducing required staff time.

The APAC suggested that the Mission explore the possibility of implementing the project in discrete phases beginning with resource assessments, followed by planning, and, finally, demonstrations and construction of energy-generating mechanisms, with appropriate training in each phase. This approach will be followed under the component activities dealing with coal briquettes, conservation, and renewable energy technologies. (See Sections III.C.2. and III.C.3.)

2. Administrative Arrangements

Both Sections IV.B. and V.B. describe the administrative arrangements which have been agreed upon by A.I.D. and the GOP to implement this multi-faceted project. The arrangements require increased staff for some agencies, the establishment of new departments in other agencies, and the formation of two overall coordinating committees comprised of representatives of participating ministries and agencies. Because of the critical importance of these staffing and organizational changes to the success of this project, the implementation of these changes has been tied to specific conditions precedent which will be included in the Project Agreement. (See Section VI.)

3. Renewable Energy Activities

The APAC recommended that the renewable energy component should promote an integrated program including small hydro, biomass, and solar options, and that activities under this component should be concentrated in the NWFP. Section III.C.3. describes a logical and systematic approach to renewables which will involve an energy end use survey, technology assessments of promising renewable options, and a program to stimulate private sector activity in this area. The project design does not limit renewable activities to the NWFP as the APAC suggested. New developments in both the technical aspects of renewable energy systems and in their marketing are taking place throughout Pakistan, and restricting project activity to the NWFP would limit the project's ability to influence these developments or to take advantage of opportunities outside the NWFP.

4. Coordination with Other Donors

Section II.F. describes other donor activity relevant to this project. A high level of coordination was achieved during project design by frequent informal meetings among donors working in the energy sector. This informal mechanism is working well, and it is expected that it will continue throughout project implementation. A donor's coordination meeting was convened in April 1983 at A.I.D.'s request and provided a more formal means to coordinate activities. At this meeting, it was agreed that additional meetings would be held to discuss the energy section of the Sixth Five-Year Plan. A Donor's Committee, with sectoral sub-committees, is also being considered as a regular means of coordinating donor activities in the energy sector.

5. Project Outputs

A detailed log frame in Annex E outlines the nature and magnitude of the project outputs described in Section III.B. In addition, the project evaluation plan, which is described in Section IV.E., provides for the collection of baseline data and the monitoring of project progress throughout the life of the project.

6. Relationship to Mission's Energy Strategy

As described in USAID/Pakistan's "Strategy Statement for U.S. Economic Assistance to Pakistan (FY 1983 - FY 1987)," dated January 1983, USAID/Pakistan's strategy in

the energy sector focuses on energy planning, supply and delivery with the objectives of:

a. strengthening Pakistan's capability to undertake energy analysis and to improve national energy policy formulation, investment planning, and decision-making;

b. increasing the availability of reliable and affordable energy in rural areas in ways which will decrease Pakistan's dependence on imported energy supplies and increase its energy self-sufficiency; and,

c. providing reasonably priced useable and reliable energy to rural areas for domestic uses, agricultural and commercial enterprise production purposes, and the delivery of health, education, and other social services.

As described in Section II.H. and III.C., all proposed project activities are consistent with the Mission's energy strategy and the Agency's energy policy.

7. Technical Issues

Specific technical issues raised at the APAC review of the PID and where they are addressed in the Project Paper are as follows:

a. What is the current supply and demand for engineering graduates in key fields?

This will be examined during project implementation as part of the energy manpower assessment sub-component. (See Section III.C.1.)

b. Is there a need for a coal analysis laboratory in Pakistan?

This question was specifically addressed by the project design team (see especially the consultant report "Coal Resources Assessment" by the US Geological Survey), and A.I.D.-supported improvements in this area are included under the coal resources assessment sub-component. (See Section III.C.2.a.)

c. What will be the role and capabilities of the USGS in implementing the coal resource survey component?

The USGS will be responsible for this activity outside the immediate PMDC lease area to be developed for

the Lakhra Coal Project. (See Section III.C.2.c.)

d. Is a coal briquette plant feasible?

Yes, according to project design consultants. (See the consultants' report "Preliminary Study of Coal as a Domestic Fuel in Pakistan" by United Engineers and Sections III.C.2.c. and V.A.)

e. What is the potential for coal substitution in key industries?

Limitations on time and resources precluded an examination of this issue during project design, but it will be addressed as a special study (See Section III. C.2.c.) early in project implementation.

f. What is the potential for private business involvement in mini hydro and renewable energy technology manufacturing?

Project design work indicates that the potential is high (see small hydro, solar, and biomass consultant reports listed in Annex O), and private sector activity in this area is a major focus of renewable energy activities proposed under this project.

g. What is the possibility of importing several U.S. small hydro units for demonstration purposes?

Project design consultants recommended that this be done (see consultants' report on small hydro), and several units are included under the small hydro sub-component. (See Section III.C.3.b.)

8. Environmental Concerns

What is the environmental impact of small-scale hydro and what measures may be taken to mitigate any adverse impacts?

As discussed in the Environmental Analysis (Section V.F.) the environmental impact of the small-scale hydro activities proposed under this project will be insignificant. The few required preventive control measures are described in the Environmental Analysis.

F. Project Issues

1. Given that energy planning responsibilities have been shared by several Ministries, is the GOP receptive to changes necessary to develop a coordinated and effective integrated energy planning capability?

Coordination of energy planning and decision-making has been a major concern of the GOP since the 1973-74 oil crisis. Recently, the GOP has taken a number of substantive steps to improve coordination in the energy sector. In 1980, the GOP established a high-level National Energy Policy Committee to coordinate energy policy-making, but the Committee meets infrequently and functions only in an advisory capacity. In 1982, the GOP contracted with International Energy Development Consultants (IEDC) to coordinate the energy proposals of the various Ministries and to draft the energy section of the GOP's Sixth Five-Year Plan. To develop the GOP's integrated energy planning capabilities, the draft Five-Year Plan discusses the establishment of an Energy Cell, an integrated energy analysis group, within the Planning and Development Division.

The Planning and Development Division is the only Ministerial agency which regards the energy sector in its entirety rather than from the perspective of any one energy supply or energy consuming Ministry. In discussions with the Mission, senior officials of the Planning and Development Division and the Economic Affairs Division have stated that the Planning and Development Division will be the lead agency for this Project and that it will assume a strong coordinating role. This position and the Planning and Development Division's recent actions lead the Mission to expect that the Division will continue to strengthen its integrated energy planning role.

2. At present, the GOP has no specific programs in place to encourage private sector activity in the coal industry or in renewable energy. Will this project be able to achieve its stated objective of assisting the GOP to mobilize the private sector in these areas?

The Mission has had a number of discussions with private mine owners, and they are understandably enthusiastic about the possibility of an expanded market for coal in Pakistan. Private mine owners state that what is needed to expand private sector activity in coal mining is for the power industry to offer long-term contracts to purchase coal. This would lead to private investment in mining and a more positive reaction from the financial community.

Mine owners consistently point to governmental barriers, such as the lack of long-term leases, and it is proposed that an examination of such barriers be a subject for early project activity. Similar barriers exist in the renewables area. For example, the GOP indirectly discourages private biogas companies by subsidizing government installed units. Positive steps to encourage the private sector's involvement in the renewables area will also be examined. Once private sector capabilities in these areas are assessed during project implementation, individual activities will be designed and implemented.

3. Will the GOP be able to attract sufficient financing to develop the Lakhra power plant and its associated mines?

The Lakhra project is a first step in a major expansion of domestic coal resources. The use of domestic energy resources other than oil and gas was recommended by the World Bank and the ADB and will substantially improve Pakistan's balance of payments by reducing the overall size of its oil import bill. The economic analysis presented in the Lakhra project review and summarized in the Executive Summary (Annex K) documents the overwhelmingly positive impact of using Lakhra coal in comparison with imported fuel oil and the foreign exchange savings when compared with imported coal. The World Bank is planning to finance a significant portion of the next thermal generation project in Pakistan. The GOP has designated Lakhra as this next project. Informal discussions with the ADB and others indicate that co-financing will be available to provide the remainder of foreign exchange requirements of the project. A.I.D. also proposes to finance under this project further feasibility investigations as may be required by prospective financial agencies for the Lakhra Project. This and other preparatory work which will be financed by A.I.D. should facilitate expeditious project appraisal by financial organizations.

4. Given that both the Directorate General for Energy Resources (DGER) within the Ministry of Petroleum and Natural Resources and the Ministry for Science and Technology have programs in renewable technologies, how will the project ensure that the activities within each Ministry complement rather than duplicate each other?

While some confusion has occurred in the past over the respective roles of each Ministry in the area of renewable energy, the GOP has recently assigned to DGER the responsibilities for "energy policy and development

of renewable sources of energy" and to Science and Technology the responsibility for "applied research" in this area. The two Ministries have cooperated on a renewable energy conference and other activities, and it is expected that the coordinating mechanism designed into the project (see Section IV.B.2.) will ensure the integration and complementarity of project activities in this area.

5. Given the present oil glut and the drop in world oil prices, will it be economical to utilize indigenous coal rather than imported oil to generate power in Pakistan?

Most petroleum analysts believe that the current drop in world oil prices is a temporary decline and that over the long-term, petroleum prices will rise. While the world's number of industries and their use of petroleum continue to increase, reserves of oil continue to decline. As more oil is used, new oil is becoming more expensive to locate and exploit. Furthermore, even at $25 per barrel, the generation of power with imported oil costs more than with domestic coal. (See Section V.C., Economic Analysis.) For these reasons, an indigenous coal-fired power plant constitutes a sound investment for Pakistan's power sector.

6. Given the current low price of natural gas in Pakistan, are the project's components on coal and energy conservation economically viable?

The price of natural gas in Pakistan has been increasing substantially. In January 1982, the Government announced an increase of approximately 20 percent in average gas prices, and the Government plans to phase in additional increases such that by 1987, the average price of natural gas to consumers will be two-thirds of the value of equivalent energy derived from fuel oil. In light of this price increase, Pakistan's coal and energy conservation options will become very attractive economically. (See Section II., Background, and Section V.C., Economic Analysis.)

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II. BACKGROUND

A. USG - GOP Negotiations

The United States and Pakistan are embarked on a renewed and strengthened effort to increase their economic and development cooperation. This effort was marked by high level U.S.-GOP consultations in 1981 which culminated in the negotiation of a $3.2 billion package of military and economic assistance which the U.S. will seek to provide to Pakistan between FY 1982 and FY 1987.

The economic assistance component was designed not only to maximize its development impact but also to produce as favorable balance of payments effects as possible. The U.S. Economic Assistance Negotiating Team, headed by the A.I.D. Administrator, visited Pakistan in August 1981 to discuss the details of the economic portion of the military/economic package with the Government of Pakistan. These negotiations were successfully completed, and agreement was reached on the FY 1982 through FY 1987 period.

The assistance package is one of the strategic elements of the renewed and expanded USG-GOP relationship. It is one of the instruments required to achieve the U.S. and GOP's mutual goals with respect to security and economic development. The assistance package is seen as an indispensable contribution to the shaping and implementation of a new U.S.-Pakistan relationship and to the critical role in the region which the U.S. Government seeks to assist Pakistan to play. The military-security-political position of Pakistan, including the burden of a massive refugee influx, accentuates the development problem to which the proposed U.S. economic assistance package responds.

It was in this context that A.I.D. agreed to allocate $200 million to support energy sector activities in Pakistan. At that point, precisely how these funds were to be allocated had not been determined. The Mission subsequently held discussions with GOP officials which resulted in the following provisional allocations: $155 million for a Rural Electrification Project; $25 million for a Forestry Planning and Development Project; and $20 million for an Energy Planning and Development Project. During project development, funding for the Energy Planning and Development Project was increased to $30 million.

B. Economic Setting

Pakistan is a poor country, both in terms of per capita income (estimated at U.S.$300 per year) and in terms of per capita consumption of commercial energy (under six million Btu per capita, which is less than one half the level of other "low income" Asian and Pacific countries). During the

first half of the 1970's, the Government tried to solve the country's socio-economic problems by investing in public sector enterprises and nationalizing key parts of the private sector. Pakistan tried to address its balance of payments problems, exacerbated by the dramatic rise in oil prices after 1973 and deteriorating world prices for agricultural exports, by a regimen of quantitative restrictions of exports and foreign exchange controls.

Pakistan's one quickly exploitable indigenous energy source, gas, was developed rapidly, and consumption was encouraged by low gas prices. Coupled with the demand for gas as a fuel was the demand for gas as a feedstock as the Government undertook a program to achieve self-sufficiency in petrochemical fertilizers. The economy developed energy-intensive activities despite a need to import petroleum. During the period 1972-1977, the nation's real output grew at a respectable 4.9 percent annually, but this was nearly offset by a 3 percent annual population growth.

Since 1977, the new Government has altered this economic policy. Public sector expansion is being limited, and the private sector is being encouraged to expand, accommodating foreign as well as domestic private investors. International trade restrictions are being replaced with customs tariffs intended to encourage only those import competitive industries that are economically efficient. The Government's programs since 1977 have helped the annual growth of Gross Domestic Product (GDP) to rise to as high as 7.3 percent annually.

During PFY 1981, agriculture expanded by 4.4 percent. Pakistan's farm sector employs roughly one-half of the nation's labor force and produces about 30 percent of Pakistan's GDP. Real value added within the sector can be expected to continue to increase. As expected, the industrial sector, which in PFY 1981 produced 18 percent of GDP, is growing more rapidly than the economy as a whole. The annual rate of increase in industrial production now exceeds 9 percent and is projected to establish a rate over the next decade of at least 10 percent.

Pakistan's Fifth Five-Year Plan, covering the period PFY 1977-1983, set its annual growth goal for GDP at 7.5 percent. The estimated actual rate for the first four years of the plan period was 6.2 percent, somewhat lower than planned but satisfactory, nevertheless. Under the GOP's Sixth Five-Year Plan, covering PFY 1984-1988, which is in the final stages of preparation, the GOP's reported plans include 5 percent and 10 percent growth rates for agriculture and manufacturing, respectively, and a 6.5 percent annual increase in GDP. These targets are generally less ambitious than those in the

current Fifth Plan, but they are still higher than those the nation has thus far managed to attain.

These planned growth targets will, without remedial action, be difficult to attain, not only because of energy supply shortages but also because of the lack of development capital due to high oil import costs. In FFY 1981, Pakistan's net imports of petroleum (crude oil plus product imports minus product exports) reached $1.4 billion and accounted for one-quarter of the nation's total import bill. To the extent that international financing must be used to pay for imported oil, investment (and probably consumption as well) is restrained. It is highly evident that finding acceptable substitutes for oil imports is a priority of energy planning in Pakistan.

The need for economical management and conservation of the nation's energy resources has become an acknowledged Government objective. Nevertheless, it is recognized that, for the foreseeable future, Pakistan will remain a net importer of energy and that petroleum imports will remain the major single cause of a continuing deficit in the balance of payments.

C. Institutional Setting

1. Public Sector

Pakistan has a national development planning system under which 5-year plans, sectoral plans and annual development plans are prepared as a basis for resource allocation decisions. The Executive Committee of the National Economic Council(ECNEC), which is chaired by the President of Pakistan, is the highest economic decision-making body and approves the various plans. The Planning and Development Division in the newly created Ministry of Planning and Development prepares the plans in consultation with the concerned Federal and Provincial ministries.

The National Energy Policy Committee (NEPC) was established in 1975 as the senior policy-making body for energy, except for nuclear which is under the National Atomic Energy Council. The Minister of Finance and Economic Affairs is the Chairman of the NEPC and the Minister for Petroleum and Natural Resources is the alternate Chairman. The NEPC also includes representatives from the Ministries of Water and Power, Agriculture, Industry, Production, and Planning and Development.

The Ministry of Petroleum and Natural Resources oversees exploration and production of oil, gas and coal as well as energy conservation and renewable energy. Operational organizations under the Ministry include the Oil and Gas Development Corporation, the Pakistan Mineral Development Corporation and the Geological Survey of Pakistan. The

Ministry of Water and Power oversees the production, transmission, and distribution of electricity. The Water and Power Development Authority, a Federal agency, and the Karachi Electric Supply Corporation, a mixed public and private stock company, are the main generation, transmission, and distribution organizations under the Ministry. The Ministry of Production manages nationalized companies, including several refineries and petrochemical facilities. Federal programs dealing with private companies fall under the Ministry of Industry. The Department of Forestry is located within the Ministry of Agriculture and is involved in fuelwood issues although forestry is primarily a provincial responsibility.

The Ministry of Science and Technology, although not a formal member of the NEPC, is involved in laboratory and field research on coal briquetting and renewable energy technologies, particularly solar, biogas, and micro-hydro. The two principal research organizations under the Ministry are the Pakistan Council for Scientific and Industrial Research (PCSIR) and the Appropriate Technology Development Organization (ATDO). These organizations sponsor research work at the engineering universities in Peshawar, Lahore and Karachi. The Ministry has recently established a Silicon Research Institute that is conducting research on silicon wafer cells for solar photovoltaic systems.

2. Private Sector

The private sector has a substantial involvement in the production of oil, gas, and coal in Pakistan. Burmah Oil has a 70 percent interest in the main Sui gas field. Attock Oil of the U.K. and AMOCO are partners with the Oil and Gas Development Corporation (OGDC) in Meyal, the major oil producing field. Occidental Oil, Shell, British Petroleum and other companies are exploring for oil in Pakistan under concessional contracts. Union Texas has made a commercial oil discovery, and OGDC has rights to take an equity interest in its development. Attock, Caltex and Burmah/Shell have investments in two petroleum refineries.

Eighty percent of Pakistan's coal production comes from over 2,000 small privately-owned mines. Power generation is primarily in the public sector, although the KESC (which produces power for Karachi) is a mixed public and private stock company. A number of private manufacturers and distributors of solar and biogas systems has emerged in the past several years.

D. Overview of the Energy Sector

Pakistan has a rather varied mix of commercial energy sources including oil, gas, hydro-electric, coal, and uranium. In addition, almost 40 percent of the country's energy needs are satisfied by non-commercial biomass fuels such as firewood, straw, and cow dung. Most areas of Pakistan have very high solar radiation levels, and substantial small-scale hydro potential exists in mountainous regions of the north. These and other renewable energy forms could play a significant role in the future for such diverse functions as rural power needs, irrigation pumping, crop drying, and process heating.

Despite internal production of both natural gas and oil, Pakistan is still one of the more seriously affected of the oil importing developing countries. Due to the sharp rise in world oil prices coupled with a relatively high economic growth rate, the cost of oil imports has risen from $50 million in 1972 to about $1,500 million in 1981. Total consumption of commercial fuel in 1981 was about 528 trillion Btu (90 million barrels equivalent) which is about 1 barrel of oil per capita. This consumption level is about one tenth the world average and is even low by developing country standards.

The need for rapid economic development to improve living standards, combined with a 3 percent annual population growth rate are creating an energy demand which challenges Pakistan's physical and financial resources. However, the country has sufficient resources of coal, gas, oil, hydropower, and renewables such that carefully planned and energy-efficient development could proceed without resorting to massive increases in oil imports.

1. Energy Supply

Commercial fuels now comprise about 60 percent of total fuel consumption, with traditional fuels (firewood, dung, straw) making up the remainder. Within the commercial sectors, natural gas is the dominant fuel with 52 percent of the total and petroleum 35 percent. Only 11 percent of this petroleum is produced domestically. Over the last 5 years, the annual growth in petroleum consumption has averaged only about 5 percent. The growth in natural gas production, however, has averaged over 10 percent during this period with annual increases in excess of 20 percent occurring in 1979-80. This very rapid growth rate reflects, in large part, the very low prices for natural gas (less than 30 percent that of petroleum) which have accelerated its use in industry and power generation.

The role of coal in the supply mix is currently very modest, providing only 5% of the commercial energy used. This low usage of coal reflects, in part, the recent availability of cheap gas which resulted in the conversion of many industrial and power systems from coal (or oil) to gas. Coal reserves are, however, large (probably in excess of 1 billion tons) compared to those of other domestic resources, and they are expected to be put to increased use in the future.

a. Petroleum

Proven reserves of oil in Pakistan are very modest and are estimated by the Oil and Gas Development Corporation to be between 80 and 95 million barrels, with present annual production of about 3 million barrels. Total petroleum consumption is about 30 million barrels annually so that these reserves are equal to only about 3 years' use at present rates. The demand for fuel oil has been decreasing over the last 10 years (primarily due to replacement by lower cost natural gas) while that for distillates has been increasing modestly. This has led to fundamental imbalances between the mix of domestic refinery output and the structure of product demand. The GOP has recently decided to invest in a hydrocracker unit to convert fuel oil to gasoline or other middle distillates so that net fuel oil output will decline.

b. Natural Gas

Total proven reserves of natural gas are about 13 trillion cubic feet (TCF) with 45 percent of this at the large Sui gas field. The rapid increase in the consumption of natural gas has resulted in both distribution system and field reservoir limitations which make it difficult to increase significantly supplies of natural gas in some areas, particularly during the winter months. The proven reserves of natural gas are only sufficient for 20-25 years, assuming gas consumption increases by 7-8% per annum over the next 10 years.

c. Coal

Pakistan currently produces between 1.8 million and 2.4 million tons of coal per year. Over 80% of this production is from about 2,000 small, private sector mines. The remaining coal is produced by 3 mines operated by the Pakistan Mineral Development Corporation. Coal production has been relatively constant for over 5 years with over 90% of production used by brick kilns. Coal mining in Pakistan uses only the most rudimentary mining techniques. Studies conducted during project design indicate, however, that it is feasible to increase current production levels by a factor of three or more within the next ten years.

Government estimates of coal reserves are about 500-600 million tons. Investigations during project design suggest that this estimate is conservative and that additional exploration would probably confirm coal reserves in excess of between one and two billion tons. Until now, there has been very little incentive to confirm these additional coal reserves due to the limited use of coal in the country. The very low and stagnant use of coal is due, in part, to its low quality and to the availability of low cost gas. Most of the coals are poor quality lignite or sub-bituminous with very limited coking potential. They usually have very high (4%-6%) sulfur content, low heating value (average 8,500 Btu/lb), and high ash content which complicate their use in large scale power or industrial applications. However, recent independent feasibility studies by both Japanese and United States experts on using coal from Lakhra in 300-600 MW power systems indicate that properly designed facilities can economically use Pakistani coal when compared to thermal plants using other fossil fuels priced at international standards.

d. Power Sector

Of the 3,900 MW of effective installed capacity in July 1982, about half is hydro-electric and half is by thermal systems. Because Pakistan's rivers are largely fed by glacier melt, the hydel capacity in the winter months diminishes to only one-third of its rated capacity. Roughly 28% of rated thermal capacity is by gas turbine, 67% by steam plants, less than 1% by a single coal-fired (15MW) plant in Quetta, and 5% by a 125 MW nuclear plant in Karachi. Total output of electricity was about 16 billion kilowatt-hours in 1981 and is growing at about 8.5% per year.

The government has actively pursued a policy of converting oil-fired facilities to gas operation. As a result, over 90% of all thermal power generation is now by natural gas. Further expansion of thermal power by natural gas will be constrained, however, by the limited availability of this resource.

GOP plans call for the further expansion of capacity to over 15,000 MW by the mid-1990's and to over 25,000 MW by the year 2000. These plans include a nuclear power plant (900MW) at Chashma by 1990 (and 2 more by the year 2000) and the use of coal at Lakhra (600 MW) by 1987 to be expanded rapidly thereafter. Most of the planned expansion in thermal capacity to the year 1990 is to be fueled by natural gas or fuel oil. The shortage of natural gas coupled with the recently recognized ability to burn indigenous coal will undoubtedly cause a review of thermal power expansion plans.

e. Traditional Fuels

Traditional fuels still satisfy about 40% of the fuel needs of the country and are the major energy sources for cooking in rural areas. Firewood accounts for about 50% of biomass fuel use, and consumption is estimated at over 10 million tons annually (roughly equivalent to 22 million barrels of oil). A modest percentage (3%) of the firewood is used in the commercial sector (for example, tobacco curing and bakeries) and is sold as a commercial fuel. The increasing use of firewood is contributing to severe deforestation in some areas, leading to soil erosion and siltation of rivers which could limit the life of costly hydro-electric facilities. Dung cakes are also a major source of biomass fuel and, in some areas, are being sold on a limited basis as a commercial fuel. The use of dung as a fuel is, however, depriving the soil of needed enrichment which could have a long-term negative impact on agricultural productivity. Partly to alleviate this problem, several organizations have initiated efforts to develop biogas plants to more effectively use the cattle dung resources. Over 1,500 family-sized units have been installed to date, and up to 5,000 units are planned by 1985. Worldwide, however, biogas generators have proved to be of little value in solving the problems of residential fuel supply.

Studies undertaken during project design indicate that the supplies of traditional fuels will be difficult to maintain, let alone to increase, in order to handle the effects of a 3% annual population growth and an increase in per capita income. This could place even greater demands on commercial fuels. The substitution of coal briquettes for wood and dung and the increased supply of fuelwood, which are contemplated under this project and the proposed FY 1983 A.I.D.-financed Forestry Planning and Development Project, respectively, are intended to assist the GOP in addressing this critically important problem.

f. Solar and Wind

Currently, neither solar nor wind energy resources are used to any significant extent anywhere in the world including Pakistan. The availability of solar energy is very high, especially in such areas as Baluchistan. In addition, there is a great deal of interest in using solar energy to provide power in rural areas. To this end, Pakistan has already installed a 5 KW demonstration solar village, and as many as 100 additional field tests with power outputs in the 5-50 KW range are in the planning stage. Other potential solar applications include solar hotwater for domestic and commercial uses, industrial process heating, crop drying,

and passive solar heating in more northern areas with large space heating loads.

Wind data are sparse, but most locations in Pakistan are not suitable for wind energy technologies. Some favorable wind sites may exist along the coast and in valleys throughout the mountainous areas of the country. While small-scale wind pumping may be feasible in these areas, wind systems are not likely to play a significant role in the future national development of Pakistan's energy resources.

2. Energy Demand

Table 1 summarizes commercial energy consumption by sector in Pakistan. Important points to note regarding energy use patterns within each of the consuming sectors are as follows:

Table 1

ENERGY CONSUMPTION BY SECTOR, 1981

Sector	Energy Use a/ (Trillion Btu's)	% of Total
Industrial	259	49.1
Residential (Household)	71	13.4
Commercial	18	3.4
Agricultural	32	6.1
Transportation	113	21.4
Other	35	6.6
TOTAL	528	100.0

Source: Energy Yearbook, 1981 and A.I.D. project design team analysis.

a/ This column distributes electricity use among the various consuming sectors.

a. Industry is the largest consumer of commercial energy and directly uses over 30% of gas and oil. Also, over 40% of the electric power is used by the industrial sector so that the combination of direct and indirect use of fossil fuels in industry approaches 50%. By far, the two largest energy-consuming industries are fertilizer and cement which use 25% and 10%, respectively, of all the natural gas. Other major energy-using industries are textiles, sugar, ceramics, steel fabrication, and brick-making. The latter activity is fueled primarily by coal and uses over 90% of total coal output. To reduce energy use in industry, the GOP is considering legislation on energy conservation. To reduce the use of natural gas, the GOP has completed studies on converting cement and large sugar plants to use coal or fuel oil.

b. Almost all energy used in the transportation sector is in the form of petroleum products. Diesel fuels constitute about 62% of the total, with gasoline providing about 18%.

c. Over 80% of all energy use in the residential (household) and commercial sectors is in the form of traditional fuels for cooking and for space heating in northern areas. Commercial fuel use has, however, increased by over 12% per year in these sectors over the last decade, further indicating the large potential demand for commercial energy for household use as living standards increase.

d. About 2% of all energy (equivalent to 2.0 million barrels of oil per year) is used directly in the agricultural sector, primarily in the form of diesel fuel to operate engine-driven tubewells and for tractors and other farm machinery. In addition, about 20% of all the electricity produced (equivalent to 4.0 million barrels of oil per year) is used to operate irrigation pumps. Further planned expansions of electricity-driven tubewell irrigation under the GOP's Rural Electrification Program could, therefore, have a significant impact on the electric system and the demand for natural gas and fuel oil.

3. Energy Prices

The general policy relative to the pricing of petroleum products is overall cost recovery. As suggested by Table 2, however, there is a significant amount of cross subsidization between petroleum product prices which are influenced by social and economic factors. The costs of all petroleum products have risen dramatically over the last 2 years (50-100%) as a result of government policies to adjust petroleum product prices to reflect, on the average, the actual cost of importing and refining crude oil.

Table 2

OVERVIEW OF ENERGY PRICES IN PAKISTAN, 1981

	NORMAL UNITS	$/MBtu
NATURAL GAS a/		
Residential (Household)	12.60 Rs/MCF	1.00
General Industry	10.90 Rs/MCF	0.87
Cement, Fertilizer, & Power	7.00 Rs/MCF	0.60
PETROLEUM PRODUCTS a/		
Kerosene	2.75 Rs/liter	6.15
Gasoline (Regular)	5.00 Rs/liter	11.10
Diesel Fuel	3.05 Rs/liter	6.80
Fuel Oil	1.32 Rs/liter	2.95
ELECTRICITY a/		
Residential (Household)	0.34-0.70 Rs/kwh	8.20-17.50
Industrial	0.35-0.70 Rs/kwh	8.80-17.50
Tubewells	0.17-0.35 Rs/kwh	4.10-8.80
COAL a/	260-600 Rs/Ton	1.25-3.00
FIREWOOD b/	16-30 Rs/40 kg.	2.80-5.20 c/

a/ Source: Energy Year Book, 1981

b/ Source: Survey undertaken by USAID/Pakistan staff in 1982

c/ Assuming: 5,500 Btu/lb. for dry wood and Rs 12.50 = $1.00

The price of natural gas has been very low compared with that of petroleum. As of 1981, it varied significantly among consumer classes, being as low as $0.60/MCF for the cement and power industries and as high as $1.00/MCF for residential consumers. (Prices of natural gas were increased significantly (over 20%) in early 1982.) Present policy is to gradually raise the price of gas so that by 1987, it is equal to two-thirds of the world export price of fuel oil. These large increases in natural gas prices will provide additional incentives for implementing energy conservation measures in all sectors and for increased participation of the private sector in exploration programs.

No direct subsidies are provided to the electric sector as a whole. There is a wide range in electricity costs both among consuming classes and within a given class. A residential rate schedule was implemented in 1981 to discourage large increases in residential demand. Very low rural rates are intended to improve living standards and the productivity of rural populations. The rates shown in Table 2 are for the WAPDA service area. The rates in the KESC service area typically are twice as high, on the average. This is due to the fact that relatively inexpensive hydro power constitutes about 50% of the WAPDA supply while KESC depends exclusively on thermal generation.

The cost of coal is not significantly below that of oil but is significantly higher than that of natural gas. This explains, in large part, the declining use of coal in Pakistan since the introduction of natural gas. The relatively high cost of coal to some extent is due to the low demand and resultant small size of existing mines. Coal mines using modern practices on a large scale should result in prices competitive with oil and with gas once the gas pricing structure is modified.

Wood is commonly sold as a commercial fuel in urban areas to small commercial establishments (such as restaurants) and for tobacco drying. In some areas of Baluchistan and the NWFP, it must be trucked in, due to local scarcities. The cost of wood has been increasing rapidly in recent years and now approximates that of kerosene in some areas. In most areas, the cost of wood is considerably higher than that of coal. This is one reason why coal briquettes are being considered as a means of supplementing wood use in household and small commercial applications.

4. Energy Supply/Demand Balances

a. Present Situation

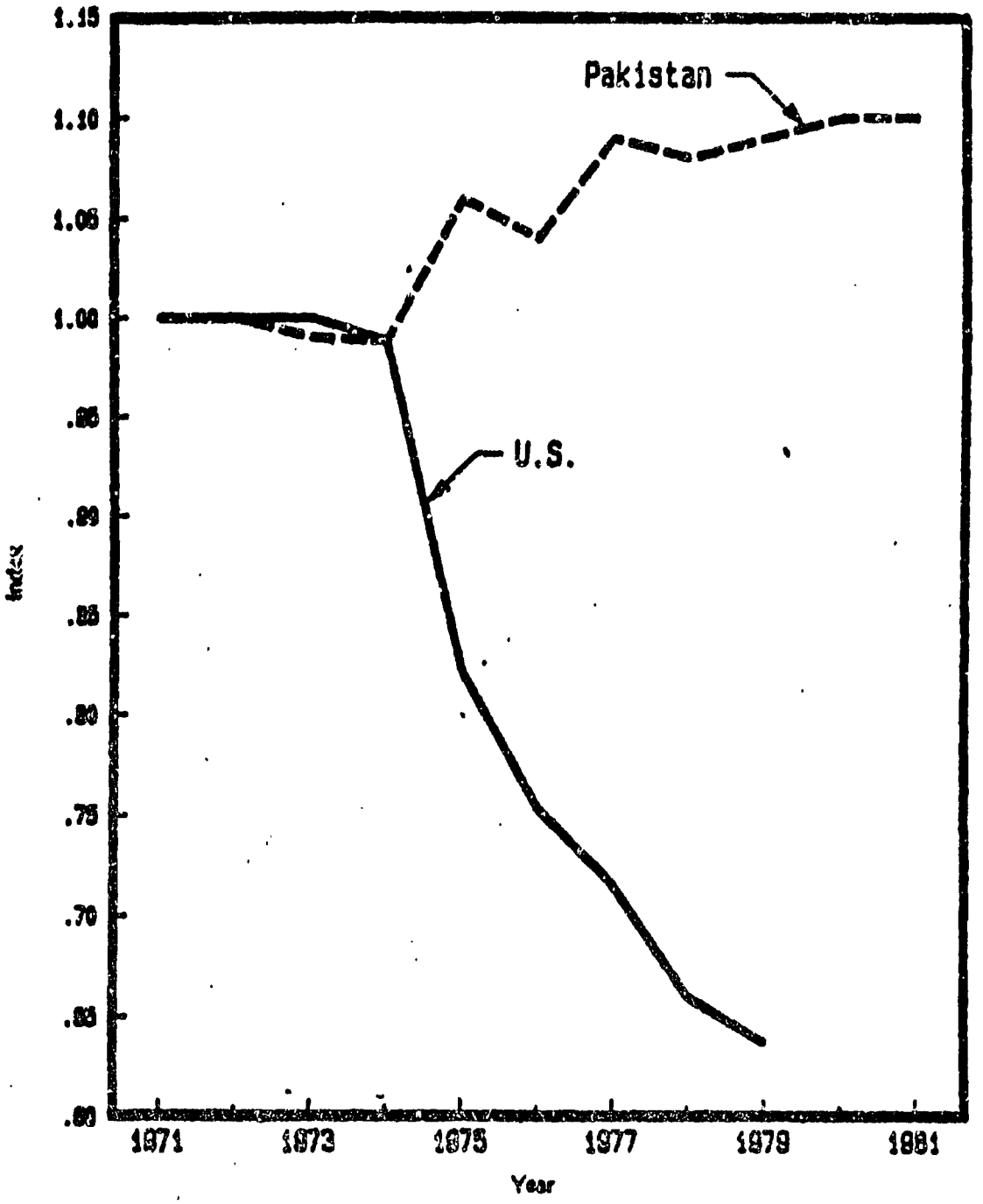
Traditional fuels provide about 40 percent of total energy use with over 85 percent being used in households. The efficiency of utilization of these fuels is, however, very low, probably ranging from 5-10 percent. Energy use in the sector could, in principle, be greatly reduced by introducing more efficient wood stoves or using an inherently more efficient stove operating with gas, liquified petroleum gas (LPG) or kerosene. Even with greatly reduced energy requirements, however, the demand for energy for household use is so large (90 trillion Btu or 15 million barrels of oil equivalent) that significant substitution (on a percentage basis) of traditional fuels with commercial fuels is not realistic, given the present status of oil and gas reserves. As a result, Pakistan will continue to rely extensively on traditional fuels in the household sector, which will result in increasing pressures on limited supplies of fuelwood and crop wastes.

Industrial energy efficiency in Pakistan continues to decline, despite higher energy prices. In contrast, energy efficiency in the U.S. has increased dramatically (See Figure 1). About 60 percent of natural gas is used either directly or indirectly (via electric power generation) in the industrial sector. Consumption in the industrial sector for the same level of output probably could be reduced by up to 30 percent, using modern energy conservation practices such as fuel-air controls, waste heat recovery, and high efficiency lighting. This would also reduce natural gas consumption by about 50 billion to 100 billion cubic feet per year, which would free up gas resources for vital expansions in all productive sectors of the economy.

The transportation sector dominates in the use of petroleum products, and there are few options available in this sector for significant reductions in energy use. Even modest increases in petroleum use in industrial power or household applications would greatly increase net petroleum consumption. For example, petroleum use would increase by over 15 percent if the cement industry were to use oil rather than gas as a fuel. As a consequence, there is little flexibility to use petroleum in sectors now using gas without large increases in imports.

The large input of natural gas needed in the electric power sector is due to the fact that, on the average, natural gas is converted into electricity at only about 25 percent efficiency, given the mix of thermal generating capacity in Pakistan. In addition, about 30 percent of all power generated is lost by a combination of transmission losses due to

FIGURE 1: INDEX OF ENERGY USE PER UNIT OF PRODUCTION



Sources: U.S. Energy Use, Annual Survey of Manufacturers, U.S. Dept. of Commerce, Pakistan Energy Use, Statistical and Fuel Use Yearbooks.

undersized lines and transformers, poor metering, and theft. The A.I.D.-financed Rural Electrification Project seeks to address both these issues by funding a combined cycle power plant at Guddu (efficiencies in excess of 30 percent) and a transmission loss reduction program. There is still a large potential for improving the efficiency of existing facilities (power generation and transmission), and steps to vigorously improve system operating efficiencies should receive, at least, equal attention as building new capacity.

b. Energy Supply/Demand Projections

The simplified analysis in this section is intended to identify major energy issues which are likely to arise over the next 5, 10, and 20 years. The major assumptions used in the "reference case" projections shown in Figure 2 were that:

i. Both gas and oil production will approximately double by 1991;

ii. Electric sector hydropower expansions will proceed on schedule;

iii. Demand for commercial energy in each sector will increase at the same rate (averaging about 8.5 percent) as the last five years to 1986 and at a uniform rate of 7.5 percent thereafter; and,

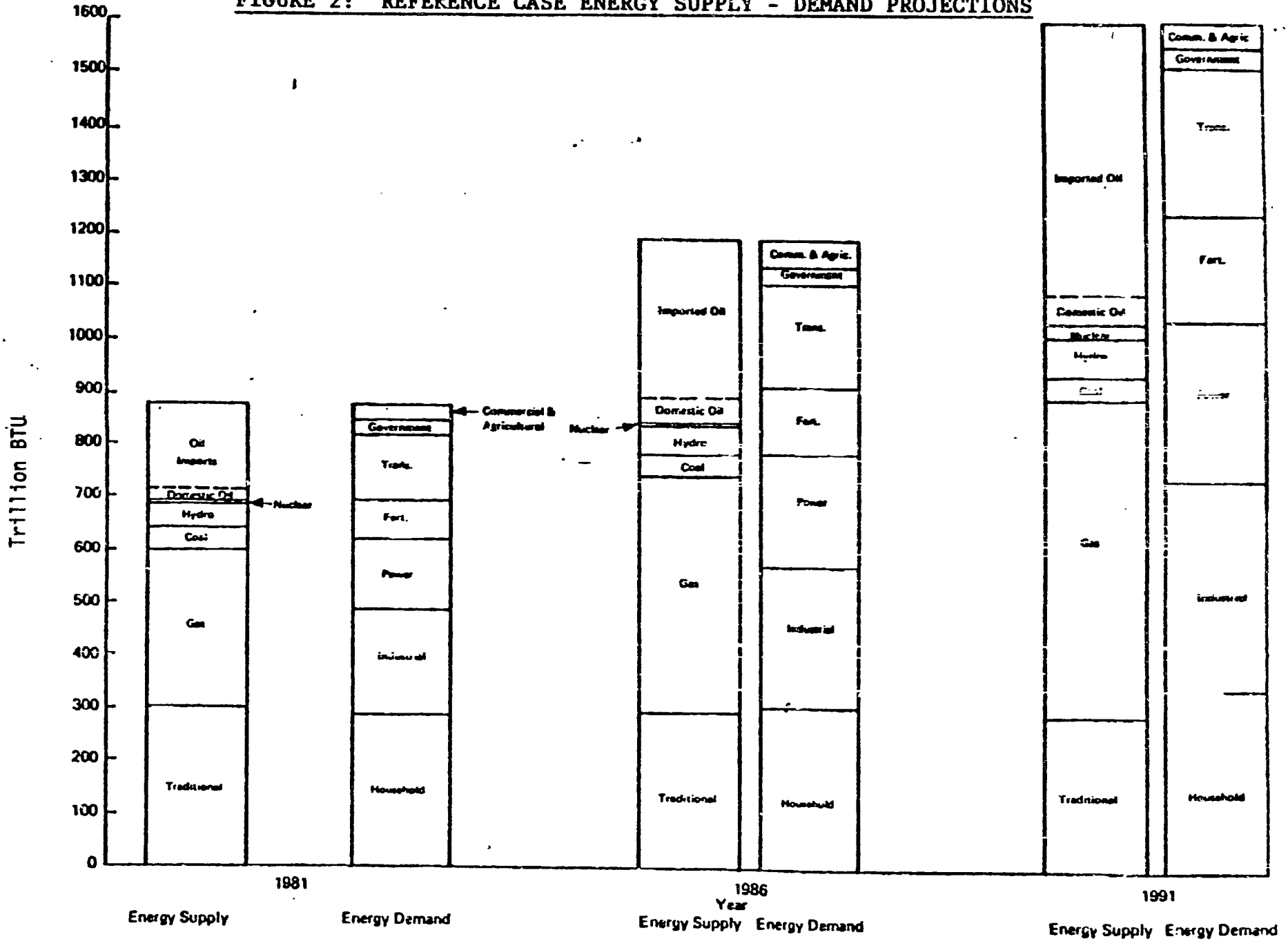
iv. Any shortfall in energy supplies will be made up with imported oil.

The energy supply projections indicate that oil imports would have to increase to 51 million barrels/year (85 percent increase over 1981) by 1986 to support the demand growth of recent historical levels. This projection ignores any increase in domestic oil production during this period (since domestic oil production is very low in absolute terms). If oil imports are not allowed to increase, the average increase in demand of commercial energy would have to be decreased to less than 5 percent per annum. The 1991 projections indicate that oil imports would have to increase to 87 million barrels/year in order to support the assumed growth in commercial energy consumption.

5. Alternative Energy Supply/Demand Balances

The "reference case" projections shown in Figure 2 are indicative of energy balances assuming that no major changes are made in the structure of either the demand or the supply options. Many options are, in fact, available

FIGURE 2: REFERENCE CASE ENERGY SUPPLY - DEMAND PROJECTIONS



for significantly changing the energy balances from those indicated in Figure 2. These options include:

a. accelerating the use of coal in both the power and heavy industry sectors;

b. emphasizing energy conservation in industry both within existing facilities and in all new plant construction;

c. promoting the increased use of solar and small-scale hydro resources in a wide range of rural power and process heating functions (possible post-1990 impacts);

d. modifying the future mix of industry toward less energy intensive activities (possibly with less emphasis on domestic fertilizer production);

e. rehabilitating and expanding the railroad system to reduce energy use in the transportation sector and effecting changes in the transport infrastructure to make more efficient use of energy; and,

f. accelerating oil and gas exploration in order to increase proven reserves and production rates of these key fuels.

These and other alternatives should be examined in an integrated energy system analysis process leading to policy and investment decisions. Most of these options are, in fact, either being pursued or are under active consideration by the GOP, many with assistance from one or more donor organizations. The first three options, in particular, could be both economically attractive and have significant energy balance impacts.

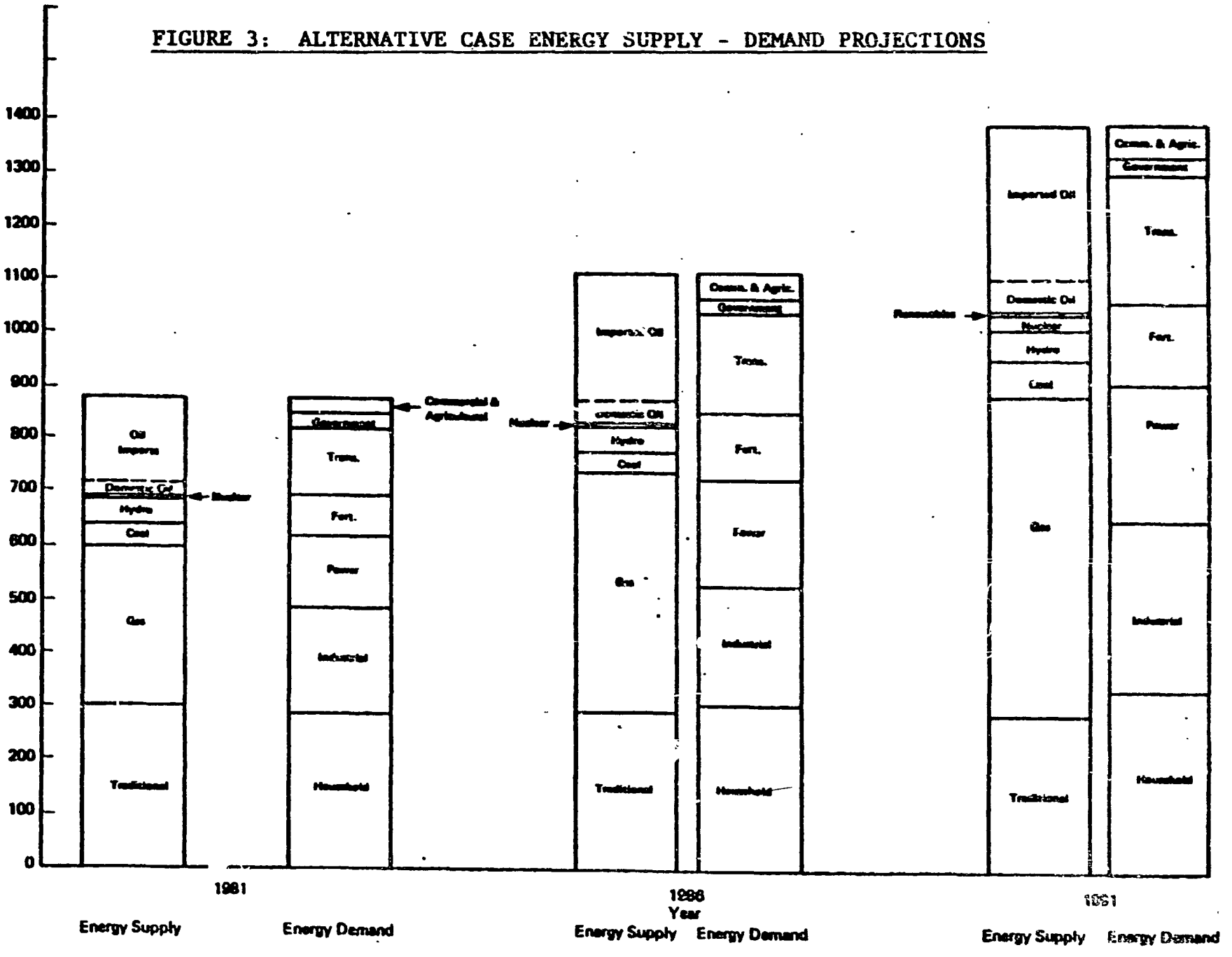
In order to quantify these impacts, alternative energy supply/demand projections were prepared (See Figure 3), based on the following assumptions:

1986:

a. A vigorous energy conservation program (in part accelerated by increasing natural gas prices) will result in a 10 percent savings in gas and electricity use in existing industrial facilities, plus a reduction in energy use growth rates to 6.5 percent in industry. As a result, total industrial energy consumption would increase only by 3.5 percent per year between 1981 and 1986.

b. Energy use will increase in the fertilizer industry by only 10 percent (as compared to almost 15 percent in recent years) due to increased efficiency.

FIGURE 3: ALTERNATIVE CASE ENERGY SUPPLY - DEMAND PROJECTIONS



1991:

a. A 600 MW Lakhra coal-fired power plant will be completed and contributing to the energy balance by 1991.

b. At least one-third of the energy needs of the cement industry will be satisfied by coal.

c. Higher gas prices and favorable government policies will together result in highly efficient industrial expansion, leading to energy growth of 6.5 percent in this sector (from 1986 levels).

d. Higher gas prices and favorable government policies will lead to the development of a solar energy industry providing systems for domestic, institutional, and industrial hot water systems, and cumulative installations by 1991 will be 2,000,000 ft^2.

e. Over 100 MW of micro and small scale (barrage) hydro systems will be installed.

All assumptions relative to gas supplies, domestic oil production, hydro expansion, and nuclear energy were the same as for the reference case projections in Figure 2.

Due mostly to reduced growth of energy use in industry, the increase in oil imports in 1986 would be reduced from 51 million barrels for the reference case to 40.8 million barrels for the alternative case. This represents a relatively modest 8 percent per year increase over 1981 levels of 28 million barrels. The alternative demand structure for 1991 would result in total commercial energy usage of 1,100 trillion Btu which is over 18 percent lower than that of the reference case. In addition, the use of coal in the power and industrial sector would result in an increased demand from about 40 trillion Btu (2.3 million tons) to 88 trillion Btu (over 5 million tons). The quantitative impact of renewables would still be modest in 1991 since the industry will have had less than five years to react to the higher gas prices (required for economic viability of renewables).

These alternative energy supply/demand projections would result in domestic energy sources satisfying most of demand with oil import requirements being about 48 million barrels annually or about 1.7 times those of 1981 levels. This corresponds to an average increase in imported petroleum of only 5.5 per annum from 1980 to 1991 which should, in itself, be manageable in a growing economy.

The alternative projections shown in Figure 3 do not take into account any further increases (over the reference case)

in oil or gas production which might result from an accelerated exploration program. Even modest success in these exploration programs when combined with the coal use and energy conservation measures of the alternative case projection could result in reducing future increases in oil imports to very manageable levels.

6. Implications of Energy Options

a. Natural Gas Depletion

Figure 4 shows the projected cumulative gas consumption to the year 2000. The resultant cumulative production would exceed 10 TCF by the year 2000 even if no further increases beyond 0.6 TCF per year (1991 assumptions) are assumed. This represents a major portion of the 13 TCF of proven gas reserves. Therefore, if gas production rates were increased substantially in order to reduce oil import requirements, the proven reserves would only last about 20 years, and significant gas curtailments would occur well before this time. This has serious implications for capital investments in gas production, distribution, and utilization infrastructure which must be amortized over long periods of time.

b. Oil Imports

Figure 5 shows annual oil imports for both the reference case and the alternative energy supply/demand projections. The implications of the reference case projections are serious since they would result in oil imports increasing from 1981 levels of 28 million barrels/year to 51 million barrels in 1986 and 87 million barrels by 1991. Even with constant (in real terms) oil prices, the value of oil imports would increase to almost $3 billion by 1991 which represents an average of 6 percent per annum increase over existing levels. The alternative projection results in only modest increases in oil imports to 1991. However, this is achieved by large capital investments in coal power plants, industrial coal conversions, and industrial energy conservation equipment. The economic trade off between these capital investments and increased oil imports should be an important component of integrated energy system analysis.

c. Coal Production

Coal production is expected to increase from existing levels of about 2 million tons per year to about 6 million tons by 1991 to support even the modest facilities assumed at that time. This projection does not include possible use of coal at the PIPRI power stations being planned

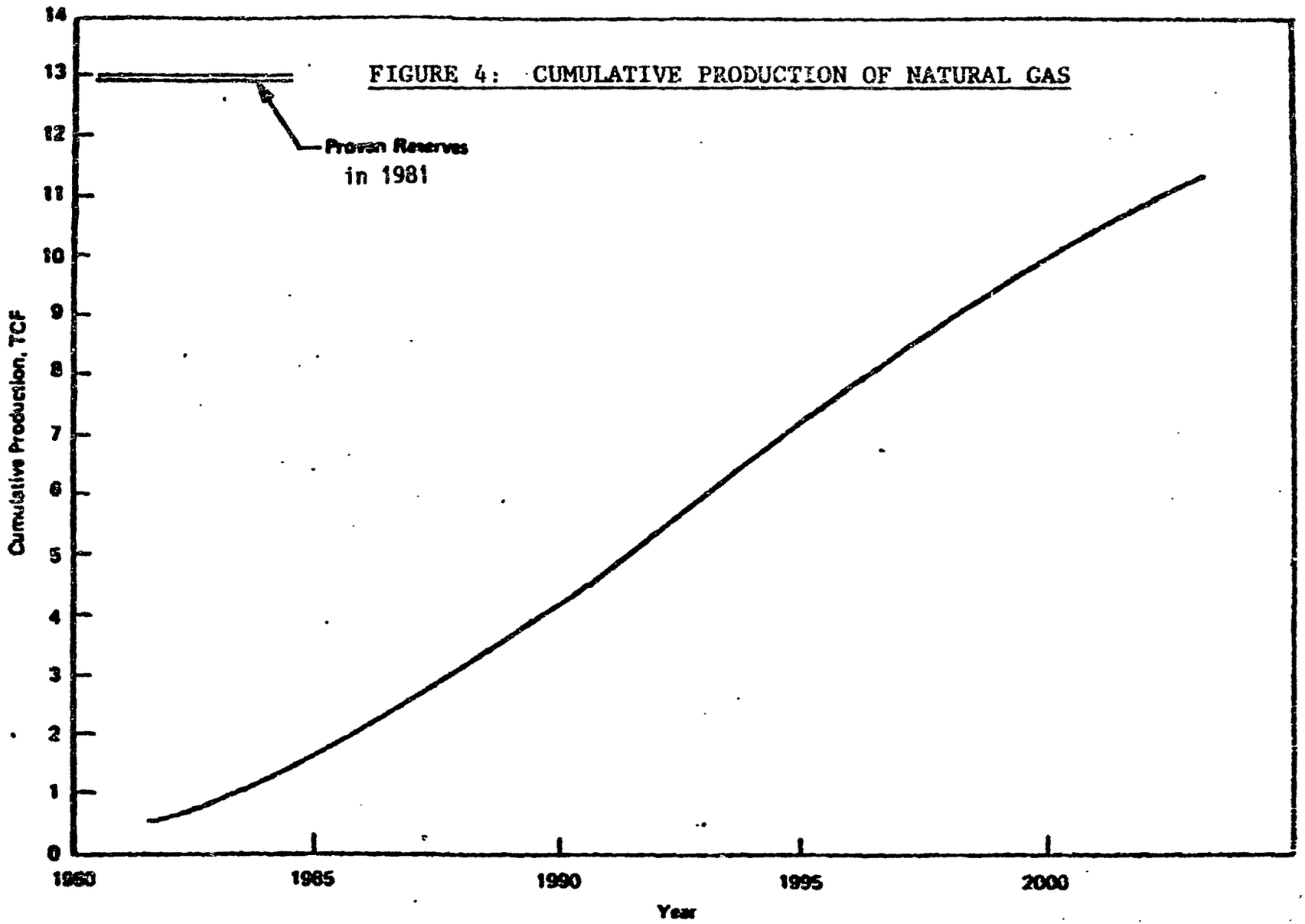
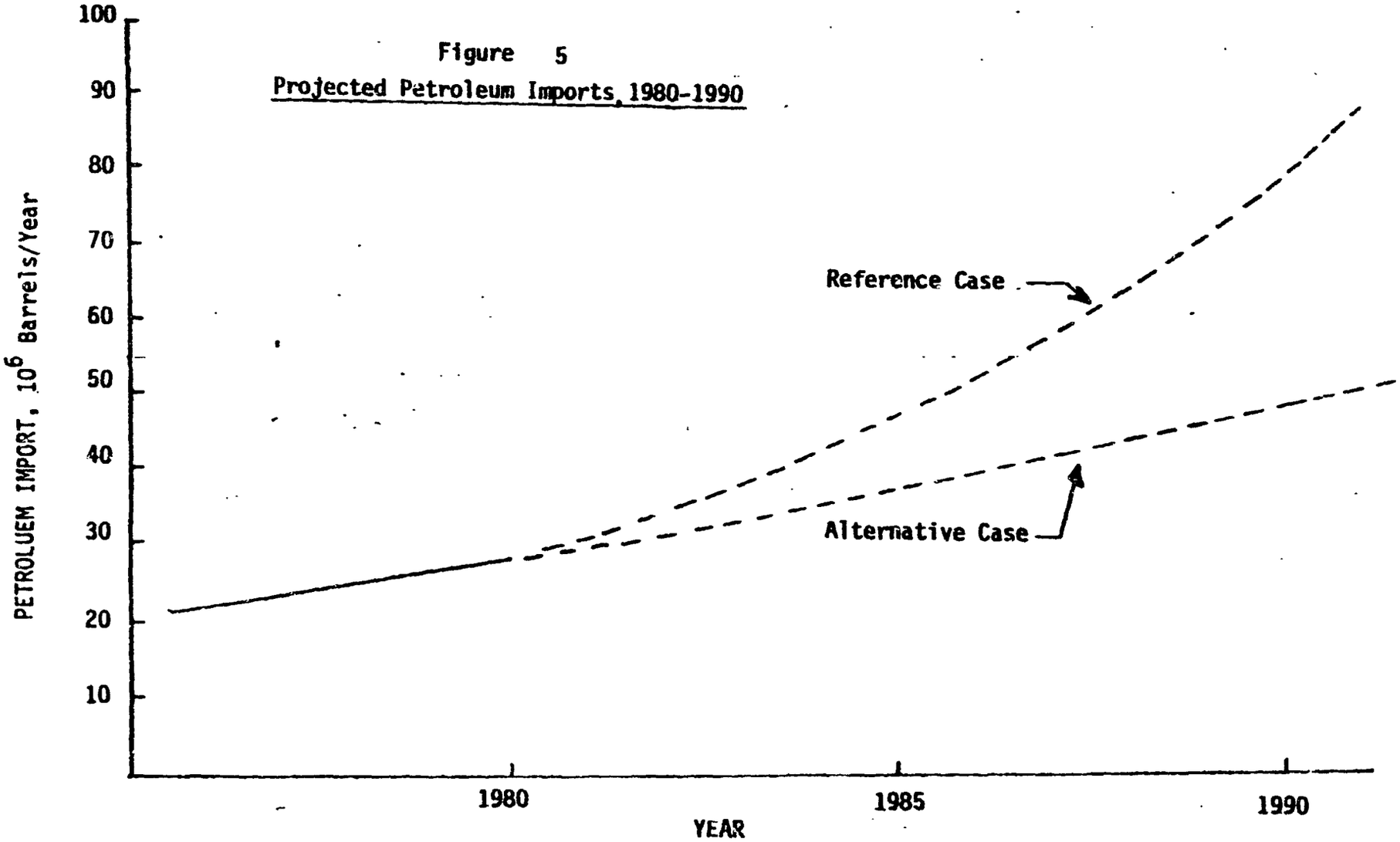


FIGURE 4: CUMULATIVE PRODUCTION OF NATURAL GAS

Figure 5

Projected Petroleum Imports, 1980-1990



by KESC (600 MW of possible coal based expansion). Inclusion of the PIPRI expansions would increase coal production needs to about 7.5 million tons by the early 1990's or about 4 times present production. The further assessment of coal resources and development of efficient coal mining and distribution capabilities is, therefore, indicated by the alternative projections.

d. Traditional Fuels

Both projections assumed that the supply of traditional fuels would not increase due to a combination of depleting woodlands and other uses for such traditional fuels as straw (now more valuable as cattle fodder). Commercial forestry programs designed to stabilize and, possibly, marginally increase wood supplies are therefore very important since any effort to replace traditional fuels with commercial fuels would greatly affect the energy balances.

The balances also implicitly assume that traditional fuels will be used more effectively in the future so that overall household energy demand would increase at a very low rate (1 percent per year). Commercial energy forms (sale wood, coal, bottled gas and electricity) now constitute only 20 percent of household energy use. By 1991, commercial energy would constitute over 38 percent of total household energy use based on the assumption that household commercial energy use increases at a rate of between 7.5 and 10 percent per annum.

7. The Lakhra Coal Project

a. History of Previous Studies

Coal was discovered at Lakhra in the Sind near Hyderabad in 1855 when Baluch nomads struck an 8 feet seam of coal at a depth of 41 feet while sinking a water well. During the 1940's and 1950's, the Burmah Oil Company and the Pak-Hunt International Oil Company encountered coal cuttings near the surface while drilling for oil. And, in 1960, Hunting Survey Corporation reported lignite seams up to five feet thick at a depth of 64 feet and recommended further exploration.

The Geological Survey of Pakistan (GSP), in collaboration with the United States Geological Survey (USGS), followed up on this recommendation in the early 1960's and subjected the area to systematic geological investigation. Thirty-four sites were drilled and 10 coal seams discovered. This work estimated theoretical reserves to be 240 million tons over an area of 80 square miles; 22 million tons of these

reserves were considered proven. The coal was found to be a lignite with a high sulfur content (in the range of 3 to 7 percent.) Underground mining appeared economically feasible, and further work was recommended to establish the feasibility of surface mining. The West Pakistan Industrial Development Corporation (WPIDC) then performed topographical and geological mapping on a 60 square mile area comprising the southwestern block of the original area explored. They arranged industrial tests to be carried out by a German firm, Lurgi Gesellschaft GmbH, and the Japan Consulting Institute. These tests showed that the coal was generally unsuitable for hard coke production but was suitable for thermal power generation.

In 1966-1967, WPIDC engaged a Polish Firm to perform a mining and power station feasibility study. The study established that underground mining operations could produce 1 million tons per year to supply a 250 MW power station and recommended further exploratory drilling. However, for some years after 1967, competition from competing energy sources (hydroelectric, natural gas, and cheap imported oil) and other factors delayed further consideration of Lakhra coal development.

The oil supply crisis of 1973 and subsequent price escalation regenerated interest in the Lakhra resource. In 1974, at the request of WAPDA, the Canadian International Development Agency (CIDA) conducted a reconnaissance study of the Lakhra coal field and an associated thermal power station. In 1976, PMDC submitted a PC-1 scheme for a Lakhra Coal Mining Project; WAPDA submitted a PC-1 scheme for a 250 MW power station to use the Lakhra coal. Subsequently, the Pakistan Government decided to integrate the two schemes. A working committee was established, and WAPDA was appointed the executive agency for the overall project.

In March 1978, a joint Japanese mission composed of the International Cooperation and International Trade Institutes was requested to undertake feasibility studies of the financial and technical assistance needs for mine and power plant development. The mission recommended a two-part program based on a review of the available data and reports:

i. detailed exploration, including drilling, in the southwestern part of the block of PMDC licenses to determine geological and mining conditions and to confirm coal reserves reported by PMDC on the basis of an exploration program implemented during 1974 and 1976; and,

ii. feasibility studies for coal mining and the power plant if the exploration program proved coal reserves suitable for power generation.

The drilling program was performed in the second half of 1979 and results reported by mid-1980. Fifty holes were drilled to supplement the 22 holes drilled in earlier studies for WPIDC/PMDC. Detailed studies of the mine, power plant, and transportation systems were completed and reported by February 1981. Results of the study indicated that the Lakhra field did in fact contain sufficient coal to support an electric power plant of 300 MW for 30 or more years.

b. The Lakhra Coal Study

Due to the growing power shortages in Pakistan, in September 1982, the GOP requested U.S. assistance in reviewing all previous Lakhra studies. AID/Washington retained a U.S. firm, Stone and Webster Engineering Corporation (SWEC) for this purpose. The Stone & Webster consultants visited Pakistan in October 1982 and worked with a team of WAPDA and PMDC engineers to:

i. confirm the technical and economic feasibility of the mine and power plant;

ii. determine the best site for the power generating plant;

iii. effect significant reductions in capital cost requirements compared with earlier reports;

iv. minimize foreign exchange capital requirements by making fullest possible use of available Pakistani equipment and materials;

v. optimize the use of local labor consistent with reasonable standards of mechanization and technical and operating efficiency;

vi. assess and recommend environmental controls and practices for both mining and power generation consistent with standards recommended for developing countries by international agencies such as the World Bank;

vii. if the study results proved acceptable to the GOP, develop an implementation plan indicating required steps necessary for obtaining project financing and achieving expeditious plant and mine design, construction and commissioning; and,

viii. prepare a report containing all of the above to support a prompt Government decision on project implementation.

To introduce the Pakistani team to U.S. coal technologies, the review of the Lakhra project included site visits to a number of relevant U.S. coal mines and power plants.

The SWEC-WAPDA-PMDC team completed the "Lakhra Coal and Power Development Project Review" in April 1983 (See Annex K). The study concluded that a 300 MW plant is feasible and can be constructed, along with the requisite mines at a cost of $558 million (in 1983 dollars), including $191 million for the mines and $367 million for the power station. The figures include import duties but do not include escalation nor interest during construction. If foreign costs are escalated at 10 percent and local costs at 13 percent per annum and interest during construction is added, the total cost (in 1987 dollars) would be $833 million, including $331 million for the mine and $502 million for the power station. The unit generation cost of electricity from the complex was calculated at 4.8 cents per KWH, not including import duty, interest and escalation. On the basis of these results, WAPDA has prepared a PC-1 to construct a 300 MW plant which can be easily and economically expanded to 600 MW capacity.

E. Policy Considerations

Implementation of this Project will proceed concurrently with that of the GOP's Sixth Five-Year Plan. This offers the project an excellent opportunity to address a number of key policy issues that the GOP faces in providing sufficient energy supplies to achieve its economic growth targets and in making a successful transition from cheap natural gas to energy sources priced at world market levels. The most significant of these issues are the following:

1. Should the GOP develop a major national effort to tap Pakistan's indigenous coal resources for power generation and other uses?

Pakistan's energy officials have long debated whether or not to use the country's indigenous coal resources for use in power generation, industrial boilers and for other purposes. The coal's low energy content coupled with its high ash and sulfur content have appeared to make the coal too expensive (on a heat content basis) to compete with natural gas or even with imported coal or oil. However, the Lakhra Coal Study analysis has indicated that the poor quality of Pakistan's coal is not an economic or technical deterrent to its widespread development and use. On the basis of these findings, the GOP is planning to develop the Lakhra Project. This study has thus already had an important impact on GOP energy policy. The successful completion and operation of the

Lakhra fired coal units, which will be initiated with A.I.D. assistance under this project, are expected to launch a major new coal industry in the country and thereby allow Pakistan to become more self-sufficient with respect to energy. Activities under this project will assist the GOP to develop the legal, economic, social and environmental aspects of its long range coal development policy.

2. Will Pakistan develop its own capability to undertake the energy analyses necessary to resolve key energy policy issues?

As described earlier, energy analysis activity in Pakistan is now scattered among various GOP organizations. To integrate this work, the GOP had to turn to an outside consulting firm to prepare the energy component of its Sixth Five-Year Plan. The proposed energy analysis activity under this project will provide the funding and technical support needed by the GOP to establish a coordinated and integrated energy analysis group. Policy issues which will receive special attention under this integrated analysis function are the following:

a. Incentives for Oil and Gas Exploration and Development

Pakistan's proven gas reserves are estimated at over 13 trillion cubic feet. Major investments are needed to develop additional gas production at the Sui and Mari fields and new production from Khandkot and other fields. The current reluctance of the international oil companies to launch new exploration and development programs in developing countries, the gas-prone nature of Pakistan's resource case, and the difficult geology that makes on-shore drilling costs extremely high call for a rethinking of current incentive and investment strategies.

b. Energy Prices

A critical factor influencing investment decisions is price. The relatively low price of Sui gas has led to the rapid conversion of power and industrial facilities from oil or coal to gas and has accelerated the development of energy intensive industrial activity in the form of cement, fertilizer and steel. The subsidization of kerosene and diesel oil has spured demand for these products and resulted in refining imbalances.

Recent agreements with the IMF/World Bank call for the price of natural gas to increase to two-thirds of the equivalent re-export price of fuel oil by 1987. The current average price of natural gas is about 25 percent of the value of the fuel oil

equivalent. Thus, depending on the price of fuel oil and given the GOP policy to increase gas prices based on oil energy prices, it is probable that gas prices will at least double and possibly triple by 1987. The full impact of this price increase on demand, cost of production, energy sector capital availability, and economic feasibility of increased coal, energy conservation, and renewable energy development has not been assessed.

c. Gas Reserve Depletion

The short-term minimization of oil imports requires increasing gas consumption to a level where the present proven reserves of 13 TCF will be depleted shortly after the year 2000. A critical policy issue, therefore, is whether it is in the national interest to increase gas consumption when this will result in a relatively short useful life for high capital cost production, transmission and utilization facilities. The qualitative advantage of natural gas for petrochemical production is also a prime consideration in the expansion of gas supplies to power, household, and industrial users that could use coal, electricity, and renewable energy systems.

3. How much emphasis should be placed on the private sector to develop Pakistan's energy resources?

As mentioned previously, the GOP is placing increasing emphasis on private sector development to attain economic growth targets. In many cases, however, the private energy sector is not yet strong enough to meet current needs. The private coal mining industry, for example, consists of many small mines, largely individually owned and scattered around the country. As a result, some GOP officials believe that public sector mines are the only ones capable of supplying needed coal supplies. As described in the project description below, this project will assist the GOP to assess the financial, legal, environmental, manpower and other barriers to private mining industry development and thereby facilitate the formulation of a revised GOP policy to encourage private mining activity.

Renewable energy resources raise the same question. At present, the public agencies and private companies are developing solar, biomass and other renewable resources. Some public activity is clearly necessary to spur the initial adoption of renewable energy technologies, but full scale development will only be accomplished successfully by the private sector. Accordingly, this project's proposed solar, small hydro and biomass technology assessment and demonstration activities will assist the GOP to develop a private sector renewable policy to encourage entrepreneurs to actively participate in this energy sub-sector.

A third area where private sector policy is unclear is energy conservation. The low price of natural gas, the lack of conservation incentives for public sector managers, and the nature of industrial contracts which often include "cost plus" provisions by which costs are passed through to the consumer, all hinder energy conservation activity. Whether or not energy conservation legislation is needed and how strong it should be is an important question which needs resolution. This project, through its energy conservation component as well as its energy analysis activity, will help the GOP to focus on these problems.

4. How much emphasis should national energy policy place on supplying energy to rural and remote areas?

The GOP is committed to provide energy for rural and agricultural development. An expanded rural electrification program is being planned to increase productive uses of electricity as substitutes for kerosene and diesel oil and to improve the quality of life in rural areas. The issue here is how fast can and should village electrification take place. Can 3000 villages be electrified each year, or should the current or other rates be pursued? Since only about 20 percent of the villages are now connected to the grid, the potential impact of electrification is important due to increased requirements for generating capacity and the high costs of extending distribution systems to areas not yet covered. While this issue will be dealt with under A.I.D.'s Rural Electrification Project, this project's integrated energy analysis activity can play a critical role in shaping a sound long range rural energy policy.

The importance of promoting development in the remote areas of Baluchistan and the NWFP may require special policies relative to the provision of energy sources. In these areas, decentralized energy systems may be suitable even though their cost is high. National energy policy should incorporate an increased concern for the energy needs, uses, resources, and options of rural areas. Policies and programs to increase fuelwood production are of central importance for both rural and urban areas and merit higher priority in national policy. Improving the efficiency of wood use and the development of substitutes (e.g. coal briquettes, biogas) are also important. This project's renewable energy activity is designed to help formulate sound policy on these issues and to assist in meeting energy needs in remote areas.

F. Other Donor Assistance

Several major multilateral and bilateral donors are funding activities in the energy sector. While these activities touch on several of the same areas which will be addressed by

A.I.D., no other donor has pursued or is pursuing a comprehensive strategy and holistic approach in the energy sector. Each donor, for the most part, is working in discrete areas or on specific activities within the energy sector. This proposed A.I.D. project is designed to complement and supplement the activities of other donors. Key multilateral institutions involved in the energy sector are the Asian Development Bank (ADB), the World Bank, and UNDP. Bilateral donors, in addition to A.I.D., are the Canadian International Development Agency (CIDA), KFW of West Germany, and the Japanese International Cooperation Agency (JICA). A summary of other donor activities in the energy sector in Pakistan is provided below.

1. Planning

The World Bank has agreed to provide $750,000 to develop a National Power Plan for WAPDA for the generation, transmission and distribution of power. The Bank's project will finance technical consultants and data processing equipment with funding from the Bank's Technical Assistance Credit of the Structural Adjustment Loan. An additional $2 million from this fund is earmarked for oil and gas studies which have not yet been identified. Two years ago, the Bank was asked to assist the GOP to build a capacity for energy planning and earmarked $5 million for this purpose. The Bank was advised at that time that the Ministry of Petroleum and Natural Resources would be the implementing agency but was never able to reach agreement on how a planning group could be established in this Ministry. As a result, the Bank withdrew its offer of assistance.

2. Coal Resources

The World Bank has recently concluded negotiations with WAPDA for a $10 million study of the Duki coal field in Baluchistan. The study includes water availability, mining feasibility and a pre-feasibility study of a minimum size (about 50 MW) coal-fired power plant. The UNDP is currently financing a $345,000 study and demonstration of the Dundot coal mine with PMDC. The major objective of the project is to develop dewatering techniques for a mine of 15,000 tons annual output.

Recent donor involvement in Lakhra coal has been confined to the Japanese and A.I.D. Both were involved in the financing of technical assistance in determining the feasibility of mining coal in the Lakhra region and the feasibility of its use for a power station. Favorable results from the Lakhra feasibility studies have significant implications for coal development and provide additional justification for a comprehensive assessment of this resource financed by A.I.D.

under this project. From the perspective of household use of coal products for cooking and heating, A.I.D. is the only donor that is proposing to fund feasibility and marketing studies on the prospects of coal briquetting.

3. Energy Conservation

The World Bank is financing plant heat balance studies on a case by case basis. Two such studies are currently in the planning stages, including the National Refinery and the four northern fertilizer plants. The UNDP has a $189,000 project with DGER underway to perform energy audits of three industries to be selected by the Ministry of Production.

4. Thermal Power

The Japanese and the ADB have made loans for thermal power generation stations.

5. Hydro Power

CIDA has financed turbines and generators for Tarbela units 7, 8, 9 and 10. A CIDA-financed hydro-ranking study to rank potential sites in the super and intermediate categories is currently underway. A super site (2000 MW capacity) has been located at Bosha, near Chilas, and a complete feasibility study is underway. The World Bank has financed studies for some earth-filled dams as potential hydro sites.

6. Electric Transmission

CIDA and the ADB are financing high voltage transmission lines.

7. Oil and Gas

CIDA, the World Bank and the ADB are financing studies, surveys and drilling programs for oil and gas prospecting, field development and gas transmission.

8. Renewable Energy

The UNDP has a $1.8 million project underway with DGER for economic and technical feasibility studies of renewable energy in four villages. The project which includes the provision of some hardware, includes studies of wind, photovoltaic, biogas and other biomass. CIDA is considering a project for biogas as an outgrowth of its successful program in India where there are several thousands of units in operation. A proposal to the GOP for a program is expected to be made soon. KFW of West Germany is currently examining

the prospects of developing small, low head hydro projects on existing canal systems and barrages. Unlike the small hydro component of this proposed A.I.D. project, the German proposal will consist of units of one or more megawatts designed to meet power shortfalls in the central grid system as an interim measure until new centralized power projects become operational.

No other donor is providing assistance on energy efficient wood stoves. A.I.D.'s activities in biomass will focus on assessing present experience in this area and in developing a long range marketing and private sector development plan.

G. Lessons Learned

As discussed in the Project Description and Project Analyses Sections and the Project Analyses Annex, the experience of A.I.D. and other U.S. public and private sector organizations as well as other developed and developing countries in undertaking many of the activities proposed under this project was heavily drawn upon to design this project and will also serve to guide the implementation of this project. The experience base in energy planning, coal activities, energy conservation, and renewable energy technologies around the world is extensive and reflects the high priority accorded to energy sector activities globally. Examples of previous experience in areas relevant to this project and how this experience has shaped the design of the Energy Planning and Development Project are provided below.

1. Energy Analysis and Manpower Development

A.I.D. has been involved in several energy policy analyses and investment planning efforts over the past several years. This experience will be applied in Pakistan to help make this component one of high technical quality. In Indonesia, an A.I.D. project is supporting an energy analysis unit within the Ministry of Mines and Energy, which also serves as the secretariat to the National Energy Coordinating Body at the Cabinet level. Work under this project has helped to highlight the oil export implications of continued high rates of growth in domestic petroleum consumption and to spur a Presidential decision to reduce large subsidies and to increase petroleum product prices. A second-phase project will develop regional energy supply and demand balances and will link these with economic growth models. An A.I.D. program in Morocco is providing software, hardware and training in investment planning using a micro-computer. A.I.D. recently sponsored a workshop on energy planning in developing countries that reviewed major experiences with these kinds of programs. The proceedings of this meeting will be useful for the implementation of this component of the proposed A.I.D. project in Pakistan.

A.I.D. experience elsewhere illustrates that even modest investments in energy planning can result in significant economic benefits. Planning in the Sudan has led to the elimination of subsidies in petroleum, policy changes to improve fuel availability for foreign exchange earners, such as farmers and agro-industries, and a short-term electric power reliability improvement program to reduce power outages (which in the past had severely curtailed industrial production). Also the need for inefficient self-generation facilities in residences and commercial establishments was reduced.

Acting in part on recommendations from an A.I.D.-financed planning and policy development team, the Government in the Dominican Republic (GODR) is embarking on a major program to switch from petroleum to coal as fuel for the generation of electric power and as a boiler fuel in many industries. Such a program will require investment for new facilities and transport equipment and other capital equipment. However, given the current relative costs of coal and oil and assumptions as to the long range prospects for coal and oil prices, the GODR expects to realize significant foreign exchange savings by encouraging utilities and industries to switch from oil to coal.

Experience in Morocco has clearly demonstrated the need for a capability to carefully and systematically weigh the costs and benefits of alternative investment projects considering changing world market prices for energy products and the changing technologies available. When the planning project first began in Morocco, the government was relying almost exclusively on plans to develop its considerable oil shale resources to satisfy future needs. Now that world market petroleum prices have declined somewhat and the returns on such an investment are less clear, the government is re-examining its program and looking more closely at ways of diversifying its supply and demand management options, including developing newly discovered natural gas resources.

Perhaps the primary lessons learned in energy planning activities is that they are effective only where they are used to rationalize decision-making and not to take the place of decision-making. Planners are not policy-makers. Analyses carried out under this project will help to make rational and economic options available to Pakistan's decision-makers. Experience in the U.S. and elsewhere indicates that planning or technology assessment done in this way can serve as an important consensus-forming tool by which difficult issues can be resolved. Where analysis groups have lost their objectivity by advocating positions or by becoming too closely associated with specific interest groups, the group's effectiveness has suffered. A second lesson learned is that analysis methods are only useful if they can be fully understood.

For this reason, IEDC has adopted a method which can be undertaken completely by hand. This avoids the problem, often encountered in the U.S., where computer models, while quite sophisticated, are not useful because their complexity prohibits the user from examining the model in detail or from easily altering parameters built into the models. This project will begin with hand-worked models and adopt computer methods only as the skills of GOP analysts develop sufficiently to allow their effective use.

A major neglected area of energy analysis is assessing the manpower implications of energy programs and options. Despite the importance of good management and technical and engineering skills to the carrying out of large national energy programs, this critical factor has received little attention. The methodologies for conducting cost-effective manpower assessments are not well-developed. Bechtel has developed a computerized model that relates energy projections for various supply areas to categories of manpower required to supply that energy. This model has been applied in Egypt and Indonesia with mixed success. This project will, therefore, help develop and improve appropriate techniques for manpower assessment.

As noted in the Project Description, the Manpower Development sub-component will finance short-term professional development and training based on the manpower needs assessment. The emphasis will be on practical training and internships with U.S. industry. This approach is technically well established. A.I.D.'s Conventional Energy Training program has had considerable success in arranging these kinds of programs and will serve both as a model and a resource to implement activities under this project.

2. Coal

Lessons learned on coal assessment work and lignite-fired power generation have been drawn from experience in the U.S. The Lakhra review team visited many mining and power plant sites in the U.S. which influenced the design of this component of the project, and experience in the U.S. will be further exploited through training of Pakistani personnel in the U.S. and through U.S. technical assistance. The same applies to the coal resource assessment work. USGS has a long history of association with the GSP dating back to the 1960's. USGS specialists participated in the design of this project, and the Mission is proposing that USGS through a PASA assist the GSP to implement the coal resource assessment sub-component of the project.

On a world-wide basis, millions of tons of briquettes are produced annually, and the briquettes find a ready sale on the residential market. In Germany, the largest producer, 80 percent of the coal

briquettes produced are sold to residential consumers, and the rest is sold to industry. In West Britain, National Smokeless Fuels, Ltd. produces over one million metric tons of smokeless briquettes per year. In Quetta, Pakistan, coal briquettes (non-smokeless) have been produced by PMDC since 1942; current production is about 10,000 metric tons per year. Briquetting started in Korea in 1930 where about 20 large briquetting plants are operating. A.I.D. has supported a briquetting project in India which also includes the use of a stove which produces its own smokeless fuels from coal. Project development consultants visited and assessed these briquetting activities and have participated directly in the Indian project. The proposed briquetting activities will therefore build on experience and will benefit from lessons learned in these other countries.

3. Energy Conservation and Renewable Energy Technologies

Over the period from 1971 to 1975, U.S. industry reduced its energy use by about 15 percent (per unit of production) by implementing improvements with low initial costs. Even greater savings have been achieved at many plants. In some cases, especially high-temperature processes like cement manufacture, thermal efficiencies have dramatically increased - from less than 20 percent to as high as 60 percent. Of particular importance for this project, much of the improvement in industrial energy efficiency has taken place over a relatively short period of time (about 4 years) using low capital cost measures with payback periods of less than 1 year.

Japan has also made remarkable progress in reducing energy intensity in industry through systematic approaches to energy management at the plant and building level. In the developing world, the Philippines, India, Tunisia, South Korea and other countries are carrying out industrial energy audits and developing tax, trade, and investment incentives to improve efficiency. The Asian Development Bank has made two major loans for industrial energy conservation - to South Korea and the Philippines - and is considering a program in Pakistan. Preliminary results from the ADB funded program in the Philippines indicates energy savings from low cost "housekeeping" improvements might decrease energy use in excess of 20 percent. This is similar to experience in other developing countries.

There are over 200 firms in the United States manufacturing and installing solar heating systems for such varied applications as domestic water heating, space heating, industrial process heating, and commercial crop drying. Many other countries, notably Israel, France, Australia, Japan, and South Africa, also have relevant experience in this area.

Considerable experience has been developed in the design of high efficiency wood stoves for use in a wide range of developing countries including Senegal, India, and Indonesia. These stoves, fabricated from locally available mud, brick and stone, could be adapted for use in Pakistan. The technical merits (and potential favorable impacts) of high efficiency wood stoves have been well demonstrated. Despite these advantages, efficient wood stoves have not in general been widely utilized in any of the developing countries where they have been developed. Common reasons cited are a lack of appreciation of stove advantages by potential users, a lack of private or public sector organizations with a strong interest in promoting stove use, and excessive incremental costs for poor rural populations. The above reasons are why this project emphasizes field testing and private sector participation in order to accelerate the use of stove designs appropriate for use in both urban and rural areas of Pakistan.

Biogas digesters are being used in a number of countries including India, China, Taiwan, and Korea. In addition, several hundred units with capacities of about 120 ft^3 have been installed in Pakistan by ATDO and the DGER. The largest base of experience exists in China where over 1 million family size units have been installed. This experience verifies the technical potential of biogas digesters. It should be noted, however, that the effective operation of digesters requires daily attention by operators (to prepare feedstock and to check pH levels) and that many systems installed in the countries mentioned above are no longer operating (including some of those in Pakistan) for a variety of technical and social reasons. The project design takes note of the mixed experience with digester systems and emphasizes assessing the performance of systems already in place and identifying practical social and institutional issues associated with using digester systems in Pakistan.

A number of studies has been conducted by A.I.D., the World Bank, and the U.S. National Academy of Sciences on the effectiveness of renewable energy programs and several lessons stand out as important. First is that these technologies (and this applies to coal briquettes as well) must be not only technically feasible but they must be acceptable to consumers, both socially and financially. Unlike grid electricity which requires little from the householder beyond paying the bill, solar, biogas and other renewable technologies require a certain amount of consumer knowledge, maintenance and operating activity. If users are not willing to provide the required inputs, then social or institutional mechanisms must be established to provide them, for example, an operator to run a community biogas plant or a small "solar utility" which would lease and maintain solar water heaters or photovoltaic panels. This project places major emphasis on these aspects of renewables development. A mistake sometimes made with renewable energy is to assume that

once a technology becomes economically attractive, consumers will purchase it. Studies in the U.S. and elsewhere indicate, however, that householders use quite different financial and purchasing criteria than do large enterprises or government. When these differences are ignored, renewable energy programs fail. This project is designed to first assess consumer demand and preferences and the marketing potential and feasibility of selected renewable options before any demonstration or field tests begin.

H. Relationship to GOP Priorities, A.I.D. Policy and Strategy, and Other A.I.D. Projects

1. Relationship to GOP Priorities

To sustain current and projected trends in economic growth and to assure the well-being of its population, the GOP places a high priority on the development of increased energy supplies from indigenous sources of both commercial and non-commercial types. As a measure of this priority, the GOP included an allocation of approximately $3.4 billion for the energy sector (or 22 percent of all public investments) spanning the Fifth Plan period from PFY 1979 - 1983. The allocation represented a substantial increase over previous years and was well above the 15 percent average figure for developing countries. Much of the financial resources were directed toward investments in the power (87 percent) and conventional fuel sectors. Not included in the energy sector's projected outlays are sizeable amounts earmarked for forestry development in recognition of the importance of forests in contributing to rural energy needs.

The GOP's Sixth Five-Year Plan (PFY 1984-1988) allocates Rs 116 billion ($8.9 billion), or approximately 25 percent of the Sixth Plan's budget, for the energy sector. This represents both an absolute increase in the amount of funds allotted to energy and an increase in the proportion of the total budget than was the case under the Fifth Plan. This A.I.D. project is fully consistent with Pakistan's energy priorities due, in part, to the fact that the project and the Sixth Plan were developed concurrently. Among other things, the Plan places emphasis on the development of domestic energy sources, energy conservation, satisfying rural energy needs, encouraging the private sector, and making institutional arrangements which will promote effective energy decision-making. As described under Section III, Detailed Project Description, each of these GOP policy priorities is also emphasized in this A.I.D. project. In addition, this project is specifically designed to assist the GOP to implement several new initiatives - coal development, energy analysis, and conservation, among others - which have been proposed in the Sixth Plan.

2. Relationship to A.I.D. Policy and A.I.D. Strategy

a. Relationship of Project to ESF Program Objectives

The central tenet of the $1.625 billion ESF program to Pakistan over the FY 1982 - FY 1987 period is to provide substantial economic assistance to support growth and economic stability in Pakistan with particular emphasis on insuring that Pakistan is able to maintain a manageable balance of payments position through the full life of the planned ESF program. The

pattern of development within Pakistan's domestic energy sector will be critical to all three of these objectives: growth, stability and balance of payments. Within the framework of an ongoing policy dialogue encompassing A.I.D. and the major multilateral donors, Pakistan has made significant progress in developing a long-term approach to policy rationalization within the energy sector. Even with this policy progress, however, growing energy demands and the high costs of imported energy make it imperative for Pakistan to fully exploit all of its domestic energy endowments to the maximum extent consistent with economic feasibility. A quarter century of heavy investments in hydro-power and substantial donor support for exploitation of remaining hydro opportunities constitute one important avenue of domestic energy exploitation which Pakistan has vigorously pursued. Ongoing work in fuelwood development in cooperation with A.I.D. and other donors represents another smaller but important attack on the domestic energy constraint. Improved policies on natural gas pricing and incentives for commercial gas exploration are a third area where Pakistan has made significant progress. All of these initiatives notwithstanding, current projections of the costs of imported hydrocarbons are staggering. About $1.7 billion in foreign exchange will be spent on oil imports in the current year, and this figure will rise to approximately $4.5 billion (in 1983 dollars) in 1992/93.

The major untapped domestic fossil fuel energy resources in Pakistan are coal (Pakistan's estimated total reserves are 1.2 billion tons of which 102 million are currently proven and recoverable), and domestic petroleum, where total reserves are still difficult to estimate, but for which the indicators are increasingly positive. On the coal side, the first 300 megawatt Lakhra coal-fired generating unit has the potential to yield $60 million to $70 million in annual foreign exchange savings by 1988. The medium term prospects for balance of payments impact from a broadly based program of coal and oil development over the 1980's suggest that total foreign exchange savings in the early 1990's could be on the order of one to one and a half billion dollars annually. The activities proposed for financing under this project are therefore fully consistent with the fundamental objectives of the U.S. Government for the six-year ESF program for Pakistan.

b. Relationship of Project to A.I.D.'s Country Development Strategy

The Mission's CDSS highlights USAID/Pakistan's energy sector objective "to increase the availability of reliable and affordable energy in rural areas in ways which will decrease Pakistan's dependence on imported energy supplies and increase its energy self sufficiency". The CDSS then identifies six strategic interventions by which USAID seeks to assist Pakistan

to realize this objective:

i. rationalize energy prices to eliminate or reduce subsidies and provide incentives for domestic energy exploration and exploitation;

ii. increase installed electric generating capacity;

iii. promote development and use of indigenous energy resources including coal, fuelwood, hydro, solar, and the like;

iv. identify and develop new energy sources;

v. increase private sector involvement in energy development and the energy sector as a whole; and,

vi. promote conservation and efficiency in energy use.

The proposed project is clearly supportive of and responsive to the Mission's CDSS.

c. Relationship of Project to the Policy Dialogue

Energy policies are inescapably on center stage in the overall dialogue among the major donors and the GOP. The importance of the energy sector for Pakistan's long range development, where constraints on power for irrigation and industry (small, medium and heavy) are already eating into potential national growth, is obvious. Similarly, the financial magnitudes of the sector, both in investment terms and in revenue terms (revenues earned and revenues foregone through inadequate rates), are enormous. The foreign exchange significance of the sector is similarly overwhelming, both in terms of the foreign exchange for direct imports of fuel and the foreign exchange components of the investments necessary to permit Pakistan to fully exploit its domestic energy resources.

The history of the multilateral and A.I.D. policy dialogue on energy issues is a positive one. Pakistan faces some energy sector problems of dramatic magnitude as a result of past policy mistakes (historically low power rates, poor recurring cost policies on energy investments, lack of attention to financing the real costs of depreciation on energy assets, and a lack of clarity on priorities and objectives within the sector to serve as organizing points for strategies and policies aimed at optimizing investment efficiency). On each of these important policy fronts, A.I.D. is actively engaged with the GOP in developing project interventions (active or under design) which are designed to improve both policy and performance.

There is broad appreciation of the relationship between energy policy and overall macro-economic performance. In general, A.I.D. has found, in company with the multilateral development banks, considerable agreement with GOP policy-makers on broad policy objectives in the sector and has been able to work with the GOP in recent years in implementing an important array of policy reforms which have included substantial rate increases, moves toward getting relative prices right in the sector (e.g., natural gas versus imported petroleum), and emphasizing economic rates of return in laying out transmission and distribution grids for electric power. Much remains to be done on the policy side, however, in areas such as building private sector participation in the sector, improved energy investment management, expanded financial incentives for domestic energy exploration and exploitation, and the overall energy pricing agenda. Neverthless, there are very real prospects for continued progress on the energy policy dialogue with the GOP over the coming few years, and this dialogue will be facilitated through this and other A.I.D. projects.

d. Relationship of Project to Agency Energy Policy

The Agency's draft Energy Strategy Paper (AID/Washington, December 1982) states that A.I.D. energy projects will focus on four basic areas:

i. energy analysis, planning and policy development;

ii. training and institutional development;

iii. technology systems development, including research, demonstration, and site testing of new supply systems; and,

iv. increasing energy supplies and improving the efficiency of energy use.

The Energy Analysis and Manpower Development component of this project is entirely consistent with both the stated objectives and method of implementation described in the Strategy Paper for the first area of emphasis. With regard to the second area, training of personnel in the energy field is one of the largest elements of the project, with about 600 person-months of short-term and long-term training in the U.S. and a significant proportion of the technical assistance intended to provide on-the-job training in Pakistan. The project will also assist in establishing two critically needed institutions devoted to energy, the Energy Analysis Group in the Planning and Development Division and the Coal Projects Department in WAPDA. Strengthening of other GOP agencies devoted to energy, such as the DGER, PCSIR and GSP is also a major project objective. In addition, under the proposed Coal Development, Pilot Briquetting, and Renewable Energy activities, new but well-established technologies for energy use will be introduced into Pakistan which is consistent

with the third area of emphasis in the Strategy Paper. Finally, the fourth area of emphasis in the Strategy Paper is embodied in the planned activities under the Coal Development, Energy Conservation, and Renewable Energy sub-components of this project.

3. Relationship to Other A.I.D. Projects

a. Rural Electrification

A major activity under the Rural Electrification Project is the preparation of a long range Master Plan which identifies, on the basis of socio-economic criteria, rural areas to be electrified. The Lakhra Coal Project will provide a major source of generating capacity to support the Rural Electrification Project. In addition, villages excluded from the Rural Electrification program may potentially be suitable as sites for the small hydro component of this project.

b. Forestry Planning and Development

This project proposes to strengthen the GOP's capability for natural resource assessment and to lay the basis for increasing firewood supply through the growth of more forests. An increased assessment and planning capability in the forestry sector will add to the GOP's overall assessment and planning capabilities for energy and will contribute to policy initiatives affecting both the supply and demand of non-commercial fuel sources such as firewood.

c. Area Development Projects

The proposed Energy Planning and Development Project is related to A.I.D.'s Tribal Areas Development Project in the NWFP in the area of water resources development for energy use. As currently envisioned, small hydro sites will be selected to test the technical and economic feasibility of small scale, low-head hydro electric systems for provding energy to remote villages. NWFP has sufficient water resources to offer several possibilities for pilot activities. If the pilot phase proves successful, an institutional framework will exist to promote the replication of similar systems within project areas. Renewable demonstrations may also be implemented under this project in conjunction with activities under the Area Development in the NWFP and the Baluchistan Area Development Projects. In addition under the latter project, scheduled for initiation in FY 1984, the potential exists for coordinating coal-related activities under this project since Baluchistan contains much of Pakistan's coal deposits and offers potential sites for locating a pilot briquetting plant which may be funded by this project.

I. Project Rationale

Pakistan is at a very important juncture relative to its overall economic development and the role of energy resources in this development process. In particular, the short-lived era of perceived high gas availability with associated low costs is rapidly coming to an end. To a large extent, gas has been a major factor in accelerating Pakistan's development over the last two decades. Decisions will have to be made on such critical issues as natural gas pricing, energy intensive industrial expansion, exploration policies, coal development, energy-related infrastructure development, and manpower development. The investment implications of these decisions will be enormous and long lasting.

Clearly, the extent of oil and natural gas reserves in Pakistan is one of the central issues which will affect all other energy supply options. However, as indicated by the energy balance projections, modest increases in gas or petroleum supply will not diminish the need to consider the increasing use of coal in industry and power generation. Nuclear energy is being developed in Pakistan, but the economics of nuclear will also not allow it to satisfy the country's projected shortfall. Currently, there is only limited experience in Pakistan in the large scale mining, transportation, and utilization of coal. It is, therefore, important to improve the capabilities of appropriate organizations (including WAPDA, PMDC, and GSP) in Pakistan to assess the potential role of coal and to lay the groundwork for its expanded use.

The energy balances also indicate the central role of industrial energy conservation in achieving a better balance between indigenous energy resources and demand. They indicate, in fact, that credible programs in expanded coal utilization would not succeed in significantly reducing the rapid increase in oil imports without simultaneous efforts to improve industrial energy efficiency. Furthermore, energy conservation is one of the few options which can have a significant impact over a 2-5 year time frame - a period which will be very important as Pakistan makes the transition from perceived ample supplies of cheap natural gas to a period where energy is priced at close to international standards. Due in part to the availability of low cost natural gas, there is only limited awareness in Pakistan of the rapid improvements in energy audit techniques, operational modifications, and energy recovery and management equipment which have occurred because of

economic necessity in the United States and elsewhere. Improving the capability of both private and public sector industry to utilize modern energy conservation methods is, therefore, an important element in the overall energy planning process.

The role of renewable energy resources in affecting near-term (to 1991) national energy balances is modest. However, this role is projected to become more significant in the post 1990 period due to a combination of increased gas prices (making solar heating more attractive), improved technologies (particularly photovoltaics), and the creation of an industrial capability to manufacture and service systems. Of particular importance is that renewable energy systems could be attractive in the near-term for servicing small loads in sparsely populated and strategically important regions such as NWFP and Baluchistan. The capability to analyze, design, and implement renewable energy technologies should be developed early in both the private and public sectors, so that scarce resources are not directed toward projects with limited practical value, a private sector capability to serve this industry can evolve, and realistic information required for integrated energy planning can be developed.

The realistic assessment of options relative to energy sector investment and strategies must be integrated with a complex mix of economic development, energy demands, and financial and policy factors. The capability to undertake the required integrated analysis does not yet exist in Pakistan and, in fact, there has not been a clear charter for such analysis within any single government organization. This has been recognized by the GOP and resulted in its using the services of a foreign consulting firm to assist in the development of the energy section of the Sixth Five-Year Plan. An enhanced capability to undertake integrated analysis of energy options will be an important factor in being able to realistically assess the merits of alternative strategies and policies relative to such issues as coal development, energy pricing, and rural electrification.

The proposed project has as its primary objective to assist the Government of Pakistan to develop essential information required to make key policy and planning decisions as well as to develop the capability to utilize this information in analyzing energy development options and energy policies. The project addresses many of the major energy-related policy and technical assistance

issues in those areas where increasing private sector participation could be particularly beneficial such as in coal mining and in developing the capability and equipment to produce and use industrial energy efficiently or to tap renewable energy resources. These are also areas where the United States private sector is very strong, so that A.I.D. is in a favorable position to provide Pakistan with highly qualified technical assistance.

In summary, the rationale for this project is that it addresses the critical energy problems which represent a major constraint to Pakistan's economic growth and stability. The effectiveness of other U.S. assistance would be enhanced if energy shortages were reduced or eliminated. The project provides opportunities to support and encourage improvements in energy policy and it reinforces A.I.D.'s emphasis on technology transfer, training, and a strengthened role for the private sector.

III. DETAILED PROJECT DESCRIPTION

A. Project Goal and Purpose

The goal of this project is to increase Pakistan's energy self-sufficiency and thereby improve the quality of life for its people. The purpose of the project is to assist the Government of Pakistan to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and increase the efficiency of energy use. This will be achieved by strengthening the capability of the Government of Pakistan to: (1) undertake effective integrated and sectoral analyses of energy development strategies in order to support financially sound GOP energy policy and development planning; (2) develop programs in coal assessment, mining, and utilization; and, (3) adopt energy conservation and renewable energy technologies.

B. Project Outputs

The project is expected to produce the following major outputs which together should achieve the project purpose:

1. the establishment of a permanent GOP Energy Analysis Group capable of carrying out integrated energy analyses and sectoral and special studies;

2. the establishment of an operational Energy Data Management System, including current and historical supply and demand information by fuel and by sector;

3. the completion of a series of Special Energy Studies to be used as reports to assist in the formulation of energy policy and in the preparation of annual, 5-year, and long-term energy development plans;

4. the completion of a coal resource assessment which will provide a quantitative understanding of coal reserves at Lakhra, Sonda Thatta, and other coal fields in Pakistan;

5. improved coal analysis facilities at GSP, PMDC and PCSIR;

6. the establishment of a Coal Projects Department within WAPDA to promote, plan and manage the development and implementation of coal-fired power generation and coal mine projects;

7. the completion of an assessment of the development barriers facing the private coal mining industry and of options available to that sector and the GOP to eliminate or reduce those barriers and to stimulate private investment in coal development;

8. the demonstration of improved mining techniques appropriate to Pakistan's coal industry;

9. preparation for the implementation of Pakistan's first large scale coal mine and coal-fired Power Generation Project (Lakhra);

10. the completion of a feasibility study, test market analysis and pilot plant for producing coal briquettes for use in the residential market;

11. the completion of approximately 60 energy use audits and the establishment of an Industrial Energy Use Data System;

12. the implementation of 4 to 8 industrial energy conservation demonstration projects;

13. the development of a comprehensive national industrial energy conservation program;

14. the completion of an energy needs survey which describes the user market for renewable energy technologies; and,

15. the completion of assessments of renewable energy technologies and programs and the demonstration of selected renewable energy technologies such as solar, small hydro, fuel efficient woodstoves, and biogas digesters.

Additional information on the relationship among the project goal, purpose, inputs and outputs is provided in the Logical Framework in Annex E.

C. Project Components

The project consists of three major components: (1) Energy Analysis and Manpower Development; (2) Coal Resource Assessment and Development; and, (3) Conservation and Renewable Energy Technologies.

1. Energy Analysis and Manpower Development

This component will strengthen the capability of the GOP to undertake integrated energy analyses necessary for sound development planning. Technical assistance, training and some small computer equipment will be provided to the GOP Planning and Development Division to support the development and management of an Energy Data System, the development of an Energy Analysis Group (EAG), a series of special energy studies, and a manpower assessment and development program.

Energy issues pervade the whole economic planning process. Petroleum products now account for over 25% of total imports,

and over 20% of the national budget is directed toward the energy sector. Development of Pakistan's industrial and agricultural sectors is being impeded by the cost and availability of energy resources. The development of financially sound policies and plans at the national level requires the ability to assess the energy-related implications (oil imports, infrastructure requirements and the like) of alternative development policies. This assessment requires an integrated analysis of often conflicting energy supply and demand issues. Such an integrated analysis usually consists of three steps:

a. developing an adequate data base on a wide range of topics such as energy technologies, energy pricing structures, regional and national demands broken down by sector, and energy transmission and transportation system costs;

b. preparing integrated energy supply and demand balances and forecasts which indicate the sectoral energy demands required to satisfy various economic development needs and the energy supply infrastructure (such as power plants and drilling programs) required to meet these demands; and,

c. estimating the financial, material, and manpower requirements of the energy supply infrastructure for comparison with available resources so decision-makers can develop sound policies and plans.

When completed, this analysis will provide a clear understanding of the energy implications of pricing policies and industrial development strategies and of the impact of various energy systems (such as coal or nuclear) on national budgets, financing needs, employment and social development.

As indicated previously, the GOP, through its Planning and Development Division, is currently undertaking integrated energy analysis with the assistance of IEDC in support of the preparation of the Sixth Five-Year Plan. In addition, several organizations in the GOP, most notably the DGER within the Ministry of Petroleum and Natural Resources, Enar-Petrotech within the Ministry of Production, WAPDA within the Ministry of Water and Power, and the Applied Systems Analysis Group within the Pakistan Atomic Energy Commission also have extensive energy-related data collection and sectoral energy analysis capabilities. This project component will use these existing GOP capabilities as the starting point to support the formation of an Energy Analysis Group, consisting of four to six professional GOP analysts within the Planning and Development Division trained in integrated energy analysis methods. The project will focus on the development of GOP capabilities rather than on the energy analyses

themselves. Beyond the obvious development value of building GOP analytical skills, an additional justification for this approach follows from the fact that any energy plan must be continually updated and re-evaluated to respond to changing world energy prices and other variables. A permanent, well organized and trained Energy Analysis Group will provide the GOP with the capability to accomplish this on a continuing basis.

The objectives of this Energy Analysis Group will be to undertake integrated analysis in support of the annual, 5 year and long-term planning cycles and to provide information required for investment planning and manpower development in the energy sector. These objectives will be achieved through the following major activities : data base development and management; integrated energy analysis; special studies; and, manpower assessment and development.

a. Energy Data Base Development and Management System

This activity will strengthen the energy data collection and processing capabilities of both the Energy Analysis Group and organizations within the line Ministries having major responsibilities for energy data collection and sectoral analysis. Under this activity, the Energy Analysis Group will compile a consistent set of energy data collected by the Ministries which supply and use energy. The Energy Analysis Group will not conduct its own primary data collection but will rely on input from other GOP organizations charged with specific energy and economic development activities such as industrial energy conservation or renewable energy development. Funds will be provided for several energy surveys which are described under the coal and energy conservation and renewable components below.

Data needs addressed under this activity will include detailed statistics on: reserves and production rates of primary energy resources; performance costs and manpower requirements of energy system options; sectoral energy demands both at the national and regional levels; financial parameters relating to trade, taxes, interest rates, and duties; costs and availability of internationally traded energy forms (oil, gas, coal, LPG); basic energy inputs required to undertake different forms of industrial activity (such as Btu per lb. of cement) and, the probable time of availability, performance, and economic parameters of new energy related technologies which might significantly affect energy supply options or energy demand.

The data needs of comprehensive integrated energy analysis are quite complex. This program will assist the GOP to develop the data inputs based on the experience gained to

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date in the DGER, the Federal Bureau of Statistics and other offices in Pakistan, in the U.S., and those in international bodies such as the International Energy Agency and the U.N. Statistical Office. Assistance will also be provided to put the data into standardized formats so that computer-based data systems will be consistent with the data needs of the analysis methods being used at various phases of the project.

b. Integrated Energy Analysis

Through technical assistance, training and provision of computer equipment, this activity will organize and build the capabilities of the Energy Analysis Group to undertake complex integrated analysis of investment and manpower resource needs in the energy sector. Activities which will be undertaken as part of this project sub-component will assist the EAG staff to:

i. use energy models (such as the Reference Energy System) in support of planning activities (annual, 5 year, and long-term plans) using the more extensive data base developed as part of the Energy Data System described above;

ii. identify additional analytical tools which can be used effectively in Pakistan consistent with EAG staff capabilities and its data base;

iii. determine training needs and arrange for training programs (both in-country and in the U.S.) essential for strengthening staff capabilities; and,

iv. identify information needs important to the integrated energy planning process which might be addressed by the special studies programs described below.

The end result of this sub-component will be an Energy Analysis Group capable of undertaking integrated energy and financial analyses with minimum outside support. This group will be in a position to provide information to decision-making bodies and, thereby, encourage policies and plans consistent with economic constraints and opportunities as well as national energy policies.

It is important that the Energy Analysis Group not duplicate the energy data collection and sectoral analysis activities already being done by the various Ministries. The proposed program will help strengthen the ability of the existing organizations to support the Energy Analysis Group in such vital functions as data collection and analysis, system cost estimating, sectoral analysis, and energy technology assessments.

c. Special Studies

Under this sub-component, assistance will be provided to appropriate GOP organizations to undertake analytical studies, technology assessments, project pre-feasibility studies, and resource evaluations in order to generate data and information required for effective integrated analyses, policy formulation, and investment planning. The subject matters to be addressed and the types of technical assistance acquired will be identified as information needs are further identified. An illustrative list of special studies which may be addressed under this sub-component are:

i. pre-feasibility studies on the use of coal in various industries in Pakistan;

ii. an assessment of the energy conservation potential in the transportation sector;

iii. a review and analysis of management assistance needs in various energy sectors; and,

iv. an assessment of the effects of alternative world oil price escalation rates on Pakistan's energy investment needs.

These special studies will usually involve the use of U.S. specialists in the technology or economic fields of interest who will work in a supportive role with GOP counterparts. The typical level of effort of each such special study is anticipated to be 6-12 person-months of U.S. specialists and 12-29 person-months of GOP staff.

d. Manpower Needs Assessment and Development

Development of Pakistan's coal and other indigenous energy resources necessitates a major effort to increase the training of Pakistanis in the planning, management, and technical implementation of energy projects. This sub-component will support:

i. a manpower needs assessment to determine the range of technical, managerial and analytical skills necessary to accomplish the goals of this project and of immediate, intermediate and long-term energy plans; an analysis of the supply and demand for engineering graduates in energy-related fields; the magnitude and cost of the training required, the programs where training can be accomplished, and the actions necessary to improve Pakistani education and training programs; and,

ii. programs of short-term training in specific sub-sectors (such as utility management. coal development, oil and gas, energy conservation, and renewable energy technologies) which will emphasize on-the-job internships with U.S. companies and special courses available at U.S. companies and universities.

This training will complement the project-specific training identified in Components 2 and 3 and will be aimed at strengthening the overall energy sector. Depending on the outcome of the needs assessment, a decision may be made to concentrate these resources on one or two specific sub-sectors where the shortage of requisite skills is a critical constraint.

e. Technical Assistance

Technical assistance for the Energy Analysis and Manpower Development Component will include a combination of both long-term and short-term advisors and specialists. Two long-term advisors will assist the Energy Analysis Group: one will have analytical, including computer, skills and will develop a methodology for and conduct energy analyses, design energy technology assessments, and help present analytical results to the NEPC and other policy-making bodies; the second advisor will have human resource development skills and responsibilities, including assessing manpower needs and implementation of on-the-job training for personnel in the Energy Analysis Group, in the Energy Section and other sections of the Planning and Development Division, in other energy analysis groups within the GOP and in GCP energy agencies in general. The advisors will work together as a team to assist the Energy Analysis Group staff to carry out integrated energy analysis and manpower development. It is anticipated that both long-term advisors will work with the EAG during the early years of the program while staff capabilities are being developed and computer-based analytical methodologies are being implemented.

Short-term advisors and consultants will be used in two capacities: to support the long-term advisors in their work with the EAG and supporting organizations; and, to work with GOP counterparts in undertaking special studies as identified during the course of the program. It is anticipated that up to 189 person-months of short-term advisory services will be used during the program: approximately 84 in support of the EAG training and support and manpower support activities and 105 to undertake approximately 7 special studies as described above.

Short-term advisors in support of EAG institutional development will focus on such activities as: developing data bases in specialized technology areas such as coal

gasification, renewables, and co-generation; providing short-term training in a wide range of subjects such as data formats, model utilization, and financial analysis; and, implementing specific computer facilities or complex software packages. Short-term advisors for the special studies will cover a wide range of skills including economics, finance, technology assessment, engineering, education and others. Short-term technical assistance for the manpower needs assessment and development sub-component will consist of specialists in the various energy supply (oil and gas, coal, power, conservation, solar and so forth) and demand (industrial, residential, transport and so forth) sectors.

f. Training

Energy analysts in the Energy Analysis Group and others will be trained in the U.S. and in Pakistan in energy analysis subjects and data management techniques. Energy analysis methods developed over the last decade vary widely with respect to complexity and sophistication, and the field continues to change rapidly. Accordingly, short-term training in the U.S. is especially important for those key staff members of the Energy Analysis Group and supporting organizations who have prime responsibility for designing analytical and data management methods. The details of the training program will be developed during project implementation as the needs of the EAG staff and supporting organizations are better identified. Short-term training activities will, however, take the following basic forms:

i. U.S. Based Training

There is a wide range of short courses (3-6 months) given in the United States in such subjects as energy systems analysis and planning, computer-based energy supply-demand models, data base management, financial analysis, and energy-related policy. These courses are given by organizations such as the State University of New York at Stoney Brook (an energy management course supported by A.I.D.), Brookhaven National Laboratories (energy supply-demand models), and private sector companies. The number of persons to be provided this type of training will be consistent with the needs identified during the manpower needs assessment.

ii. In-Country Training

Training in Pakistan will consist of short courses (5-10 days) and seminars provided to EAG staff, the staff of supporting Ministries, the staff of the Planning and Development Division sections, and private sector organizations. These courses will be given by both U.S. and Pakistani professionals drawn from the public and private sectors. The subject matters to be covered will be identified with the assistance of the long-term advisors during the course of the program.

Other training needs will be identified by the manpower needs assessment. Topics may include environmental monitoring and control technologies, efficiency in the transport sector, new sources of energy such as hydrogen or geothermal energy, active and passive solar design methods, and others. A limited amount of long-term academic training, for example, in economics, may be necessary for members of the EAG staff. This will be decided during project implementation.

g. Commodities

While analytical methods employed under this component will in their initial stages allow hand computation, eventually machine computation will be required to carry out new sophisticated and complex modeling exercises necessary for detailed supply and demand forecasts. Pakistan's industrial sector, for example, consists of several dozen subsectors, each with its own characteristic energy demand pattern. Geographical distribution of non-commercial fuel use will likewise be disaggregated, potentially down to the district level. Achieving the necessary accuracy will require use of computers.

Perhaps the greatest need for computer capability will arise from development of the Energy Data System, which must store thousands of pieces of energy supply and demand information. While selection of a suitable computer depends on analytical methods and data processing chosen by the Energy Analysis Group, it is not envisioned that a large main frame computer will be necessary. Small computers with disc memory, cathrode ray display screen, line printer, and graphics capability will be most appropriate for the computer services required under this component.

In addition to computer hardware, this program will support the procurement of computer software packages and associated technical support. With more complex models, technical support (i.e., intensive specialized training in software use and modification) is an essential aspect of effectively transferring capabilities for computer-based analysis.

2. Coal Resource Assessment and Development

This project component will support GOP and private sector efforts to develop Pakistan's coal resources as an alternative to natural gas, imported oil, and fuelwood. Technical assistance, training, and commodities will be provided to assist the GOP to assess and plan the development of national coal reserves, to prepare for the implementation of the country's first large scale coal mine and power generation project (Lakhra), to define the private sector's role in coal mining, and to introduce processed coal briquettes as an alternative to increasingly scarce and expensive fuelwood.

a. Coal Resource Assessment

The coal mine, power generation and briquetting activities described below are the first steps toward a major expansion of the coal industry in Pakistan. Developing the maximum contribution that coal can make to Pakistan's economic development will require a careful assessment of the country's total coal resources. This sub-component will strengthen the capability of and assist the Geological Survey of Pakistan (GSP) to carry out such an assessment. It will also strengthen the coal analysis capabilities of the GSP and the Pakistan Council for Scientific and Industrial Research (PCSIR) Laboratories.

Coal fields and areas identified by a joint USGS-GSP team as promising for more detailed assessment include Lakhra (discussed below), Sonda-Thatta, Sor Range-Zarghun, Trans-Indus Coal fields, Khost-Sharigh-Harnai, Mach, and the Northern Indus area. An assessment of the Duki field, which also is very promising, is being funded by the World Bank. Priority attention will be given to Lakhra under this project. A strategy for coal resource assessment in the Lakhra fields will be developed during project implementation to determine priorities for the assessment work. To accomplish these assessments, a number of activities are necessary. These include coal exploratory drilling, coal analysis and testing, and data management and geological study activities.

i. Coal Exploratory Drilling

Exploratory drilling is commonly done with "core drills" which retrieve rock and coal samples as the drill hole is dug. Drill rigs now used by the GSP will be refurbished, primarily with bits and drill pipe needed to drill larger holes which will allow deeper drilling, easier geophysical logging (determining the nature of a stratigraphic sequence by measuring geophysical properties such as radioactivity, density and electrical resistivity), and better core sampling of the coal. Two additional drill rigs will also be provided. Augmentation of the GSP's existing drilling equipment, in conjunction with the relevant training required, will greatly increase the capability of the GSP to undertake the considerable quantity of drilling necessary to support the GOP's expanding coal assessment program. During this exploratory drilling program, this activity will provide the GSP with familiarization and training in the techniques of geophysical logging and will supply equipment suitable for use in coal exploratory programs in Pakistan. This geophysical logging capability is necessary for accurate interpretation of the rock sequence penetrated in drill holes.

ii. Coal Analysis and Testing

Coal analysis capabilities will be strengthened at the GSP and PCSIR Laboratories. Coal analyses will consist of a standard coal analytical sequence: proximate and ultimate analysis; heat value forms of sulfur; ash-fusion temperature; grindability; agglomerating character; and major, minor and trace element analysis. These coal tests will be used to predict mining and combustion properties of individual coal seams. The capability to perform such a program is now scattered among various labs in Pakistan. An expanded coal program will require a modern coal laboratory capable of expeditiously analyzing a large number of samples.

A.I.D. will provide funds for a Workshop on Analytical Excellence to review existing capabilities and to determine specific needs to staff and equip new facilities. The workshop would also establish protocols for handling coal samples and for reporting and managing data on analytical results.

A.I.D. will also provide funds to update equipment for a modern coal analytical laboratory in the GSP. Equipment needs at this lab and at other labs in Pakistan identified during project development are only approximate and will be refined after the above workshop is held and after a thorough review is made of laboratory needs. Relevant training at USGS laboratories in Reston, Virginia, in USGS contract laboratories in Sommerset, Pennsylvania, and by USGS chemists in Pakistan will be supported.

iii. Data Management and Geophysical Studies

In order to support a systematic assessment of Pakistan's coal resources, the following activities will be financed under this project:

(a) Geodata Center

The value of geologic, engineering, and other scientific and technical data is directly related to the availability of the data to those who need to use it. A central location for organizing, cataloging, storing and reviewing geologic, engineering and related technical information from Pakistan agencies with responsibilities in the geologic and mineral resource fields has been authorized by the GOP and is being established in Islamabad by GSP. A.I.D. will provide computer capability and other support to the Geodata Center.

(b) Geophysical Studies

Many, or most, of the known coal fields of Pakistan are located in structurally complex areas where resource assessment and mining are complicated because of folding and faulting of the coal beds. Geophysical methods and techniques supported under this activity will help interpret the geological setting of the coal fields of Pakistan. In particular, geophysical methods will be helpful in determining the regional extent of the coal bearing rocks of the Lakhra and Sonda-Thatta coal fields in addition to the geophysical work directly associated with the Lakhra Coal Project described below. Seismic reflecting and refraction and selected other geophysical techniques are applicable in regional coal assessment studies. Some of these techniques can be applied by GSP and will be supported by technical assistance from U.S. geophysicists experienced with those techniques.

(c) Photogrammetry and Remote Sensing

The need for special maps derived by photogrammetric methods is met in GSP through the use of the 1 to 40,000 aerial photographs that cover much of Pakistan and the map plotters that GSP acquired about 20 years ago. The four plotters of GSP are capable of satisfying the basic expected needs of the coal resource assessment program if brought up-to-date by add-on equipment available from the manufacturer. All four of the GSP plotters will be updated. Familiarization and training in methods and techniques of regional coal resource assessment will include some experience using modern types of stereo-plotting instruments.

Remote sensing through the use of satellite photography is rapidly developing into an essential tool for establishing regional stratigraphic and tectonic settings. Some computerized interpretive approaches are essentially unavailable because of hardware or software unavailability, but less sophisticated approaches are still applicable and are useable in studying coal-bearing areas in Pakistan. Therefore, training in this field of remote sensing will be made available to GSP. In addition, satellite photographic coverage in forms suitable for GSP use will be made available.

The basic aerial photography available in most of the coal-bearing areas is 1 to 40,000 scale, black and white coverage dating from around 1955. This old coverage is still useable in some areas although the negatives are seriously deteriorating, but aerial photography is not available at all in some of the coal-bearing areas. Aerial photography is a basic required element in modern fast-paced resource studies, and funding will be provided for coverage in key areas.

(d) Publication of Reports

Rapid publication of the results of all types of studies undertaken to contribute to the coal resource assessment of Pakistan is necessary for use in further exploration and development. The goal must, in all cases, be to aid those whose responsibilities, such as mine-planning, are dependent on fast availability of accurate exploratory information. Publications will range from progress reports of all types, even though of only short-term value, to finished scientific papers for formal publication. In order to update the capabilities of GSP in the preparation and publication of reports resulting from the coal resource assessment program, USGS specialists will guide and assist in the development of GSP's report preparation and processing activities. In addition, provision will be made to supply state-of-the art equipment to GSP, such as word processors, lettering machines, reducing and enlarging dry-print reproducers, and similar aids.

(e) Coal Petrography

Coal petrography, the characterization of coals through study of their mineral-like constituents, is a necessary part of modern coal resource assessment. The size, shape, distribution and interrelationships of the materials that make up coal provide information useful in understanding possible coal quality variations and, most importantly, allow prediction of potential uses. As a very specialized sub-discipline of geology, effective academic training in coal petrography must be accomplished at a school specializing in the subject followed by consultation and guidance while becoming an effective and productive researcher. This component will include training in this field.

iv. Technical Assistance, Training and Commodity Inputs

For the coal resource assessment sub-component, one member of the USGS will be assigned full-time (totalling approximately 45 person-months) in Pakistan. USGS will also provide up to 88 person-months of short-term technical assistance in a variety of disciplines within the coal sector. This Senior Coal Geologist will have responsibility and authority as the representative of the USGS to guide and support all the various USGS activities of the project.

Training needs for the resource assessment consist of approximately 68 person-months of short-term training in the U.S. for about 27 GSP employees. Topics include: coal resource assessment methodology (10 individuals); geochemical characterization (4 individuals); and, geophysical logging, data management, satellite data methods and report preparation (13 individuals). Limited academic training will also be provided.

Commodities that will be provided to the GSP for the coal resource assessment include: (a) equipment to augment existing core drill capability; (b) geophysical logging equipment; (c) new core drills; (d) analytical laboratory equipment; (e) coal petrography equipment (needed for prediction of utilization); (f) Geodata Center support equipment; (g) photogrammetric equipment; (h) publication support; (i) geophysical surveying equipment; (j) rapid surveying equipment; and, (k) textbooks and manuals. The list is roughly in order of priority. Amounts will be determined in accordance with overall project needs and priorities.

b. Coal Mine and Coal-Fired Power Generation Development

A recent feasibility study concluded that the GOP's first large-scale Coal Mine and Power Generation Project, Lakhra, is technically and economically feasible and urgently required. It is projected that the Lakhra mines will produce initially about 1.4 million tons of coal per year to fire a 300 MW power generation station. The total estimated cost of the Lakhra Project is $833 million, consisting of $293 million in foreign exchange and the equivalent of $540 million in local currency. (See Annex K).

In recognition of the tremendous opportunity afforded by the Lakhra Project to begin the large scale use of its coal reserves, the GOP has accorded the Lakhra Project one of its highest priorities under the Sixth Five-Year Plan. The GOP is currently seeking financing from the donor community and is anxious to complete all the preparatory work for the Project and to have a trained staff in place which is capable of managing coal-based power projects as soon as financing has been secured. The GOP has concluded that U.S. technology in mining and burning lignites is most appropriate for the type of coal in Pakistan and has therefore requested assistance from A.I.D.

Accordingly, A.I.D. will provide, under this Energy Planning and Development Project, approximately $9.0 million for engineering services, training, and commodities to assist WAPDA and PMDC to set up and train the staff of a Coal Projects Department within WAPDA to perform field surveys and studies which are required before embarking on the engineering work on the Lakhra mine and coal-fired power station, and to assist private miners by transferring some of the latest coal mining technology, including mine demonstrations. These activities are described below as Phase 1 of the Lakhra Project.

Funding for Phase 2 activities, which are also described below and include front end engineering work and training, may be provided by A.I.D., through an amendment to this Project in FY 1984, depending on the outcome of the additional feasibility work and studies which will be undertaken during Phase 1 and the GOP's progress in securing funding from the donor community for the balance of goods and services required for the Lakhra Project. (See Phase 3 below.) An illustrative financial plan for Phases 1 and 2 of the Lakhra Project is provided below:

Input	In $ Million		
	Phase 1 a/	Phase 2 b/	Total
Technical Assistance	5.5	3.2	8.7
Training	1.2	0.8	2.0
Commodities	2.3	-	2.3
Total	9.0	4.0	13.0

a/ Phase 1 activities will be financed by A.I.D. under the Energy Planning and Development Project.

b/ Phase 2 activities may be financed by A.I.D. through an amendment to the Energy Planning and Development Project in FY 1984.

i. Phase 1

The primary focus of Phase 1 is the transfer of coal mining technology to the WAPDA Coal Projects Department and to private miners, and of coal-fired plant technology to the Coal Projects Department. WAPDA has recently created a Coal Projects Department to manage and implement coal mine and coal-fired generation projects. The Department will be staffed with experienced power plant personnel from WAPDA and experienced mining engineers from PMDC. PMDC, which owns the lease on the Lakhra mine, has agreed to turn over its operation to the new Department.

Assistance provided under this Phase will include: (1) the procurement of selected commodities; (2) selected WAPDA-PMDC staff training; and, (3) the provision of engineering assistance required to complement the feasibility study, including, but not limited to, assistance to the GOP to: respond to requests from potential funding agencies to undertake additional analytical work, refine cost estimates, and prepare alternative component packages; complete site surveys; complete mine development drilling;

analyze coal samples; develop engineering design criteria and plans; and, establish and strengthen the Coal Projects Department in WAPDA to promote, plan and manage the development and implementation of the Lakhra, Duki and other future coal mine and coal-fired power generation projects.

A key complementary activity will be an assessment of development barriers facing the private sector coal mining industry in Pakistan and of options available to that sector and the GOP to eliminate or reduce those barriers and stimulate private investment in the coal mining industry, especially the Lakhra Project. Senior GOP officials have expressed support for a major foreign and domestic and private sector role in the coal mining industry and have agreed to support a Mining Industry Workshop at which U.S. and Pakistani private sector mining company representatives can meet, share experiences, explore possibilities for collaboration, and discuss Pakistani coal mining industry plans and problems with GOP officials. The Workshop will be organized as soon as possible after A.I.D. project funds become available as part of the assessment of development barriers facing Pakistan's private sector coal mining industry.

Another complementary activity that will be undertaken during this phase is coal mining technology transfer. Pakistan's private coal industry is primitive in nature. Techniques used consist essentially of hand labor working under difficult conditions. A minimum of mechanization is used, and mine owners assert that due to an insufficient market, they cannot afford the investment needed to improve the situation. Project design consultants assert that fairly simple and relatively inexpensive equipment and mining methods improvements would greatly increase output while improving working conditions in the mines. Examples include the use of electric cap lamps for lighting instead of open kerosene flame lamps, the use of fans to improve ventilation, improved general support, and better coal haulage methods.

Limited mining technology is only one of the most critical barriers which must be removed if coal output is to increase. Pakistan's smaller coal mines have difficulty obtaining money for the development of their projects. Both the Pakistan Industrial Development Bank and the Pakistan Industrial Credit and Investment Corporation consider mining too risky to provide loans. Some GOP officials are of the opinion that the coal mining industry is self-financing and does not need financial assistance. Private mine owners, on the other hand, assert that lack of capital due to insufficient coal demand is the principal problem.

Barriers which have been identified by project design consultants and which will be examined under this activity include lack of a long-term market, shortage of miners, safety, capital availability, lack of leasing policy and procedures, infrastructure constraints and lack of an environmental policy. On each topic, experts from U.S. firms or government agencies will work with a Pakistani counterpart team guided by the Coal Division in WAPDA and made up of members from PMDC and other relevant GOP organizations as well as representatives of private mine owners. This activity will rely as much as possible on coal mining experience within the U.S.

Limited mining technology is identified above as a critical constraint that must be removed if Pakistan coal output is to increase. A substantial increase in output is needed even if coal is not used to fire power plants. A.I.D. will support GOP efforts to eliminate technology barriers through the funding of technical assistance, training and commodities for on site demonstrations of both open pit and underground mining technologies. The Lakhra Project offers an excellent, administratively efficient, and cost-effective opportunity to provide these demonstrations on a timely basis. For that reason and because there is a need to begin the demonstrations as soon as possible, funding for this activity has been included under Phase 1 of this sub-component.

ii. Phase 2

Because of the severe power shortages that the GOP is facing, A.I.D. has been requested to help expedite the implementation of the Lakhra Project as soon as funding sources for Phase 3 activities (see below) have been identified. Phase 2 activities include front-end engineering work and training that should be provided immediately after agreement is reached about Lakhra Project funding in order to satisfy the fast-track implementation schedule that the A.I.D. consultants agree can be accomplished and the GOP has requested be followed. Key outputs of this phase include: detailed mine development plans; technical specifications for mining, transportation and power generation equipment; and, the preparation of invitations for bids for the procurement of such equipment, in accordance with GOP, and financing agencies' understandings and agreements. Depending on the outcome of the additional feasibility work and other studies under Phase 1 and the GOP's progress in securing funding for Phase 3 of the Lakhra Project, A.I.D. may provide funding, through an amendment to the Energy Planning and Development Project in FY 1984, for the Phase 2 activities described above.

iii. Phase 3

Phase 3 activities of the Lakhra Project include the balance of services and goods required to design, construct and place the coal mine and transportation and power generation facilities in service. Funding of the foreign exchange costs of this phase is currently being sought by the GOP from the World Bank, A.I.D. and a number of other sources. Funding for this phase of the Lakhra Project is not currently being proposed under this A.I.D. Project.

iv. Technical Assistance

(1) General

A long-term General Advisor will be provided to assist WAPDA, PMDC and the private sector with overall coordination and planning of the Lakhra Project; to guide technology transfer activities; and, to serve as the technical assistance team leader. It is expected that the balance of general technical assistance will be short-term and will be provided as required to: complement the feasibility study; assist the GOP to respond to requests from potential funding agencies to undertake additional analytical work, refine cost estimates, and prepare alternative component packages; complete site surveys; develop engineering design criteria and plans; and, establish and strengthen the Coal Projects Department in WAPDA to promote, plan, and manage the development and implementation of the Lakhra, Duki and other future coal mine and coal-fired power generation projects.

In addition to the above, short-term consultants will assist in developing: sample coal supply guidelines and contracts; a comprehensive coal sampling system to assure a supply of consistent quality coal to the power plants; an environmental monitoring system; training programs; a program to assess and remove barriers to the expansion of private sector coal mining activities; a coal mining technology transfer program; a comprehensive project implementation plan; and, a detailed project implementation management system. The private mining sector will need assistance in the development of appropriate mining techniques suitable for the production of large volumes of coal required for power plants. Technical assistance will also be provided for this purpose.

(2) Mining and Infrastructure

Field work on Lakhra mine development and infrastructure will be facilitated by a long-term Mining and Infrastructure Project Advisor. To determine the actual configuration and types of mines to be developed at Lakhra, an area west of the western PMDC lease will be drilled and geo-

physically logged. A mining geologist and several technicians will operate the equipment and train local technicians. After completing this reserve drilling, mine development drilling and geophysical logging will be conducted for the detailed design of the mines. Although similar drilling must continue for the entire life span of the mines, A.I.D.-financed technical assistance will be provided only to acquire sufficient data to permit the detailed design of the first phase of the mining complex.

Mine survey technical assistance will consist of the following tasks: aerial surveying and topographical mapping (one inch=400 ft) of mine area; preliminary drilling planning (logging program and schedule); selecting laboratories for analyses and testing of coal and rock samples and awarding contracts; specifying procedures for sampling, sample handling and preparation, analysis, testing data logging and data base management; establishing office/field communications systems and information transfer; managing field operations and data base generation so that a major milestone - development of a basic mine plan - can be made at the earliest feasible time; and, planning for a preliminary mine and infrastructure base camp and procuring and installing components. To accomplish the above mine survey tasks, the services of a site project leader, a mining engineer, a project geologist, a mining hydrologist, and project engineers will be provided.

To survey and plan the construction of mine infrastructure at Lakhra, technical assistance will be provided for an aerial and surface survey of the Lakhra to Jamshoro area and survey of the road/rail/pipeline corridor. If funding is made available by A.I.D. for Phase 2, the Mine and Infrastructure Project Advisor will assist WAPDA to: prepare bid specification packages for construction and earthmoving equipment and design railroad and road corridors; prepare bid specifications for road and rail construction; prepare bid specifications for the locomotive; monitor WAPDA's or the subcontractor's design of the substation and power line; and, monitor the subcontractor's design and construction of the mine colony. Technical assistance would also be provided in Phase 2, if A.I.D. funds are made available for this purpose, for preliminary design and bid specifications for detailed design and construction of workshops, maintenance facilities, warehouses, explosives stores, offices and amenities, and coal handling facilities.

(3) Power Plant

Field surveys needed for the subsequent design of the Power Plant will be undertaken with the assistance of a long-term power plant project advisor and a short-term site planning engineer. Many of the geotechnical, civil, structural, electrical, mechanical and power engineering services required for Phase 1 (and in particular under Phase 2) on the power station will be undertaken at the contractor's home office in conjunction with WAPDA personnel working in an on-the-job training mode.

v. Training

Except for initial training provided to key GOP counterpart officials, all training will be in accordance with a training plan that will be developed with the assistance of the advisory team. It is anticipated that the technical assistance contractor will manage all training provided. Using the Lakhra project as a training tool, approximately 250 person-months of short-term technical training in the U.S. will be provided during Phase 1 for over 50 Pakistanis drawn from the staffs of WAPDA and PMDC and the private sector (See Section IV.D).

The training in all instances will be short-term, ranging in duration from 4 to 8 months. After a period of training, some trainees will spend a period of time with a utility actually operating a power plant or appropriate mining equipment and in the engineering contractor's home office to acquire on-the-job experience. Maintenance personnel will be trained by equipment manufacturers. After returning to Pakistan, the trainees will assume the positions for which they were trained. They will participate in project implementation and subsequent operation alongside U.S. consultants and thus continue their training under Pakistani conditions.

vi. Commodities

Commodities procured under Phase 1 will include the following:

(1) Environmental sampling and analysis equipment will be procured so that observation stations can be set up around Lakhra, Jamshoro and elsewhere and analyses carried out to determine environmental baseline conditions. Self-recording equipment for approximately 15 weather stations will be required including instruments to measure wind speed and direction, humidity, dew point, temperature, precipitation, and solar insolation. Selected stations will be equipped for NO_2, SO_2 and particulate measurements. In spot checks, air and runoff samples will be taken and analyzed for heavy metals, for example, cadmium, mercury and arsenic.

Water samples will be analyzed for pH, alkalinity and heavy metals. Equipment will be required to measure atmospheric stratification and to describe inversion conditions;

(2) Demonstration mining equipment will be procured to transfer modern, intermediate scale mining technologies to Pakistan's private mine owners. Specific equipment lists and designs will be prepared after selection of mine sites and after decisions have been made on the types of mines to be developed at Lakhra. Typical equipment will include electric cap lamps, electric mine locomotives, compressors and pneumatic drills for handloading longwall operations, ventilation systems, and safety techniques and systems;

(3) Four four-wheel drive vehicles;

(4) A "Porta Drill" (a truck mounted drill, capable of drilling open holes as well as taking core samples) will be provided to define reserves and perform mine design drilling. This will become the permanent equipment of the PMDC mine development drilling crew and will be continuously required for the life span of the mines;

(5) A geophysical logging truck will permit taking core samples of every fifth hole drilled. The logging tool determines depth to and thickness of different types of rock strata, including coal. This equipment will be used in conjunction with the "Porta Drill";

(6) Drilling crew, mine design and rail construction teams will have to be based at Lakhra. Therefore, a base camp housing about 30 people, including support personnel, will have to be set up. In the camp, a fuel supply depot for the drilling and logging trucks will have to be maintained. Proper spare parts and workshops will have to be provided. Power generator, water tank, first aid and the like will have to be provided. For the drilling, mine design surveys, rail survey, and construction, a reliable field communications system will also have to be established; and,

(7) A 4,000 gallon capacity tank truck.

c. Processed Coal Briquettes for Residential Use

Pakistan has significant potential for briquetting coal to produce a smokeless fuel substitute for firewood. Two approaches are possible. Coal briquetting and coking for use in braziers similar to those used in India and Pakistan coal mining areas, and coal briquetting without coking for use in a "smokeless" stove. PCSIR has been conducting laboratory scale briquetting experiments over the past several years. Activities under this sub-component will include technology assessment, briquetting tests for Pakistani coal, a test marketing program, and a briquetting pilot plant.

A.I.D. will provide the Ministry of Science and Technology and PMDC with technical assistance from a briquetting specialist and a marketing analyst to undertake an assessment of the briquetting potential and to design a plan for developing that potential. The assessment will use energy survey data developed under component 3 to estimate the potential market and scale of production required. The smokeless stove developed at the Indian Central Fuel Research Institute near Calcutta will be examined. Technology assessment activities will be a cooperative effort between PMDC and PCSIR.

Concurrent with the above assessment, several independent briquetting studies will be made of Pakistani coal. Three American manufacturers of briquetting equipment have indicated to the project design team that they would carry out bench-scale tests without charge on small samples. If these prove successful, larger tests will be made on full-scale equipment.

Assuming that results of the above work are positive, A.I.D. will then provide technical assistance by a marketing specialist to field test the acceptability and marketability of smokeless briquettes and smokeless stoves. Approximately 1,000 tons of briquettes will be needed for this test. These can be produced by PCSIR, or they will be imported, if necessary.

Again, assuming a favorable outcome from the above test, A.I.D. will support the design and installation of a pilot briquetting plant. A 25 ton per day plant at Lakhra, as an illustration, could provide enough briquettes to supply the daily needs of more than 4,500 families in the Hyderabad area. This is a significant population and would provide adequate data upon which to base larger scale production. The entire briquetting program will proceed in a cautious manner with reports and go-ahead decisions made at critical points in the work.

An estimated 28 person-months of marketing assistance will be provided to establish a sound basis on which to plan and evaluate briquetting opportunities. Pilot plant design and construction management will require 9 person-months of short-term assistance.

Approximately twenty samples of Pakistan coal will be shipped to the U.S. and tested for briquetting qualities. Laboratory equipment in Pakistan will be provided to augment PCSIR's existing capabilities. For the briquette test marketing program, approximately 1,000 tons of smokeless briquettes will be imported (or produced locally). Smokeless stoves will also be imported for this purpose. The largest procurement under this activity will be equipment for the anticipated 25 tons per day coal briquetting pilot plant.

3. Conservation and Renewable Energy Technologies

This component consists of two elements: an energy conservation program to increase the efficiency of industrial energy use; and, a program to assess and develop renewable energy technologies. The GOP agency responsible for implementation of this component will be the Directorate General of Energy Resources of the Ministry of Petroleum and Natural Resources.

a. Energy Conservation

Energy conservation is the most promising option available to Pakistan to deal with its near-term energy supply and demand imbalance. The preliminary energy supply projections discussed earlier indicate the importance of more efficient use of energy in the industrial sector if production growth goals are to be achieved without larger increases in oil imports. In addition, analyses by the project design team consultants indicate large potential for reduced industrial energy use through better energy management procedures and equipment changes with financially attractive payback periods of less than 3 years. The policy of gradually increasing natural gas prices to two-thirds of fuel oil prices, combined with government policies to encourage (and possibly, in some cases to require) energy efficiency improvements, in public and private sector industry, suggest that A.I.D. assistance in this area could have important near and longer-term impacts on industrial energy use. This project sub-component will be based on extensive U.S. experience in this field and will have the following elements: energy audits, industrial energy use data systems, training, and demonstrations.

Two types of energy audits will be undertaken:

i. Preliminary audits of about 2 person-weeks each, which will examine gross energy use data and visually inspect plant layout and operations to identify the more obvious energy conservation opportunities; and,

ii. Detailed audits of about 4 person-weeks each, in which energy flow maps of specific industrial processes will be prepared and sample measurements of key process parameters will be made to verify those balances. Such measurements could include temperature levels at different points in the process, efficiency of combustion determined by flue gas compositions, and through puts of products.

It is anticipated that up to 40 preliminary audits and 20 detailed audits will be executed over a two-year period in order to support the development of the Industrial Energy Use Data System and to identify specific projects for implementation. Each audit will result in a report which can

be used by plant managers to design and obtain financing for low cost energy conservation measures. Under the project, the technical advisors will work with GOP and private sector counterparts to identify both industrial sectors and specific facilities within those sectors for the energy audit program. Industrial sectors will include, at a minimum, cement, textile, fertilizer, ferrous and non-ferrous metal industries, brick-making, ceramics, and food processing. All audits will be undertaken jointly by U.S. experts and Pakistani counterparts (both public and private sector) so that the audit program has a strong "on-the-job" training impact. Implementation of audit recommendations will be monitored to evaluate the effectiveness of the audit program.

Data compiled as a result of these audit programs will be used to establish an industrial energy use data system. With the possible exception of cement and fertilizer, the energy consumption patterns in the industrial sector by fuel type, function, and temperature level are not well documented. Under the project, U.S. specialists will work with GOP counterparts to :

i. review existing reports and the results of the energy audit program to improve the industrial energy use data base;

ii. develop realistic energy use reporting procedures for both public and private sector industrial operations; and,

iii. establish an industrial energy use data base which is periodically updated and provided in formats appropriate for both sectoral analyses and for use in integrated energy analysis and planning functions. This activity will make extensive use of similar work done in the United States and elsewhere in improving energy use data in support of developing technical support programs and policies.

Knowledge of energy conservation technologies and practice is not widespread in Pakistani industry due, in part, to the very low cost of natural gas which has prevailed until recently. U.S. specialists in energy conservation will work with Pakistani counterparts in the public and private sectors to prepare short courses in energy conservation options which will be given to operating managers of industrial operations, Ministry personnel, and private sector consultants. The course material will take advantage of a large base of experience in similar programs in the U.S. adapted to be consistent with conditions in Pakistan. The U.S. advisors will assist in preparing course materials and planning program presentations. Trained Pakistani

counterparts will have primary responsibility for making presentations and working directly with industrial representatives.

This sub-component will support limited demonstrations of energy-saving techniques. The field of industrial energy conservation in the U.S. has advanced rapidly over the last few years as a result of rapid increases in fuel prices. Plant managers and industrial planners in Pakistan are often not aware of how these technologies can be applied or of the benefits which will accrue in operating efficiencies. This activity will make use of the knowledge gained in the audit programs to develop a limited demonstration program displaying the advantage of several improved energy conservation systems. The criteria for selecting demonstrations will include :

i. large potential for replication in similar industrial units;

ii. highly favorable economics (payback period less than 3 years) so that national benefits would be large if systems are widely used;

iii. low to modest equipment costs so that program resources can support a multiplicity of projects; and,

iv. potential for total or partial equipment manufacture in Pakistan.

In implementing the demonstration program, U.S. specialists will in cooperation with Pakistani counterparts : select specific applications and systems for demonstrations; work with local firms in designing and planning installations and monitoring equipment; and, assist in the preparation of a plan and an information dissemination program so that the benefits of the energy conservation program become widely recognized by the industry and the government. It is anticipated that 4-8 demonstrations projects will be implemented under this project. Typical systems which might be considered for demonstration include energy management systems, high efficiency motors, and automatic air-fuel ratio control systems.

i. Technical Assistance

Program activities will be coordinated by a resident advisor responsible for energy conservation technologies. This advisor and GOP counterparts from DGER and the Ministries of Production and Industry will make final project plans and will identify the requirements for

short-term specialist assistance. Due to the multiplicity of industries, technologies, and functions considered under the conservation activity, most of the activities will be executed by teams of short-term specialists (about 102 person-months) with appropriate experience. Illustrative skill requirements are: energy audit techniques, industrial process experience in cement, fertilizer, textiles, metals, and the like, and energy conservation equipment and technologies. It is anticipated that the resident advisor will devote half of his time to coordinating the implementation of this sub-component.

ii. Training

"On-the-job" training through Pakistani participation in all component activities is an important aspect of this sub-component and will be coupled with both U.S.-based training and formal short-term courses in Pakistan. Intensive short courses on industrial energy conservation technologies, economics, and policies are available in the U.S. Each year, two to four key staff members of the Pakistani counterpart team will participate in one of these courses. This will help upgrade the overall capabilities of the GOP in this subject and expose key Pakistani staff to U.S. practices.

Most of the formal training will be via a series of short courses and seminars in energy audit technologies, energy conservation technologies, and the financial analysis of energy conservation projects. Examples of short courses which will be considered include :

(a) courses in energy audit techniques for public and private sector personnel who will participate in the energy audit program (1-2 weeks);

(b) broadly-based courses in industrial energy conservation economics, policies, and impacts for GOP planning staff in the Planning and Development Division, the line Ministries, and managers of large industries (1-2 days); and,

(c) trends in industrial energy conservation technologies for plant managers, private sector engineering companies, and GOP counterpart staff (2-4 days).

The details of course content, audience, and presentation format will be determined cooperatively with the GOP counterparts as the program progresses and needs are better identified.

iii. Commodities

A limited amount of demonstration equipment will be purchased under this program and will be selected as the program progresses after results of the energy audit activity are analyzed. An illustrative list of possible equipment purchases identified during project development include: (a) high efficiency motors; (b) boiler and furnace controls; (c) foam finishing equipment in the textile industry; and, (d) high efficiency lighting.

Approximately $890,000 has been allocated under the project to procure energy conservation equipment and education materials which further analysis will indicate as having the most potential impact in accelerating energy conservation in Pakistani industry.

b. Renewable Energy Assessment and Development

Several Federal government agencies, notably the Directorate General of Energy Resources (DGER) within the Ministry of Petroleum and Natural Resources and the Appropriate Technology Development Organization (ATDO) within the Ministry of Science and Technology, have developed a considerable amount of experience in renewable and decentralize energy technologies. Renewable energy techniques have been applied to two important needs: to conserve or substitute for wood and dung, supplies of which are not keeping pace with demand as cooking and heating fuels; and, to provide power to rural areas not served by the central electricity grid. To meet these needs, Pakistan has helped pioneer the use of several renewable technologies, especially biogas generators, solar, and small hydro power, and has successfully demonstrated the technical feasibility of these technologies. The potential role of these techniques in the nation's future energy supply and demand balance, however, is not clear.

This sub-component will assist the GOP to develop a renewable energy assessment and development program to delineate the long-term role of these techniques and to accelerate implementation of promising technologies. The project will facilitate coordination between the various Ministries dealing with decentralized technologies and will provide guidance on appropriate levels of support necessary to achieve program goals. Agencies involved in the implementation of this sub-component are likely to include the DGER within the Ministry of Petroleum and Natural Resources, the ATDO and the PCSIR of the Ministry of Science and Technology, and the Agricultural Development Bank. These and other designated public and private sector entities will coordinate their participation through a National Renewable Energy Activities Coordination Committee which will be chaired by the DGER.

The approach taken in the renewable energy assessment and development program will be as follows: energy needs which can be met by renewable technologies will be surveyed and

analyzed; technologies which are meeting, or which could meet, these needs will then be described and analyzed from a technical, economic, social and environmental point of view; barriers to development of the technologies will be identified and implementation options available to the GOP to reduce or eliminate those barriers will be described and analyzed; pilot projects will be designed and carried out to augment existing renewable projects and to demonstrate the feasibility and usefulness of the most promising technologies; and, applied research will be undertaken to remove implementation barriers. Activities under this subcomponent will include a residential and small commercial energy needs survey and assessments and demonstrations for a number of specific renewable technologies, including solar energy, small hydro, energy efficient wood stoves, and other biomass technologies.

i. Residential and Small Commercial Energy Needs Survey

This survey of residential and small commercial fuel use and supply will update and expand work done by the Energy Resources Cell, now the DGER. As described in the Background (Section II), non-commercial fuels account for approximately 40 percent of total fuel use in Pakistan. This figure is estimated from a "non-commercial energy resources survey" of 5,000 urban and rural households undertaken in 1974/75. This pioneering effort in Pakistan was designed and conducted by the Energy Resources Cell with technical assistance from a Canadian firm, Acres International. As of late 1982, the DGER was in the process of updating this survey (without external support) and has requested A.I.D. assistance.

This activity will strengthen DGER's survey by supporting more disaggregated data collection in areas surveyed and will provide technical assistance and training to improve survey instruments and to analyze survey results. Assistance will be provided to DGER to undertake surveys and to gather information needed for developing decentralized energy technologies addressed under this project, for example, information needed to examine the feasibility of various forms of solar energy and the feasibility of substituting smokeless coal briquettes for firewood. Survey results will be used to evaluate alternative energy options including: new sources such as mini-hydro or solar; efficiency improvements in stoves or lamps; and price strategies, including providing domestic fuels at subsidized prices.

ii. Assessment and Demonstrations of Renewable Technologies

Based on the energy needs survey described above, candidate technologies capable of meeting these needs

will be assessed and demonstrated. Available or potential resources and technical readiness to develop and use each technology will be evaluated. Current uses of each technology in Pakistan will be described, evaluated and compared with experience in other developing countries and, where appropriate, in the U.S.

Of particular interest in these assessments and demonstrations is the social acceptance and private sector marketing aspect of decentralized technologies. The full potential of these technologies has yet to be attained in Pakistan. The major constraints may be much less engineering or technical in nature than they are problems of fitting each technology to the daily practices and finances of its users. As a result of the energy needs survey described above, an understanding of how these technologies can fit into the local socio-economic setting will be developed and private sector approaches to better disseminate knowledge and use of renewable technologies will be identified. Extension service activity and private sector marketing will be emphasized.

Assessment and limited demonstration activities will be done on a continuing basis. These activities will strengthen the technology assessment capabilities of the DGER who will coordinate this work with the Planning and Development Division, the Ministry of Science and Technology, NEPC and the Energy Analysis Group described under the planning component above. Technologies addressed in this program will cover a range of renewable systems which are applicable in Pakistan. During project development, preliminary examinations were made of several of these : solar energy, small hydro power systems, efficient wood stoves and other biomass technologies.

(a) Solar Energy

As described in the Background Section, Pakistan enjoys a plentiful suppl: of solar radiation. A number of programs are underway to tap this resource. The DGER has begun to demonstrate photovoltaic technologies for use in village water pumping and electrification. The Agricultural Development Bank of Pakistan (ADBP) has experimented with solar irrigation pumps. A researcher at the University of Engineering and Technology at Peshawar(UETP) has explored the use of solar heat to replace firewood in tobacco curing and drying. While these programs are appropriate, Pakistan has not developed a coordinated approach to most effectively develop its solar resources. This sub-component will assist the GOP to: (1) acquire solar resource data; (2) identify and assess promising solar applications; (3) prepare a long-term plan to develop Pakistan's solar potential; and, (4) demonstrate solar technology options showing promise for widespread use in Pakistan.

A.I.D.'s assistance on the solar resource sub-component will help define requirements and obtain solar resource data necessary for the completion of the technology assessment planning tasks which follow. DGER now has several solar monitoring systems and, under this project, up to 6 small commercially-available solar monitoring stations will be installed to augment DGER's capability. After measurement sites are selected and the instruments are purchased and installed, solar data will be collected, analyzed and published.

The results of the energy needs survey described above will be used to identify and assess solar technologies which show promise in Pakistan. Short-term engineering and marketing assistance will be provided to help DGER to evaluate its existing solar experience, to assess proposed solar applications, and to identify new applications for use in Pakistan. Each technology will be described and analyzed from a technical, economic and social point of view.

A.I.D. will provide technical assistance on energy analysis to the DGER to help prepare a long-term plan to develop solar energy technology in Pakistan. Based on the results of the technology assessment described above, the task will define reasonable solar development goals, describe the series of steps from R&D through commercial readiness, and prepare a GOP strategy to provide maximum encouragement to the private sector in the development of solar applications. This plan will be directed toward the NEPC and other public and private Pakistani organizations engaged in energy activities.

Candidate demonstration projects identified during project design include solar thermal industrial systems, photovoltaic systems, and passive solar applications. The textile industry, one of the largest industries in Pakistan, is a good candidate for an industrial solar demonstration, and one large private corporation has expressed interest in a cooperative project. Technical design and monitoring assistance may be provided to help DGER undertake this demonstration. A second possible solar thermal demonstration is a tobacco drying system being developed by the ATDO in conjunction with the Pakistan Tobacco Board.

Photovoltaic systems are generally estimated to become cost competitive in the late 1980's or early 1990's. Solar-driven irrigation pumping is the closest to being competitive now, and DGER and the ADBP may receive design and monitoring assistance to demonstrate the technology. Village electrification is another photovoltaic candidate for demonstration under this component which could benefit from design assistance and U.S. solar equipment.

A field demonstration may consist of design assistance and evaluation of solar passive heating and cooling systems for residential or commercial buildings. "Passive" solar systems rely on architectural devices to collect and store the sun's heat. These and other candidates for demonstration projects will be considered during the course of the project. Only those system options which show promise for widespread use and where a demonstration will assist in accelerating private sector commercialization will be considered. These will be identified by the technology assessment and solar development plan previously discussed.

(b) Small Scale Hydro Power

An active small hydro program is already underway in Pakistan at the University of Engineering and Technology in Peshawar (UETP) in association with the ATDO within the Ministry of Science and Technology. This activity has resulted in locally-made units averaging 5-10 KW each being installed in the NWFP. The project design team estimates that many potential sites for similar units exist with a total capacity on the order of 100 MW. The NWFP Department of Irrigation and Public Health Engineering, among others, has begun to install small hydro units of several hundred kilowatts each. In addition, several studies indicate a significant potential for small scale hydro (50 KW to 2 MW) on Pakistan's irrigation canal barrage system.

This project sub-component will strengthen both the technical and management capabilities of the DGER as well as the ATDO and other organizations already working in the small hydro field. In large part, this be done by assuring that key staff are familiarized with worldwide experience so that they minimize duplication of effort in adapting technologies for manufacture and implementation in Pakistan.

This program sub-component will consist of 3 activities; assistance in small scale hydro system technology assessment and design; monitoring of systems already installed; and, installation of selected demonstration projects. Under the technology assessment and design aspects of this sub-component, technical advisors will work with appropriate organizations in Pakistan to:

(1) review the designs of small hydro units and compare these designs with those in other countries. This activity will include visits of key staff to other centers of small hydro activity such as Nepal, Thailand, Peru, and the United States;

(2) assist in designing a simple system for testing small hydro units and providing equipment for such a test system;

(3) develop management approaches for implementing systems consistent with the capabilities of the local population in the NWFP and elsewhere; and,

(4) prepare firm estimates of the small hydro power potential in the NWFP and develop a plan to exploit that potential.

There is very little monitoring data available on the technical performance and social impacts of the existing small hydro units. Under this activity, assistance will be provided to the GOP to develop a monitoring plan for selected installations. Necessary instrumentation (anticipated to be relatively simple watt-meters, timers, and flow meters to measure system outputs, time of use, and other variables) will be provided.

There are numerous small-scale hydro power systems being developed in the U.S. which might be appropriate for use and eventual manufacture in Pakistan. The installation and demonstration of up to three such systems (power levels to 50 KW) will be supported, both by technical assistance in system design and procurement of the turbine-generators. The selection of system types and applications will be made by the GOP, base on technical advisors' recommendations and subject to the concurrence of A.I

(Biomass

(i) Energy Efficient Wood Stoves

It would be a simple technical matter to double the efficiency of wood burning in Pakistan and thereby reduce considerably the amount of wood cut from the country's trees. Experience in other countries has shown that the potential economic and cultural difficulties associated with wood stove activity to accomplish this, however, may be formidable. This activity will assist the GOP in developing its embryonic wood stove project developed by ATDO and UETP so that future possibilities can be clearly understood and future development directions set. Activities will include a technology assessment and market analysis for efficient wood stoves in Pakistan and, following this, a pilot project and test marketing activity.

Based on the residential and small commercial energy survey, this activity will provide short-term technical assistance from an energy analyst to assist the ATDO to analyze the patterns of fuelwood use in daily life: how much wood is used in various regions; the purposes that wood combustion

serves (for example, cooking, heating, lighting, insect suppression); the timing and practices of using wood; and, the significance of cultural values and meanings attached to current methods of using fuelwood. The means and mechanisms by which fuelwood is procured for family and commercial use will also be analyzed. The quantity, price, origin, and distribution of purchased fuelwood will be assessed as will the quantities collected and distances travelled by those who gather wood for their own use. Based on the results of this analysis, criteria will be developed that can be used to identify and evaluate wood stove designs with promise for application in one or more regions of Pakistan. Finally, the results of the survey analysis and evaluation will be used to select urban and rural locations for test marketing promising stove designs. Locales will be selected where the supply of fuelwood is most critical, where adequate substitutes are not readily available, and where people from other villages will have the opportunity to observe the wood stove initiative.

A pilot project will be implemented to examine the adaptability and marketability of alternative wood stove designs in various regions of the country. This program will be developed to accomplish three ends. First, it will identify the most attractive stove types for urban and rural applications. Second, it will determine the market potential for efficient wood stoves. Third, it will identify the most effective means for GOP support to encourage private sector marketing of efficient wood stoves. Under this project sub-component, A.I.D. will support the travel of appropriate Pakistanis to successful wood stove projects in other countries and will provide technical assistance and training to design and undertake training programs for district level technicians.

(ii) Other Biomass Technologies

Both DGER and ATDO have installed biogas digesters throughout Pakistan. At the request of a farmer, DGER will arrange for local contractors to install a DGER designed digester unit, usually producing from 40 to 150 cubic feet of gas per day. ATDO now provides only advice to those wishing to construct their own digesters. At least one private firm, "Energy King" in Lahore, is now commercially marketing biogas systems.

Project design consultants examined other biomass options in Pakistan. While a number of technologies appear to have potential, none was considered to be ready for immediate demonstration or pilot project activity. While the technologies themselves are fairly well developed, questions of economics, social acceptance, marketing, and management require additional study and analysis. It is proposed here, therefore, to assist the GOP to re-examine biomass technologies

from these latter points of view. The energy survey described above will improve understanding of which new technologies may have the most significant impact. Markets then need to be identified and biomass projects designed which will demonstrate the feasibility and marketability of specific biomass technologies.

Under this project sub-component, A.I.D. will provide technical assistance, training, and some demonstration equipment. The specific nature of this assistance will be determined during project implementation after the energy surveys results begin to be analyzed and after further discussion with the GOP agencies involved.

(d) Project Inputs for Renewable Energy Assessment and Development

Activities under this sub-component will be coordinated by the team member responsible for renewable technologies. This responsibility and that for conservation will be assumed by one full-time resident advisor.

(1) Technical Assistance

Aside from the services of the team leader for conservation and renewable energy, most technical assistance provided under this activity will be short-term. Skills needed and functions served are listed below by activity:

(i) Approximately sixteen person-months of short term assistance from a social scientist, a rural development specialist, and a marketing specialist will be provided to assist the DGER to design and conduct the residential and commercial energy needs survey. Their work will focus on sample and survey instrument design and design of a training program for survey interview teams;

(ii) Solar energy activities will require two short-term engineering and planning advisors to help DGER to assess present solar applications and to assist in preparing the long-term solar development plan. Additional short-term assistance will be provided to design, install and monitor demonstration projects;

(iii) Small hydro activities will require about twelve person-months of short-term advisors in engineering (for turbine, generator and control system design), economics and management (for selecting and designing financially feasible and sustainable electric generating systems), and small business development (both

to encourage private development of small hydro systems and also to find commercial uses for generated power); and,

(iv) The biomass activity will share some of the marketing assistance provided for coal briquetting under the coal component and will require in addition an estimated twelve person-months of short-term assistance in wood stove and digester design and field testing to be provided by engineers and rural development experts.

(2) Training

This sub-component will include training for up to 10 renewable energy managers and technicians at courses such as the 6-month A.I.D.-supported courses at the University of Florida. Four or more individuals will visit appropriate small hydro sites in Nepal and/or the Northwestern states in the U.S. to learn how small business developments in those areas might be applied in Pakistan. Training for the wood stove and biomass activity will consist of up to 12 person-months of short-term training in marketing for the wood stove work. In addition, one or two members of the project staff will visit A.I.D.- sponsored wood stove projects in Africa and/or elsewhere.

(3) Commodities

The equipment to be purchased under this project sub-component will be determined as technologies are assessed and marketing studies completed. It is anticipated that at least the following types of equipment will be necessary. Monitoring equipment to determine the incidence of solar energy (up to 6 systems) will be needed for the solar resource assessment. The monitoring stations will include pyrheliometers to measure solar radiation as well as thermometers and data recording equipment. Solar performance equipment for monitoring solar installation will include electronic temperature sensing equipment, watt meters and data recording equipment. Upon completion of the technology assessment phase of the solar energy activity, solar thermal, photovoltaic and passive demonstration equipment will be designed and selected. Watt meters and flow measuring equipment will be required to monitor existing and new small hydro installations. One or two micro computers will be procured to assist in system design and data management. Three or four small hydro units from the U.S. will be provided to determine their applicability in Pakistan. Hydraulic equipment will be provided to the UETP specifically for turbine design studies. Commodities provided under the biomass activity will include wood stoves and equipment to test stoves, both in the laboratory at UETP and in the field.

IV. IMPLEMENTATION PLAN

A. Implementation Schedule

All project activities are scheduled to take place over a five year period between August 1983 and July 1988. A proposed implementation schedule is shown in Table 3. In order to facilitate the timely implementation of project activities, the Mission has already begun to prepare required PIO/Ts, RFPs, and PIO/Cs. In addition, some of the organizational changes and new institutional arrangements in GOP implementing entities, which are tied to specific conditions precedent (See Section VI.), have already been initiated. It is contemplated that several key GOP project implementation staff will be sent to the U.S. for training under the Mission's Development Support Training Project and/or the AID/Washington centrally-funded Conventional Energy Training Project even before the Project Agreement is signed. Advertising for the two major technical assistance contracts may also be initiated once the project is authorized and before the Agreement is signed.

As soon as possible after the Agreement is signed and the necessary conditions precedent have been met, the Mission, with the concurrence of the GOP, will:

1. execute a Personal Services Contract (PSC) with an individual to serve as the long-term General Advisor;

2. procure household and office furnishings for all long-term advisors under the project;

3. procure project vehicles;

4. request that SER/CM, AID/Washington execute a Participating Agency Services Agreement (PASA) with the USGS to provide assistance under the Coal Resources Assessment sub-component;

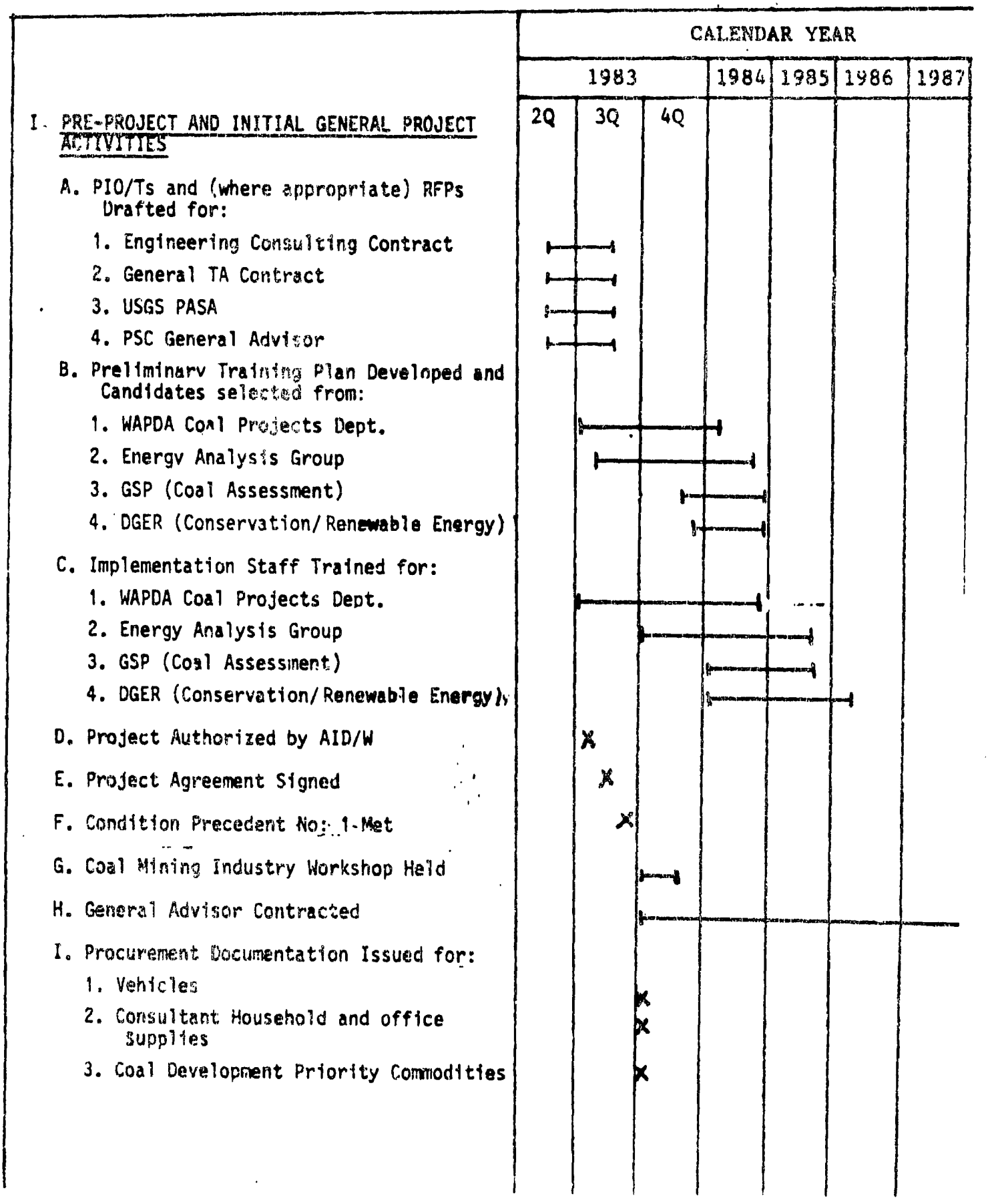
5. negotiate and award a contract for Consulting Engineering Services under the Coal Mine and Coal-Fired Power Generation sub-component;

6. negotiate and award a contract to a U.S. firm or association to assist the GOP to implement the remaining activities under this project;

7. procure the truck mounted drill and accessories and the geophysical logging truck for the Coal Mine and Coal-Fired Power Generation sub-component; and,

TABLE 3

PROPOSED IMPLEMENTATION SCHEDULE



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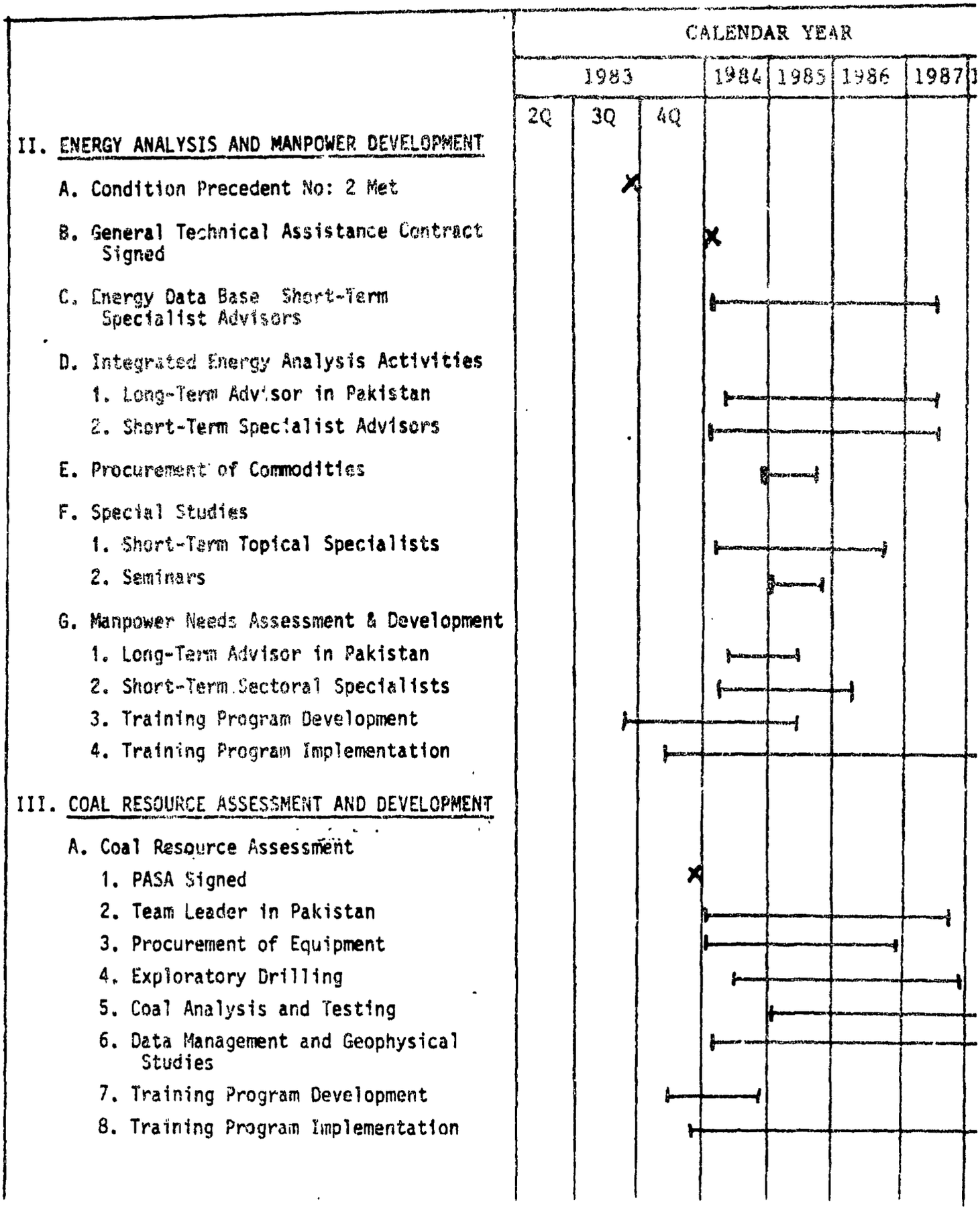
PROPOSED IMPLEMENTATION SCHEDULE



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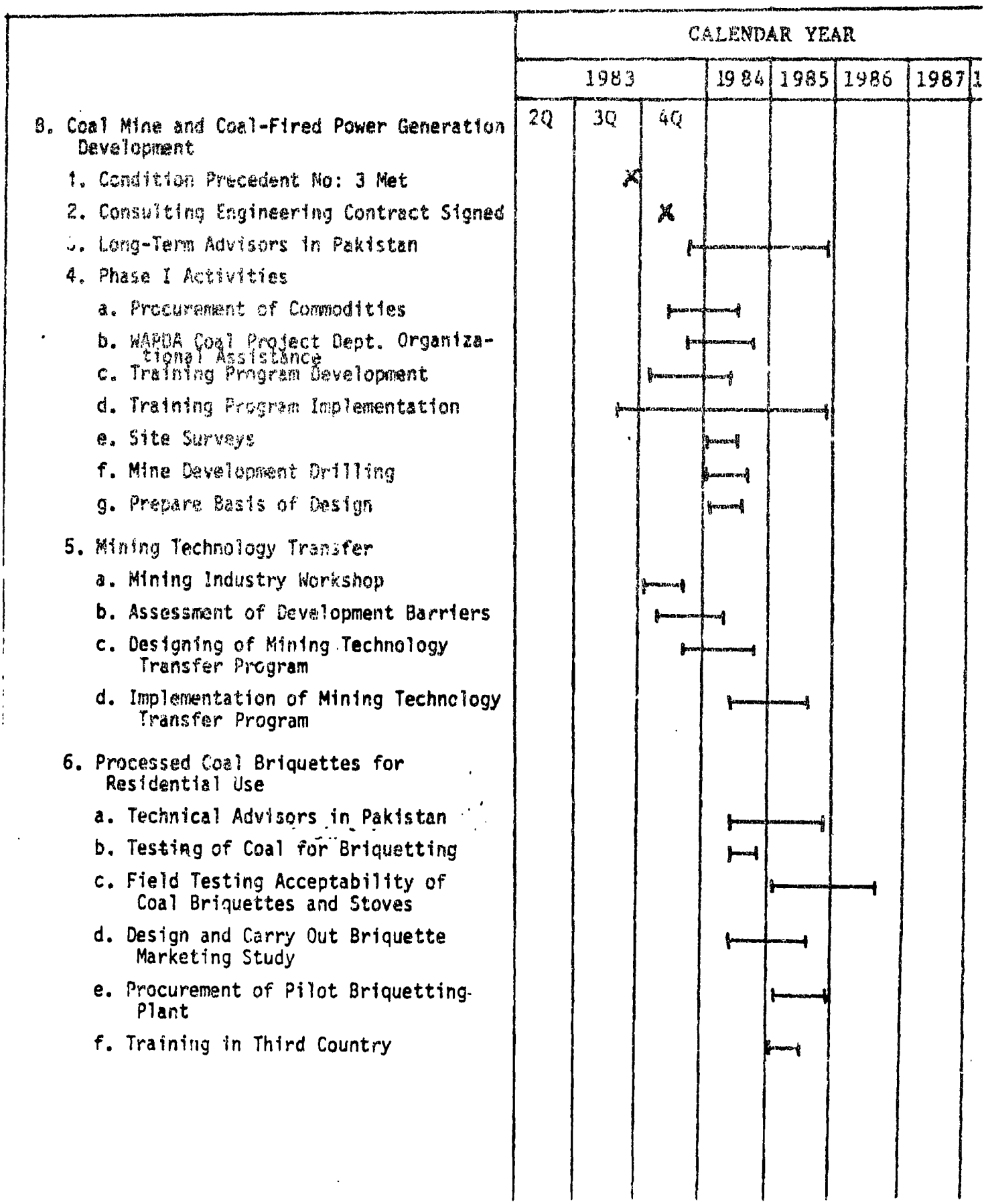
PROPOSED IMPLEMENTATION SCHEDULE



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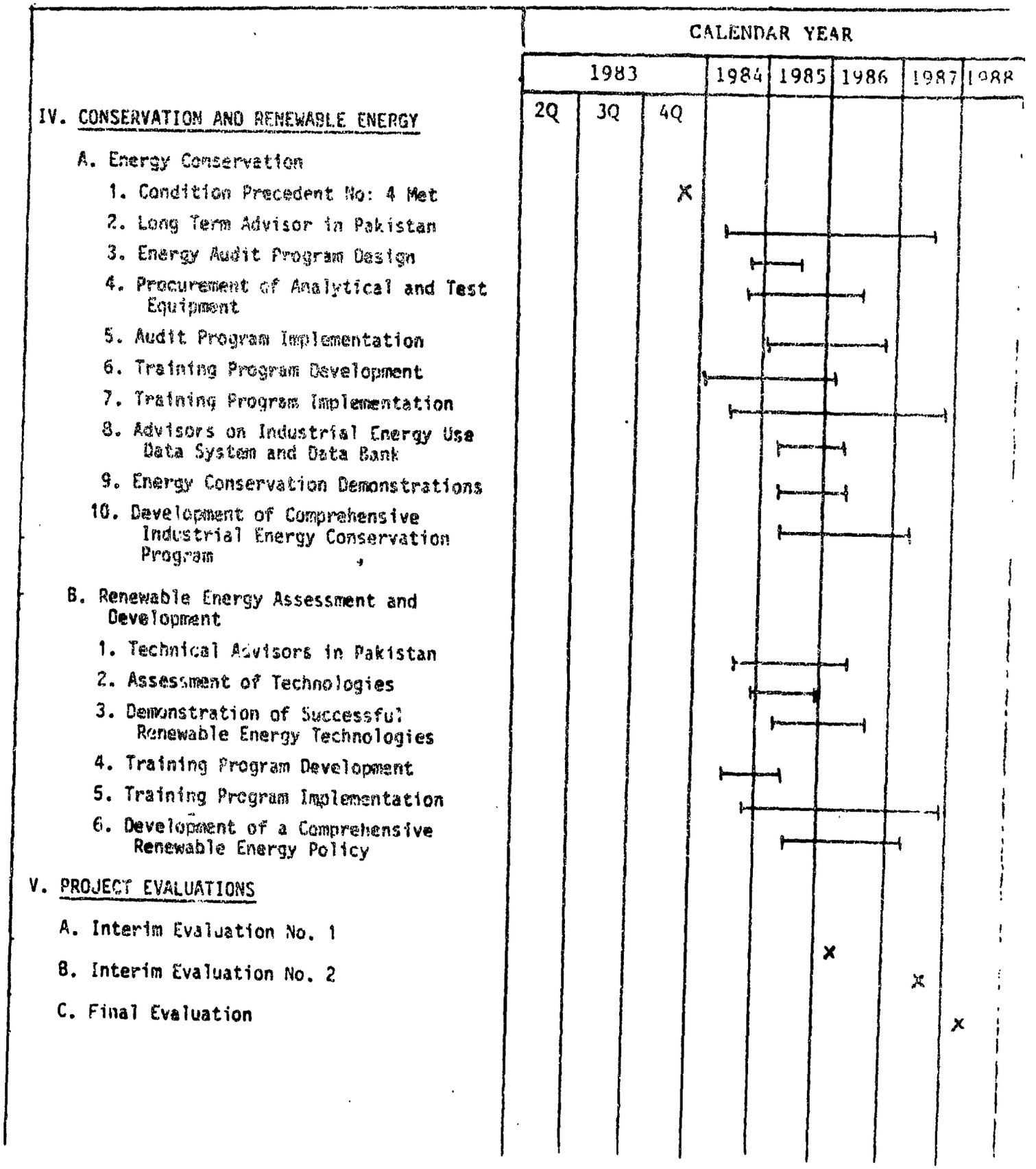
PROPOSED IMPLEMENTATION SCHEDULE



8. develop preliminary training plans for each of the project components, identify suitable candidates, and make arrangements to enroll these individuals in appropriate programs.

In the early stages of the project and until the arrival of the long-term advisors, the Mission will utilize short-term contractors under PSCs and/or IQCs to undertake feasibility studies and other activities requiring immediate attention. Such activities are likely to include planning and management assistance to: (1) implement the coal mining industry workshop; (2) organize and staff the Energy Analysis Group in the Planning and Development Division, the Coal Projects Department in WAPDA, the GSP, and the DGER; and, (3) prepare preliminary training plans and arrange for training of key GOP project implementation staff.

It is anticipated that the proposed PASA with the USGS will be signed by December 1983 and that the long-term advisor will arrive in-country in January 1984. One of the first activities the USGS will be asked to perform will be to prepare bid packages for the purchase of drilling and test equipment which are essential for the Coal Resource Assessment program. The early procurement of these items will enable the exploratory drilling work to begin by the summer of 1984 and the coal analysis and testing work to be initiated soon thereafter. Data management and geophysical studies are scheduled to begin in the spring of 1984 with the assistance of both the long-term advisor and short-term consultants.

In order to respond to a GOP request to provide coal development support activities as soon as possible, the Mission has already begun to prepare the necessary contract documentation in order to facilitate the early signing of a competitively awarded contract before the end of the calendar year. WAPDA has made significant progress to date in establishing its Coal Projects Department such that the long-term advisors will be able to begin immediately to assist the Department to organize its staff, develop a training plan and a work plan, and procure required commodities. Site surveys and mine development drilling will take place as soon as possible in 1984.

It is anticipated that the long-term contract for the remaining project activities will not be signed prior to early 1984 and that the long-term advisors will be in-country no earlier than the late spring/early summer of 1984. It is likely, however, that short-term consultants will be provided, in the interim, to assist the Energy Analysis Group to plan a program of action for energy data base, integrated energy analysis, and manpower assessment and development activities.

One of the first activities of the General Technical Assistance Contractor under the Renewables component will be to assist the DGER to undertake the Energy Use Survey which will also serve as an important input for the coal briquettes market study. This survey will assist DGER to establish the nature of both rural and urban energy use for household and small commercial applications. On the basis of this survey, the General Technical Assistance Contractor will assist the DGER to assess the technical and economic potential of renewable energy technologies and to develop coherent pilot demonstration programs for these technologies, which will begin in early 1985 and continue throughout the life of the project. The pilot briquette plant is also scheduled for implementation in 1985 once the planned coal testing and market feasibility studies have been completed and analyzed. Under the Energy Conservation sub-component, it is anticipated that most of the activities to be undertaken in 1984 will consist of training and program analysis and design and that implementation of audits and demonstrations will not begin until 1985.

Three external project evaluations are planned: the first in February 1985, the second in August 1986, and the final in June 1988. The scope of these evaluations is described in Section IV.E.

B. Administrative and Monitoring Arrangements

1. A.I.D. Responsibilities

The USAID/Pakistan Office of Energy and Engineering (E&E) will have overall responsibility for managing the project. E&E is currently staffed with two U.S. Direct Hire (USDH) and thirteen Pakistani Professionals, nine of whom are engineers. Two additional USDH positions and one Pakistani professional position have recently been approved, and qualified professionals with recent energy training and experience have been assigned to them. One of the new USDH positions is that of an Energy Advisor, and the position will be filled by an individual who has a broad background in energy systems. This USDH engineer will serve as the Project Officer for this project.

It is estimated that the implementation of this project will require the equivalent staff time of 1½ USDH and 2 FSNs to carry out A.I.D.'s responsibilities. The USDH staff time will be provided by the Project Officer, working on almost a full-time basis, plus a percentage of the time of the Chief of the Office of E&E, the Mission Director, Deputy Director, Regional Legal Advisor, Controller, and staff of the Offices of Program, Project Development and Monitoring, and Human Resources and Training. The efforts of these A.I.D. staff will be supported by a strong technical team provided under 2 direct A.I.D. contracts with private firms, one direct A.I.D. PSC, and a PASA with the U.S. Geological Survey. (See Section IV.C.1.) The expatriate PSC in his capacity as Consultant/General Advisor will be responsible for, inter alia, the coordination of all activities undertaken by the two prime technical assistance contractors and the USGS and will work closely with and assist the GOP Project Director on a day-to-day basis to direct and orchestrate the activities of all government and private sector agencies involved in implementing the project. In this way, the USAID Project Officer will thereby be able to devote his efforts to major program oversight responsibilities and liaison with senior GOP officials. Figure 6 graphically depicts the formal and informal relationships among A.I.D., Project Contractors, and key GOP and other Pakistani implementing entities.

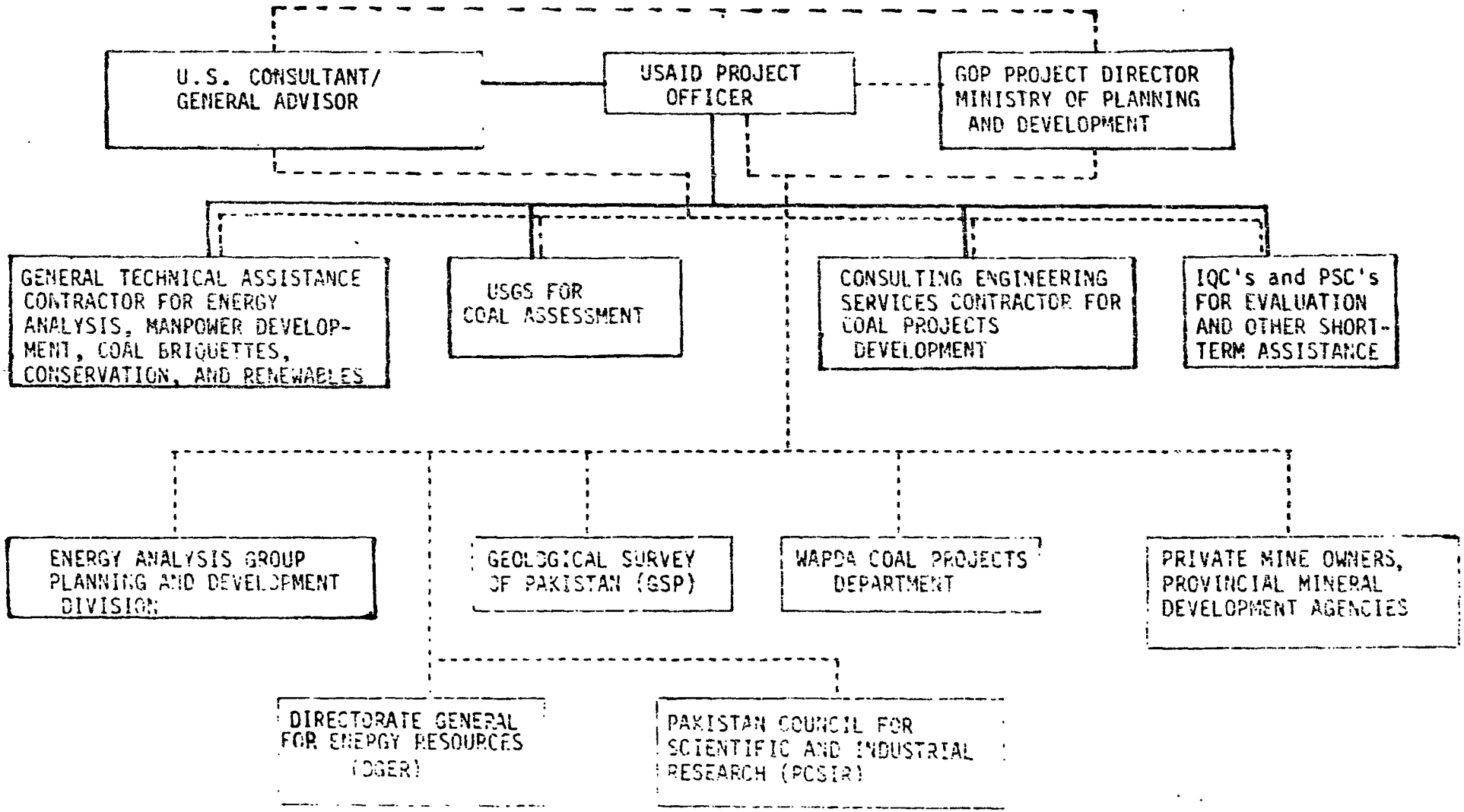
E&E will be assisted in all contracting and procurement actions by the Mission's Office of Project Development and Monitoring, all disbursement matters by the Office of Financial Management, all evaluation activities by its Program Office, all training activities by its Office of Human Resources and Training, and all logistic matters by its Office of Management. These Mission staff resources together with the assistance of AID/Washington backstopping staff in

FIGURE 6

RELATIONSHIPS AMONG A.I.D., PROJECT CONTRACTORS, AND KEY GOP AND OTHER PAKISTANI IMPLEMENTING ENTITIES

— = Direct contractual/ supervisory relationship

--- = Informal collaborative relationship



ASIA/TR, ASIA/PD, S&T/EY, SER/CM, SER/COM, and SER/DM and the Regional Legal Advisor (located in Islamabad), Environmental, Contracts and Commodity Management Advisors are considered adequate to meet USAID/Pakistan's responsibilities under the project.

2. GOP Responsibilities

The head GOP implementing agency for the project will be the Planning and Development Division in the recently established Ministry of Planning and Development whose Minister is also the Deputy Chairman of the National Planning Commission. The Planning and Development Division will also have responsibility for establishing the Energy Analysis Group such that it reports at a sufficiently high level to have an impact on energy planning and policy formulation and is able to coordinate effectively with agencies of other Ministries that will be responsible for undertaking other project activities. A GOP Project Director in the Planning and Development Division will be in charge of the overall Project and will also most likely head the Energy Analysis Group which will be in charge of implementing Component 1, Energy Analysis and Manpower Development. (See Figure 7).

Within the Ministry of Water and Power, WAPDA will take the lead for all Coal Development activities. A Coal Projects Department is being established within WAPDA to manage all coal mining and coal-fired power plant projects. Its senior staff will be drawn from WAPDA and from PMDC (See Figure 8). The Chief Engineer of the Coal Projects Department will serve as the GOP's overall manager for the Coal Development sub-component and as an Additional Grantee's Representative for the Project in WAPDA. In exercising this responsibility, he will be assisted by the Project Manager/Team Leader and other consultants provided by A.I.D. under a Consulting Engineering Services Contract plus a staff of WAPDA and PMDC officers assigned to WAPDA who will be provided special training. The Chief Engineer will report to the General Manager (Generation) of WAPDA. The Coal Briquetting sub-component will be the responsibility of PCSIR which will designate a project team to work with the U.S. contractor to undertake the market tests and set up and operate the coal briquetting pilot plant.

The lead agency for implementing the energy conservation and renewable energy technology activities and the coal resource assessment work will be the Ministry of Petroleum and Natural Resources. This ministry is responsible for geological assessments of natural resources through the GSP, government controlled aspects of coal mining through the PMDC, and industrial energy conservation and renewable energy programs through the DGER. These agencies will

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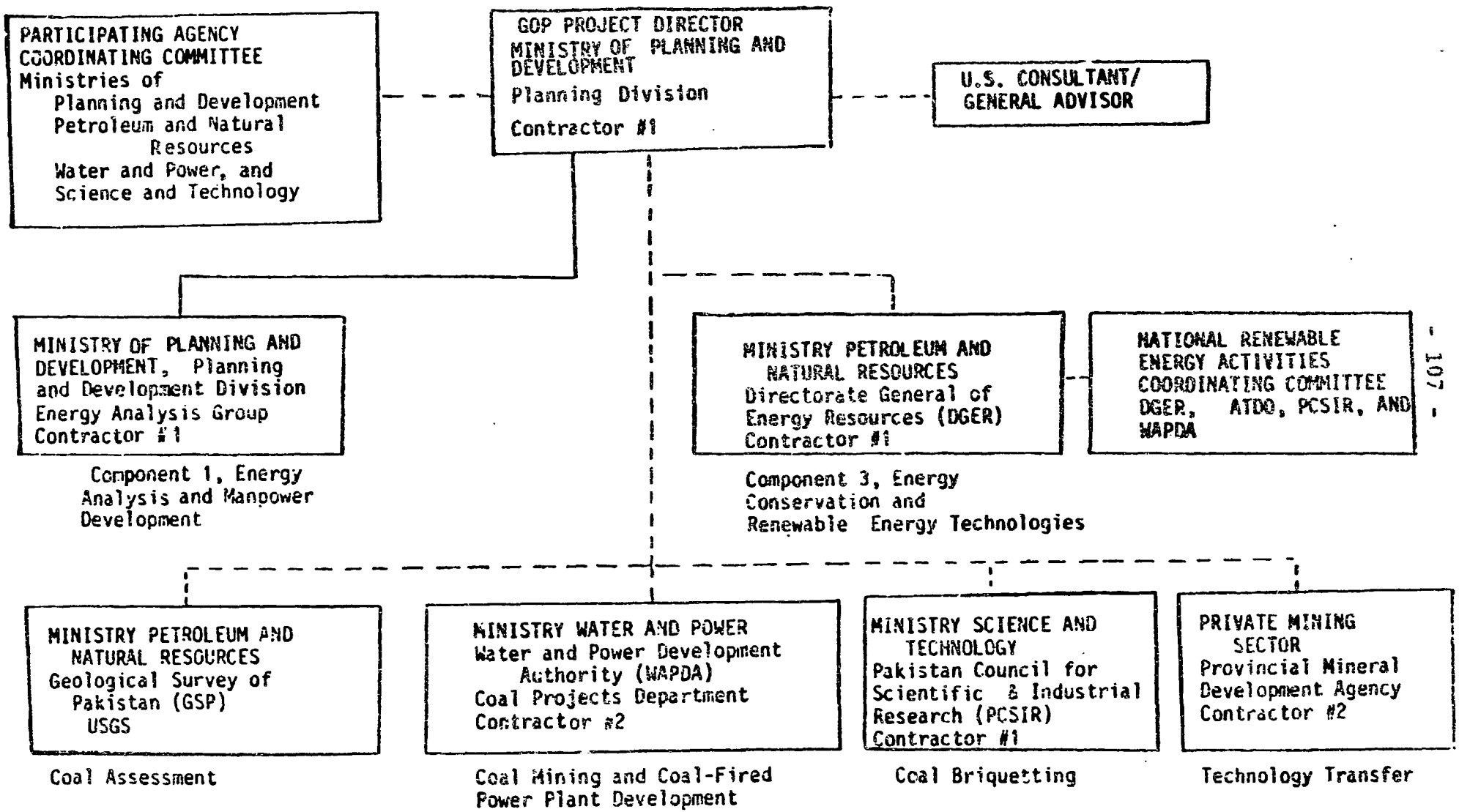
FIGURE 7.

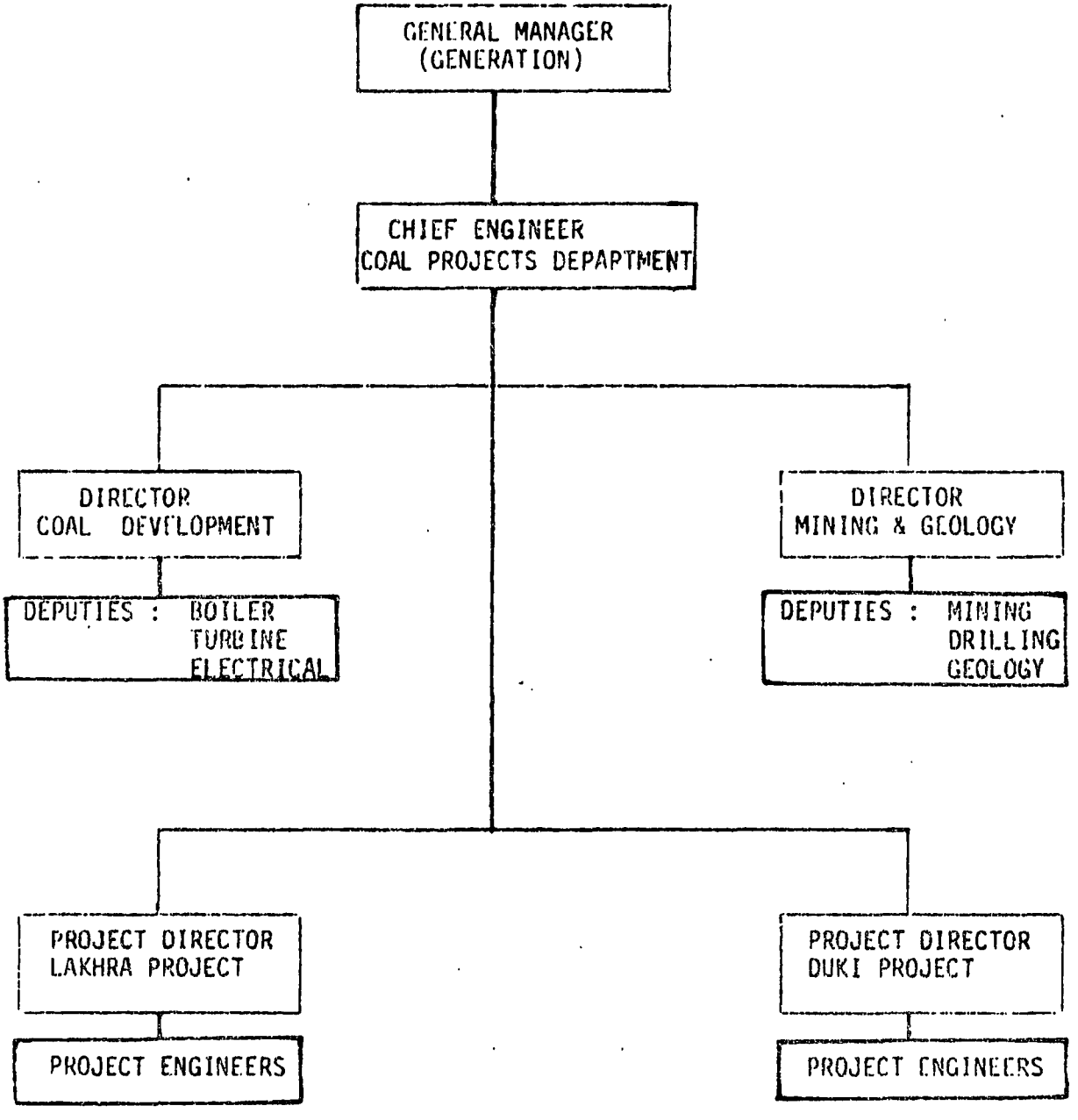
INSTITUTIONAL RELATIONSHIPS AMONG IMPLEMENTING ORGANIZATIONS



Contractor #1 = General Technical Assistance
Contractor #2 = Consulting Engineering Services

FIGURE 8

ORGANIZATION OF
WAPDA'S COAL PROJECTS DEPARTMENT



designate full-time Project Managers and staffs to work with the U.S. Contractors. As described in the Administrative Analysis Section, in the Mission's judgement, with the technical assistance and training to be provided under this project, all of these agencies should be capable of handling their administrative and monitoring responsibilities under the project.

To provide effective overall leadership, establish policy and program guidelines, review and solve major project implementation problems, and serve as a continuing forum for all Pakistani ministries and agencies to monitor project progress, a high level committee made up of members from key ministries directly involved in the energy sector will be established at the beginning of the project and will meet at least quarterly throughout the project. This Participating Agency Coordinating Committee will be made up initially of members from the Ministries of Planning and Development, Petroleum and Natural Resources, Water and Power, and Science and Technology and will be chaired by the GOP Project Director. Other ministries representing energy users may be invited to meetings. The Committee will regularly review project plans, schedules, budgets and implementation progress.

Renewable energy technologies and programs are handled in Pakistan by several different agencies including the DGER, ATDO, PCSIR, WAPDA, and the Silicon Technology Development Agency. In order to assure coordination and integration of activities and dissemination of results, a National Renewable Energy Activities Coordinating Committee made up of officials of these agencies will be formed and will be chaired by the Director General of Energy Resources or his designated Chief of the Energy Conservation and Renewable Energy Technologies Component of the Project. The Committee will meet regularly to review project plans, schedules, budgets and implementation progress.

The key Pakistani implementing agencies all have existing resources for effectively undertaking their responsibilities. The staff of the Planning and Development Division are in the final stages of preparation of the GOP's Sixth Five-Year Plan. This experience will provide an initial data base and experience for key personnel in energy supply-demand balances under Component 1. The DGER within the Ministry of Petroleum and Natural Resources and ATDO within the Ministry of Science and Technology are already active in assessing and implementing renewable energy technologies and industrial energy conservation projects. The DGER is now establishing district offices in 5 major cities. WAPDA within the Ministry of Water and Power is responsible for over 80 percent of power generation in Pakistan and has already initiated action to establish a Coal Projects Department which will form the core from which to improve the capabilities in Pakistan to assess large coal utilization projects. The GSP has previously been active, with assistance from USGS, and has considerable experience in assessing Pakistan's mineral resources.

C. Procurement Plan

1. Technical Assistance

Table 4 summarizes the broad range of technical assistance required to implement this project. Overall project coordination and management will be facilitated by a long-term expatriate Consultant/General Advisor, who will be housed in the GOP Planning and Development Division and contracted under a direct A.I.D. Personal Services Contract(PSC) for up to 57 person-months. In addition, up to 6 person-months of short-term assistance will be required for the scheduled project evaluations, and these services will be procured under direct A.I.D. PSCs and/or Indefinite Quantity Contracts (IQCs). The remaining technical assistance will be provided under 3 major contracts: (a) a direct A.I.D. contract with a U.S. firm or association selected through competitive solicitation to provide all the required technical services under Component 1 (Energy Analysis and Manpower Development), Component 3 (Conservation and Renewable Energy Technologies), and the Coal Briquettes Program under Component 2; (b) a Participating Agency Services Agreement (PASA) with the U.S. Geological Survey (USGS) for the Coal Resource Assessment Program under Component 2; and, (c) a direct A.I.D. contract awarded in accordance with A.I.D.'s competitive procedures to a U.S. firm for the Coal-Fired Power Generation Program under the Coal Development sub-component of Component 2. During the early stages of project implementation and until the execution of these 3 major contracts, some of the short-term technical assistance needs identified in Table 4 may be provided through direct A.I.D. PSCs and/or IQCs. In addition, maximum use of Pakistani consulting firms is planned, and the solicitations for the 2 major technical assistance contracts will encourage where possible or require in specific instances joint ventures or subcontracting with Pakistani firms.

One Request for Proposals (RFP) will be issued to solicit offers from U.S. firms or associations to undertake all the activities under Components 1 and 3 and the Coal Briquettes activity under Component 2. This amounts to an estimated 376 person-months of short-term technical assistance and 3 long-term advisors for a total 84 person-months. Depending on the responses received from potential offerors, either one or two direct A.I.D. contracts may be executed. If one U.S. firm or association with considerable depth and experience in a broad range of both conventional and non-conventional energy sources meets the requirements of the solicitation, only one contract will be awarded.

The project activities to be undertaken by the selected contractor(s) address complex energy planning and technology issues and will be implemented by 3 different Ministries (Planning and Development; Petroleum and Natural Resources;

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TABLE 4

PROPOSED TECHNICAL ASSISTANCE PLAN [a/]

	Type [a/]	Duration (In PM)	Source
1. Energy Analysis and Manpower Development			
a. Team Leader and Integrated Energy Analysis Specialist	Long Term	36	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
b. Advisors to Energy Analysis Group			
i. Manpower Needs Assessment	Long Term	12	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
ii. Energy Data Base Activities	Short Term	9	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
c. Sectoral Energy Advisors			
i. Manpower Needs Assessment	Short Term	24	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
ii. Energy Data Base Activities	Short Term	18	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
iii. Integrated Energy Analysis	Short Term	24	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm

a/ Some of the short-term assistance indicated above may be provided through existing IQCs and/or PSCs especially during the early stages of the project prior to the arrival of the long-term technical assistance teams.

TABLE 4 (Continued)

	Type	Duration (In PM)	Source
d. Tutors for Seminars	Short Term	30	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
e. Topical Specialists	Short Term	84	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
	Total	237	
2. Coal Resource Assessment and Development			
a. Coal Resource Assessment			
i. Team Leader - Resident Advisor	Long Term	45	USGS PASA
ii. Regional Coal Assessment Advisors	Short Term	39	USGS PASA
iii. Coal Exploratory Drilling and Geophysical Logging Advisors	Short Term	15	USGS PASA
iv. Coal Analysis Specialists	Short Term	16	USGA PASA
v. Data Management and Geophysical Studies Advisors	Short Term	18	USGA PASA
	Total	133	
b. Coal Mining and Coal-Fired Power Plants			
i. Phase 1			
(1) Team Leader - Resident Advisor	Long Term	24	Competitive Direct A.I.D. Consulting Engineering Serv. -- Contract #2 with U.S. Firm
(2) Mine and Transport Project Manager	Long Term	18	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm

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TABLE 4 (Continued)

	Type	Duration (in TM)	Source
(3) Power Station Project Manager	Long Term	18	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(4) Advisors to WAPDA Coal Projects Department	Short Term	31	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(5) Coal Resource Definition Engineering Specialists	Short Term	7	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(6) Mine Development Drilling Engineering Specialists	Short Term	21	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(7) Mine Design Specialists	Short Term	43	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(8) Mine Infrastructure Design Specialists	Short Term	18	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(9) Mine Surface Facilities Specialists	Short Term	18	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(10) Engineering Project Management Systems Specialists	Short Term	10	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm

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TABLE 4 (Continued)

	Type	Duration (In PM)	Source
(11) Engineering Site Planning Specialists	Short Term	20	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(12) Engineering Management System Development and Implementation Specialists	Short Term	25	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
	Total	253	
ii. Phase 2			
(1) Energy Balance Engineering Specialists	Short Term	18	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(2) Mine and Transport Engineering Specialists	Short Term	6	Competitive Direct A.I.D. Consulting Engineeering Services Contract #2 with U.S. Firm
(3) Turbine and Boiler Specifications Specialists	Short Term	80	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(4) System Descriptions, Logistics, Piping and Instrumentation Diagrams Specialists	Short Term	24	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
(5) Plant Equipment Specifications Specialists	Short Term	25	Competitive Direct A.I.D. Consulting Engineering Services Contract #2 with U.S. Firm
	Total	153	

TABLE 4 (Continued)

	Type	Duration (in PM)	Source
c. Coal Briquetting			
i. Advisors on Feasibility Study and Market Assessment	Short Term	20	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm
ii. Test Marketing Specialists	Short Term	8	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm
iii. Engineering Design and Pilot Plant Construction Management Specialists	Short Term	9	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm
	Total	37	
3. Conservation and Renewable Energy Technologies			
a. Conservation and Renewable Energy Advisor	Long Term	36	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm
b. Energy Audits Advisors	Short Term	28	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm
c. Conservation Training Advisors	Short Term	58	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm
d. Energy Needs Survey Advisors	Short Term	16	Competitive Direct A.I.D. General Technical Assistance Contract [illegible] U.S. Firm

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TABLE 4 (Continued)

	Type	Duration (In PM)	Source
e. Solar, Small Hydro, Wood Stoves, and Other Biomass Advisors	Short Term	48	Competitive Direct A.I.D. General Technical Assistance Contract #1 with U.S. Firm
	Total	166	
4. Project Implementation Coordinator/ Advisor	Long Term	57	Direct A.I.D. PSC
5. Evaluation Specialists	Short Term	6	Direct A.I.D. PSCs or IQCs

and, Water and Power). Each of these ministries has sufficient experience in executing and managing expatriate consultant contracts. Nevertheless, because of the number of GOP organizations involved and the diverse nature of the activities, the Mission has determined that it is in the best interests of the project to procure the required services under a direct A.I.D. contract. This arrangement will enable the contractor to work closely with A.I.D. to ensure that project resources are appropriately allocated among the various project activities and that project activities are implemented in a timely and coordinated manner.

The Mission plans to obtain the services of the USGS under a PASA to undertake the activities under the Coal Resource Assessment Program under Component 2. The services required include one long-term resident advisor for a total of 45 person-months and up to 88 person-months of short-term assistance in such disciplines as geology, geophysics, geochemistry, coal drilling, surveying, and data management and analysis. In the Mission's judgment, the USGS is uniquely qualified by experience and association to work with the Geological Survey of Pakistan (GSP) to strengthen its capability to undertake coal assessments by implementing an intensive training program and by carrying out regional coal assessments of known coal deposits. The USGS has performed similar services in other countries, including the U.S., and is the repository of background information on coal resources throughout the world. It has extensive training facilities for the large number of participants anticipated under the project and has direct access to other USG organizations for personnel and training, e.g. the Bureau of Mines, Minerals and Management Services, the Department of Energy, and others. The USGS has a long-term and well-established association with the GSP and its personnel, dating back to the 1960's, and the GSP has specifically requested that the USGS

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be the contractor for the coal assessment portion of the project. Previous experience in other countries has shown that the USGS has important advantages over private contractors in performing the services required under this project.

The second largest amount of technical services falls under the Coal Mining and Coal-Fired Power Generation (Lakhra) sub-component of this project with an estimated 193 person-months of short-term assistance and 3 long-term advisors for a total of 60 person-months under Phase 1 and an additional 153 person-months of short-term assistance under Phase 2. Phase 2 activities of this sub-component would consist of mostly home-office engineering in the U.S. and may be funded by A.I.D. through an amendment to this project in FY 1984. The solicitation for this procurement will therefore indicate, with the appropriate caveats, the possibility of follow-on work. WAPDA has requested that the U.S. Contractor providing these services enter into a joint venture or sub-contract with a Pakistani consulting firm and that the personnel of the latter firm participate in the work to the maximum extent possible. All costs of the Pakistani firm will be borne by WAPDA. The U.S. Contractor will also be required to sub-contract with a U.S. laboratory to perform rock and coal testing and coal analyses and to sub-contract with a Pakistani firm to provide some of the aerial photography maps. (See Section IV.C.2.).

2. Commodities

The proposed commodity procurement plan shown in Table 5 lists the commodities which are likely to be procured under this project and shows for each, the anticipated year of purchase, the probable source, and the likely method of procurement. Estimated costs of individual items are shown in the Financial Annex (Annex L). Project vehicles, the truck mounted drill and accessories, and, the geophysical logging truck will be purchased directly by USAID/Pakistan because of the need for an early delivery of these specific items. All remaining commodities will be procured by the respective long-term technical assistance contractors except for several items under the Coal Mine and Coal-Fired Power Generation sub-component which will be procured by WAPDA. All computer hardware and software will be procured in consultation with SER/DM, AID/Washington. With the exception of vehicles, which will likely be procured from Japan, all commodities procured under this project will have their source and origin in the United States or Pakistan.

Ten right-hand drive, 4-wheel drive passenger vehicles will be procured as soon as possible after the Project Agreement is signed. A source/origin waiver request for these vehicles is included in Annex F. Eight groups of commodities will be procured under the Coal Mine and Coal-Fired Power Generation sub-component. Environmental monitoring/sampling equipment,

TABLE 5

PROPOSED COMMODITY PROCUREMENT PLAN

	Year Purchased and Source	Method of Procurement
1. Energy Analysis and Manpower Development		
a. Mini Computers with disc storage, line printer CRT and graphics capability	FY 1985 U.S.	General Technical Assistance Contractor
b. Energy Analysis, Data Analysis and other relevant software	FY 1985 U.S.	General Technical Assistance Contractor
c. Training and Seminar Materials	FY 1984-86 U.S.	General Technical Assistance Contractor
d. Two Right-Hand Drive, 4 Wheel Drive Land Cruiser Station Wagons	FY 1983 Japan	USAID/Pakistan
2. Coal Resource Assessment and Development		
a. Coal Resource Assessment		
i. Core Drills	FY 1984-86 U.S.	USGS
ii. Core Drill Augmentation Equipment	FY 1984-86 U.S.	USGS
iii. Geophysical Logging Equipment	FY 1984-86 U.S.	USGS
iv. Laboratory Equipment	FY 1984-86 U.S.	USGS
v. Coal Petrography Equipment	FY 1984-86 U.S.	USGS
vi. Geodata Center Equipment	FY 1984-86 U.S.	USGS
vii. Photogrammetric Equipment	FY 1984-86 U.S.	USGS
viii. Aerial Photography Equipment	FY 1984-86 U.S.	USGS
ix. Geophysical Surveying Equipment	FY 1984-86 U.S.	USGS
x. Rapid Surveying Equipment	FY 1984-86 U.S.	USGS
xi. Publication Support Equipment	FY 1984-86 U.S.	USGS
xii. Textbooks and Manuals	FY 1984-86 U.S.	USGS

Table 5 (Continued)

	Year Purchased and Source	Method of Procurement
b. Coal Mine and Coal-Fired Power Generation		
i. Truck Mounted Drill and Accessories	FY 1984 U.S.	USAID/Pakistan
ii. Geophysical Logging Truck	FY 1984 U.S.	USAID/Pakistan
iii. Coal Analyses and Rock and Coal Testing Equipment	FY 1984 U.S.	Consulting Engineering Contractor
iv. Mining Camp including Generator, Communications Equipment, Shop, First-Aid, Houses	FY 1984 U.S. and Pakistan	Consulting Engineering Contractor and WAPDA
v. 4000 Gallon Water Tank Truck	FY 1984 Pakistan	WAPDA
vi. Environmental Sampling Equipment	FY 1983 U.S.	Consulting Engineering Contractor
vii. Aerial Photographs and Maps	FY 1984 Pakistan	Consulting Engineering Contractor
viii. Mining Demonstration Equipment	FY 1985 U.S.	Consulting Engineering Contractor
ix. Four Right-Hand Drive, 4 Wheel Drive Land Cruiser Station Wagons	FY 1983 Japan	USAID/Pakistan
c. Coal Briquetting		
i. 25 Ton per day Coal Briquetting Plant	FY 1986 U.S.	General Technical Assistance Contractor
ii. One Right-Hand Drive, 4 Wheel Drive Land Cruiser Station Wagon	FY 1983 Japan	USAID/Pakistan

Table 5 (Continued)

	Year Purchased and Source	Method of Procurement
3. Conservation and Renewable Energy Technologies		
a. Energy Conservation		
i. Industrial Energy Auditing Equipment	FY 1984-86 U.S.	General Technical Assistance Contractor
ii. Education Materials for Auditor Training	FY 1984-86 U.S.	General Technical Assistance Contractor
iii. Demonstration Equipment, High Efficiency Motors, Boiler Controls, Foam Finishing Equipment	FY 1984-85 U.S.	General Technical Assistance Contractor
b. Renewable Energy Technologies		
i. Solar Radiation Monitoring Equipment	FY 1984 U.S.	General Technical Assistance Contractor
ii. Photovoltaic Equipment and Instrumentation Systems	FY 1985-86 U.S.	General Technical Assistance Contractor
iii. Small Hydro Monitoring Equipment	FY 1984-86 U.S.	General Technical Assistance Contractor
iv. Hydro Testing Facilities	FY 1984-86 U.S.	General Technical Assistance Contractor
v. Micro Hydro Units	FY 1984-86 U.S.	General Technical Assistance Contractor
vi. Combustion Test Equipment for Wood Stoves	FY 1984-86 U.S.	General Technical Assistance Contractor
vii. Biogas Monitoring Equipment	FY 1984-86 U.S.	General Technical Assistance Contractor
viii. Demonstration Equipment for Renewable Energy Technologies	FY 1984-85 U.S.	General Technical Assistance Contractor
ix. Three Right-Hand Drive, 4 Wheel Drive Land Cruiser Station Wagons	FY 1983 Japan	USAID/Pakistan

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mining demonstration equipment, coal testing equipment, and aerial photographs and maps will be procured by the U.S. contractor. A truck mounted drill and accessory equipment capable of drilling open holes and coring, valued at about $460,000, and a geophysical truck and spare parts for logging of drill holes, valued at about $145,000, will be procured competitively in the U.S. by USAID/Pakistan as soon as possible after the Project Agreement is signed so that they will be in-country to begin the survey work.

Mining camp equipment and accessories, valued at about $550,000, and consisting of prefabricated housing units, water and fuel tanks, maintenance shops, generator and electrical equipment, communications, household, shops and first aid equipment will be procured in both the U.S. and Pakistan, and the camp will be constructed as soon as possible. A 4,000 gallon tank truck will be procured by WAPDA in Pakistan. WAPDA has agreed to provide half the local cost for the mining camp and to purchase the tank truck locally. Environmental sampling and analysis equipment, valued at $400,000, and consisting of basic and specialized equipment must be procured in the U.S. since it is not available in Pakistan.

Mining demonstration equipment, valued at $600,000, will be procured in the U.S. since it is not available in Pakistan. A contract with a U.S. Laboratory will be entered into by the U.S. prime contractor for this component to perform rock and coal testing and coal analyses. Funds have been earmarked under the project for shipping of samples and sample rests and analyses. Aerial photographs will be procured from the Surveyor General of Pakistan, and aerial photography at 1 space inch to 400 feet scale will be contracted for by the U.S. prime contractor with a commercial supplier in Pakistan.

Approximately $2.6 million has been earmarked for commodities under the Coal Resource sub-component. Equipment to augment core drill capacity is needed specifically to allow drilling of large holes. The geophysical logging equipment will include two complete sets of portable equipment. The core drills will be provided with accompanying supplies and equipment plus two heavy duty support vehicles per core rig. Coal petrography equipment will include a microscope, hoods, benches, lapidary and miscellaneous equipment. The photogrammetric equipment to be procured includes items required to update existing photogrammetric equipment. Report production equipment includes processors, lettering machines, and a reducing photocopy machine. Geophysical surveying equipment may include gravity meters, magnetmeters and micro-seismometers. If the budget permits, additional equipment may be procured, including textbooks and manuals, stereo-plotting equipment, a small computer for the Geodata Center, and additional parts for the core drills.

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Commodities needed for the Energy Conservation sub-component include educational material for the auditor training program and industrial energy auditing equipment. This auditing equipment is not available in Pakistan and hence will be procured in the U.S. Solar radiation monitoring commodities include pyrheliometers, recording equipment and associated batteries. Solar demonstration photovoltaic equipment may be supplied, and it will be either of the conventional silicon cell type, amorphous silicon, or an advanced technology. Assessment activities for solar, hydro and biomass technologies will require wattmeters, recording equipment, and small micro processor equipment, among other items. Flow measuring equipment, some mini-computer equipment, and recording equipment will be required for the small hydro test facility.

D. Training Plan

Training is the key to the success of all aspects of this Project and of future energy development in Pakistan. The training program planned under this Project will involve the use of training organizations in the U.S. and, to a limited extent, in Third Countries, as well as the development of training capabilities in Pakistan. Near-term training requirements must be met as soon as possible in order to enhance the prospects of project success and can, in part, be accomplished by using short-term training opportunities in the U.S. While some long-term training fellowships (up to two years) at the Master's degree level are likely to be financed, this project will emphasize short-term, practical and to the extent possible, hands-on training. Table 6 summarizes the proposed training plan. It is estimated that at least 368 professionals will participate in the program.

U.S. training will consist of the following courses and programs:

1. Academic courses, which focus on specific energy technologies, engineering and economics, management, planning and analysis. A number of U.S. Universities offer such courses, including the Colorado School of Mines, the University of Pennsylvania, and Southern Illinois University, among others.

2. Internships with be arranged with U.S. industries such as Pennsylvania Power and Light, southern Electric Company and other utilities, private coal companies, Westinghouse Power Systems Division, the General Electric Corporation, Stone and Webster Engineering Corporation, Bechtel Company and others which can provide hands-on, practical, on-the-job training in a variety of operational and managerial skills.

TABLE 6

PROPOSED TRAINING PLAN a/

Project Activity and Intended Audience	Type of Training	Length	Place	No. of Participants	Proposed b/ Schedule
1. Energy Analysis and Manpower Development					
a. Training for EAG Staff	Energy Training Courses at Stoney Brook, ADL or Elsewhere	3 months	U.S.	3 1	1983 4th Quarter 1986 3rd Quarter
b. Training for EAG Staff	Courses at Brookhaven or Argonne National Labs in Use of Energy Balance Models	3 months	U.S.	1 1	1984 1st Quarter 1985 1st Quarter
c. Short-Term Sectoral Training	Special Courses or Internships	3 months per course	U.S.	19	1984 - 1986
d. Training for EAG Staff and Staff of Energy Supply and Use Ministries	Courses in Energy Analysis Methods	1 month per course	Pakistan	20 (2 Courses) 10 (1 Course)	1984 1985 } 3 person-months of U.S. instructor required for each course
e. Training for EAG Staff and Staff of Energy Supply and Use Ministries	Seminars in Special Energy Topics	3 months per course	Pakistan	80 (4 Seminars) 60 (3 Seminars) 40 (2 Seminars)	1984 1985 1986 } 3 person-months of U.S. instructor required for each course
f. Long-Term Academic Training in Energy Economics and/or Public Finance	(Master's Degree [illegible] or MBA)	2 Years	U.S.	1	January 1984

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(Table 5 Continued)

PROPOSED TRAINING PLAN [a]

Project Activity and Intended Audience	Type of Training	Length	Place	No. of Participants	Proposed [b] Schedule
2. Coal Resource Assessment and Development					
a. Coal Resource Assessment					
i. Coal Assessment Methods	Internships and Special Courses at USGS	3 months	U.S.	2	1983 4th Quarter
		3 months		3	1984 1st Quarter
		3 months		2	1985 1st Quarter
		3 months		2	1986 1st Quarter
		3 months		1	1987 1st Quarter
ii. Coal Analysis	Internships and Special Courses at USGS	2 months	U.S.	2	1983 4th Quarter
		3 months		1	1984 1st Quarter
		3 months		1	1985 1st Quarter
iii. Data Management and Geophysical Studies	Internships and Special Courses at USGS	2 months	U.S.	3	1984 1st Quarter
		3 months		1	1984 1st Quarter
		4 months		1	1984 2nd Quarter
		2 months		5	1984 2nd Quarter
		2 months		1	1985 1st Quarter
iv. Long-Term Academic Training	Master's Degree	2 years	U.S.	2	Jan. 1984- Mar.1985 Sept.1985-June 1986
b. Coal Development					
i. Phase 1					
(1) Plant Operation and Maintenance for Senior Plant Operation/Maintenance Staff	Technical Internship programs	8 months	U.S.	8	Oct.1986 - July 1987

(Table 6 Continued)

PROPOSED TRAINING PLAN a/

Project Activity and Intended Audience	Type of Training	Length	Place	No. of Participants	Proposed Schedule b/
(2) Operation Management in Open Pit Mining for Senior Mine Engineering/Management Staff	Technical Internship programs	6 months	U.S.	3	Jan.1984 - July 1984
(3) Open Pit Mining	Technical Internship programs	6 months	U.S.	6	Aug.1984 - Feb.1985
(4) Underground Mining	Technical Internship programs	6 months	U.S.	8	May 1984 - Nov.1984
(5) Equipment Maintenance for Equipment Mechanics	Technical Internship programs	4 months	U.S.	11	June 1984 - Oct.1985
(6) Coal Handling	Technical Internship programs	6 months	U.S.	4	Jan.1984 - Sept.1984
(7) Energy Project Management for Senior Staff	Technical Internship programs	6 months	U.S.	6	Jan.1984 - Jan.1985
(8) Generation Planning (Coal) for Planning Staff	Technical Internship programs	6 months	U.S.	2	Jan.1984 - Jan.1985
(9) Coal Supply Contracting and Business Management for Managers with Business/Legal Background	Technical Internship programs	4 months	U.S.	2	Jan.1984 - May 1984
(10) Environmental Protection	Technical Internship programs	6 months	U.S.	2	Jan.1984 - July 1984

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(Table 6 Continued)

PROPOSED TRAINING PLAN [a/]

Project Activity and Intended Audience	Type of Training	Length	Place	No. of Participants	Proposed [b/] Schedule
ii. Phase 2 [c/]					
(1) Engineering and Design for Mid Level to Senior Engineering Staff	Technical Internship programs	6 months 8 months	U.S.	5 10	Aug.1984 - Jan.1985 Mar.1985 - Nov.1985
(2) Construction Management for Mid level to Senior Construction/Management Staff	Technical Internship programs	8 months	U.S.	6	Sept.1984 - May 1985
c. Coal Briquettes	Third Country Intern Training in Briquette Production and Marketing	9 months	U.S., India, Korea	3	1985
3. Conservation and Renewable Energy Technologies					
a. Conservation	Energy Courses in U.S.	3 months	U.S.	2 4 2	1983 4th Quarter 1984 3rd Quarter 1985 3rd Quarter
b. Renewables					
i. DGER and ATDC staff including ATDC contractors at University of Peshawar, PCSIR and elsewhere	Renewable Energy Courses at Univ. of Florida and Elsewhere	6 months	U.S.	4 3 3	1985 1986 1987

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(Table 6 Continued)

PROPOSED TRAINING PLAN a/

Project Activity and Intended Audience	Type of Training	Length	Place	No. of Participants	Proposed Schedule b/
ii. Small Hydro: ATDO Staff, University of Peshawar Faculty	Internships at Small Hydro Operations	4 months	U.S.	2	1985
	Internships at Small Hydro Operations	4 months	U.S.	2	1985
		2 months	Nepal or Other Third Country	2	1985
iii. Wood Stoves: ATDO, PCSIR, Univ. of Peshawar and Private Sector	On-Site Training at A.I.D. Projects	2 months	Third Country	3	1985
iv. Biomass: DGER, ATDO, PCSIR	Marketing Internships	4 months	U.S.	3	1985

a/ Funding for some of the proposed training activities may be provided under the Mission's Development Support Training Project or the AID/Washington centrally-funded Conventional Energy Training Project.

b/ Quarter refers to calendar year.

c/ Funding for these training activities may be provided by A.I.D. through an amendment to this project in FY 1984.

The duration of such internships will be determined by the type of training required and is likely to range from 6-12 months each.

3. Internships will also be arranged with U.S. national laboratories and U.S. Government technical agencies such as the Energy Technology Center (U.S. Department of Energy), the U.S. Geological Survey, the U.S Army Corps of Engineers, Oak Ridge National Laboratory, Brookhaven National Laboratory, Battelle Memorial Institute, Los Alamos National Laboratory, and the Tennessee Valley Authority (TVA), among others. Though not normally training organizations, these institutions provide training opportunities in various areas of energy management, technology, planning and resource identification techniques.

4. Institutes and training programs sponsored by A.I.D. and various private sector organizations. These include the Arthur D. Little Management Institute, the Energy Management Course of Stoney Brook (State University of New York), the University of Florida Solar Technology Course, and the Energy Conservation Workshop for Utility and Industrial Plant Engineers (at TVA), among others.

Under Phase 1 of the Coal Development component, up to 312 person-months of specialized training and internships will be provided for about 50 Pakistani personnel. Training in generation planning, coal supply contracting, and business management for utility personnel will be provided and will be coordinated with the management and engineering training program. Training in open pit mining techniques, equipment operation, operation management and coal handling will be performed by the Texas Utilities Training Center or a similar U.S. firm with experience in this field.

In some cases, the training programs will be arranged and implemented by the appropriate long-term technical assistance contractors under this project. For some of the training activities, the services of the long-term technical assistance contractor under the Development Support Training Project will be utilized for placement and support services. In addition, the Mission plans to utilize the services available under the central A.I.D. Conventional Energy Training Project (CETP) which is administered by the Institute of International Education. If necessary, special training needs can be met through tailored programs under the CETP. In all cases, it will be the responsibility of the GOP implementing organizations, with the assistance of the relevant long-term advisors, to determine training needs and the best means of satisfying those needs and to identify appropriate and qualified candidates.

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E. Evaluation Plan

1. General Discussion

Three formal external evaluations are planned over the life of this five-year project, in February 1985, August 1986, and June 1988. The 1985 and 1986 evaluations will require about 4 weeks of effort to review secondary source data, conduct interviews, and make field visits. The final evaluation in 1988 will entail about 8 weeks of effort and may include, in addition to the above methods of evaluation, the collection and analysis of primary source data.

All evaluations will be undertaken by individuals who are not directly involved in the implementation of this project to ensure objectivity, but representatives of all participating GOP ministries and agencies, Mission personnel, and the contractors' long-term resident staff will serve as valuable resources for the evaluation team. All evaluations will also require the participation of AID/Washington personnel and either local and/or expatriate consultants. All formal evaluations will be conducted under the auspices of the Participating Agency Coordinating Committee, which will be responsible for effecting policy and program changes which may be required as a result of the evaluations.

In addition to these formal external evaluations, internal assessments are planned for every six months and will consist of program reviews by personnel directly involved in project implementation, including the USAID Project Officer, the long-term expatriate General Advisor, the GOP Project Director, GOP Project Coordinators, and the long-term contractors' team leaders. Other personnel from the GOP, USAID and the contractors' teams may also attend these review meetings. Subjects to be reviewed during these meetings may include but will not be limited to: the status of contracting and procurement actions; progress achieved in implementing training programs; the outcome of demonstrations and studies and decisions taken as to how the results will be disseminated and acted upon; progress achieved in effecting planned organizational and institutional changes; the appropriateness and effectiveness of administrative arrangements; and, the effectiveness of key implementing organizations, especially the Energy Analysis Group and the Coal Projects Department, in implementing the project. On the basis of these reviews, assessment reports will be prepared and distributed to relevant agencies and ministries. The Participating Agency Coordinating Committee will be responsibile to ensure that recommendations from these internal assessments are implemented. The regularly scheduled meetings of this Committee will also serve as a forum for project monitoring and informal project evaluations.

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A variety of data will be generated and available for all formal external project evaluations as a result of the data-gathering, data analysis, and reporting activities which will take place throughout the life of the project as follows:

a. energy data base, integrated energy analysis, and manpower needs assessment activities as well as special energy studies to be undertaken by the Energy Analysis Group under the Energy Analysis and Manpower Development component;

b. coal analysis and testing, exploratory drilling, and data management and geophysical studies to be undertaken by the GSP under the Coal Resource Assessment sub-component;

c. site surveys and mine development drilling to be undertaken by WAPDA's Coal Projects Department under the Coal Mine and Coal-Fired Power Generation sub-component;

d. coal testing and market feasibility studies to be undertaken by the PCSIR under the Coal Briquettes sub-component;

e. the establishment of an energy use data system and data bank to be undertaken by the DGER under the Energy Conservation sub-component;

f. the energy end use survey and assessment activities to be undertaken by the DGER under the Renewables sub-component;

g. quarterly progress reports prepared by the three major technical assistance contractors and the long-term expatriate General Advisor; and,

h. the minutes of the meetings of the Participating Agency Coordinating Committee and the National Renewable Energy Activities Coordinating Committee.

The following discussion outlines the objectives of each of the three formal external evaluations which will take place under this project.

2. <u>February 1985 Evaluation</u>

This evaluation will serve both as a project management "audit" and an opportunity to examine the results of feasibility studies and analyses which are scheduled to be undertaken during the first year and a half of the project and the resultant plans developed to implement demonstration and field activities beginning in 1985. By February 1985,

all of the long-term advisors should have been in-country for at least six months (and some about one year); comprehensive training and demonstration plans should have been developed; most of the project commodities should have been received; major studies and assessments should have been completed; and, organizational changes and institutional arrangements should have been formalized. In particular, progress with respect to the Lakhra Project and other coal projects, training of project implementation staff, and mining technology transfer activities will be critically examined. Necessary modifications in the project implementation schedule, institutional arrangements, the project financial plan, and workplans developed for key project components on the basis of the planning and analytical work completed as of that date will be made.

2. August 1986 Evaluation

This evaluation is scheduled to coincide with the projected completion date for the majority of activities under the Energy Conservation and Renewables Energy Technologies component and the Coal Briquetting activities. In addition, the Energy Analysis Group will have functioned for almost three years and will have carried out a significant proportion of the analytical work and studies under the Energy Analysis and Manpower Development component of the project. This evaluation will focus on the progress achieved in meeting project outputs as described in the Logical Framework. In particular, the following aspects of the project will be critically examined:

a. the effectiveness of the EAG in coordinating and integrating energy analysis and planning activities in Pakistan;

b. a preliminary analysis of how well and to what extent information generated by the project is being used as an input to decision-making in both the public and private sectors;

c. policy changes which have been effected as a result of the project;

d. the appropriateness and feasibility of the Comprehensive Industrial Energy Conservation Program and the progress achieved in implementing this program, including responsiveness of the private sector to this initiative;

e. the appropriateness and feasibility of the Comprehensive Renewable Energy Policy and the progress achieved in implementing this policy, including the extent of private sector participation in the program;

f. the GOP's progress in establishing and implementing a coherent and feasible coal program in Pakistan and the extent of private sector participation in this program;

g. the GOP's progress in implementing the Manpower Development program; and,

h. the outcome of the pilot briquetting plant and the GOP's future plans with respect to coal briquetting activities in Pakistan, including the response of consumers and the private sector to this initiative.

3. June 1988 Evaluation

This evaluation is scheduled to coincide with the expected completion date of all project activities. This evaluation will measure the impact of the project on energy planning and on policy formulation and implementation including an examination of the lessons learned and progress achieved in meeting the goal and purpose of the project as well as the end of project status (EOPS) indicators. Particular attention will be paid to this project's impact in promoting technology transfer, in increasing the role of the private sector in the energy sector, in strengthening institutions and manpower involved in the energy sector, and in influencing and catalyzing the adoption by the GOP of sound and appropriate energy policies. An attempt will also be made to develop a statistical profile of the project's direct impact on various beneficiary groups.

Several specific questions which will be examined include the following:

a. How are the integrated analysis techniques and technology economics information developed during the project being used in decision-making processes?

b. How effective were the training programs and technical assistance support in improving the GOP capability to assess the potential for coal utilization, implement industrial energy conservation technologies and policies, evaluate decentralized energy systems options, and to undertake financial and technical analyses required to effectively use resources in energy sector development? How have these been used to date and what indications are there that the GOP will continue to use these resources in its economic planning? and,

c. How successfully have the energy conservation and renewable energy demonstration programs been in providing important performance information and in accelerating the use of economically viable systems? Have projects or programs resulted from these demonstrations, and have they been successful in improving energy use efficiency?

V. PROJECT ANALYSES

A. Technical Analysis

The following section summarizes the comprehensive technical analysis which is provided in Annex N.

1. Energy Analysis and Manpower Development

National energy investment decisions should be based on a comprehensive assessment of the costs and benefits of different investment options. Techniques used in such analyses are ones in which U.S. public and private organizations have many years of experience. Under this component of the project, approaches known to be technically feasible will be used in the energy planning process including:

a. economic models which project sectoral economic activity;

b. energy supply-demand balance models which show the relationships between supply options and the demands imposed by economic activity (often on an equilibrium basis as determined by areas, production costs and demand price elasticity);

c. investment models which convert energy supply requirements into an investment schedule based on a large data base containing equipment costs, implementation schedules, local manpower needs, foreign manpower needs, and commodity needs; and,

d. sectoral models which analyze specific economic supply sectors in detail (most commonly used by the electric utility sector).

As a starting point, the Reference Energy System (RES) model, developed at Brookhaven National Laboratory, will be used. At least one GOP Agency, Enar Petrotech, an analysis group within the Ministry of Production, has developed energy models which will also be used.

A major neglected area of energy analysis is assessing the manpower implications of energy programs and options. The methodologies for conducting cost-effective manpower assessments are not well developed, although models do exist which have been used with mixed success. This project will help develop and improve appropriate techniques for manpower assessment. Short-term professional development and training based on manpower needs assessment under this project component will emphasize practical training and internships with U.S. industry.

In summary, both the energy analysis and training activities of this component are based on sound and proven A.I.D. and other U.S. experience, and are therefore technically feasible.

2. Coal Resource Assessment and Development

a. Coal Resource Assessment

Techniques proposed under this sub-component for conducting regional coal assessments are well established and are known to be technically feasible. The U.S. Geological Survey has been active in Pakistan since 1950 when the GSP and USGS began a cooperative program to intensify the mapping and appraisal of the geological resources of Pakistan. Project design consultants from the USGS helped design geological survey techniques for this sub-component which are not only technically well established but which are also technically appropriate for Pakistan. Both exploratory core drilling and geophysical logging techniques are widely used in the U.S. Geochemical characterization, photogrammetry, and remote sensing techniques are also well known in the U.S. The project proposes sufficient technical assistance from U.S. experts to ensure high technical quality for this sub-component.

b. Coal Development

i. Coal Power Generation

The Lakhra Coal Study recommends designs for coal production and power generation facilities that substitute labor-intensive designs for capital-intensive ones and minimize foreign exchange requirements whenever practicable. These designs are technically feasible and directly applicable to Pakistan. Training of operating and maintenance personnel will be required to properly prepare Pakistani coal production and power generation personnel to assume full responsibility for, and control of, the facility after a short (1-2 years) transition period. The Lakhra project consists of a mining complex to produce initially 1.4 million tons per year of Lakhra lignite, associated infrastructure and a 300 MW power plant which could be expanded to 600 MW. The Lakhra Coal Mining and Power Generation Project Review (summarized in Annex K) documents the technical feasibility and elaborates on the details of mining techniques and power plant technology used. Neither the mining, the unit train, nor the power plant technologies are currently utilized in Pakistan, but are essential for developing this major domestic energy resource. The specific technologies selected are those which are most suitable for the experience level in the country.

The current plan envisions Jamshoro as the site of a large Lakhra lignite-fired power complex beginning with one 300 MW unit. To support the GOP goals of expanding thermal power generation, based on domestic fuels and thus mitigating electric power shortages and balance of payments problems due to imported fuels, a second 300 MW unit will be commissioned in 1 to 3 years after commissioning of the first one. To accommodate operator training and common spare parts inventories and to further decrease costs, the second power station will be a duplicate of the first unit, with the exception of the addition of some form of flue gas scrubbing if required by environmental observations. To accommodate the second and future power units, the coal mining complex will be expanded with emphasis placed on developing private mining in the Lakhra area. A number of small mines are already active in the area and expansion of coal-fired power generation will provide a ready market for their expansion. The proposed coal mining and power plant technologies are considered technically sound and feasible.

ii. Coal Briquettes

The object of briquetting is to convert a low grade fuel like Pakistani lignite into one of superior quality. Lignite can be converted into a hard compact fuel with a high heat value. Briquettes may also be carbonized (heated in the absence of air to drive off the coal's volatile gases) to yield smokeless char briquettes of still higher quality. The process of briquetting consists of applying pressure to pulverized coal to form a compact agglomerate. A binder material may or may not be employed. Commonly used binders include coal tar pitch, asphalt, starchy waste materials, molasses and cement. Briquetting of coal thus involves grinding, drying, mixing with binder and pressing the coal, and cooling the briquettes before loading into trucks or wagons. Project design consultants estimate that a population of 10 million people constitutes the potential briquette market in Pakistan. This would require approximately 500,000 metric tons of coal per year to serve the residential and small commercial markets. This level of production is feasible. Coal mining activities necessary to encourage greater production are discussed under the mining sub-component of the Lakhra Coal Project. Based on experiences in other countries, the capabilities of U.S. firms to design and operate briquetting plants, and the programs developing in Pakistan to increase coal production, this sub-component is considered technically feasible and sound.

3. Conservation and Renewable Energy Technologies

a. Industrial Energy Conservation

Conservation refers to the efficiency with which energy is used in a process - that is, how much energy is used to produce one unit of output. This concept is sometimes also called "energy intensity". It does not imply, in any way, a reduction in output. Rather, energy conservation should allow higher levels of output for the same amount of energy expended. The industrial sector in Pakistan is an important energy-consuming sector, accounting for more than 50 percent of total commercial energy consumption. During 1975/76 to 1980/81, industrial energy consumption grew at an annual compound rate of 7.1 percent. The major energy consuming industries in Pakistan are textiles, cement, steel, fertilizers, chemicals, brick, foods, and paper. Due to the concentration of energy consumption in a few industries and even in a few plants, significant potential exists for energy efficiency measures to have a quantitative impact on national energy demand.

In Pakistan, a wide variety of energy conservation practices are already in use - from steam pipe insulation and maintenance to the addition of heat exchangers to preheat feed streams as hot wastes are dumped. Plants visited during project design maintained energy use records of various kinds and sophistication. Substantial interest exists at these plants in learning about state-of-the-art techniques and about the experience of other plants in Pakistan as well as in other countries. In summary, the considerable potential for energy efficiency improvements in Pakistan coupled with a notable record of success of relatively simple industrial conservation techniques in the U.S. and in other developed and developing countries suggests that this activity is technically feasible and sound.

b. Renewable Energy Technologies

Pakistan has a good resource base in most of the renewable energy sources. Solar energy availability in most parts of the country is comparable to the southern half of the United States. The northern mountainous areas have extensive small scale hydro resources which the design team estimated as being in excess of 90 MW in one region alone. The irrigation system barrages located throughout the country have a potential for over 500 MW of small scale hydro potential. Over 27 million head of cattle in the country could provide up to 35 million tons of cow dung for operation of digester systems. Other sources of biomass include rice husks and other agricultural

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residues. Considerable wood fuel savings are available by the use of more efficient wood stoves.

From a basic resources point of view, therefore, renewable energy systems could make a significant contribution to energy balances in Pakistan, particularly in rural areas where commercial fuels and electricity are either unavailable or very costly and traditional firewood resources are being rapidly depleted. Established technologies are available in both developed and developing countries to tap these resources and the United States has considerable expertise it can apply to assist the GOP in strengthening its renewables programs.

Under this project, investigations and assessments will be made of the existing renewable energy programs and projects to determine which ones have the potential to have an impact on the national energy picture. Funds will be provided to undertake demonstrations of technologies useful in Pakistan and also to conduct market surveys and investigate manufacturing options. The thrust of this sub-component will be to rationalize programs and initiatives in the renewable energy area, many of which have already started in a small way, and to develop the useful ones into successful national programs.

A number of forms of renewable energy are clearly feasible technically in specialized situations in many countries of the world, and there is now enough experience with equipment in operation that it is no longer considered experimental. In Pakistan, some situations considered specialized in other countries are common and some of them make renewable forms of energy especially attractive. For example:

i. A very high percentage of cloudless days with bright sunlight over most of the country. This is ideal for solar energy;

ii. A large number of small high head streams in the NWFP and of low head irrigation canals in Punjab. These are ideal circumstances for mini and micro hydro generators;

iii. Large amounts of biomass very inefficiently used. Biogas generators can efficiently use biomass currently wasted, such as dung, rice hulls and other refuse;

iv. A large part of the country not covered by the electric power grid, many parts so remote they probably never will be reached by the main grid; and,

v. Limited resources and high real costs of conventional fuels such as oil, gas and coal.

In summary, several sources of renewable energy, including solar heating, solar cells, small hydroelectric generators, fuel efficient wood stoves and biomass gas generators are technically feasible to use in Pakistan.
The approach of this project, to determine which options are economically viable and socially acceptable and to assist the GOP and private sector in developing the widespread use of them, is considered a feasible method of exploiting this opportunity.

B. Administrative Analysis

1. Energy Analysis and Manpower Development

Energy production in Pakistan over the past two decades has largely been the responsibility of the government. The country's two utilities, the Water and Power Development Authority (WAPDA) and the Karachi Electric Supply Corporation (KESC) were created in 1959 and are responsible for developing the country's water and electric power resources. Coal resources are controlled by the provincial governments and, while 80 percent of Pakistan's coal is produced by private miners, a federal agency, the Pakistan Mineral Development Corporation, established in 1974, generally enjoys greater access to the coal fields through long-term development leases not now available to private companies.

The Oil and Gas Development Corporation, created in 1961, promotes exploration and development of these two fuels. The Economic Reforms Orders of 1972 created a nationalization policy for the country's key sectors, thereby discouraging new exploration investment by private oil companies. More recently, however, private initiatives are again being encouraged in the energy sector. The Arab oil embargo of 1973 and the resulting rise in oil prices instigated a 1976 bill to permit joint ventures and production sharing arrangements with foreign companies. The present government, which came to power in 1977, encourages private sector activity and is now discussing ways of returning energy production and distribution to the private sector. It is also considering allowing small private power generation facilities.

This renewed private sector activity notwithstanding, energy production remains primarily the function of the government. Energy planning, in turn, is thus the responsibility of the government. Federal energy policy is made by a number of Ministries (described in the

Background Section II.C.), and each has some measure of energy planning capability. This project proposes to integrate the planning capability of the individual Ministries by supporting the development of an Energy Analysis Group within the Planning and Development Division of the Ministry of Planning and Development, to undertake integrated energy analysis. The GOP has demonstrated its commitment to such integrated planning by contracting with International Energy Development Consultants (IEDC), a Geneva-based energy consulting firm, to do the integrated analysis necessary to draft the energy section of the Sixth Five-Year Plan. IEDC's representative in Islamabad works within the Planning and Development Division and has had the cooperation of all GOP Ministries, both those which supply energy and those which consume it. IEDC collected and analyzed data supplied by the Ministries and integrated that analysis to prepare a coherent long-term energy plan for Pakistan. The Energy Analysis Group proposed for Component 1 will build capability within the Planning and Development Division to undertake these functions with its own staff rather than relying on foreign consultants. The IEDC project provides the Planning and Development Division with a successful model to follow in developing its energy analysis activities.

The precise location of the Energy Analysis Group has not yet been decided upon by the GOP, but the possiblity of a sister organization to the Energy Section of the Planning and Development Division would be a logical choice. Like the Energy Section, it could be completely within the Division or it could be positioned outside but responsible to, the Division, much like the relationship which the national laboratories in the United States have with their sponsoring agencies. Working within the Division would provide close proximity with GOP officials developing energy investment plans and reviewing all GOP energy projects. Some detachment would allow more attractive compensation for the staff to facilitate recruitment of high quality professionals. Either approach is administratively feasible and would be acceptable to A.I.D.

To undertake successful integrated energy analysis will require the Planning and Development Division to recruit additional skilled analysts and planners, either from within the Division or by detail from other agencies. A.I.D. considers a minimum staff of 3 professionals to be necessary along with the ability to contract outside consultants for special tasks. This project will provide the latter for the first five years of the Energy Analysis Group's existence. The GOP has within its various Ministries the skills necessary to undertake energy analysis. With a decision to organize these skills into a coherent energy analysis unit, and with

the technical assistance proposed under this project, the GOP can begin to build a capability sufficient for its energy planning needs. Training activities under this project will be augmented by A.I.D./Washington's Conventional Energy Training Project and the Mission's Development Support Training Project. These resources, coupled with A.I.D.'s demonstrated commitment to training in the energy area, will ensure the administrative feasibility of the manpower development and training aspects of this project.

2. Coal Resource Assessment and Development

An analysis of the professional staff needed by the GSP for various activities of the Coal Resource Assessment sub-component indicates well over a dozen geologists plus chemists, geophysicists, data handling specialists, publications personnel and others are required. Supporting technical and non-technical personnel will also be required for each activity. Appropriate staff assignments by other GOP agencies will also be needed from time to time. This staff will be built up, trained, and given on-the-job experience throughout the life of the project and will have the capability to continue the work at the end of the project. The GSP already has a core of professionals who have participated in other assessment projects and has the capacity to expand for this project.

WAPDA is in the process of creating a Coal Projects Department to handle development, construction and operation of coal-fired electric power stations and the coal mining to fuel them. The organization when fully staffed will be managed by a Chief Engineer reporting to the General Manager (Generation). Coal-fired power station work will be supervised technically by a Director of the Coal Department, and mining work will be under the technical supervision of the Director of Mining and Geology, on assignment from PMDC. Both these Directors will have staffs of technical personnel. Each coal project will be handled by a Project Director, for example the Lakhra and Duki projects. The Project Directors will be assigned assistants for project management and receive technical expertise from the individual Directors.

WAPDA and PMDC have technically trained personnel to staff the new Department and to manage the project. A large amount of training associated with coal projects will be provided under this A.I.D. project, and a large amount of on-the-job training will be provided during the field exploration and survey work. The consulting engineering services contractor will also assist in organization of the Department.

The Coal Projects Department has already been authorized and partially staffed. Training in coal-fired plants will begin in July 1983 in the TVA conventional energy training program. WAPDA has a large staff and has been involved in a number of major projects. The organization is administratively capable of handling the project.

Coal briquetting activities will be conducted jointly by PCSIR and PMDC, with PCSIR handling the pilot plant operations. Private miners will be requested to participate from the beginning in market testing including definition of target markets and determination of which type of briquettes are most acceptable. A coordinating group of private miners, PCSIR and PMDC will be formed to assure dissemination of test results, and the private miners will be encouraged to do the actual marketing. PCSIR is the GOP organization experienced in technical demonstrations and, with the assistance of expatriate consultants, should have no difficulties with the pilot plant.

3. Conservation and Renewable Energy Technologies

Both energy conservation and renewable energy technologies are the responsibility of the DGER which has Departments of Energy Conservation, Biogas Development, Solar Development, Renewable Energy for Village Electrification, and Energy Resources Assessment and Survey, among others. Some energy audits have already been made, and at least one private consulting firm has performed energy audits. The DGER will work with the Ministries of Production (for public sector plants) and Industries (private sector plants) to determine the highest priority targets and make arrangements for the auditing. Although DGER personnel will be trained in audits and in managing them, it is expected that most actual audits will be performed by private consultants who will work with and receive training from the U.S. consulting firm. Demonstration projects can be handled in the same manner. These administrative arrangements appear adequate for now to initiate the program, and as experience is gained, the procedures for implementing this sub-component and the National Industrial Energy Conservation Program will be established.

DGER also has experience in installing biogas generators, solar voltaic cells for village power, and micro hydro stations. This project will work within the current administrative arrangements to develop programs for much more extensive use of successful technologies. DGER, in its current projects, acts as a funding and project selection agency, and private contractors do the actual installations.

This appears currently to be the correct approach administratively. Since several other agencies are involved in renewable energy programs in one way or another, a National Renewable Energy Activities Coordinating Committee, chaired by the Director General of Energy Resources will be formed to include representatives of AIDO, PCSIR, WAPDA, universities and others. The purpose of the Committee will be to assure the dissemination of information to concerned organizations and to avoid duplication. Interested persons from private companies, user organizations and equipment manufacturers may be invited to attend meetings. This administrative organization is considered appropriate and feasible for implementing the project.

4. Overall Coordination

Responsibility for overall GOP coordination of this project will rest with the Planning and Development Division of the Ministry of Planning and Development. The GOP will appoint an overall Project Manager, who may be the same person as the Component Manager for Component 1. In addition, an advisory Participating Agency Coordinating Committee will be established. It will be chaired by the GOP's overall Project Manager and will consist of senior level representatives of the primary Ministries involved: Planning and Development; Petroleum and Natural Resources; Water and Power; and, Science and Technology. Representatives from Ministries of energy user agencies such as Production and Industries as well as representatives from private energy users may also be invited to be members of the Committee. In addition, an A.I.D. Project Coordinator will work closely with the GOP Project Director in the Planning and Development Division to ensure that all project activities are implemented in a coordinated and timely manner.

In summary, effective and appropriate administrative mechanisms have been or will be established to meet the unique implementation requirements of this project. In addition, the organizations involved in the implementation of this project have the required manpower, experience, and already established administrative systems to effectively implement the project. This competence will be enhanced under the project through the provision of training and technical assistance. The project is therefore considered administratively feasible and sound.

C. Economic Analysis

This project has three components, two of which, Coal Resource Assessment and Development and Conservation and Renewable Energy Technologies, will have direct economic benefits. All three, however, as can be seen below, have the potential for very large economic benefits.

The energy crisis in Pakistan has two serious dimensions. The first is the effect of supply shortages on agricultural and industrial production. For example, 20 percent of all electricity is used to operate tubewells, which are essential for maintaining agricultural output at current levels and increasing the production of food and fiber for consumption and export. The population is growing at 3 percent per year and food consumption by more than that. Exports of rice, cotton and cotton products account for more than two-thirds of total exports. Industrial production is almost totally dependent on gas and electricity. Exports and essential local consumption could drop precipitously without these inputs. Agriculture would suffer if the production of nitrogenous fertilizer and agricultural implements were to decline.

The second dimension of the energy crisis is foreign exchange. The indirect effect on exports has already been mentioned. The more direct effect is the substitution of imported fuel for local energy: petroleum for natural gas in the generation of electricity and steam and petroleum to substitute directly for electricity for tubewells and other motor driven machines. Diesel fuel imports have been growing to operate generators and engines as well as for mobile uses. Inadequate electrical supplies as well as limited domestic petroleum production make

these imports necessary. Kerosene is imported for lighting and cooking, in part because of gas and electric shortages. A more serious problem, however, is furnace oil (residual oil), which Pakistan has been exporting. Inadequate gas supplies have increased its use domestically for generating electricity, and very soon, large supplies will be imported for the same purpose. Turbines and steam boilers that burn residual oil to generate electricity can be put into operation more quickly than coal fired equipment. Because of the lower capital cost and faster installation, Pakistan may rush into this technology and end up paying huge bills for imported fuel for the next forty years. There is uncertainty over the amount of oil that would be imported because Pakistan has been exporting this oil at relatively low prices, and decisions may be made because of the belief that it is almost a free good.

Foreign exchange is a large component of the investment needed in energy as well as in current imports. For example, in the portfolio of projects presented at the Paris Consortium in 1983, the foreign exchange component of the total cost of energy projects was 47 percent. For non-energy projects, the percentage was 39 percent. The average foreign exchange cost for energy projects works out to nearly $1 billion per year during the Sixth Five-Year Plan period. The POL imports this year are projected at about $1.7 billion out of total imports of about $6.0 billion. When one considers that merchandise exports are about $2.6 billion and the current account deficit is about $1.4 billion, it is clear how important energy and decisions about energy are.

Pakistan's balance of payments is in deficit and although the outlook for the next year or so is encouraging, the deficit could grow in the next few years. An increase in the balance of payments deficit would necessitate a cutback in essential imports and inevitably obstruct development progress if not halt it. Although Pakistan faces other barriers to continued economic growth, its prospects still are promising relative to many other countries. A long-term balance of payments deficit, however, would overshadow its other problems. Even now, balance of payments support is a key element of the

A.I.D. assistance program. This support would have limited lasting value without sound decisions in the energy field. This project as well as the rural electrification and forestry planning projects are designed to, among other things, strengthen decision-making in the energy sector.

1. Energy Analysis and Manpower Development

It is not possible to quantify the economic return which may be achieved by the Energy Planning and Manpower Development activities under this project. Qualitatively, however, it is clear that the returns should be large. In Pakistan, energy planning and policy-making are largely governmental functions. Oil and gas production is the responsibility of the governmental Oil and Gas Development Corporation. Power generation is the responsibility of the Water and Power Development Authority and of the Karachi Electric Supply Corporation, both governmentally-controlled organizations. Improving the basis for governmental energy policy-making will, therefore, have a large impact on Pakistan's energy situation.

Estimates of investments needed during the Sixth Five-Year Plan period exceed $13 billion for the energy sector. Energy expenditures are expected to account for 25 percent of the total costs of the Plan. Ill - conceived decisions on investments of this magnitude would exact heavy costs. By providing a sounder basis on which to make energy investment decisions, the relatively modest funds provided for this component will have a very considerable impact.

Besides a direct impact on more efficient energy investments by government, A.I.D. planning assistance is expected to help Pakistan reap large private sector benefits. Private industry in Pakistan is hampered by disruptive blackouts caused by electrical load shedding due to insufficient generating capacity. Shortages of gas are also beginning to impede industrial development and may soon slow agricultural growth. To the extent that planning activities financed under this project induce more efficient distribution and use of electricity and gas, the private industry and the economy as a whole will reap benefits much greater than the funds expended.

Foreign exchange spent on POL this year are projected to amount to approximately $1.7 billion. If energy analysis and manpower development activities reduce this by only one percent, the resulting return on A.I.D. funds would be 300 percent per year. These savings would free up monies for other needed investments. Special studies undertaken under this component will address specific policy and investment decisions and will thus have immediate financial implications.

In summary, while economic returns from investments in energy planning cannot easily be quantified, they clearly justify the level of expenditure proposed for this component.

2. Coal Resource Assessment and Development

a. Coal Resource Assessment

Economic returns and activities to better understand the extent of Pakistan's coal resources are difficult to quantify, but qualitatively they can be seen to be considerable. Reserves of between 1 billion and 2 billion tons of coal, if half are recovered, will be worth on the order of $20 billion - $40 billion (in 1982 dollars) in 1987 when the first power plant is expected to begin operation. Given the scarcity of data on Pakistan's coal resources and the large potential value of that coal, relatively small expenditures to assess coal resources are economically justifiable. Benefits which this assessment will have for the rest of the Energy Planning and Development project and for Pakistan include the following:

i. Improved energy policies and timely investment decisions can be expected as a result of the improved information that will be available on energy resources and the increase in trained and knowledgeable personnel in GSP and other agencies involved in these activities.

ii. The GOP's capability for energy analysis and planning will be strengthened through the training of personnel in the investigation and assessment of resources, through increased information about energy resources, through strengthening the Geodata Center and data handling systems, and through the coordinating mechanisms discussed above.

iii. Greater private sector participation will be promoted through periodic meetings of GSP and USGS staff with the Pakistan Mine Owners Association as mentioned earlier in this paper, through the preparation and publication of maps and reports showing areas favorable for leasing and development, and through consultative geological and engineering assistance to the mine operators on practical mine development problems.

iv. A better understanding of the potential uses of coal will be obtained through more complete and accurate information on the chemical and petrographic constituents, heating value, and by-product possibilities of the coal and associated raw materials, as well as better quantitative estimates of the available quantities of coal in various categories of quality and rank.

b. Coal Development

i. Coal Power Generation

The Lakhra Coal Study and subsequent analyses carried out during project design indicate that generating electric power with Lakhra coal is economically feasible. Previous studies estimated the costs of producing coal and installing a power plant at Lakhra to be higher than the Lakhra Coal Study estimates. The Lakhra Study lowered coal production and power generation costs by incorporating less capital-intensive mining techniques and by eliminating the flue gas desulfurization on the 300 MW unit, which was found to be unnecessary to meet World Bank environmental standards.

The discussion that follows compares Lakhra coal with the two most attractive power generation alternatives: imported furnace oil (also referred to as residual oil, Bunker "C" and No. 6 oil) and imported coal. It assumes that a power plant burning either imported oil or imported coal would be located at Karachi, using existing facilities at Port Qasim.

(1) Comparison of Lakhra Coal with Imported Oil

While some of costs associated with power generation alternatives are quantifiable, others are not. Nevertheless, all costs and benefits should be included in the evaluation. Two benefits associated with the comparison of Lakhra coal and imported oil that are not quantified are job creation and technology transfer associated with the initiation of a modern, large-scale coal industry in Pakistan.

The Lakhra coal production, preparation, and transportation facilities supplying 1.4 million tons of coal per year for a 300 MW power plant would employ approximately 1,200 people. The installation of this first 300 MW of coal production capacity at Lakhra would thus provide for the daily needs of approximately 1,200 Pakistani families for over 30 years. With an imported oil plant, this benefit would not exist.

The mine at Lakhra required to supply the first 300 MW power plant would be about 7 times larger than the largest mine currently operating in Pakistan. The development of the coal production facilities at Lakhra would, for the first time,

introduce large-scale coal technology into Pakistan. Mining coal on this scale requires a certain amount of mechanization even with the labor-intensive designs recommended for the Lakhra facility. Thus, a wide range of coal-based technology would be transferred to Pakistan. The expertise to explore, sample, analyze, transport, and prepare for utilization would be developed, preparing the way for widespread use of coal in other energy-intensive industries such as cement and steel.

The quantifiable costs incurred by power plants burning Lakhra coal and imported oil are outlined in Table 7. Columns (1) and (2) of Table 7 summarize the annual and unit (per kilowatt-hour) generation costs for the Lakhra and imported oil alternatives. Import duty, escalation, and interest during construction are excluded from the calculation. All costs are presented in millions of January 1983 dollars. The generation cost is broken down into three component costs: the annual fixed charges on the capital investment (i.e., interest and depreciation costs), the annual fuel cost, and the annual operation and maintenance (O&M) cost. The total cost for each alternative is found by adding the three component costs. The unit generation cost is then calculated by dividing the total annual cost by the total annual power output in KWH.

As shown in Table 7, the capital cost of a power plant burning Lakhra coal is approximately 30 percent higher than one designed to burn imported furnace oil. The higher costs are due primarily to the coal handling and preparation equipment, the larger steam generator required, and the ash handling and disposal equipment. The fuel cost of a power plant burning Lakhra coal, however, is about half that of one burning imported furnace oil. The savings are due primarily to the lower fuel costs of the coal. Lakhra's higher annual operation and maintenance (O&M) cost is due to higher labor and materials replacement requirements associated with coal. When all costs are added up, the Lakhra plant is over $30 million cheaper per year than imported oil. A power plant burning imported furnace oil would thus have to charge 30 percent more for the electricity generated than one burning Lakhra coal.

One can also compute the return on the additional capital investment incurred by the Lakhra coal alternative relative to the imported oil alternative. This additional capital investment is recovered in about 2½ years by a reduction in net operating (fuel and O&M) costs relative to the imported oil alternative. Investing in the Lakhra alternative would yield an incremental internal rate of return of 51 percent (including escalation and interest during construction in the calculation).

TABLE 7

Economic Comparison of Lakhra Coal, Imported Oil and Imported Coal a/

Costs	Lakhra Coal	Imported Oil (In $ Million)	Imported Coal
1. Annual Fixed Capital Charges b/			
a. Domestic	14.5	10.5	13.1
b. Foreign	20.0	14.4	18.0
Total	34.5	24.9	31.1
2. Annual Fuel Cost			
a. Domestic	20.7	0.0	0.0
b. Foreign	20.7	84.6 d/	42.8
Total	41.4	84.6	42.8
3. Annual Operation and Maintenance Cost			
a. Domestic	4.5	3.0	4.5
b. Foreign	4.2	2.8	4.2
Total	8.7	5.8	8.7
4. Total Annual Generation Cost			
a. Domestic	39.7	13.5	17.6
b. Foreign	44.9	101.8	65.0
Total	84.6	115.3	82.6
5. Unit Generation Cost	4.6 ¢/kwH	6.3 ¢/kwH	4.5 ¢/kwH

a/ All costs are expressed in millions of January 1983 dollars. Import duty, interest during construction, and escalation are not included.

b/ Interest and sinking fund depreciation costs for a capital recovery period of 30 years. Interest rates used are 11.75 percent for domestic debt, and 8.75 percent for foreign debt.

c/ Based on the output from a 300 MW power plant operated at full load for 70 percent of the year (i.e. 6,132 hours per year).

d/ Based on imported oil, priced at $25 per barrel plus freight.

Source: Stone & Webster Engineering Corporation

An additional cost associated with the Lakhra coal and imported oil comparison is the "shadow cost" of foreign exchange. As indicated in Table 7, the additional foreign exchange required by the imported oil alternative would be $56.9 million if the two alternative power plants were operating in 1983. This represents approximately 4.5 percent of Pakistan's current foreign exchange reserves. A power plant fired by imported oil would thus be a significant drain on the country's foreign exchange.

(2) Comparison of Lakhra Coal with Imported Coal

The qualitative discussion offered in the comparison of Lakhra coal and imported oil concerning employment and technology transfer associated with the development of a modern coal industry in Pakistan holds true for this comparison as well. The quantifiable costs used to compare the Lakhra coal and imported coal alternatives are listed in columns (1) and (3) of Table 7. The capital cost of a power plant designed to burn Lakhra coal is approximately 10 percent higher than one designed to burn higher quality imported coal. Compared to imported coal, Lakhra coal has higher ash, moisture, and sulfur and a lower heating value; therefore, more Lakhra coal must be burned per KW of electricity produced. This increases the size of the boiler and related auxiliaries which increases power plant capital costs. The delivered price of imported coal to a power plant near Karachi is approximately 15 percent higher than the delivered price of Lakhra coal. This price differential is partially offset because a power plant burning Lakhra coal will be slightly less efficient than one burning higher quality imported coal. Differences in O&M costs for the two plants are considered to be negligible.

Adding component costs indicates that the higher Lakhra Plant capital cost is nearly offset by the higher imported coal fuel cost. The difference in unit generation costs of one-tenth of a cent per KWH is insignificant, given the accuracy of the cost estimates used here. Thus, the total annual generation costs for the Lakhra coal and imported coal alternatives are essentially equal. The additional foreign exchange required by the imported coal, however, would be $20.1 million annually. While this foreign exchange drain is less than the one for the imported oil alternative, it is still significant and should be considered in the overall evaluation of alternatives over the scheduled 30 year lifetime of the plant.

(3) Nuclear Power Generation

An economic evaluation of this alternative was not performed. It may be worth noting, however, that operating costs associated with nuclear power are generally one-half to one-sixth those for thermal power plants. But nuclear power

is more capital intensive, requiring about 1.5 to 2.5 times as much capital as a thermal power unit of the same site. According to the World Bank (Energy in Developing Countries, August 1980), the total cost of generating electricity with a single relatively small (300-500 MW) nuclear power plant would be about 40 percent higher than the cost of generating power with Lakhra coal. Considerably more foreign exchange is required for nuclear power than for thermal power. Whereas approximately 60 percent of a thermal plant's capital cost is foreign exchange, the comparable figure for nuclear power is in the vicinity of 80 percent.

Nuclear power can be competitive in developed countries with large generating systems, if economy-of-scale is taken advantage of by installing multiple units in the 800 to 1,000 MW range. However, installing large units rather than smaller ones in a relatively small system like Pakistan's requires significantly more reserve capacity to maintain a constant system reliability. This tends to offset the economy-of-scale advantage. One approach to nuclear power may be to wait until the power system is large enough to absorb these large units.

In summary, the Lakhra coal alternative is Pakistan's least-cost power generation alternative and will continue to be even with substantially lower oil prices. The imported oil alternative incurred a total generation cost 36 percent higher than the Lakhra coal total generation cost which corresponds to an incremental internal rate of return of 51 percent for the Lakhra plant. An additional $56.9 million of foreign exchange would be consumed annually (in 1983 dollars) by a power plant burning imported oil. While the total generation costs for the Lakhra coal and imported coal alternatives were found to be essentially equal, the power plant burning imported coal consumes an additional $20.1 million in foreign exchange annually. The Lakhra coal facility would employ an additional 1,200 people over any imported fuel alternative and initiate the development of a modern, large-scale industry in Pakistan. The WAPDA grid system is probably too small at present to support large nuclear units economically. A prudent approach would be to delay consideration of nuclear power until WAPDA's system is sufficiently large.

ii. Coal Briquettes

Coal briquettes as a fuel for Pakistan's residential and commercial sectors offer a number of benefits. Project design consultants suggest that 10 million people are a likely early market for briquettes, substituting for firewood now purchased in the market. Once briquettes come into use, the market may grow even larger. Based on existing levels of consumption of firewood by the population, briquettes would displace roughly 12 percent of

the firewood used. This would produce a significant reduction in firewood burned and hence a significant reduction in the wood harvested from Pakistan's dwindling wooded areas. The UN Food and Agriculture Organization, World Bank and the Pakistan Forest Institute each estimate annual fuelwood use to be about 16 million cubic meters. Project design consultants estimate the annual growth of wood to be about 11 to 13 million cubic meters or roughly 75 percent of the total used. If coal briquetting fulfilled its potential, it would eliminate one half of this shortfall. A.I.D.'s support for a market assessment and a pilot briquette plant will therefore lead to considerable economic benefits.

A second major benefit of briquettes, the reduction of indoor smoke, is not possible to quantify. The economic benefit of improved health due to reduced air pollution has been the subject of much research in the U.S. and elsewhere, but to date, concrete results are not available. There can be little doubt, however, that a cleaner indoor environment is of significant value to householders. Very high levels of particulates and carcinogens, levels high enough to impair health, have been measured in studies in Kenya and India. Use of briquettes will reduce these concentrations.

Project design consultants analyzed the economics of a pilot coal briquetting plant. Briquettes produced compete favorably with firewood and other fuel sources. In locating the plant, the prime economic considerations are: price, availability of coal, and a good market. Based on many discussions, two sites seem most attractive; one is the Lakhra coal field, and the other is the Punjab coal field. The advantages of Lakhra are the low coal price and a local market around Hyderabad, while selection of the site in the Punjab coal field may result in lower transportation costs to a major segment of its rural population. However, the Punjab coal is higher priced. Likewise the price of firewood in the Punjab is greater than that at Lakhra. Thus, there is not a clear advantage at one site over the other on the basis of economics. However, because of the current interest in Lakhra as the site of a coal-fired power plant complex and the resulting technical infrastructure that will be developed there, Lakhra was selected as the site of the briquetting plant to be analyzed.

In the design and selection of the plant size, the economy of scale can be significant. Initially, a 25 TPD plant would introduce and develop the technology and the market. In this size plant, briquettes can be produced at Rs 35 to Rs 41 per million Btu which, if compared with the fuel prices given in Table 2, shows that briquettes are quite economical. The average firewood price is about Rs 48 per million Btu. Thus, briquettes, with the exception of a few cases, where firewood is available at a very low price, should be a competitive fuel. The briquette price is well below the price of kerosene.

After the 25 TPD plant has clearly shown that the briquetting technology is appropriate, the same pilot plant can be used to test coals from other locations. Plants of this size or larger can then be built in other areas. The entire briquetting industry can be established by private investment, primarily by private coal mine owners. Only the first briquetting plant that will be used for introducing the technology and development of a briquette market needs to be subsidized to demonstrate to the private sector its profitability.

3. Conservation and Renewable Energy Technologies

a. Conservation

Pakistan is currently paying a high economic cost due to the shortages of gas and electricity to industry. Scheduled and unscheduled outages are hampering production, wasting and damaging materials, equipment, and energy, and constraining expansion of plant and production. Unreliability of supply, therefore, erodes profits and renders prohibitive new investments in energy efficiency.

Pakistan industries are aware that gas prices will have to be increased in the future. Prices were increased by 20 percent in early 1982. They will double or triple by 1988. In the absence of measures to conserve energy, these price increases will further erode industries' profits and the incentives to expand investment and output. Given typical costs for industrial fuels in the U.S. ($2.50 to $5.00 per million Btu), low and moderate energy conservation measures have favorable rates of return of over 30 percent. Based on present prices of natural gas in Pakistan (about $0.65 per million Btu), very few energy savings measures would have the rates of return experienced in the U.S. Table 8, however, estimates the energy saving potential and approximate rate of return in Pakistan if gas prices were increased to U.S. levels.

Even at current low gas prices, low cost measures have proven economic in specific plants. Knowledge of available and effective energy conservation alternatives, however, is not widespread. This project, with a minor investment in training, technical assistance, and selected demonstrations could result in significant savings. The project design consultant estimated that a $3 million program could be a major factor in reducing overall industrial energy use by 10-15 percent within 3 years, particularly given the GOP's increasing commitment to this subject. A 10 percent reduction in industrial energy use would correspond to about 25 x 10^6 MCF of natural gas having an oil displacement value of $110 million, assuming an oil price of $25 per barrel. This saving in the industrial sector is comparable to the total present domestic oil production. If these positive economics can be demonstrated to industry and financial institutions, the government's role in financing these measures can be kept to a minimum. This is one of the objectives of

this project component.

Table 8

Potential Energy Savings in Pakistan Industry a/

Relative Cost of Conservation Activity	%Reduction in Energy Requirement	Rate of Return	Potential Energy Savings (Btu/Year)
Low	15	100	40×10^{12}
Moderate	10	30-100	27×10^{12}
High	up to 15	30	40×10^{12}
Total Potential Energy Savings	40	Less than 30	107×10^{12}

a/ Based on U.S. experience and Pakistan consumption of 267 trillion Btu/year.

b. Renewable Energy Technologies

There are large variations in the economic feasibility of renewable energy systems. Solar heating has been found economically attractive in several sunbelt countries. Photovoltaic power, on the other hand, is still very expensive and is now economically attractive for providing small amounts of power in remote, high value applications, such as telecommunications or safety equipment. Widespread use of photovoltaics in Pakistan (and elsewhere) will depend on large reductions in costs which are projected by the industry to occur in the late 1980's and early 1990's. Small hydro economics are very site sensitive and strongly dependent on the willingness and capability of local inhabitants to donate their labor for system installation and operation. The incremental cost of high efficiency wood stoves appropriate for use in Pakistan is not well defined at this time. However, for consumers who pay for wood, often at costs approaching that of kerosene, efficient wood stoves should be economically attractive based on the limited experience in other countries.

This project was designed in recognition of the differences in the present and projected economics of the different renewable energy source options and the economic uncertainties often

associated with specific technology and application opportunities. Consequently, the renewable energy sub-component emphasizes undertaking detailed economic analysis of options prior to providing technical assistance and hardware for specific demonstration projects. The following is a general discussion of renewable energy system economics based on both design team analysis and experience in other countries.

i. Solar Heating

Solar heating (primarily hot water) systems have been found economically attractive in a number of countries such as Israel, Cyprus, Australia, Japan and the United States. Table 9 indicates the approximate rates of return for solar water systems over a cost range which would probably be achievable in Pakistan (assumed to be $10-$25 per square foot of collector). The lower end of the cost range might be achieved with simple thermosyphon units commonly used in sunbelt countries for residential hot water heating while the higher end would be associated with larger pumped systems for low temperature industrial heat or for institutional buildings.

Table 9

SOLAR HEATING ECONOMICS - PAKISTAN

Annual Energy Collected a/	=	240,000 Btu per ft² of collector
Assumed life of Collector	=	20 years
Fuel Displaced (oil equiv) b/	=	2.4 gallons per ft² of collector
Value of Displaced Fuel	=	Kerosene at $1.20/gal = $2.88 per ft² per year
		Kerosene at $0.25/gal. or equiv. c/ = $0.60 per ft² per year

CASE A:	System Cost	=	$10/ft²
	Rate of Return	=	41 percent at $1.20/gallon
	Rate of Return	=	1 percent at $0.25/gallon
CASE B:	System Cost	=	$25/ft²
	Rate of Return	=	12 percent at $1.20/gallon
	Rate of Return	=	negative at $0.25/gallon (uneconomical investment)

a/ Solar availability is approximately 600,000 Btu/ft² per year and system efficiency is assumed to be 0.40

b/ Assumed oil (or gas) used at 70 percent efficiency.

c/ Approximate price of natural gas having a cost of Rs 25 per 1,000 ft³.

These costs assume local manufacture based on straightforward flat plate collector technology. As indicated, returns of from 12 percent to 41 percent could be achieved assuming the cost of displaced fuel is equivalent to $1.20/gallon oil. The return when displacing low priced natural gas is 1 percent or less which indicates the importance of commercial fuel pricing in determining the economics of alternative energy systems. These rates of return (relative to oil or higher priced gas) are attractive. With increasing gas prices and decreasing gas availability for new users, solar heating systems should become an attractive option for a wide range of domestic, commercial, and industrial applications.

ii. Photovoltaics

Photovoltaics are currently very high cost energy systems with panels costing about $10,000 per peak kilowatt and the rest of the system (battery storage, controls, and the like) costing from $20,000 to $30,000 per kilowatt. The cost of electric energy from systems in this cost range is well in excess of $1 per kwh which is several times that from diesel generators for most fuel cost assumptions of practical interest.

The great interest in photovoltaic power is due to the projections of industry and government R&D sponsors that the costs can be greatly reduced from present levels so that they often become lower in cost than alternative approaches (grid extensions or diesel generators) in rural areas. If the cost of panels can be reduced to the $2-$4 per peak watt range, the economics of photovoltaic power will become attractive in rural, non-grid connected areas for such critical functions as water pumping, cold storage, and minimal village power.

Table 10 compares the cost of energy from a small generator and a photovoltaic power system where the cost of panels approaches $2.50 per peak watt. As shown in the Table, the cost of power from the photovoltaic power unit would be significantly lower than that from the engine generator system under most conditions. This is why many large firms in the U.S., Japan, and Europe are directing substantial resources to develop photovoltaic panels with costs lower than $2-$3 per peak watt.

Given the rapidly changing technology of photovoltaics, the objective of technical assistance activities at this time will be to develop a capability to assess the technical and economic performance of specific applications of interest and to develop a base of practical field experience with carefully selected demonstrations so that both the private sector and the government are positioned to expand the areas of practical applications as system costs decrease.

TABLE 10

ECONOMIC ANALYSIS OF PHOTOVOLTAIC POWER SYSTEMS FOR REMOTE APPLICATIONS
(1990 INSTALLATION)

Energy Source	Fuel Escalation %/yr.	Levelized Cost of Energy $/KWH c/ r = .04	r = .10	r = .16
Gasoline Engine/Generator a/ (For 1kw capacity)				
Inicial installed cost: $825 Annual O&M cost: $311 Annual fuel usage: 300 gal	0	.97	1.00	1.04
Fuel cost: $1.20/gal Construction period: 0 yrs Useful life: 3 yrs.	5	1.20	1.22	1.26
Annual net energy output: 1000 kwh	10	1.54	1.58	1.61
Photovoltaic Power System for Remote Applications b/				
Initial installed cost: $5,185 Equipment: PV modules, 65 wt pk: $1,625 Batteries, $300/kwh: $2,160 Controls and wiring: $ 200 Shipping: $1,000 Installation: $ 200 Annual O&M cost: $100 Construction period: 0 yrs Useful life: 15 yrs Annual net energy output: 807 kwh	--	.70	.96	1.27

a/ Source: Informal quotes from Honda, Ohan, and Kohler Technical Representatives and NASA estimates (NASA CR - 165286).
b/ Source: NASA estimates.
c/ r = discount rate

iii. Small Scale Hydro

Small scale hydro systems cover a range of options from micro systems of 5 KW capacity to serve lighting and communications needs in small settlements of the NWFP to 50 MW systems which might be installed on large streams or on the irrigation barrages. The economics of these options vary greatly, depending on such factors as the use of power generated and the cost of alternative approaches for supplying the power.

The project design team focused on micro hydro systems for use in the mountainous regions of the NWFP. The primary benefit resulting from the introduction of minimal power in these remote regions was assumed to be reduced use of kerosene in lighting. Table 11 indicates the rate of return estimates for such applications for a number of assumptions relative to system capacity and the level of local participation in system installation and operation. The economics are very favorable for those systems where local participation reduces the installed system cost even where the only economic benefits would be for lighting. System economics would improve further in those locations where the power would also have some productive uses, such as grinding grain or wood-working.

The economics of larger systems depend on such factors as how the power is used, the degree to which they replace the need for costly grid extensions, and the value of displaced conventional generating capacity. The installed cost of multi-megawatt (1-50) small-scale systems are typically in the $800-$2,000/KW range depending on site conditions and head. These capital cost requirements are lower than most of the grid connected conventional systems likely to be constructed in Pakistan in the future (for example, large scale hydro or coal-fired thermal) so that small-scale hydro would have both favorable capital cost structures and fuel savings which would make their use highly attractive in good locations. For example, favorable economics of small hydro units on the larger barrages (25 MW capacity) have been projected as the result of studies by a German technical team. There seems little doubt, therefore, that well-selected small-scale hydro systems can be economically implemented over a wide range of capacities serving diverse populations and power needs.

Table 11

ECONOMIC INTERNAL RATES OF RETURN FOR VARIOUS SMALL HYDRO SCHEMES

(in %)

APPROACH	SIZE OF SCHEME		
	5 KW	15 KW	200 KW
A. Participatory (civil works constructed by users)			
1. Residential Load	30	46	-
2. Residential + Industrial Load	35	57	-
B. Conventional (civil works constructed by contractor)			
1. Residential	12	29	4
2. Residential + Industrial Load	15	35	9

SOURCE: USAID/Pakistan and project design consultants.

iv. Wood Stoves

Very little work has been done in Pakistan in the field of high efficiency wood stoves. This, is itself, complicates the task of assessing their potential economics. In addition, there are a number of national benefits deriving from the introduction of high efficiency wood stoves which are difficult to factor quantitatively into economic analysis. These include decreased deforestation, improved health as a result of less smoke being present in the household (most high efficiency wood stoves vent smoke to the outside), and decreased time spent collecting firewood and crop wastes.

One approach for assessing in a preliminary way the economics of efficient wood stoves is to estimate the value of the wood saved for those users who actually purchase their wood on a commercial basis. If it is assumed that:

(1) the cost of firewood is Rs 20 per 40 kg (about in the middle of the price range for firewood);

(2) stove efficiency is doubled (a reasonable expectation based on studies done on this subject in several countrie

(3) present wood consumption for a family of five is 1500 kg per year,

then, the annual savings would be $29 per year, which would readily justify incremental costs of stoves considered suitable for Pakistan. For example, modified clay Chula's designed for use in Bangladesh are estimated to have an incremental cost of about $1-$2 (for a metal grate to improve air circulation patterns), and a stove designed by the University of Peshawar in Pakistan had an incremental cost estimated to be about $10-$20 for additional metal piping for venting and a variable damper for air control. The price of these stoves would thus be recovered in from two weeks to 8 months. The economic advantages of efficient wood stoves (at least for those who purchase firewood) are easily demonstrated. The project is designed, therefore, to determine what designs fo wood stoves are likely to be accepted by consumers, and to assist in field testing to accelerate commercial introduction.

v. Biogas Economics

The economics of biogas digester systems depend on costs, the value of displaced energy, and the costs of operation and maintenance. Several studies have shown that biogas digesters can be economically attractive in larger sizes to serve (for example feedlots) where no value is attached to the feedstock. The large number of individual units in China and India suggest that, under some conditions, even small systems can be economically and socially attractive. In Pakistan the cost of individual systems currently ranges from Rs 4,000 - Rs 10,000 ($308 to $769). These systems produce about 75 cubic feet per day of biogas. Table 12 indicates that the payback period for a $400 system would be on the order of 4 years (a rate of return of about 40 percent if the digester lasts 10 years), assuming the biogas displaces a commercial fuel such as kerosene or bottled gas. This level of economic performance could be quite attractive for homeowners with enough cattle to provide dung to the unit. If the system costs $760, it would not be an economical investment. The economics of larger systems which could serve several families or operate engine generators are usually better than those of smaller, individual units. This is due to the economics of fabricating the digester systems. It appears, therefore, that biogas digesters could be economically viable in some markets in Pakistan if operational reliability can be established.

Table 12

BIOGAS DIGESTER ECONOMICS

System Cost:	$300 - $800
Annual Output: a/	27,370 ft^3
Kerosene Displaced: b/	98 gallons
Value of Displaced Kerosene c/	$118
Rate of return (10 year life)	40 percent for a $300 system 4 percent for a $800 system

a/ Average daily output of 75 ft^3.

b/ Average heating value of biogas of 500 Btu/ft^3

c/ At $1.20 per gallon

The above discussions indicate that renewable energy resources show good potential for economic applications in Pakistan. In addition, all of these technologies are consistent with manufacture in Pakistan and operation by local personnel. Therefore, these technologies have a number of added benefits relative to employment opportunities and foreign exchange savings not explicitly accounted for in the economic discussions. As indicated previously, the economics of renewable energy technologies tends to be very site and application-specific so that care must be taken to ensure that program resources are directed toward those applications showing particularly favorable economics and having efficiently large market potentials to have measurable regional or national impacts.

D. Social Soundness Analysis

1. Socio-Cultural Feasibility

All three components of this project have been designed with Pakistan's value systems and social structures in mind and, hence, project activities are considered feasible from a social and cultural point of view. The Energy analysis and Manpower Development component was designed to mesh with the larger economic and technical planning context in Pakistan. As described earlier, both Provincial and Federal Government personnel are familiar with annual, medium term and five-year planning cycles. It is expected, therefore, that the proposed planning and manpower development activities under this project will not encounter any particular social or cultural difficulties.

The socio-cultural feasibility of the Coal component must be considered both with respect to the feasibility and impact of the electricity supplied and with respect to the feasibility and impact of the mining and burning of coal. The social and cultural aspects of supplying electricity are, of course, significant as electricity will make possible, for at least some of the population, perhaps the first modern technologies (lighting, radio, television) to be used in their homes. While this impact will be significant, it has been treated many times before in the general literature and in other analyses for energy projects in Pakistan. (See, for example, the Social Soundness Analysis for the Rural Electrification Project, 391-0472). This topic was also the subject of a 1978 A.I.D.-financed survey of the impact of previous electrification efforts in twenty-five villages located in five regions of the Punjab, Sind and the NWFP. The survey found that electricity is compatible with existing village social patterns and is a familiar and desired service in rural areas.

Mining and using coal are also expected to be socially and culturally acceptable in Pakistan. Mining activities under this project are designed to greatly improve safety and other working conditions in Pakistan's existing mines. Development of major coal mining facilities at Lakhra, which could be triggered by this project, will require new communities to be developed at Lakhra for the miners and perhaps their families. As was noted in the Project Description, a major assessment of the barriers to the development of an indigenous mining industry will be supported as part of this project. Social and cultural aspects of new mining communities will be included as issues in this assessment.

The cultural feasibility of coal briquetting and the residentially oriented renewable energy technology activities will be a major issue in the successful development of the technologies. As discussed in the Technical Analysis, the

technical aspects of the technologies are relatively well understood and pose no serious obstacles. New coal briquettes, efficient wood stoves and other innovations fit into the daily patterns of life and into the finances of the household or small commercial establishments, however, are not well understood and pose a formidable set of tasks during project implementation. For this reason, a residential and small commercial energy end use survey has been built into the project to precede any actual technology demonstrations.

As noted in the Project Description Section, the emphasis of the demonstration activities will be, not on the engineering feasibility of the technologies, but on the feasibility of marketing and other delivery mechanisms to achieve their wide-scale adoption. The demonstrations will be used to assess potential consumer acceptance of these new ways of cooking, heating and lighting and to devise measures which may be taken to encourage and satisfy consumer demand for these energy products. The end-use energy surveys will include the gathering of socio-economic baseline information on target groups surveyed. Information will be collected on the the role of women and children in gathering wood and in cooking, cooking patterns and types of other household energy needs, and energy use patterns in small commercial establishmen Because of the project's reliance on private sector mechanisms wherever possible to disseminate these technologies, small business activity will be analyzed in conjunction with market analyses to determine the potential for entrepreneurs to market briquettes, stoves and other innovative technologies. Local government structures will be examined to help ensure compatability of project activities with local conditions. Consideration will be given to selecting a small number of target villages or neighborhoods to serve as case studies for the demonstration projects.

2. Spread Effects: The Diffusion of Innovation

Components of the project in which it is important to achieve diffusion of innovative technologies are the demonstrations in coal mining, energy conservation, coal briquettes and renewable energy technologies. Diffusion of coal mining and energy conservation technologies will involve economic and political considerations rather than social or cultural ones. Accordingly, only briquetting and renewables will be addressed in this section.

As discussed in the Project Description Section, energy survey results will be used to identify likely sites to test consumer acceptance and market potential for briquettes and stoves. Given successful test market results, A.I.D. will assist the GOP in encouraging private entrepreneurs to manufacture and market the energy products. The expectation of profit will motivate initially a limited number of tradesmen whose example in turn will motivate others to enter the business.

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Consideration will be given during project implementation to targeting small urban and semi-urban commercial establishments as an appropriate group with which to begin test marketing activities. These small businessmen are careful about their fuel budgets, and they are probably less fettered by traditional customs than are their rural counterparts. Also, they are visited and observed by a large number of customers and passersby from both the city and the country.

The first activity to be undertaken on small hydro, solar and biogas technologies will be an in-depth assessment of present experience with each of these technologies in Pakistan and an analysis of private sector possibilities in their manufacture and marketing. Each of these technologies has been demonstrated to be technically feasible in Pakistan, but their potential for wide scale adoption is not clear. Since achieving wide scale use is beyond the capability of either A.I.D. or the GOP, the private sector will have to be mobilized if renewable technologies are to play a significant role in the country's national energy scheme. The private sector has been active in each technology, but a systematic GOP program has to be developed to encourage private activity on a larger scale. Development of such a program is a major objective of this project. A significant part of this program development activity will address the social and cultural acceptability of each technology by its potential users.

3. Social Consequences and Benefit Incidence

Stimulating more analysis of expensive energy options and assisting to develop necessary skill bases will save taxpayers money directly and will benefit them indirectly by making more energy available for development uses. Coal-related activities will benefit more those who currently use commercial energy. Approximately five-sixths of the population currently have no access to electricity, and these individuals will benefit from the increased coal energy stimulated by this project. The number of people who will be able to receive electrification, in part because of project activities cannot be quantified, nor could they be attributed to this specific project, but the use of coal will certainly ease Pakistan's serious shortage of fuel for electrical generation and will thereby allow the continued spread of rural electrification. Completion of just the Lakhra plant would increase the country's electrical generation capacity by almost one-tenth.

Those individuals in remote areas who have no access to electricity will receive special attention under the Renewable Energy component. Small hydro activities will focus on the NWFP, and solar and biomass activities will pay special attention to rural villagers nationwide. These activities will directly assess the needs of rural villagers and the appropriateness of specific technologies to satisfy end use

needs identified. It will assist the GOP in its programs to meet those needs. The needs of the rural poor and unemployed will be a special focus of the energy survey activity. With these survey results, further implementation activities will be designed to pay special attention to the needs of this group.

Women will receive special attention under the coal briquetting and wood stove activities. They do the major part of wood gathering and most of the household cooking and so use most of the wood. In order to obtain fuel for the household, they must expend their own energy. As fuelwood shortages increase, their situation will be aggravated since more energy is require to travel greater distances to collect fuel or generate cash income to purchase fuel. More efficient wood stoves or the substitution of cheaper, more efficient coal briquettes will reduce the time and energy women spend for obtaining fuel, thus freeing them for other productive activities. Women, therefore, have a large stake in greater household fuel efficiency and in substitution of cheaper, more convenient energy forms. In addition, more efficient household energy use and substitution of smokeless briquettes for wood will reduce household smoke, thus producing a healthier household environment for women and small children who spend much of their time at home.

E. Financial Analysis

1. General

As shown in Table 13, the estimated cost of the project over the five-year period is $36,295,000, consisting of an ESF grant by A.I.D. of $30,000,000 and the equivalent of $6,295,000 by the GOP. The former amount does not include an estimated $800,000 under the Mission's Development Support Training Project and the AID/Washington centrally-funded Conventional Energy Training Project to finance a portion of the training activities under this project. Similarly, the GOP's contribution does not take into account the GOP's outlay for energy sector activities in general which is anticipated to equal about 25 percent of the GOP's Sixth Five-Year Plan total budget, which will be implemented during the same time period as this project.

Three summary tables are provided on the following pages: Table 13 summarizes project costs by fiscal year and source of funding; Table 14 describes project costs by expense category and source of funding; and Table 15 depicts project costs by project component, expense category, and source of funding. Additional data are provided in the Financial Analysis Annex (Annex L). Project costs are defined as anticipated sub-obligations or commitments of funding through, for example, PIO's, contracts, or purchase orders. Inflation was calculated on the basis of 10 percent per year for U.S. consultant salaries, 15 percent for all other foreign exchange costs, and 20 percent for local costs, all compounded annually. A contingency factor of about 7 percent was applied to all costs. Local costs, where shown, are expressed as dollar equivalents at the exchange rate of U.S. $1.00 = Rs 13.00.

2. Summary Cost Estimates and Financial Plan

a. A.I.D. Contribution

Approximately 82 percent of the A.I.D. dollar grant of $30 million will finance foreign exchange costs under the project with the remaining 18 percent for local costs. Of the total $30 million grant, 60 percent will finance U.S. short and long-term technical assistance; 24 percent for vehicles and other commodities; 8 percent for U.S. short-term and long-term training; 1 percent for evaluation; and, the remaining 7 percent for contingency. A.I.D. will finance the international travel costs of participants enrolled in training programs under one year in duration. A participant training travel waiver, which exempts the GOP from having to cover these costs, has been

TABLE 13

SUMMARY OF PROJECT COSTS
BY FISCAL YEAR AND SOURCE OF FUNDING a/
(in $000)

SOURCE OF FUNDING	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	TOTAL
A.I.D. b/	13,000	5,000	6,000	6,000	-	30,000
GOP c/	1,075	1,700	1,245	1,020	1,255	6,295
TOTAL	14,075	6,700	7,245	7,020	1,255	36,295

a/ Project costs are defined as anticipated sub-obligations or commitments of funding through, e.g., PIOs, contracts, purchase orders, and the like.

b/ Does not include any funding for the Lakhra Project beyond Phase 1 as described in this project paper, nor an estimated $800,000 under the Mission's Development Support Training Project and AID/Washington Centrally-funded Conventional Energy Training Project to finance a portion of the training activities under this project.

c/ Expressed as dollar equivalents at the exchange rate of US $1.00 = Rs 13.00.

TABLE 14

SUMMARY OF PROJECT COSTS
BY EXPENSE CATEGORY AND SOURCE OF FUNDING a/
(in $000)

EXPENSE CATEGORY b/	Life of Project Funding				
	A.I.D. Grant c/			GOP d/	Grand Total
	FX	LC	Total		
1. Technical Assistance					
a. Long-Term	5,266	1,795	7,061	202	7,263
b. Short-Term	8,446	2,472	10,918	183	11,101
Sub-Total	13,712	4,267	17,979	385	18,364
2. Training					
a. U.S. Long-Term	184	-	184	10	194
b. U.S. Short-Term	2,111	185	2,296	-	2,296
c. In-country	-	-	-	375	375
d. Third Country Short-term	35	6	41	-	41
Sub-Total	2,330	191	2,521	385	2,906
3. Commodities					
a. Vehicles	160	78	238	-	238
b. Other	6,305	477	6,782	235	7,017
Sub-Total	6,465	555	7,020	235	7,255
4. Other Costs					
a. Evaluation	340	60	400	-	400
b. Operating Expenses	-	-	-	5,290	5,290
Sub-Total	340	60	400	5,290	5,690
TOTAL	22,847	5,073	27,920	6,295	34,215
Contingency	1,680	400	2,080	-	2,080
GRAND TOTAL	24,527	5,473	30,000	6,295	36,295

a/ Project costs are defined as anticipated sub-obligations or commitments of funding through,e.g. PIO's, contracts, purchase orders, and the like.

b/ Inflation = 10% of FX salaries, 15% of all other FX costs, and 20% of local costs, all compounded annually.

c/ Does not include any funding for the Lakhra project beyond Phase 1 as described in this project paper, nor an estimated $800,000 under the Mission's Development Support Training Project and the AID/Washington Centrally-funded Conventional Energy Training Project to finance a portion of the training activities under this project.

d/ Expressed as dollar equivalents at the exchange rate of U.S. $1.00 - Rs 13.00.

TABLE 15

SUMMARY OF PROJECT COSTS BY PROJECT COMPONENT, EXPENSE CATEGORY, AND SOURCE OF FUNDING a/
(in $000)

PROJECT COMPONENT b/	Life of Project Funding				
	A.I.D. Grant c/			GOP d/	GRAND TOTAL
	FX	LC	Total		
1. Energy Analysis and Manpower Development					
a. Commodities	125	23	148	-	148
b. Technical Assistance	3,525	1,260	4,785	50	4,835
c. Training	277	90	367	385	752
d. Operating Expenses	-	-	-	425	425
Sub-Total	3,927	1,373	5,300	860	6,160
2. Coal Resources Assessment and Development					
a. Coal Resources Assessment					
i. Commodities	2,620	-	2,620	-	2,620
ii. Technical Assistance	1,938	646	2,584	78	2,657
iii. Training	318	78	396	-	401
iv. Operating Expenses	-	-	-	2,915	2,915
Sub-Total	4,876	724	5,600	2,993	8,593
b. Coal Mine and Coal Fired Power Generation Development (Phase 1)					
i. Commodities	2,092	54	2,146	235	2,381
ii. Technical Assistance	4,504	1,216	5,720	90	5,810
iii. Training	1,068	166	1,234	-	1,364
iv. Operating Expenses	-	-	-	700	700
Sub-Total	7,664	1,436	9,100	1,025	10,125
c. Processed Coal Briquettes for Residential Use					
i. Commodities	520	74	594	-	594
ii. Technical Assistance	796	85	881	10	881
iii. Training	22	3	25	-	25
iv. Operating Expenses	-	-	-	140	140
Sub-Total	1,338	162	1,500	150	1,650

(Table 15 Continued)

SUMMARY OF PROJECT COSTS BY PROJECT COMPONENT, EXPENSE CATEGORY, AND SOURCE OF FUNDING a/
(in $000)

PROJECT COMPONENT b/	Life of Project Funding				
	A.I.D. Grant c/			GOP d/	GRAND TOTAL
	FX	LC	Total		
3. Energy Conservation and Renewable Energy Technologies					
a. Energy Conservation					
i. Commodities	889	15	904	-	904
ii. Technical Assistance	1,721	620	2,341	88	2,429
iii. Training	98	28	126	-	126
iv. Operating Expenses	-	-	-	280	280
Sub-Total	2,708	663	3,371	368	3,739
b. Renewable Energy Technologies					
i. Commodities	453	155	608	-	608
ii. Technical Assistance	1,228	440	1,668	69	1,737
iii. Training	313	60	373	-	373
iv. Operating Expenses	-	-	-	830	830
Sub-Total	1,994	655	2,649	899	3,548
4. Evaluation	340	60	400	-	400
TOTAL	22,847	5,073	27,920	6,295	34,215
Contingency	1,680	400	2,080	-	2,080
GRAND TOTAL	24,527	5,473	30,000	6,295	36,295

a/ Project costs are defined as anticipated sub-obligations or commitments of funding through, e.g. PIO's, contracts, purchase orders, and the like.

b/ Inflation = 10% of FX salaries, 15% of all other FX costs, and 20% of local costs, all corresponded annually.

c/ Does not include any funding for the Lakhra project beyond Phase 1 as described in this project paper, nor an estimated $800,000 under the Mission's Development Support Training Project and the AID/Washington Centrally-funded Conventional Energy Training Project to finance a portion of the training activities under this project.

d/ Expressed as dollar equivalent at the exchange rate of US $1.00 = Rs 13.00.

signed by the USAID/Pakistan Mission Director and is included as Annex G.

Allocation of the A.I.D. contribution by project component is as follows: 18 percent for Energy Analysis and Manpower Development; 54 percent for Coal Resource Assessment and Development; 20 percent for Conservation and Renewable Energy Technologies; 1 percent for evaluation; and, the remaining 7 percent for contingency.

b. GOP Contribution

The GOP contribution to this project will consist of office space for U.S. advisors, local per diem for in-country seminar participants, half of the cost of the mining camp, the water truck for the Coal Mine and Coal-Fired Power Generation sub-component, and the salaries and other costs for professional and non-professional staff working on the project. The GOP contribution as shown in the preceding tables does not reflect the costs associated with: (i) local contractors who will have to be hired by the DGER to assist in the design and installation of renewable energy demonstrations; (ii) local consultants who will have to be hired, most likely by the DGER, to undertake the energy audits under the Energy Conservation sub-component; (iii) the recurrent costs of all renewable energy demonstrations and the pilot coal briquetting plant; and, (iv) land on which renewable energy demonstrations, the pilot coal briquetting plant, and the mining camp and coal exploratory work will be undertaken. All of these costs are difficult to estimate at this stage of the project, but they will be determined as the project is implemented and incorporated accordingly in the GOP's PC-1 documents to ensure that adequate funds are available for these activities.

F. Environmental Analysis

The PID for this project included an Initial Environmental Examination (IEE) of the foreseeable environmental effects of proposed project activities. The IEE concluded that the analysis and assessment components of the project were categorically excluded from environmental impact assessment requirements and that the remaining components would not have a significant effect on the environment. A Negative Determination was, therefore, recommended with the provision that, if the use of coal was expanded after project approval and the environmental effects of this use appeared significant, additional environmental studies would be carried out. AID/Washington concurred with the Mission's recommendation for a Negative Determination for the project but requested some discussion in the project paper on the potential environmental impact of small scale hydro development, particularly possible destabilization of watercourse banks and detrimental effects on the habitat of fish (See Annex A.)

After the PID was approved, A.I.D. responded to a GOP request to review all the data and studies that had been completed on the Lakhra coal mining and power generation project. AID/Washington retained the Stone & Webster Engineering Corp. (SWEC) to undertake this review in cooperation with a Pakistani counterpart team from WAPDA and PMDC. Based on the favorable preliminary results presented by the WAPDA-PMDC-SWEC team in January 1983, the GOP requested A.I.D. to provide support to help develop a Coal Projects Department in WAPDA, to undertake additional feasibility studies and other preparatory work, and to finance the front-end engineering work necessary to develop a 300 MW power plant and associated mines in the Lakhra/Jamshoro area. The PID was subsequently amended to include this work except for the front-end engineering which may be financed by A.I.D. through an amendment to this project in FY 1984. In accordance with A.I.D. guidelines (Regulation 216.1-8), an Environmental Assessment was prepared for the Lakhra project and is contained in Annex M.

The environmental analysis of the Lakhra project concluded that the project is environmentally sound. While the power plant may have some negative air pollution effects, it would not cause ambient air quality levels to exceed standards deemed adequately protective of public health by the World Bank. Moreoever, suitable mitigation measures would be taken to minimize air quality impacts. The environmental analysis of the small hydro sub-component found that negative environmental effects would be insignificant and would be outweighed by environmental benefits.

1. Small Hydro Sub-Component

An environmental expert assisted the Mission in examining small hydro environmental concerns in the context of conditions in the NWFP. In addition, A.I.D.'s Regional Environmental Advisor visited typical hydro field sites in Pakistan. From their reports, the Mission concluded that the possible negative environmental impact of small hydro installations, namely erosion and negative effects on fish, will not be significant.

Erosion along watercourse banks can increase due to diversion and impoundment especially in steep terrain. However, Pakistan's hydro schemes are run-of-river and do not impound any water. Water channels which feed water to the penstock and turbines are masonry lined, thereby eliminating erosion there. Erosion of stream banks is thus not a problem. Fish habitats may be adversely affected in the immediate vicinity of the hydro installations, but the very limited number of installations (A.I.D. will finance fewer than 10) and their very small size would reduce this impact to negligible levels. Impacts downstream of the installations are unlikely to be significant because of the relatively high sediment levels already present in NWFP streams and because the installations will not affect those sediment levels to any measurable extent. The largest impact of small hydro plant activity would probably be felt during construction. Engineering and construction procedures which will minimize these impacts will, therefore, be employed in installing plants and their associated civil works.

In summary, the possible negative environmental impacts of small hydro units installed under this project will be minor. A.I.D.'s Regional Environmental Advisor concurs with this conclusion. What negative impacts result will be more than outweighed by the positive environmental impacts of using electricity generated by the small hydro units. This electricity will be used primarily for lighting, replacing kerosene and thereby reducing indoor smoke and emissions of carbon monoxide and hydrocarbons in village homes. Furthermore, by reducing the need for large fossil or nuclear power plants, the adverse environmental impacts associated with those plants would be avoided.

2. The Lakhra Coal Project

Annex M contains an environmental assessment of the Lakhra Coal project. Its main conclusion is that the project is environmentally sound. The assessment addresses five potential environmental problems which the plant and its mines could present: (a) air pollution; (b) water pollution; (c) solid waste; (d) noise and worker safety; and, (e) secondary effects.

Air pollution will be produced by the plant and by dust from surface mines. The environmental assessment shows that sulfur oxides and particulates from the first 300 MW unit will fall well below World Bank ambient air quality standards. Flue gas desulfurization (FGD) technology will not be needed on this unit. During Phase 1 activities under this project, an environmental monitoring and analysis program will be established to determine if FGD equipment is needed on the second 300 MW unit. By the time that decisions must be made about FGD for the second unit, sufficient data and analysis will have been completed to allow a well-informed decision.

Dust from surface mines will add to dust already present in the area from natural wind erosion. The environmental monitoring program will analyze these dust levels so that estimates can be made of how much the dust from the mines will contribute. Dust from the mines alone will not cause World Bank standards to be exceeded. Mitigation measures and reclamation applied to the mines will minimize additional dust production. Water pollution is not expected to be a problem. The main concern is possible heating of irrigation canal water by waste cooling water from the power plant. Since the cooling towers will use a closed-cycle water system, the problem should not be significant.

3. Other Coal Activities

As discussed in the Project Description, the project will provide funds to assess Pakistan's coal resources and to undertake a series of assessment and planning activities in coal mining and coal use. These activities are primarily analytical studies and assessments including technical and economic feasibility studies of various coal projects and conceptual design studies and assessments of coal technologies for future use in Pakistan. As such, they will have no direct impact on the environment.

These studies will assist the GOP in developing a national coal policy to tap the country's significant coal reserves. Development of coal on a national scale could have major environmental impacts, primarily air and water pollution and land despoliation. For this reason, environmental analysis will be undertaken during Phase 1 to provide the information necessary to eliminate or reduce potential negative impacts. These analyses include the monitoring of baseline environmental conditions in the area of the power plant using Lakhra coal and an analysis of the capital and operating costs of air pollution control technologies required to meet appropriate ambient air and emission standards. Additional studies may focus on environmental controls necessary to prevent destructive impacts from surface mining in the Lakhra and other coal fields which are expected to be mined.

At the present time, Pakistan is developing an environmental policy. GOP energy officials, therefore, have no existing guidance to follow to incorporate environmental protection measures in the development of Pakistan's coal resources. By means of the analyses and assessments noted above, A.I.D. will make a significant contribution to the formulation of Pakistan's environmental policy.

The coal briquetting market assessment will provide information on the present distribution of stoves and may include development of a small pilot plant to produce briquettes. These assessment activities will have insignificant environmental impacts in themselves but may lead to larger projects later which could affect the environment. Environmental analyses will be incorporated into all briquetting activities such that if larger scale activity is undertaken beyond this project, measures may be taken to mitigate negative environmental impacts.

G. Narcotics Impact Statement

None of the proposed project activities can be meaningfully connected to the U.S. Government's continued efforts, in conjunction with the GOP, to curtail opium poppy cultivation and the processing of opium into heroin in Pakistan. The Lakhra area, where the only significant construction may take place as a result of this project, is not a poppy-growing or heroin-processing area. Site selection for demonstration projects, such as small hydro electric generators, will exclude poppy-growing and heroin-processing areas. In addition, the following poppy clause will be included in the Project Agreement:

> "The Government of Pakistan (GOP) agrees to undertake appropriate measures to prohibit cultivation of opium poppy and/or processing of opium into heroin or morphine base within any area benefiting from this Project. In the event that a determination is made that the cultivation of opium poppy and/or processing of opium into heroin is occurring in an area programmed to benefit or benefiting from this Project, no assistance under this Project directly benefiting that area shall commence, and, if commenced, such assistance shall be suspended until the prohibited activity is eliminated. This suspension of assistance may, at the option of the United States Government, and in accordance with applicable law, include removal of any services or facilities in the area until the prohibited activity is fully eliminated. If the prohibited activity found to exist is not fully eliminated within a specified period of time to be agreed upon by the United States Government and the GOP, all assistance under this Project directly benefiting that area may be terminated.

If, prior to the Project Assistance Completion Date (PACD) established by A.I.D. for this Project as it may be from time to time amended, it is determined that the prohibited activity is occurring in an area which has benefited from this Project and the prohibited activity is not eliminated within a period of time to be agreed upon by the United States Government and the GOP, the GOP shall reimburse A.I.D. for all assistance that the GOP has received from A.I.D. under this Project, which has resulted in direct benefits to that area in which the prohibited activity is occurring. Such reimbursement shall be treated as a refund under the relevant provisions of the Project Agreement."

VI. CONDITIONS, COVENANTS AND NEGOTIATING STATUS

A. Conditions Precedent to Disbursement

1. Condition Precedent to First Disbursement

Except as A.I.D. may otherwise agree in writing, prior to any disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which disbursement will be made, the Grantee shall furnish or have furnished to A.I.D., in form and substance satisfactory to A.I.D., within sixty (60) days after the signing of the Project Agreement:

a. a written opinion of Counsel acceptable to A.I.D. that the Project Agreement has been duly authorized and/or ratified by and executed on behalf of the Grantee and that it constitutes a valid and legally binding obligation of the Grantee in accordance with all of its terms; and,

b. a written statement setting forth the names and titles of persons holding or acting in the Office of the Grantee and representing that the named person or persons have the authority to act as the representative or representatives of the Grantee, together with a specimen signature of each such person certified as to its authenticity.

2. Condition Precedent to the Selected Disbursement of Funds under the Energy Analysis and Manpower Development Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made for the long-term general technical assistance contract, participant training and special studies under the Energy Analysis and Manpower Development Component of this Project, the Grantee, acting through its Planning and Development Division, Ministry of Planning and Development, shall furnish to A.I.D., in form and substance satisfactory to A.I.D. evidence that:

a. an administrative unit within the Planning and Development Division has been authorized and established to assume responsibility for Energy Analysis and Manpower Development activities and is being organized, staffed, and equipped; and,

b. a Participating Agency Project Implementation Coordinating Committee has been authorized and established, its duties and responsibilities have been defined, and the Committee is being organized, staffed, and equipped.

3. Condition Precedent to the Selected Disbursement of Funds for Activities under the Coal Mine and Coal-Fired Power Generation Development Sub-Component of the Coal Resource Assessment and Development Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which disbursement will be made for the Coal Mine and Coal-Fired Power Generation Development Technical Assistance Contract under the Coal Resource Assessment and Development Component of this Project, the Grantee, acting through its Planning and Development Division, Ministry of Planning and Development, shall furnish to A.I.D., in form and substance satisfactory to A.I.D., evidence that:

a. a Coal Projects Department has been authorized and established to promote, plan, and manage the development and implementation of coal mine and coal-fired power generation projects within WAPDA and adequate funds have been made available for its operation;

b. the authority, duties and responsibilities of the overall manager and the coal mine and power section managers of the Department have been adequately defined; and,

c. an adequately trained and experienced overall manager of the Department has been appointed and persons to fill the other two managerial positions have been identified.

4. Condition Precedent to the Selected Disbursement of Funds under the Conservation and Renewable Energy Technologies Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made under the Conservation and Renewable Energy Technologies Component of this project, except for vehicles and household/office furniture and equipment, the Grantee, acting through its Directorate General for Energy Resources (DGER) of the Ministry of Petroleum and Natural Resources and its Planning and Development Division of the Ministry of Planning and Development shall furnish to A.I.D., in form and substance satisfactory to A.I.D., evidence that:

a. an adequately staffed administrative unit has been authorized and established within the DGER to manage all Component activities; the authorities, duties and responsibilities of the overall manager and the conservation and renewable energy managers in the administrative unit have been adequately defined; and, an adequately trained and experienced overall manager of the administrative unit has been appointed; and,

b. a National Renewable Energy Activities Coordinating Committee has been authorized and established and its duties and responsibilities as well as those of both its public and private sector members have been adequately defined.

B. Covenants

1. The Grantee, acting through its Planning and Development Division, Ministry of Planning and Development, and each of the Participating Agencies in the Project, shall make every reasonable effort to require that each person trained under this Project works in energy sector activities in Pakistan for not less than three times the length of time of his or her training program provided, however, that in no event shall the individual be allowed to work in energy sector activities for less than one year nor be required to work in energy sector activities for more than five years from the date of the individual's completion of training.

2. The Grantee shall furnish to A.I.D., in form and substance satisfactory to A.I.D., periodic activity reports, the requirements of which shall be, from time to time, set forth by A.I.D. in Project Implementation Letters. The requirements may include, but shall not be limited to providing information concerning:

a. progress of each of the implementing agencies in organization, staffing and training;

b. progress of each of the long-term technical assistance contractor teams with respect to meeting established targets in the schedules and workplans of individual advisors; effecting commodity procurements; scheduling, implementing and evaluating training programs and demonstrations; and, preparing required reports and other project documents; and,

c. a combined summary report for the entire Project.

3. The Grantee shall participate in periodic external project evaluations by assigning senior representatives of participating ministries and agencies to joint A.I.D.-Grantee Evaluation Teams. Participants in project evaluations are to be individuals who are familiar with the project but who are not directly involved in its implementation.

C. Negotiating Status

The above Conditions Precedent and Covenants have been discussed with and agreed to by the Government of Pakistan. During Project Agreement negotiations, USAID/Pakistan will incorporate into the Agreement appropriate language to cover these terms and conditions.

PROJECT PAPER

PAKISTAN - ENERGY PLANNING AND DEVELOPMENT

391-0478

VII. A N N E X E S

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E.O. 12065: N/A
TAGS:
SUBJECT: ENERGY PLANNING AND DEVELOPMENT (391-0478)
APAC GUIDANCE

1. APAC REVIEWED SUBJECT PID JUNE 17. PID WAS APPROVED AND MISSION IS AUTHORIZED TO PROCEED WITH DESIGN OF PP FOR AID/W REVIEW AND AUTHORIZATION. FOLLOWING ISSUES SHOULD BE ADDRESSED.

2. MISSION WORKLOAD: APAC WAS CONCERNED WITH THE MANAGEMENT REQUIREMENTS INVOLVED WITH IMPLEMENTING THE FIVE DISTINCT PROJECT COMPONENTS, ESPECIALLY GIVEN MISSION STAFFING CONSTRAINTS. PP SHOULD INCLUDE DETAILED ANALYSIS OF HOW PROJECT WILL BE MANAGED. ANALYSIS SHOULD DISCUSS ESTIMATED AMOUNT OF STAFF TIME EACH OF THE FIVE ACTIVITIES WILL REQUIRE, HOW CONTRACTORS WILL BE UTILIZED, AND OPTIONS CONSIDERED BY MISSION FOR REDUCING REQUIRED STAFF TIME. ONE SUGGESTION TO SIMPLIFY IMPLEMENTATION WHICH MISSION SHOULD EXPLORE DURING PP DESIGN WOULD BE TO IMPLEMENT PROJECT IN DISCRETE PHASES, DEVOTING FIRST PHASE TO RESOURCE ASSESSMENTS, THE SECOND PHASE TO POLICY PLANNING, AND THE THIRD PHASE TO THE DEMONSTRATION AND CONSTRUCTION OF APPROPRIATE ENERGY-GENERATING MECHANISMS. APPROPRIATE TRAINING COULD BE INCLUDED IN EACH PHASE.

3. ADMINISTRATIVE ARRANGEMENTS: NUMEROUS GOP AGENCIES INVOLVED IN PROJECT ACTIVITIES WILL ALSO COMPLICATE IMPLEMENTATION. PP SHOULD IDENTIFY THE CHANGES NECESSARY WITHIN THE GOP TO ACHIEVE PROJECT GOALS AND SHOULD DELINEATE RELATIONSHIPS BETWEEN RELEVANT GOP AGENCIES AND BETWEEN THE AGENCIES AND THE MISSION. IF, IN ORDER TO ENSURE COORDINATION BETWEEN THE PARTICIPATING AGENCIES, THE MISSION CHOOSES TO UTILIZE AN INTER-MINISTERIAL COMMITTEE APPROACH, THE APAC BELIEVES IT WOULD BE USEFUL TO HAVE A COVENANT THAT A LEAD ORGANIZATION BE IDENTIFIED. THE LEAD ORGANIZATION SHOULD BE GIVEN APPROPRIATE AUTHORITY TO ENSURE THAT THE COMMITTEE IS ABLE TO REACH DECISIONS IN A TIMELY MANNER.

4. RENEWABLE ENERGY: THE RENEWABLE ENERGY COMPONENT OF THE PROJECT SHOULD PROMOTE AN INTEGRATED PROGRAM WHICH

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INCLUDES THE DEVELOPMENT OF SMALL HYDRO, BIOMASS, AND SOLAR OPTIONS, AS APPROPRIATE. IN ORDER TO SIMPLIFY IMPLEMENTATION, COMPONENT ACTIVITIES SHOULD BE CONCENTRATED IN THE NORTHWEST FRONTIER PROVINCE.

5. OTHER DONORS: COORDINATION AMONG THE INTERNATIONAL DONORS ACTIVE IN THE ENERGY SECTOR IS CRITICAL. THE MISSION SHOULD IDENTIFY KEY AREAS FOR IMPROVED COORDINATION, EXPLORE VARIOUS COORDINATING MECHANISMS WITH THE OTHER DONORS AND THE GOP, AND PRESENT A WORKABLE APPROACH TO COORDINATION IN THE PP.

6. PROJECT OUTPUTS: PID WAS NOT CLEAR AS TO WHAT END-OF-PROJECT STATUS WILL BE. IN ADDITION TO DETAILED LOGFRAME, PP SHOULD THOROUGHLY DISCUSS PROJECT OUTPUTS AND PROVIDE FOR A COLLECTION OF BASELINE DATA AND FOR THE ESTABLISHMENT OF BENCHMARKS OR TARGETS AGAINST WHICH PROJECT PROGRESS WILL BE MEASURED.

7. RELATIONSHIP TO MISSION STRATEGY: SINCE MISSION IS NOT REQUIRED TO PREPARE CDSS IN THE TRADITIONAL SENSE, PP SHOULD PROVIDE OVERVIEW OF MISSION ENERGY STRATEGY AND DISCUSS HOW THIS PROJECT FITS INTO THE CONTEXT OF THAT STRATEGY.

8. TECHNICAL ISSUES: SPECIFIC TECHNICAL ISSUES WHICH PP SHOULD ADDRESS ARE:

A. CURRENT SUPPLY/DEMAND FOR ENGINEERING GRADUATES IN KEY FIELDS;

B. THE NEED FOR A COAL ANALYTICAL LAB IN PAKISTAN;

C. THE ROLE AND CAPABILITIES OF THE USGS IN IMPLEMENTING THE COAL RESOURCE SURVEY COMPONENT;

D. FEASIBILITY OF A COAL BRIQUETTE PLANT;

E. THE POTENTIAL FOR COAL SUBSTITUTION IN KEY INDUSTRIES;

F. THE POTENTIAL FOR PRIVATE BUSINESS INVOLVEMENT IN MINIHYDRO AND RENEWABLE ENERGY TECHNOLOGY MANUFACTURING; AND

G. THE POSSIBILITY OF IMPORTING SEVERAL U.S. SMALL HYDRO UNITS FOR DEMONSTRATION PURPOSES.

9. ENVIRONMENTAL CONCERNS: APAC CONCURRED WITH PID'S RECOMMENDATION FOR NEGATIVE ENVIRONMENTAL DETERMINATION. HOWEVER, SOME CONCERN WAS EXPRESSED REGARDING THE ENVIRONMENTAL IMPACT OF MINIHYDRO AND THE CUMULATIVE ENVIRONMENTAL IMPACT OF MICROHYDRO. POTENTIAL PROBLEMS

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MAY INCLUDE INCREASING INSTABILITY OF BANKS ALONG WATERCOURSES DUE TO DIVERSION AND IMPOUNDMENT ACTIVITIES, AND INTRODUCING DETRIMENTAL EFFECTS ON THE NATURAL HABITAT OF FRESHWATER FISH. PP SHOULD DISCUSS ENVIRONMENTAL IMPACT OF SMALL-SCALE HYDRO AND IDENTIFY MITIGATION MEASURES FOR ANY ADVERSE IMPACT THAT IS ANTICIPATED AS A RESULT OF THE HYDRO PROGRAM.

10. PROJECT APPROVAL: ALTHOUGH FUNDING LEVELS ARE WITHIN AUTHORITY REDELEGATED TO THE FIELD, APAC DECIDED THAT PP SHOULD BE REVIEWED AND AUTHORIZED IN AID/W. THIS IS PRIMARILY BECAUSE ISSUES IDENTIFIED DURING APAC MEETING TRANSCEND SCOPE OF THIS PROJECT AND ARE OF BUREAU/AGENCY-WIDE CONCERN, AND SECONDARILY BECAUSE OF INHERENT COMPLEXITY OF PROJECT AS PROPOSED IN PID. STOESSEL
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5C(2) PROJECT CHECKLIST

Listed below are statutory criteria applicable to projects. This section is divided into two parts. Part A. includes criteria applicable to all projects. Part B. applies to projects funded from specific sources only: B.1. applies to all projects funded with Development Assistance Funds, B.2. applies to projects funded with Development Assistance loans, and B.3. applies to projects funded from ESF.

CROSS REFERENCES:	IS COUNTRY CHECKLIST UP TO DATE?	Yes.
	HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?	Yes.

A. GENERAL CRITERIA FOR PROJECT

1. FY 1982 Appropriation Act Sec. 523; FAA Sec. 634A; Sec. 653(b).

   (a) Describe how authorizing and appropriations committees of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that amount)?

   (a) Congressional Notification and Congressional Presentation.

   (b) Yes, assistance is within the FY 1983 operational year budget.

2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,00, will there be

(a) engineering, financial or other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?	(a) Yes. (b) Yes.
3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?	No further legislative action is required.
4. FAA Sec. 611(b); FY 1982 Appropriation Act Sec. 501. If for water or water-related land resource construction, has project met the standards and criteria as set forth in the Principles and Standards for Planning Water and Related Land Resources, dated October 25, 1973? (See AID Handbook 3 for new guidelines.)	N.A.
5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	Yes, a Mission Director's 611(e) certification is included in the Project Paper.

6. FAA Sec. 209. Is project susceptible to execution as part of regional or multilateral project? If so, why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	Project is not susceptible to execution as part of a regional or multilateral project nor will it encourage regional development programs. The project is very Pakistan-specific.
7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; and (c) encourage development and use of cooperatives, and credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	(a) The project will assist Pakistan to develop and substitute indigenous energy resources for imported oil. The foreign exchange thus saved would be available for the importation of other commodities. (b) The project will promote the increased involvement of the Pakistani private sector in coal mining, coal briquette manufacture and marketing, and in the manufacture of renewable energy devices. (c) No (d) No (e) The project will improve the energy efficiency of industrial plants and residential fuel users. (f) No
8. FAA Sec. 601(b). Information and conclusions on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).	U.S. private enterprises will participate as suppliers of both goods and services under the project.

9.	FAA Sec. 612(b), 636(h); FY 1982 Appropriation Act Sec. 507. Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized in lieu of dollars.	This project is financed by ESF funds. Nevertheless, the GOP and the Provincial Governments will contribute the equivalent of $6,295,000 over the life of the project to help finance the local costs of the project. The Mission Director has certified the disbursement of U.S. dollars in lieu of U.S. Treasury-owned excess rupees to cover some of the local costs under this project. This action is consistent with one of the major objectives of the renewed economic assistance program to Pakistan which is to maximize the balance of payments impact of the program.
10.	FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?	Yes. The U.S.-owned excess Pakistani rupees known as Mondale rupees have been fully programmed in support of other projects.
11.	FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	Yes.
12.	FY 1982 Appropriation Act Sec. 521. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity?	N.A.
13.	FAA 118(c) and (d). Does the project comply with the environmental procedures set fo th in AID Regulation 16? Does	Yes. An Environmental Analysis is included in the Project Paper.

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the project or program take into consideration the problem of the destruction of tropical forests?	N.A.
14. FAA 121(d). If a Sahel project, has a determination been made that the host government has an adequate system for accounting for and controlling receipt and expenditure of project funds (dollars or local currency generated therefrom)?	N.A.

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria	This is an ESF-funded Project.
a. FAA Sec. 102(b), 111, 113, 281(a). Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and	N.A.

otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?	N.A.
b. FAA Sec. 103, 103A, 104, 105, 106. Does the project fit the criteria for the type of funds (functional account) being used?	N.A.
c. FAA Sec. 107. Is emphasis on use of appropriate technology (relatively smaller, cost-saving, labor-using technologies that are generally most appropriate for the small farms, small businesses, and small incomes of the poor)?	N.A.
d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activitiy with respect to which the assistance is to be furnished (or is the latter cost-sharing requirement being waived for a "relatively least developed" country)?	N.A.

e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"? (M.O. 1232.1 defined a capital project as "the construction, expansion, equipping or alteration of a physical facility or facilities financed by AID dollar assistance of not less than $100,000, including related advisory, managerial and training services, and not undertaken as part of a project of a predominantly technical assistance character."	N.A.
f. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase of productive capacities and self-sustaining economic growth?	Yes. The project is intended to make Pakistan more efficient in its use of energy and to develop and substitute indigenous sources of energy for imported oil. This should result in a significant savings of foreign exchange and the provision of a reliable energy supply to the population, thereby contributing directly to the development of economic resources and an increase in productive capacities.
g. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage	The project will provide assistance to three existing Ministries involved in the energy sector. Staff of these Ministries as well as other Pakistanis will benefit from the considerable amount of overseas and in-country training planned under the project. In addition, project funds will be used to finance an energy end use survey to determine the special needs, and capacities of residential and small commercial consumers with respect to energy.

institutional development; and supports civil education and training in skills required for effective participation in governmental processes essential to self-government.	
2. Development Assistance Project Criteria (Loans Only)	This is an ESF-funded project.
a. FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan, at a reasonable rate of interest.	N.A.
b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete with U.S. enterprises, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?	N.A.
c. ISDCA of 1981, Sec. 724 (c) and (d). If for Nicaragua, does the loan agreement require that the funds be used to the maximum extent possible for the private sector? Does the project provide for monitoring under FAA Sec. 624(g)?	N.A.
3. Economic Support Fund Project Criteria	
a. FAA Sec. 531(a). Will this assistance promote economic or political	The project focuses on making the country more fuel efficient in industries and in the home, and on providing more and better energy

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stability? To the extent possible, does it reflect the policy directions of FAA Section 102?	to the home. The poor will benefit to the extent home energy is more plentiful and cheaper. This significant favorable impact on the poor should contribute to economic and political stability.
b. FAA Sec. 531(c). Will assistance under this chapter be used for military, or paramilitary activities?	No
c. FAA Sec. 534. Will ESF funds be used to finance the construction of the operation or maintenance of, or the supplying of fuel for, a nuclear facility? If so, has the President certified that such use of funds is indispensable to nonproliferation objectives?	No
d. FAA Sec. 609. If commodities are to be granted so that sale proceeds will accrue to the recipient country, have Special Account (counterpart) arrangements been made?	N.A.

ANNEX C.1

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
MISSION TO PAKISTAN

Cable : USAIDPAK

HEADQUARTERS OFFICE
ISLAMABAD

Office of the Director

ENERGY PLANNING AND DEVELOPMENT PROJECT 391-0478

FAA SECTION 611 (e) CERTIFICATION

I, Donor M. Lion, the principal officer of the Agency for International Development in the Islamic Republic of Pakistan, having taking into account, among other things, the maintenance and utilization of projects in the Islamic Republic of Pakistan previously financed or assisted by the United States, do hereby certify, pursuant to Section 611 (e) of the Foreign Assistance Act of 1961, as amended, that, in my judgement, the Islamic Republic of Pakistan has both the financial capability and the human resources capability to effectively implement, utilize, and maintain the proposed Energy Planning and Development Project 391-0478.

This judgement is based upon the project analyses as detailed in the Energy Planning and Development Project Paper and is subject to the conditions imposed therein.

Donor M. Lion

Donor M. Lion
Director
USAID/Pakistan

May 25, 1983

Date

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
MISSION TO PAKISTAN

Cable : USAIDPAK

HEADQUARTERS OFFICE
ISLAMABAD

Office of the Director

ENERGY PLANNING AND DEVELOPMENT PROJECT 391-0478

FAA SECTION 612 (h) CERTIFICATION

A major purpose of the $1.625 billion economic assistance program negotiated between the Governments of the United States of America and Pakistan, acknowledged by both governments and a primary reason for both governments having decided to develop an economic assistance package, is to provide balance of payments assistance to Pakistan.

I have carefully reviewed the advisability of disbursing United States dollars in lieu of United States-owned excess foreign currency to pay for local costs of projects being implemented in Pakistan. In light of the United States Government's objectives concerning the program, I have determined that it would be prejudicial to U.S. interests and goals to pay for all local currency costs with United States-owned rupees. Such a procedure would prevent the U.S. from providing the maximum amount of balance of payments support under the economic assistance package, and would consequently undercut one of the basic objectives of the program. The objective of providing balance of payments assistance to Pakistan can best be achieved by disbursing United States dollars to pay for local costs of the program. Section 612 (b) of the Foreign Assistance Act of 1961, as amended, authorizes the administrative official approving the voucher to determine that local costs will be funded with direct payment of dollars for the program. Pursuant to this provision, Handbook 19 requires that the Mission Director (or his designee) make a determination as to the reason in any instance where United States dollars are used (disbursed) when United States-owned foreign currency is available. Where dollars are used for local cost financing, USAID/Pakistan will, therefore, make disbursements to the Government of Pakistan in U.S. currency.

FAA SECTION 612 (b) CERTIFICATION (Continued)

In view of the above rationale, I, Donor M. Lion, Principal officer of the Agency for International Development in Pakistan, pursuant to Section 612 (b) of the Foreign Assistance Act of 1961, as amended, do hereby certify the need to disburse United States dollars to cover local currency costs in lieu of using United States-owned excess rupees under the Energy Planning and Development Project.

Donor M. Lion

Donor M. Lion
Director
USAID/Pakistan

May 25, 1983

Date

Telegram: ECONOMIC
Telex : ECDIV No 08-834
SECRETARY
Phone: 20629

No. 5(61)FA.III/82
Government of Pakistan
MINISTRY OF FINANCE AND
ECONOMIC AFFAIRS
(ECONOMIC AFFAIRS DIVISION)

Islamabad, the 5th June 1983

Dear Mr. Lion,

As part of the agreement between our two governments on a six-year $ 1.625 billion economic assistance program, the Government of Pakistan formally requests from A.I.D. thirty million dollars(US$ 30,000,000) in United States assistance to fund an Energy Planning and Development Project. The Planning and Development Division in the Ministry of Planning and Development will have primary responsibility for the implementation of this project.

Funds provided by A.I.D. under the project will be used, amongst other things, to procure technical assistance, training and commodities required to:

(1) establish a permanent GOP Energy Analysis Group capable of carrying out integrated energy analyses and sectoral and special studies;

(2) establish an operational Energy Data Management System, including current and historical supply and demand information by fuel and by sector;

(3) carry out a series of special energy studies to be used as reports for assisting in the formulation of energy policy and in the preparation of annual, 5-year, and long term energy development plans;

(4) carry out a comprehensive coal resources assessment which will provide a quantitative understanding of coal reserves at Lakhra, Sonda Thatta, and other coal fields in Pakistan,

...2/-

Best Available Document

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(5) improve coal analysis facilities at GSP, PMDC and PCSIR;

(6) establish a Coal Projects Department within WAPDA to promote, plan and manage the development and implementation of coal mine and coal-fired power generation projects;

(7) carry out an assessment of development barriers facing the private coal mining industry and options available to that sector and the GOP to eliminate or reduce those barriers and to stimulate private investment in coal development;

(8) prepare for the implementation of Pakistan's first large-scale coal mine and coal-fired power generation plant (Lakhra),

(9) select and demonstrate improved mining technologies appropriate to Pakistan's coal industry;

(10) carry out a feasibility study and market analysis and design and build a pilot plant for producing coal briquettes for residential use;

(11) perform industrial energy use audits and establish an Industrial Energy Use Data System;

(12) implement 4 to 8 industrial energy conservation demonstration projects;

(13) assist in the development of a comprehensive national industrial energy conservation program;

(14) carry out a national energy needs survey which will describe the user market for renewable energy technologies; and,

(15) assess renewable energy technologies and national renewable energy programs and demonstrate selected renewable energy technologies such as solar, small hydro, fuel efficient woodstoves, and biogas digesters.

I also understand that limited additional funds for some of the training activities planned under the Energy Planning and Development project may be provided under other A.I.D. financed projects such as the Development Support Training Project and a central A.I.D. energy training project.

The Government of Pakistan assures the United States of its full cooperation in carrying out the Energy Planning and Development Project. The personnel, financial and other inputs required of us will be provided in an expeditious manner. Once the Project Agreement is signed, A.I.D. is hereby authorized to proceed with the implementation of the project in accordance with the terms and conditions as set forth in that Agreement.

We look forward to a continued, combined effort by both our governments to produce a productive and beneficial program for the people of Pakistan.

Yours sincerely,

(EJAZ AHMAD NAIK)

Dr. Donor N. Lion,
Director,
USAID Mission to Pakistan,
ISLAMABAD

AID 1330-5(10-79)

ANNEX B
Page 1

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project
From FY 1981 to FY 1988
Total U.S. Funding $30.6 million
Date Prepared [illegible]

Project Title & Number: Energy Planning and Development, 391-0438

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objectives to which this project contributes: - To increase Pakistan's energy self-sufficiency	Measures of Goal Achievement: -Imported oil provides smaller percentage of total energy use -Increase in power outages/shortages -Decrease in rate of consumption of fuelwood -Indigenous coal provides larger percentage of total energy use	-Pakistan's energy balance sheets -Data collected by the Energy Analysis Group -Project evaluations -Data collected and records kept by relevant GOP Ministries -Studies and surveys undertaken by project staff -Facility inspections	Assumptions for achieving goal targets: -GOP policies will continue to encourage reduced fuel imports, increased exploitation of indigenous sources of energy, and increased energy efficiency
Project Purpose -To assist the GOP to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and to improve the efficiency of energy use.	Conditions that will indicate purpose has been achieved: End of project status: -GOP plans place increased emphasis on energy efficient programs and projects -Improved GOP inventory of availability of domestic sources of energy -Coal mining industry capable of meeting increased demand generated -Increased reliance on domestic sources of energy -Reduced consumption of energy per unit production -Increased use of alternative fuels for coal including marketing and acceptance of coal briquettes -Increased use of renewable and alternative energy sources	-Pakistan's energy balance sheets -Data collected by the Energy Analysis Group -Project evaluations -Data collected and records kept by relevant GOP Ministries -Studies and surveys undertaken by project staff -Facility inspections	Assumptions for achieving purpose: -GOP policies will continue to encourage the development of the private sector, especially in the coal industry and renewable energy areas -GOP will review price structure for fuels to protect their real cost of production and give preference to Pakistan's large low to very low grade coal reserves -GOP will utilize the analyses, studies, and other planning inputs generated by the Energy Analysis Group for policy formulation in the energy sector -Agencies involved in renewable energy sources will coordinate and integrate their activities and only those technologies (Cont'd on p.2)
Outputs: Component 1: Energy Analysis and Planning Development. -A permanent GOP Energy Analysis Group (EAG) established within the Ministry of Planning and Development and capable of doing integrated analyses of sectoral and special studies. -An Energy Data Management System within the EAG established -A series of sectoral energy study reports completed and used in formulating energy policy and in preparing annual, mid-term and five year development plans. Component 2: Coal Development and Development. -A Coal Technical Department established in WAPDA capable of planning and managing development of coal fired power plants. -Coal resource assessment completed which will provide a quantitative understanding of coal reserves. -Coal analysis facilities upgraded at CDP, PMDC and PCSIR -Completed assessment of the development barriers facing public and private coal mining industry and options available to GOP to remove these barriers and stimulate private investment in coal. -Completed design and demonstration of improved mining techniques appropriate to Pakistan Coal Industry. -Design manual completed containing all the field investigations and analytical data necessary for the design of certain surface underground mines at Lakhra to produce at least 1.4 million tons per year coal for a 200 MW electric power station. -A feasibility study, coal market analysis and pilot plant for producing coal briquettes for the residential market. (Cont'd on p.2)	Magnitude of Outputs: Component 1: -An operational analysis group exists within EAG with 3 to 6 persons qualified full-time analysts. -An operational Data Management System exists within the EAG equipped with computers and software -EAC, PED, and other energy sector officials trained -Manpower assessment completed and training plan developed -3 special study reports covering energy pricing and demand by sector, on GOP forecast, manpower assessment, etc. Component 2: -WAPDA, CDP, PMDC, and PCSIR employees and private sector participants trained in U.S., Pakistan and Third Countries -Report completed Laboratory facilities. -Recommendations prepared and implemented including incentives for the development of a modern coal mining industry -Demonstration mine operating including truck mounted drill, geophysical truck, electric mine locomotives, underground unit, conveyors and other equipment -25 ton per day briquetting plant tested and operation. (Cont'd on p.2)	-Pakistan's energy balance sheets -Data collected by the Energy Analysis Group -Project evaluations -Data collected and records kept by relevant GOP Ministries -Studies and surveys undertaken by project staff -Facility inspections	Assumptions for achieving outputs: -Qualified participants are selected for training -Technical consultants are effective in working with their counterparts -Training programs will effectively transfer skills and technology -Adequate personnel and budgetary support will be provided by the GOP -The Pakistani private sector will be responsive to and participate in new initiatives in energy conservation, coal development, and renewable energy

Best Available Document

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 1981 to FY 1986
Total U.S. Funding $30.0 million
Date Prepared [illegible]

Project Title & Number: Energy Planning and Development, 391-0478

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Outputs: Component 1: Conservation and Renewable Energy -Energy audits completed and Industrial Energy Audit Data System established -Industrial efficiency increased as a result of energy conservation measures -Industrial energy efficiency demonstration projects implemented -Energy needs survey describing the user market for renewable energy technologies completed -Technology assessments and demonstrations of renewable energy technologies (solar, small hydro, efficient wood stoves, and biogas digesters) completed	Magnitude of Outputs: -60 completed audits -10 percent overall improvement in efficiency -4 to 8 -1 -6 solar water heating systems installed -Long-term solar plan completed and 3 or more solar demonstration systems in place and 2 to 4 small hydro generators with test instrumentation installed -Wood survey report completed and up to 10 demonstration high efficiency stoves in operation -Up to 20 DGAI and ATRO personnel trained in U.S.	—	Assumptions for achieving goal targets:
			Assumptions for achieving purpose: which are socially and economically sound will be pursued -Coal briquetting will be economically and socially acceptable in Pakistan
Inputs: 1. A.I.D. -Short and long-term expatriate and Pakistani technical assistance -Short and long-term U.S. and third country training -Vehicles, computers, coal exploratory equipment, renewables and coal briquetting commodities and energy audit and conservation equipment -Renewables and energy conservation demonstrations and pilot coal briquetting plant 2. GOP -Staff salaries and operating expenses -Land royalties -In-country training -Office space for expatriate advisors -Locally-procured commodities (e.g. mining camp and water truck) -Recurrent costs of renewable demonstrations and pilot briquetting plant -Local consultants to undertake energy audits and to design and install renewable demonstrations -Salary of participants while in training status	Implementation Target (Type and Quantity): -See Financial Analysis, Implementation Schedule, and Proposed Technical Assistance, Commodity, and Training Plans in the project paper	-A.I.D. and GOP project records and financial reports -Project evaluations	Assumptions for providing inputs: -A.I.D. and GOP proposed funding levels are approved by their respective governments and disbursements are made on a timely basis -Appropriate overseas training programs can be identified -The GOP meets the conditions precedent for this project -Appropriate consultants can be recruited to provide the required technical assistance

DRAFT VEHICLE WAIVER REQUEST

ACTION MEMORANDUM FOR THE ASSISTANT ADMINISTRATOR, BUREAU FOR ASIA

From: ASIA/PD, G.R. Van Raalte

Subject: Source/Origin Vehicle Procurement Waiver for Energy Planning and Development Project(391-0478) - Pakistan

I. PROBLEM

You are requested to waive Section 636 (i) of the Foreign Assistance Act and to waive the source/origin requirements from A.I.D. Geographic Code 000 to A.I.D. geographic Code 935.

II. BACKGROUND

A. Cooperating Country	: Pakistan
B. Authorizing Document	: Project Grant Agreement No.391-0478 dated July 1983
C. Project	: Energy Planning and Development Project 391-0478
D. Geographic Code of Project	: 000 and Pakistan
E. Importer of Commodity	: USAID/Pakistan on behalf of the Ministries of Planning and Development, Water and Power, and Petroleum and Natural Resources
F. Description of Commodity	: Ten (10) Land Cruiser Station Wagons, 1 with 6-cylinders, 9 with 4-cylinders, diesel, right-hand drive, 4-wheel drive, air-conditioning, at estimated cost of $12,000 each Total Value: $120,000
G. Nature of Funding	: ESF Grant
H. Probable Source and Origin	: Japan

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III. DISCUSSION

Activities under the Energy Planning and Development Project require that expatriate and Pakistani technical advisors, GOP Component Project Managers and their staffs travel throughout Pakistan to supervise and monitor work on coal field exploration, field surveying, market testing and setting up demonstrations. During the life of the project, approximately 150 short-term U.S. advisors will be in-country in addition to eight long-term team leaders and managers. Much of their travel, together with their Pakistani counterparts, will be to remote areas. Two to three of the vehicles will be stationed at the Lakhra mine site, 30 miles from the nearest town where roads are very bad to non-existant.

Project Implementation requirements are such that groups of eight or nine will be scheduled to undertake overnight trips in remote areas. On such occasions, a vehicle with adequate capacity for eight or nine persons with overnight luggage and field equipment is required. These larger groups of eight or nine will have to travel in areas where road conditions necessitate four wheel drive vehicles. These field visits can be expected to occur throughout the year including summer months when temperatures may well exceed, on the average, one hundred degrees Farenheit. USAID therefore considers it essential to the health and well being of U.S. advisors and their counterparts that the vehicles be air-conditioned. These vehicles must also be right-hand drive. In Pakistan, traffic moves on the left side of the road, and much of the travel can be expected to be of long duration in rural areas where road conditions are less than optimal. Passing situations on the roads of Pakistan can be quite dangerous, and maximum visibility is critical to ensure the safety of both the driver and passengers.

The Mission is aware that the American Motors Corporation manufactures a station wagon (CJ-8) with right-hand drive and that this model, or comparable model, is also assembled locally in Pakistan. After examination of the suitability of this model, USAID has determined that this model does not meet the required specifications. The CJ-8 is primarily a utility vehicle which has a maximum seating capacity for only five passengers and does not, in the Mission's judgment, provide passenger comfort for long distance driving. Australian made vans, somewhat similar to Land Cruiser Station Wagons, were also considered, but these vehicles provide neither adequate seating/luggage space nor do they have four wheel drive. One vehicle found suitable for project requirements is the Toyota Land Cruiser Station Wagon.

Another important consideration in vehicle procurement relates to the maintenance and repair capability and the availability of spare parts for vehicles in Pakistan. This consideration is especially relevant to this project because much of the transport will be in rural areas where vehicles break down easily but where only the most widely available spare parts can be obtained. Due to considerable imports of Japanese-made vehicles into Pakistan, an extensive service and repair network and an adequate spare parts inventory exists for Japanese vehicles throughout the country. This capability and inventory are essential to ensure adequate maintenance, especially in remote regions, and to facilitate timely project implementation by making it possible for training sessions, inspections, and other activities to be completed according to schedule.

IV. JUSTIFICATION

Section 636 (i) of the Foreign Assistance Act of 1961, as amended, requires A.I.D. to procure U.S. manufactured vehicles but also provides for special circumstances that may justify waiving this requirement. The special circumstances which are directly applicable in this case are the inability of U.S. manufacturers to provide a particular type of needed vehicle, such as right-hand drive, (A.I.D. Handbook 1, Supplement B, Chapter 4C2d(1)(a)), and the lack of adequate service facilities and supplies of spare parts for U.S. manufactured vehicles (A.I.D. Handbook 1, Supplement B, Chapter 4C2d(1)(b)). Handbook 1, Supplement B. Chapter 4C2d (3) and Delegation of Authority No. 40 authorize Assistant Administrators to waive source/origin requirements in this instance.

V. ACTION REQUESTED

For the above reasons, it is recommended that you:

A. Waive the source/origin requirements set forth in Handbook 1, Supplement B, to permit the procurement of the above-mentioned vehicles from countries included in A.I.D. Geographic Code 935; and,

B. Certify by signature below that, pursuant to Section 5B4c of A.I.D. Handbook 1, Supplement B, exclusion of procurement of these project vehicles from Free World countries other than the Cooperating Country and Countries included in A.I.D. Geographic Code 941 would seriously impede the attainment of U.S. foreign policy objectives and the objectives of the foreign assistance program.

Approved_____

Disapproved_____

Date_____

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
MISSION TO PAKISTAN

Cable : USAIDPAK

HEADQUARTERS OFFICE
ISLAMABAD

THE DIRECTOR

USAID/PAKISTAN MISSION DIRECTOR'S WAIVER FOR A.I.D. PAYMENT OF INTERNATIONAL PARTICIPANT TRAVEL COSTS

A.I.D. Handbook 10, Chapter 15B1, provides that the cost of international travel, including incidental costs en route as well as the cost of travel between the participant's city and the points of departure and return in the participant's home country, shall be paid by the host government or other sponsor unless, in the case of Mission-funded programs, the Mission Director has justified and authorized full or partial waivers and has so notified S&T/IT.

Training and institution-building are important components of the $1.625 billion economic assistance program negotiated between the Governments of the U.S. and Pakistan. USAID/Pakistan's experience, however, has been that the Government of Pakistan (GOP), due to serious foreign exchange and budgetary constraints, has been historically unable to fund international travel costs for short-term training programs. The consequence has been that Pakistani participants have, on numerous occasions, been denied worthwhile and much needed training, inhibiting the achievement of project targets.

I have carefully reviewed the advisability of requiring full GOP funding for travel costs for participant training of one year or less and the alternative of funding such travel with grant and loan funds provided through USAID/Pakistan to the GOP. Recognizing the objectives of many of our projects and the fact that project success will be enhanced by encouraging opportunities for short-term training, I have determined that it would be prejudicial to U.S. interests to require that the GOP pay the entire international participant travel costs for training programs of one year or less.

Therefore, on all Mission-funded training programs up to and including one year, USAID/Pakistan shall be responsible for the entire cost of the round-trip economy class air ticket and other necessary incidental costs en route. Where a PIO/P has been originally written for a program of one year or less, but, after the participant has initiated his or her program, the program is extended so that it exceeds one year in total, USAID/Pakistan shall also fund the round-trip ticket. The justification for funding programs that are extended is to minimize administrative problems which are otherwise likely to occur.

On the basis of the above justification and pursuant to Handbook 10, Chapter 15B1a, I, Donor M. Lion, principal officer of the Agency for International Development in Pakistan, do hereby waive the requirement that the host government fully fund international travel for training courses of one year or less and authorize payment with USAID/Pakistan loan and grant funds for travel costs as specified above.

Donor M. Lion

Donor M. Lion
Director
USAID/Pakistan

March 17, 1982

Date

DRAFT PROJECT AUTHORIZATION

Name of Project: Energy Planning and Development

Number of Project: 391-0478

Pakistan

1. Pursuant to Section 531 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Energy Planning and Development Project for the Islamic Republic of Pakistan involving planned obligations of not to exceed U.S. dollars thirty million ($30,000,000) in grant funds over a four (4) year period from the date of authorization, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the Project.

2. The Project is designed to increase Pakistan's energy self-sufficiency by assisting the Government of Pakistan (GOP) to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and to increase the efficiency of energy use. This will be accomplished by, among other things, strengthening the capability of the GOP to: (a) undertake effective integrated and sectoral analyses of energy development strategies in order to support financially sound GOP energy policy and development planning; (b) develop programs in coal assessment, mining, and utilization; and, (c) adopt energy conservation and renewable energy technologies.

3. The Project Agreement(s) which may be negotiated and executed by the officer(s) to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority shall be subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

a. Source and Origin of Goods and Services

Goods and services financed by A.I.D. under this Project shall have their source and origin in the Cooperating Country or in the United States, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the Project shall, except as A.I.D. may otherwise agree in writing, be financed only on flag vessels of the United States and the Cooperating Country.

b. Condition Precedent to the Selected Disbursement of Funds under the Energy Analysis and Manpower Development Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made for the long-term general technical assistance contract, participant training and special studies under the Energy Analysis and Manpower Development Component of this Project, the Grantee, acting through its Planning and Development Division, Ministry of Planning and Development, shall furnish to A.I.D., in form and substance satisfactory to A.I.D. evidence that:

i. an administrative unit within the Planning and Development Division has been authorized and established to assume responsibility for Energy Analysis and Manpower Development activities and is being organizaed, staffed, and equipped; and,

ii. a Participating Agency Project Implementation Coordinating Committee has been authorized and established, its duties and responsibilities have been defined, and the Committee is being organized, staffed, and equipped.

c. Condition Precedent to the Selected Disbursement of Funds for Activities under the Coal Mine and Coal-Fired Power Generation Development Sub-Component of the Coal Resource Assessment and Development Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which disbursement will be made for the Coal Mine and Coal-Fired Power Generation Development Technical Assistance Contract under the Coal Resource Assessment and Development Component of this Project, the Grantee, acting through its Planning and Development Division, Ministry of Planning and Development, shall furnish to A.I.D., in form and substance satisfactory to A.I.D., evidence that:

i. a Coal Projects Department has been authorized and established to promote, plan, and manage the development and implementation of coal mine and coal-fired power generation projects within WAPDA and adequate funds have been made available for its operation;

ii. the authority, duties and responsibilities of the overall manager and the coal mine and power section managers of the Department have been adequately defined; and,

iii. an adequately trained and experienced overall manager of the Department has been appointed and persons to fill the other two managerial positions have been identified.

d. Condition Precedent to the Selected Disbursement of Funds under the Conservation and Renewable Energy Technologies Component

Except as A.I.D. may otherwise agree in writing, prior to the disbursement under this Project or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made under the Conservation and Renewable Energy Technologies Component of this project, except for vehicles and household/office furniture and equipment, the Grantee, acting through its Directorate General for Energy Resources (DGER) of the Ministry of Petroleum and Natural Resources and its Planning and Development Division of the Ministry of Planning and Development shall furnish to A.I.D., in form and substance satisfactory to A.I.D., evidence that:

i. an adequately staffed administrative unit has been authorized and established within the DGER to manage all component activities; the authorities, duties and responsibilities of the overall manager and the conservation and renewable energy managers in the administrative unit have been adequately defined; and, an adequately trained and experienced overall manager of the administrative unit has been appointed; and,

ii. a National Renewable Energy Activities Coordinating Committee has been authorized and established and its duties and responsibilities as well as those of both its public and private sector members have been adequately defined.

e. Covenant as to Participant Training

The Grantee, acting through its Planning and Development Division, Ministry of Planning and Development, and each of the Participating Agencies in the Project, shall make every reasonable effort to require that each person trained under this Project works in energy sector activities in Pakistan for not less than three times

the length of time of his or her training program provided, however, that in no event shall the individual be allowed to work in energy sector activities for less than one year nor be required to work in energy sector activities for more than five years from the date of the individual's completion of training.

f. Covenant as to Activity Reports

The Grantee shall furnish to A.I.D., in form and substance satisfactory to A.I.D., periodic activity reports, the requirements of which shall be, from time to time, set forth by A.I.D. in Project Implementation Letters. The requirements may include, but shall not be limited to providing information concerning:

i. progress of each of the implementing agencies in organization, staffing and training;

ii. progress of each of the long-term technical assistance contractor teams with respect to meeting established targets in the schedules and workplans of individual advisors; effecting commodity procurements; scheduling, implementing and evaluating training programs and demonstrations; and, preparing required reports and other project documents; and,

iii. a combined summary report for the entire Project.

g. Covenant as to External Evaluation

The Grantee shall participate in periodic external project evaluations by assigning senior representatives of participating ministries and agencies to joint A.I.D.-Grantee Evaluation Teams. Participants in project evaluations are to be individuals who are familiar with the project but who are not directly involved in its implementation.

4. The following waiver to A.I.D. regulations is hereby approved: a source/origin waiver from A.I.D. Geographic Code 000 to A.I.D. Geographic Code 935 to permit the purchase of ten (10) right-hand drive vehicles.

APPROVED: _____

M. Peter McPherson
Administrator

DATE: _____

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CONGRESSIONAL NOTIFICATION

PLANNED PROJECT SUMMARY SHEET

Country	: Pakistan
Project Title	: Energy Planning and Development
Project No.	: 391-0478
Appropriation Category	: Economic Support Funds
Life of Project	: FY 1983 - FY 1988
Intended Obligation FY 1983	: $13.0 million ESF Grant

This is to advise that A.I.D. intends to obligate $13.0 million of Economic Support Funds in FY 1983 for the Pakistan Energy Planning and Development Project. The Energy Planning and Development Project is designed to assist the Government of Pakistan to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and to improve the efficiency of energy use.

ANNEX: Activity Data Sheet

PROGRAM: PAKISTAN

ACTIVITY DATA SHEET

ANNEX I
Page 1

TITLE	FUNDS	PROPOSED OBLIGATION (in thousands of dollars)	
Energy Planning and Development	ESF	FY 83: 13,000	LIFE OF PROJECT: 30,000
NUMBER 391-0478; GRANT [X] LOAN [ ]; NEW [X] CONTINUING [ ]	PRIOR REFERENCE: None	INITIAL OBLIGATION FY 83; ESTIMATED FINAL OBLIGATION FY 86	ESTIMATED COMPLETION DATE OF PROJECT FY 88

Purpose: To assist the Government of Pakistan to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and to improve the efficiency of energy use.

Background: Pakistan is highly dependent on imported oil which provides over 25 percent of all energy used. At the same time, the country has large reserves of low grade coal, but only a small part is proven, and coal production is very low, providing less than 5 percent of energy use. The country has limited experience in energy planning and analysis and in implementing renewable energy programs, and its capability in these areas needs to be significantly strengthened.

Pakistan is at a very important juncture relative to its overall economic development and the role of energy resources in this development process. In particular, the short-lived era of perceived high gas availability with associated low costs is rapidly coming to an end. To a large extent, gas has been a major factor in accelerating Pakistan's development over the last two decades. Decisions will have to be made on such critical issues as natural gas pricing, energy intensive industrial expansion, exploration policies, coal development, energy-related infrastructure development, and manpower development. The investment implications of these decisions will be enormous and long lasting.

Project Description: The project consists of three major components as follows:

The purpose of the Energy Analysis and Manpower Development component is to strengthen the capability of the GOP to collect and analyze data on energy resources, sectoral demand, and economic and social factors so that the financial implications of energy development options are made available to and can be clearly understood by policy-making bodies in Pakistan. Technical assistance, training and commodities will be provided to the GOP Planning and Development Division in the Ministry of Planning and Development to support the development and management of an Energy Data System, the development of an Energy Analysis Group, and the implementation of a series of special energy studies and of a manpower assessment and development program.

The Coal Resource Assessment and Development component will support GOP and private sector efforts to develop Pakistan's coal resources as an alternative to natural gas, imported oil and fuelwood. Under this component, technical assistance, training, and commodities will be provided to assist the GOP to assess and plan for the development of national coal reserves, prepare for the implementation of the country's first large scale coal mine and power generation project (Lakhra), define the private sector's role in coal mining, and introduce processed coal briquettes as an alternative to increasingly scarce and expensive fuelwood.

The Conservation and Renewable Energy Technologies component consists of two sub-components: an energy conservation program to increase the efficiency of industrial energy use; and, a program to assess and develop renewable energy technologies. Energy conservation is the most promising option available to Pakistan to deal with its near-term energy supply and demand imbalance. This project sub-component, which will be based on extensive U.S. experience in this field, will include the following activities: energy audits of specific industrial plants, industrial energy use data systems, training, and demonstrations. The overall objective is to develop a national industrial energy conservation program. Under the renewable energy assessment and development sub-component, technical assistance, training, and demonstration equipment will be provided to develop a comprehensive national renewable energy assessment and development program which will delineate the long-term role and accelerate implementation of promising renewable energy technologies. Activities will include a residential and small commercial energy needs survey and assessments and demonstrations of a number of specific applications and technologies, including solar heating and power, small hydro, energy-efficient wood stoves, and other biomass technologies.

Relationship of Project to A.I.D. Country Strategy: The Mission's Country Development Strategy Statement (CDSS) highlights USAID/Pakistan's energy sector objective "to increase the availability of reliable and affordable energy in rural areas in ways which will decrease Pakistan's dependence on imported energy supplies and increase its energy self sufficiency". The CDSS then identifies six strategic interventions by which USAID seeks to assist Pakistan to realize this objective: (1) rationalize energy prices to eliminate or reduce subsidies and provide incentives for domestic energy exploration and exploitation; (2) increase installed electric generating capacity; (3) promote development and use of indigenous energy resources including coal, fuelwood, hydro, solar, and the like; (4) identify and develop new energy sources; (5) increase private sector involvement in energy development and the energy sector as a whole; and, (6) promote conservation and efficiency in energy use. The proposed project is clearly supportive of and responsive to the Mission's CDSS. It is also consistent with the general thrust of the $1.625 billion ESF program to Pakistan over the FY 1982 - FY 1987 period, which is to provide substantial economic assistance to support growth and economic stability in Pakistan with particular emphasis on insuring that Pakistan is able to maintain a manageable balance of payments position through the full life of the planned ESF program. The pattern of development within Pakistan's domestic energy sector will be critical to all three of these objectives: growth, stability and balance of payments.

Host Country and Other Donors: The GOP is expected to contribute the equivalent of $6,393,000 over the life of the project in the form of office space for U.S. advisors, local currency for in-country training, a portion of commodities under the coal component including the mining camp, and Pakistani staff salaries and related costs. The GOP will also cover the recurrent costs of all renewable energy demonstrations and the pilot briquettes plant as well as the costs of Pakistani consultants to design and install renewable demonstrations and to undertake energy audits.

Several major multilateral and bilateral donors are funding activities in the energy sector. While these activities touch on several of the same areas which will be addressed by A.I.D., no other donor has pursued or is pursuing a comprehensive strategy and holistic approach in the energy sector nor is any donor addressing the planning and coordination problems nor attacking industrial energy efficiency and coal development problems. Each donor, for the most part, is working in discrete areas or on specific activities within the energy sector. This proposed A.I.D. project is designed to complement and supplement the activities of other donors. Key multilateral institutions involved in the energy sector are the Asian Development Bank (ADB), the World Bank, and UNDP. Bilateral donors, in addition to A.I.D., are the Canadian International Development Agency (CIDA), KfW of West Germany, and the Japanese International Cooperation Agency (JICA).

Beneficiaries: Stimulating more analysis of expensive energy options and assisting to develop necessary skill bases will save taxpayers money directly and will benefit them indirectly by making more energy available for development uses. Coal-related activities will benefit more those who currently use commercial energy. Those who currently have no access to electricity will benefit from the increased coal energy stimulated by this project, since the use of coal will certainly ease Pakistan's serious shortage of fuel for electrical generation and will thereby allow the continued spread of rural electrification. Those individuals in remote areas who have no access to electricity will receive special attention under the Renewable Energy component. Small hydro activities will focus on the NWFP, and solar and biomass activities will pay special attention to rural villagers nationwide. Women will receive special attention under the coal briquetting and wood stove activities. More efficient wood stoves or the substitution of cheaper, more efficient coal briquettes will reduce the time and energy women spend for obtaining fuel, thus freeing them for other productive activities. In addition, more efficient household energy use and substitution of smokeless briquettes for wood will reduce household smoke, thus producing a healthier household environment for women and small children who spend much of their time at home. Finally, the private sector will be a direct target group of the energy conservation activity, and the increased private sector involvement, which are major objectives of both the coal development and renewable energy activities, will clearly directly benefit this group.

Major Outputs	All Years
Permanent Energy Analysis Group Established	1
Operational Energy Data Management System Established	1
Special Energy Studies Completed	8
Coal Resource Assessments Completed	3
Coal Analysis Facilities Improved	3
Coal Projects Department Established	1
Pilot Briquettes Plant Established	1
Energy Use Audits Completed	60
Industrial Energy Use Data System Established	1
Industrial Energy Conservation Demonstration Projects Implemented	6 - 8
Selected Renewable Energy Demonstration Projects Implemented	4 - 8
Comprehensive National Industrial Energy Conservation Program Developed	1
Mining Techniques Demonstrations Implemented	4
Energy End Use Survey of Residential and Small Commercial Sectors Completed	1

A.I.D. Financed Inputs:	Life of Project ($000)
Technical Assistance	17,379
Training	2,121
Commodities	7,020
Evaluation and Contingency	3,480
Total	30,000

U.S. FINANCING (in thousands of dollars)	Obligations	Expenditures	Unliquidated
Through September 30, 1981	-	-	-
Estimated Fiscal Year 1982	-	-	-
Estimated through September 30, 1982	-	-	-
		Future Year Obligations	Estimated Total Cost
Proposed Fiscal Year 1983	13,000	17,000	30,000

PRINCIPAL CONTRACTORS OR AGENCIES

U.S. firms or associations and the U.S. Geological Survey

Best Available Document

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DRAFT PROJECT DESCRIPTION FOR INCLUSION IN THE PROJECT AGREEMENT

A. Project Goal and Purpose

The goal of the Energy Planning and Development Project is to increase Pakistan's energy self-sufficiency and thereby improve the quality of life for its people. The purpose of the project is to assist the Government of Pakistan (GOP) to formulate and implement plans and programs to assess, develop and use Pakistan's indigenous energy resources and increase the efficiency of energy use. This will be achieved by strengthening the capability of the GOP to: (1) undertake effective integrated and sectoral analyses of energy development strategies in order to support financially sound GOP energy policy and development planning; (2) develop programs in coal assessment, mining, and utilization; and, (3) adopt energy conservation and renewable energy technologies.

B. Project Components

The project is divided into three major components: (1) Energy Analysis and Manpower Development; (2) Coal Resource Assessment and Development; and, (3) Conservation and Renewable Energy Technologies.

The purpose of the Energy Analysis and Manpower Development component is to strengthen the capability of the GOP to collect and analyze data on energy resources, sectoral demand, and economic and social factors so that the financial implications of energy development options are made available to and can be clearly understood by policy-making bodies in Pakistan. Technical assistance, training and commodities will be provided to the GOP Planning and Development Division in the Ministry of Planning and Development to support the development and management of an Energy Data System, the development of an Energy Analysis Group (EAG), and the implementation of a series of special energy studies and of a manpower assessment and development program. Assistance will be provided to enable the Energy Analysis Group to undertake integrated analyses in support of the GOP's annual, five-year and long-term planning cycles and to provide information required for investment planning and manpower development in the energy sector.

The Coal Resource Assessment and Development component will support GOP and private sector efforts to develop Pakistan's coal resources as an alternative to natural gas, imported oil and firewood. Under this component, technical assistance,

training, and commodities will be provided to assist the GOP to (a) assess and plan for the development of national coal reserves, (b) prepare for the implementation of the country's first large-scale coal mine and power generation project (Lakhra), (c) define the private sector's role in coal mining, and (d) introduce processed coal briquettes as an alternative to increasingly scarce and expensive fuelwood. A substantial amount of training of Pakistani professional personnel both on-the-job and in the U.S. and third countries is included under all three sub-components described below:

Assessment of coal reserves is planned to be done by the Geological Survey of Pakistan (GSP) with the assistance of the U.S. Geological Survey (USGS). Activities under this sub-component will include coal exploratory drilling, coal analysis and testing, data management and geological studies.

A high priority of the GOP as expressed in its Sixth Five-Year Plan is to substantially increase the use of indigenous coal by constructing a 300 MW coal-fired power generation station and developing a mine at Lakhra to provide the coal. This A.I.D. project will include assistance to the Water and Power Development Authority (WAPDA) to undertake final exploratory and survey work at the Lakhra deposit so that engineering work, procurement and construction can proceed rapidly as soon as capital financing is available.

A third important area of development for Pakistan's coal industry is the introduction of the use of processed coal for household use as a substitute for firewood. Under this project, a market survey and tests will be conducted, a pilot coal briquetting plant will be built, and a marketing system will be established to sell the briquettes to selected markets.

The Conservation and Renewable Energy Technologies component consists of two sub-components: an energy conservation program to increase the efficiency of industrial energy use; and, a program to assess and develop renewable energy technologies. Energy conservation is the most promising option available to Pakistan to deal with its near-term energy supply and demand imbalance. This project sub-component will include the following activities: energy audits of specific industrial plants, industrial energy use data systems, training, and demonstrations.

The overall objective is to develop a national industrial energy conservation program.

This project sub-component includes assistance to identify industrial sectors and specific facilities within those sectors for the energy audit program. Funds are included to implement several demonstration conservation projects. Data compiled as a result of these and other energy audits will be used to establish an industrial energy use data system.

Under the renewable energy assessment and development sub-component, assistance will be provided to develop a comprehensive national renewable energy assessment and development program which will delineate the long-term role and accelerate implementation of promising renewable energy technologies. Pilot projects will be designed and carried out to demonstrate the feasibility and usefulness of the promising technologies.

C. Implementation Plan

1. Illustrative Implementation Schedule

All project activities are scheduled to take place over a period of five (5) years from the date of signing of this Project Grant Agreement. As soon as possible after the Agreement is signed, A.I.D. will, amongst other things:

a. execute a contract with an individual to serve as the long-term General Advisor;

b. procure household and office furnishings for all long-term advisors under the project;

c. procure project vehicles;

d. negotiate and execute a Participating Agency Services Agreement (PASA) with the U.S. Geological Survey (USGS) to provide assistance under the Coal Resources Assessment sub-component;

e. award a contract for Consulting Engineering Services under the Coal Mine and Coal-Fired Power Generation sub-component;

f. award a contract to a U.S. firm or association to assist the GOP to implement the remaining activities under this project;

g. procure selected equipment for the Coal Mine and Coal Fired Power Generation component; and,

h. develop preliminary training plans for each of the project components, identify suitable candidates, and make arrangements to enroll these individuals in appropriate programs.

A.I.D. will also procure the services of short-term contractors to undertake feasibility studies and other activities as appropriate including assistance to:
(a) implement the coal mining industry workshop;
(b) organize and staff the Energy Analysis Group in the Planning and Development Division, the Coal Projects Department in the Water and Power Development Authority (WAPDA), the Geological Survey of Pakistan (GSP), and the Directorate General of Energy Resources (DGER); and,
(c) prepare preliminary training plans and arrange for training of key GOP project implementation staff.

A.I.D. has already begun to prepare the necessary contract documentation in order to facilitate the early signing of a contract for the coal development sub-component. WAPDA has made significant progress to date in establishing its Coal Projects Department such that the long-term advisors will be able to begin immediately to assist the Department to organize its staff, develop a training plan and a work plan, and procure required commodities.

2. A.I.D. Responsibilities

A.I.D. will be responsible for: (a) contracting with all expatriate technical consultants; and, in specificed cases, Pakistani consultants; (b) purchasing directly all project vehicles, all household and office equipment and supplies for long-term consultants, and several priority items for the Coal Development sub-component as well as arranging

for the procurement of the remaining commodities; (c) arranging for long-term and short-term training of Pakistanis outside of Pakistan; (d) providing sufficient staff to participate in the scheduled project evaluations and to liaise with host country staff in the implementation of this project; and, (e) inspecting and certifying for payment construction installations.

3. GOP Responsibilities

The major GOP implementing agency for the project will be the Planning and Development Division of the Ministry of Planning and Development. A full-time Project Director shall be appointed in the Planning and Development Division to be in charge of the overall project. This individual may also be the head of the Energy Analysis Group which will be established under the project and will be responsible for implementing the Energy Analysis and Manpower Development Component of this project. Within the Ministry of Water and Power, the Water and Power Development Authority (WAPDA) will take the lead for all Coal Development activities under this project through its Coal Projects Department. The Pakistan Council for Scientific and Industrial Research (PCSIR) in the Ministry of Science and Technology will be responsible for the implementation of the Coal Briquetting sub-component. The lead agency for implementing the energy conservation and renewable energy technologies activities and the coal resource assessment work will be the Ministry of Petroleum and Natural Resources. Within this Ministry, the Geological Survey of Pakistan (GSP) will be responsible for the Coal Resource Assessment sub-component, and the Pakistan Mineral Development Corporation (PMDC) will work closely with WAPDA to implement the Coal Development sub-component. The Directorate General of Energy Resources (DGER) in this Ministry will assume overall responsibility for the Energy Conservation and Renewable Energy Technologies Component of this project. All of these agencies shall appoint and delegate authority to full-time Project Component Managers and assign to them adequate staff to implement, with the assistance of expatriate advisors, their respective components of the project.

To provide effective overall leadership, establish policy and program guidelines, review and solve major project implementation problems, and serve as a continuing forum for all relevant Pakistani ministries and agencies to mointor project progress, a high level committee made up of members

and arranging for the hiring of local consultants to design and install renewable energy demonstrations and undertake energy audits; and, (i) providing A.I.D. with timely approvals of reports, commodity purchases, training programs, expatriate contract personnel, and construction installations, as may be required from time to time during the life of the project.

ILLUSTRATIVE

SUMMARY OF PROJECT COSTS BY EXPENSE CATEGORY AND SOURCE OF FUNDING
(In 000's)

Expense Category	FY 1983		Life of Project Funding a/	
	A.I.D. Grant (In $)	GOP (In Rs)	A.I.D. Grant b/ (In $)	GOP (In Rs)
1. Technical Assistance				
a. Short-Term	4,940	1,200	10,918	2,400
b. Long-Term	4,400	1,300	7,061	2,600
Sub-Total	9,340	2,500	17,979	5,000
2. Training				
a. U.S. Long-Term	90	-	184	-
b. U.S. Short-Term	610	-	2,296	-
c. In-Country	-	1,000	-	5,000
d. Third Country Short-Term	-	-	41	-
Sub-Total	700	1,000	2,521	5,000
3. Commodities				
a. Vehicles	160	-	238	-
b. Other	2,800	3,050	6,782	3,050
Sub-Total	2,960	3,050	7,020	3,050
4. Other Costs				
a. Evaluation	-	-	400	-
b. Operating Expenses	-	7,425	-	68,770
Sub-Total	-	7,425	400	68,770
Total	13,000	13,975	27,920	81,820
Contingency	-	-	2,080	-
Grand Total	13,000	13,975	30,000	81,820

a/ Does not include funding under the A.I.D.-financed Development Support Training Project (391-0474) and the AID/Washington centrally-funded Conventional Energy Training Project which may be used to finance some of the training activities under this project, subject to the availability of funds to A.I.D. for this purpose.

b/ Subject to the availability of funds to A.I.D. for this purpose and to the mutual agreement of the parties to proceed at the time of each subsequent increment.

LAKHRA PROJECT

SECTION 1

EXECUTIVE SUMMARY

1.1 INTRODUCTION

Pakistan's growing demand for electricity is rapidly outpacing its electric generation capacity. This power short-fall is rapidly approaching serious, if not critical, proportions. Load shedding of up to 500 MW was required in 1981/82 and is expected to reach 1,000 MW by 1983/84. A primary reason lies in the uneven electric generation of installed hydroelectric capacity since rainfall and glacial melt are seasonal and the priority on water use is in irrigation. Shortages of natural gas for industry have lead to a national policy prohibiting further use of this resource for power generation. Fuel oil is an imported fuel with a large foreign exchange demand and one that could be the subject of future supply disruptions.

Hence, the use of indigenous coal resources is a primary option as a fuel for thermal electric power plants in Pakistan. Preliminary geological investigations of a 26-square kilometer section of the Lakhra Coal Field, located 45 kilometers northwest of Hyderabad (Figure 1.1-1), indicate that this section alone contains sufficient economically recoverable coal to fuel several hundred megawatts of electric power generation capacity. In addition to the Lakhra reserve, there are other coal deposits in Pakistan and efforts are currently underway, with support from the World Bank and others, to better define the extent, quality, and development prospects of Pakistan's coal resources.

Over the past 15 years, several studies have been conducted by the Government of Pakistan (GOP), with some assistance from foreign governments, to examine the technical feasibility and costs of generating electric power using Lakhra Coal. The results of these studies were not sufficiently conclusive to convince the GOP that a Lakhra coal mine supplying coal to a steam-electric power plant was a technically sound and economically attractive investment.

In response to a formal request from the GOP, the United States Agency for International Development (USAID) agreed to support a thorough reexamination of the technical feasibility and costs of such a project. USAID designed the study to be a collaborative effort of a U.S. contractor working with two Pakistan organizations, Pakistan's Water and Power Development Authority (WAPDA), and the Pakistan Mineral Development Corporation (PMDC). The intent was to involve these Pakistan organizations thoroughly in the examination of key technological and economic issues and the formulation of the study results. The participants would also be exposed to modern large-scale coal production and power generation technology currently being used in the U.S. and would gain first hand knowledge of the coal technology that can be applied in a Lakhra Coal Facility. In view of the potential national importance of such a project, USAID also arranged for senior GOP officials to review the results of this study. In this fashion, a well informed decision could be made on the advisability of implementing a Lakhra Coal Facility project.

Study activities began in the fall of 1982. Stone & Webster Engineering Corporation (SWEC) was retained by USAID to provide expertise in coal mining, coal handling, and power generation technology. A joint WAPDA, PMDC, SWEC analytical team was formed in October 1982. Data collection and field visits in Pakistan followed immediately. Analytical activities in SWEC Boston headquarters were combined with visits to U.S. coal mines and power generation plants in December and January. Initial findings were reviewed with senior GOP and USAID officials in January 1983. These findings were sufficiently positive, so that WAPDA management decided to propose to the Pakistan Planning Commission that a Lakhra Coal Facility project be included in Pakistan's Sixth Five-Year Economic Development Plan. Accordingly, the study activities were extended through April 1983 in order to expand certain analyses, plan in more depth the project's implementation and provide technical and other support to the authorization of the project.

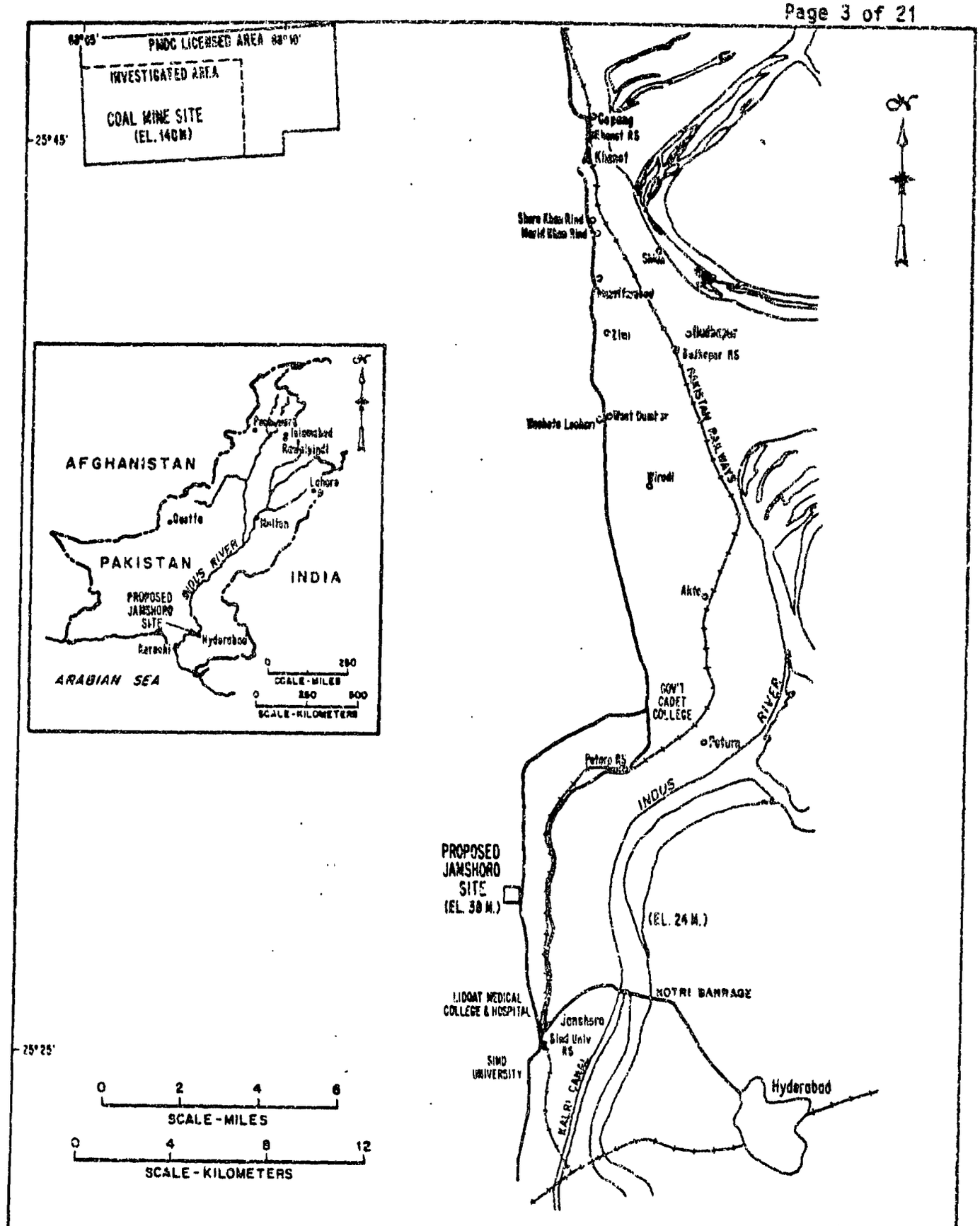

FIGURE 1.1-1
LAKHRA PROJECT-SITE LOCATION
LAKHRA COAL STUDY

1.2 STUDY APPROACH

The ground rules established by USAID required that key officials from WAPDA and PMDC work with SWEC counterparts participating in every phase of the study. Following a three-week trip to Pakistan by SWEC mining and power engineers to gather data and refine the scope of the study, WAPDA's Director of Fuels and Efficiency, PMDC's Chief Mining Engineer and PMDC's Deputy Chief Geologist came to the U.S. and spent approximately two months participating in the analysis and preparation of the written report. Two weeks before the presentation of the draft report, WAPDA's Chief Engineer - Thermal, and Resident Engineer at Quetta's Power Station came to review and comment on the study before final preparation. In addition, the WAPDA officials visited several coal-fired power stations, while the PMDC officials visited numerous surface and underground mining operations.

The study team used the geological data developed by previous investigators to independently assess the quality and extent of the Lakhra Coal Reserve. No new field exploration or core drilling activities were to be conducted.

Following the study team's presentation of preliminary findings concerning a 300-MW facility to senior GOP officials and to USAID in January of 1983, SWEC was asked to develop planning and scheduling summary networks and cash expenditure schedules for both the 300-MW facility and a 600-MW facility incorporating two identical 300-MW power plants. In addition, the team was asked to assist WAPDA and PMDC in preparing in Pakistan the PC-1 Report to be submitted to the GOP for inclusion of the Lakhra Project in the Sixth Five-year Economic Development Plan.

The study team took a pragmatic approach in the design of the Lakhra Facility, emphasizing the fact that this would be the first application in Pakistan of large-scale coal production and power generation technology. Only proven and reliable technology with extensive operating experience would be recommended for Lakhra. Designs that improved system reliability, maintainability, and operability were generally favored to those that reduced plant costs. Moreover, designs were selected to comply with the Pakistan Government's policy of encouraging domestic economic growth while minimizing foreign exchange commitments. Consequently, designs which allowed equipment manufacture in Pakistan were selected whenever possible and labor-intensive designs were generally favored to capital-intensive ones.

The specific issues addressed in this study follow:

1. Extent of coal reserves in the delineated area
2. Acceptability of coal quality
3. Type of mining methods
4. Beneficiation of Lakhra Coal
5. Environmental protection

6. Power plant siting

7. Power plant design parameters

8. Minimum implementation schedule

9. Capital costs

10. Unit costs of delivered coal and busbar electricity

11. Comparison of power generation alternatives

12. Transfer of technology and training needs

The examination of each issue resulted in the findings described in the following section.

1.3 DETAILED FINDINGS

1.3.1 Coal Reserves

As shown in Figure 1.1-1, the Lakhra Area is 45 km north northwest of Hyderabad (Pakistan's third largest city), 20 km west of the Indus River and 112 meters above the Indus flood plain. The area consists of flat-topped hills and is barren with a few shrubs and bushes but no trees. The population is sparse consisting mainly of nomads who graze their herds during the wet season.

The present estimate of proven, recoverable reserves based on field data reported by previous consultants* in the delineated area of the Lakhra coal field is 64.4 million metric tons. This estimate will be increased substantially if subsequent mining experience indicates that stripping ratios exceeding 1:15 can be justified. Increasing the maximum ratio to 1:20 will increase recoverable coals within the delineated area by thirty to forty percent. The present estimates are therefore sufficient to support a coal production rate of 2 million metric tons per year for the scheduled 30 year life of the power generating station. A 300-MW unit, burning coal of the quality indicated in Section 1.3.2 would consume 1.4 million metric tons per year.

The prospects for finding further reserves of recoverable coal in areas adjacent to the delineated area are considered favorable. In particular, an extension of the western boundary of the delineated area, where stratigraphical conditions appear least disturbed and where mining conditions are most favorable, appears to offer good prospects that substantial additions to the present estimates will be proven. This could also eliminate the need for an underground mine, at least for the first 300-MW facility. It is, therefore, desirable that field drilling be undertaken as soon as possible because a finding of substantial additional reserves will have a major impact on the present plans for designing mining operations.

1.3.2 Coal Quality

An average analysis of coal in the delineated area, based on borehole analyses data reported by previous consultants*, follows:

	As-Received Basis
Moisture	25.0 percent by weight
Ash	19.3 percent
Volatile Matter	28.8 percent
Fixed Carbon	26.9 percent
	100 percent

*See "Feasibility Report for Lakhra Coal Mining Power Station," February, 1981; Japan International Cooperation Agency.

Total Sulfur	5.95 percent
Calorific Value (HHV)	15,890 KJ/Kg (6,830 Btu/lb)

ASTM standards rank this coal as Lignite A, bordering on Sub-bituminous C.

The quality parameters are subject to considerable variation both within and between the coal seams. Thus, total sulfur is reported to vary in the range 3.3 to 9.8 percent and contains a substantial proportion in pyritic form. Iron oxides, present in substantial quantity in the coal ash, vary from 17 to 71 percent. Other minerals present include varying quantities of gypsum, which is visible as intercalated bands in the coal seams.

The combined presence of high iron, and pyritic and inorganic sulfur contents raises problems relating to slagging and corrosion in steam generators which will require special attention in boiler design.

The coal is readily subject to spontaneous combustion. This finding is based on the direct experience of private coal producers mining coal from the same seams in adjacent lease areas and by laboratory tests carried out by previous consultants. These observations confirm the well-known propensity of low rank coals to spontaneous combustion which is usually enhanced by the presence of iron pyrites. Particular attention will need to be given to this behavior of the coal in all aspects of mine design and operation, coal handling, and storage.

The study team and experts at SWEC met with several major U.S. boiler manufacturers to discuss problems arising out of the quality of the Lakhra coal. The conclusions from these discussions were that if (1) representative samples of Lakhra coal are made available for detailed investigation, (2) boiler designs appropriate to the slagging corrosion and erosion propensities of the coal are employed and, (3) proper boiler operating and maintenance procedures are followed, a Lakhra coal-fired steam generator can be designed and operated without experiencing abnormal outages. The discussions emphasized the importance of obtaining representative samples so that these preliminary conclusions can be confirmed by additional data specifically oriented to the problems identified.

1.3.3 Mining Methods

A review of the available geological and geotechnical data confirmed that mining factors such as seam continuity, faulting, depth of cover, seam thicknesses and interseam separations divided the delineated area into three blocks: One western block and one larger eastern block having stripping ratios favorable for surface mining; and a small central block suitable only for underground mining. Further investigation of mining methods applicable to the surface minable blocks indicated that truck and shovel or combination dragline with truck and shovel operations, were feasible. The strata are not suitable for mining by bucketwheel excavators. Cost, delivery times and job creation are issues that favor the truck and shovel method at the present time.

Present underground mining plans are based on a combination of handloading and mechanized longwall operations employing retreating sequences. A principal factor controlling the design of an underground mine is the propensity to spontaneous combustion of the coal in situ. This requires that exposed faces and ribs of the coal seams in active and passive areas of the mine, and in abandoned and sealed areas, be minimized. An additional factor is the need to maximize coal recoveries because of the limited reserve base available. These factors tend to favor longwall mining methods over pillar and stall operations.

1.3.4 Coal Beneficiation

A review of all the available data indicate that beneficiation of the coal by washing is not justified and that cleaning should be limited to removal of visible rock dilution by hand-picking. Previous investigators* reported washability data determined by laboratory testing of ten borehole core samples taken from representative areas of the delineated area. It recommended that further work be done. The washability data were obtained under conditions much more favorable than can be provided in practical operations. Even so the results show that the coal is extremely difficult to wash by available commercial processes. Indicated yields are low and improvements in ash and sulfur contents are marginal for the resulting losses. Disposal of a refuse still containing substantial thermal values would also pose a serious problem from spontaneous combustion.

1.3.5 Environmental Protection

In the absence of Pakistan environmental protection criteria, the study team found that guidelines issued by the World Bank offered the most practicable environmental protection criteria available for the Lakhra Facility. The degree of protection was found to be consistent with Pakistan's level of economic development.

The highest uncontrolled 24-hour ambient air concentration of SO_2 produced by a 300-MW facility burning Lakhra coal containing 6 percent sulfur, as-received by the steam generator was estimated to be 226 micrograms per cubic meter (ug/m^3). The corresponding maximum concentration of SO_2 allowed by the World ank guidelines is 500 ug/m^3. Thus, flue gas desulfurization (FGD) is not required on the first 300-MW unit. The need for FGD on subsequent units should be assessed prior to the consideration of more units at Jamshoro.

Based on the particulate stack emission limit of 150 milligrams per cubic meter (ug/m^3) and the maximum 24-hour ambient air particulate concentration of 500 ug/m^3 specified by the World Bank Guidelines, the required removal efficiency for the electrostatic precipitator at the Lakhra power plant burning Lakhra coal containing 20 percent ash on an as-received basis is 99.3 percent. This is a practical level to achieve with conventional equipment.

*See "Feasibility Report for Lakhra Coal Mining Power Station," February, 1981; Japan International Cooperation Agency.

1.3.6 Power Plant Siting

Jamshoro is the preferred site (see Figure 1.1-1) for the power plant(s) out of four sites examined by the previous investigators.* Table 1.3-1 indicates the factors included in the site selection study and comparative capital and operating cost effects.

An evaporative heat rejection system employing mechanical draft cooling towers incurs a slightly lower lifetime cost and a significantly lower initial capital cost than the once-through system proposed by previous investigators.

A dedicated railway and unit train is the preferred coal transport mode from the mines at Lakhra to the Jamshoro site. The railway will be about 50 km long. The rolling stock consists of one diesel locomotive and approximately fifty 40-metric ton railcars manufactured in Pakistan. The possibility of converting from diesel to electric drive should be considered at an early stage of project implementation.

As long as cooling towers are used, sufficient space and cooling water are available at Jamshoro to support Lakhra coal-fired generation capacity expansion in excess of 2,000 MW.

1.3.7 Power Plant Design Parameters

The net capacity of the first coal-fired power plant at Jamshoro should be 300 MW. This size fits well into WAPDA's system with a maximum system capacity of 3,225 MW (in early 1982) and a maximum unit capacity of 210 MW (Unit 3 at Guddu). The coal reserves in the delineated mine area appear to be sufficient to support 500 MW of Lakhra coal-fired generation capacity for 30 years. Moreover, the coal production potential of the Lakhra field is likely to be an order of magnitude higher than that for the delineated area. Thus, the prospect of adding two 300-MW units at Jamshoro appears favorable pending detailed geological investigations two determine the adequacy of the coal reserves.

Turbine throttle steam conditions at the maximum guaranteed load should be 12,515 kPa (1,800 psig) and 538°C (1000°F). These conditions are consistent with U.S. steam generator design practice for accommodating the expected slagging and corrosion characteristics of Lakhra coal. Moreover, these conditions are typical of the larger thermal units in WAPDA's current system. Thus, operating and maintenance personnel are already experienced to manage a power plant operating at these steam conditions.

Net station heat rate is estimated to be 11,510 kJ/kWh (10,900 Btu/kWh) based on a wet bulb temperature of 27°C, a boiler efficiency of 82.3 percent, and an auxiliary power ~~efficiency~~ consumption of 10 percent of gross turbine-generator output.

The four sites are Lakhra (mine mouth), Khanot, Petaro, and Jamshoro.

Physical layout of the power plant will allow for multiple duplication of the first 300-MW unit and the ability to retrofit flue gas desulfurization equipment.

1.3.8 Implementation Schedule

A 54-month implementation schedule is practical. The realization of this schedule is contingent upon:

- Present market conditions prevail for equipment supply
- Technology transfer and training do not become critical paths
- Pakistan institutional structure is organized to accommodate multifaceted project implementation
- Financing of equipment and services does not become the critical path

1.3.9 Capital Costs

The total capital cost of the 300-MW Lakhra Coal Facility excluding import duty, escalation, and interest during construction, expressed in millions of January 1983 dollars, is the following:

	Foreign Exchange	Local Currency	Total
300-MW Facility	260.8	218.2	479.0

Details of the capital costs estimates are provided in Tables 1.3-2 and 1.3-3. All costs were determined for a facility producing, handling, and burning the Lakhra Coal specified in Section 1.3.2. To enhance the reliability of the estimate, manufacturers of major equipment were asked to quote a present day (January 1983) price for their equipment. These prices were compared to SWEC-in-house cost data and modified as required to provide the most realistic estimate of an actual price quoted in a competitive bidding situation. The price of labor and material provided locally were estimated in rupees. All prices on foreign materials and labor were estimated in dollars. The exchange rate used was Rs.12.75 = one dollar. This cost estimate includes indirect costs, such as WAPDA and PMDC administrative costs, engineering services, housing and community related facilities for the mining and power plant labor forces, and infrastructural facilities such as telecommunications, water supply, and roads.

The savings in capital cost obtainable with a second duplicate unit of identical design is:

	Foreign Exchange	Local Currency	Total
Savings on duplicate 300-MW facility	58.0	72.5	130.5

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These estimated savings assume a decision to install a second duplicate unit is made no later than 12 months after project start date.

On the basis of two units, authorized sequentially, the capital cost of the two unit 600-MW facility is (in millions of January 1983 dollars):

	Foreign Exchange	Local Currency	Total
600-MW Facility	463.6	363.9	827.5

Import duty is charged by GOP at 40 percent of the delivered price of foreign equipment. Total capital expenditures including import duty increase and are shown as a column item in the summary of capital cost estimates shown in Table 1.3-4.

1.3.10 Unit Costs of Delivered Coal and Busbar Electricity

The cost of coal delivered to the 300-MW power plant in January 1983 dollars is estimated to be $34/metric ton ($31/short ton). The busbar cost of electricity delivered to the WAPDA grid by a 300-MW power plant in January 1983 dollars is estimated to be 4.6¢/kWh. These cost estimates do not include escalation and interest during construction.

If a second 300-MW unit is constructed, the estimated cost of delivered coal will be reduced by approximately 10 percent, while the cost of electricity will be reduced by roughly 15 percent.

If import duty is levied on foreign equipment, the cost of coal for the first 300-MW facility increases by 7 percent and the cost of electricity rises by 15 percent.

1.3.11 Comparison of Power Generation Alternatives

The cost of generating electricity with Lakhra coal is 30 percent less expensive than that obtainable using imported oil at $28/bbl. While the generation costs using Lakhra coal or imported coal are comparable, use of imported coal will consume an additional $34 million dollars of foreign exchange each year of plant operation. Furthermore, generating electricity with the Lakhra coal would employ an additional 1,900 Pakistanis and initiate the development of a modern large-scale coal industry in Pakistan. Details of these costs are shown in Table 1.3-5.

1.3.12 Transfer of Technology and Training Needs

The transfer of technology begun during the cooperative study efforts should be continued and significantly expanded. The needs are:

1. Training of Pakistan personnel to gain experience in the use of technologies to be applied in the Lakhra Coal Facility, especially those with which they are not yet familiar.

2. Organizational capabilities of Pakistan institutions to provide effective project management and reliable operations of the operating facilities.

TABLE 1.3-1

ECONOMIC COMPARISON OF POWER PLANT SITES

All costs are expressed in millions of January 1983 dollars. Escalation, interest during construction and import duty are not included.

Evaluated Capital Costs	Alternative 1: Once-Through/ Jamshoro	Alternative 2: Cooling Tower/ Jamshoro	Alternative 3: Cooling Tower/ Minemouth	Alternative 4: Air-Cooled/ Minemouth
Condenser	3.0	3.0	3.0	25.3
Cooling Towers	NA	4.0	4.0	NA
Circulating Water Piping & Pumps	36.0	2.0	2.0	NA
Cooling Tower Makeup System	NA	13.0	67.0	NA
Railway & Cars	11.0	11.0	NA	NA
Transmission Line	NA	NA	6.3	6.3
Total Evaluated Capital Cost	50.0	33.0	82.3	31.6
Evaluated Lifetime Operating Costs				
Coal Transportation	3.0	3.0	NA	NA
Auxiliary Power Penalty	6.1	9.1	11.6	17.4
Back Pressure Penalty	Base	9.3	9.3	55.8
Total Evaluated Lifetime Operating Costs	9.1	21.4	20.9	73.2
Total Evaluated Lifetime Costs	59.1	54.4	103.2	104.8
Difference	4.7	Base	48.8	50.4

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TABLE 1.3-2

CAPITAL COST ESTIMATE FOR 300 MW
COAL PRODUCTION FACILITY

All costs are expressed in thousands of January 1983 dollars. Escalation, interest during construction and import duty are not included.

Item	Foreign Component	Local Component	Total
East Open Pit	16,339	21,656	37,995
West Open Pit	16,256	25,028	41,284
Underground Mine	7,630	13,661	21,291
Coal Prep/Handling	2,072	4,988	7,060
Surface Facilities	387	1,816	2,203
Railway and Cars	825	10,040	10,865
Colony	0	15,686	15,686
Engineering	12,500	2,196	14,696
Subtotal	56,009	95,071	151,080
Contingency	8,401	14,261	22,662
Total Capital Cost, 1/83	64,410	109,332	173,742

NOTE:

1. Equipment cost includes the cost of erection, spare parts, shipping, inland transport, and insurance.

TABLE I.3-3

CAPITAL COST ESTIMATE FOR
FIRST 300 MW POWER PLANT

All costs are expressed in thousands of January 1983 dollars. Escalation, interest during construction, and import duty are not included.

Item	Foreign Component	Local Component	Total
Land and Site Prep.	0	455	455
Coal Handling	7,437	510	7,947
Ash Handling	10,269	660	10,929
Cooling System	6,356	9,660	16,016
Turbine and Aux.	26,754	715	27,469
Boiler and Aux.	60,817	3,160	63,977
Precipitator and Aux.	10,682	840	11,522
Chimney	323	2,553	2,876
Boiler and Turbine Bldg.	2,698	9,694	12,392
Yard and Civil Work	4,728	6,600	11,328
Office Bldg.	3,128	1,948	5,076
Spare Parts	6,690	60	6,750
Erection Charges	9,438	17,715	27,153
Supv./Maint. for 1 Yr.	300	200	500
Lease of Equipment	0	12,500	12,500
Colony	0	8,518	8,518
Subtotal	149,620	75,788	225,408
Engineering and Consult.	31,800	3,400	35,200
WAPDA Admin.	0	11,253	11,253
Contingencies	14,963	7,578	22,541
Forward Handlg. & Trans.	0	7,000	7,000
Insurance During Constr.	0	3,900	3,900
Total Capital Cost, 1/83	196,383	108,919	305,302

NOTE:

1. Estimate was itemized according to WAPDA format for PC-1 Report.

TABLE 1.3-4

SUMMARY OF CAPITAL COST ESTIMATES

Capital Cost Estimates Expressed in Millions of Dollars	Foreign Component	Local Component	Total Excluding Import Duty	Import Duty	Total Including Import Duty
o 300 MW (Net) Power Plant	196.4	108.9	305.3	61.5	366.8
o 300 MW Coal Production Facility	64.4	109.3	173.7	17.4	191.1
Total 300 MW Facility	260.8	218.2	479.0	78.9	557.9
o First 300 MW (Net) Power Plant	196.4	108.9	305.3	61.5	366.8
o Second 300 MW (Net) Power Plant	149.2	78.5	227.7	53.5	281.2
o 600 MW Coal Production Facility	118.0	176.5	294.5	26.2	320.7
Total 600 MW Facility	463.6	363.9	827.5	141.2	968.7
Capital Cost Estimates Expressed in Millions of Rupees					
o 300 MW (Net) Power Plant	2504.1	1388.5	3892.6	784.1	4676.7
o 300 MW Coal Production Facility	821.1	1393.6	2214.7	221.9	2436.6
Total 300 MW Facility	3325.2	2782.1	6107.3	1006.0	7113.3
o First 300 MW (Net) Power Plant	2504.1	1388.5	3892.6	784.1	4676.7
o Second 300 MW (Net) Power Plant	1902.3	1000.9	2903.2	682.1	3585.3
o 600 MW Coal Production Facility	1504.5	2250.4	3754.9	334.1	4089.0
Total 600 MW Facility	5910.9	4639.8	10550.7	1800.3	12351.0

NOTES:

1. Capital cost estimates include direct costs, indirect costs, and an allowance for indeterminate costs based on prices quoted for January 1983. Escalation and interest during construction are not included in these estimates. Exchange rate: Rs. 12.75 = 1.00 Dollar.

2. Coal Production Facilities include coal transportation facilities.

3. The 300 MW and 600 MW coal Production Facilities incorporate different designs. Thus, the total cost of each facility is provided separately.

4. The two 300 MW power plants employ identical designs. Thus, the incremental cost of the second 300 MW power plant is provided.

TABLE 1.3-5

ECONOMIC COMPARISON OF ALTERNATIVES

All costs are expressed in millions of January, 1983 dollars. Import duty, interest during construction, and escalation are not included.

Costs	Lakhra Coal	Imported Oil	Imported Coal
1. Annual Fixed Capital Charges[1]			
Domestic	14.5	10.5	13.1
Foreign	20.8	15.0	18.7
Total:	35.3	25.5	31.8
2. Annual Fuel Cost[2,3]			
Domestic	38.4	0.0	0.0
Foreign	6.8	84.6	42.8
Total:	45.2	84.6	42.8
3. Annual Operation & Maintenance Cost			
Domestic	4.1	2.7	4.1
Foreign	4.0	2.7	4.0
Total:	8.1	5.4	8.1
4. Total Annual Generation Cost			
Domestic	57.0	13.2	17.2
Foreign	31.6	102.3	65.5
Total:	88.6	115.5	82.7
5. Unit Generation Cost[2]	4.8¢/kwH	6.3¢/kwH	4.5¢/kwH

NOTES:

1 Includes interest and sinking fund depreciation costs for a capital recovery period of 30 years. Annual interest rates used are 13 percent for domestic debt, and 10 percent for foreign debt.

2 Based on the output from a 300 MW power plant, operated in 1983 at full load for 70 percent of the year (i.e., 6,132 hours per year).

3 The 1983 fuel prices used in this comparison are:

Lakhra Coal	$2.37/10^6$ kJ ($34/metric ton)
Imported Coal	$2.46/10^6$ kJ ($70/metric ton)
Imported Oil	$4.91/10^6$ kJ ($28/bbl)

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1.4 CONCLUSIONS

1. The Lakhra Facility

The initial 300-MW Lakhra Coal Facility should consist of the following:

- A three-section mine within the delineated mine area in the Lakhra coal field; the east and west sections - open pit mines; the central section - underground;
- Surface coal preparation facilities;
- A colony for miners and mine support personnel;
- A new dedicated railway for coal transport about 35 kilometers in length between Lakhra and Jamshoro;
- Coal receiving, storage and handling facilities and a 300-MW net capacity coal-fired, steam turbine power plant located at WAPDA's Jamshoro site;
- Electrical connection facilities to WAPDA's existing transmission network;
- An intake water system located at the Kotri Barrage on the Indus River and a makeup water line to the Jamshoro site of a size sufficient for evaporative cooling towers; and
- A colony at the Jamshoro site for plant construction and plant operation and maintenance personnel.

2. Technical Feasibility

The design, construction, and operation of the Lakhra Facility is technically feasible. Proven technologies and methods can be supplied in the mining, coal transport and power plant elements of the facility. Extensive experience exists in the application and use of these technologies and methods.

3. Economic Feasibility

The Lakhra Facility is economically competitive with other power generation alternatives for meeting Pakistan's growing requirements for electricity. Electricity generation costs would be significantly less with Lakhra coal than with imported oil and comparable to imported coal. Exploiting domestic Lakhra coal will save millions of dollars in foreign exchange each year, thousands of Pakistanis will be employed, and a modern coal industry will emerge.

4. Environmental Feasibility

The Lakhra project can be implemented so that its emissions will meet World Bank guidelines and have a minimum impact on the environment.

5. Institutional Organization

The institutional structure to efficiently support the implementation and operation of the Lakhra Facility does not currently exist in Pakistan. An institutional organization is required that has the authority to effectively manage the design, construction, and operation of the facility.

6. Implementation Schedule

A 54-month implementation schedule is practical to adopt. Thus, the Lakhra Facility can help satisfy Pakistan's urgent need for power generation capacity as early as 1988.

7. Technology Transfer

The implementation of the Lakhra Coal project requires a substantial amount of large-scale, coal-based technology transfer and adaptation. New related industrial activities in Pakistan, having the potential to impact significantly on national economic growth, would soon follow.

8. Pakistan Coal Industry Growth and Modernization

The demonstration by the Lakhra Facility of large scale coal field development and production, the building of a coal mining infrastructure, and the generation of a large scale demand for domestic coal can lead to:

- Development of other Pakistan coal fields;
- The availability and use of lower cost coal for other energy applications;
- Future expanded use of coal fuels for electricity generation.

Such a program provides a solid foundation on which the nation can enlist the many resources and capabilities of its private sector.

9. Second 300-MW Unit

Cost considerations clearly support the construction of a second identical coal-fired unit at the Jamshoro site. The initial operation date of a second unit should be scheduled 1 to 3 years after the initial operation date of the first Lakhra unit pending the proof of sufficient coal reserves by additional geological investigations. Achievement of the associated cost savings requires a decision to install a second unit within ~~12~~ 9 months of project start date.

1.5 RECOMMENDATIONS

WAPDA has recommended to the Government of Pakistan (GOP) that the Lakhra Coal Facility be included as a project in Pakistan's Sixth Economic Development Plan covering the period 1983-1988. The following recommendations are directed at the implementation of a project to design, construct, and commission the Lakhra Facility

Institutional

1. Establish a Lakhra Project Implementation Organization* within the GOP. This organization should be responsible for the complete implementation and eventual operation of the Lakhra Facility. It should also be capable of planning, implementing and overseeing the operation of all future coal-fired power generation projects in Pakistan.

2. Staff the Lakhra Project Implementation Organization with highly-qualified, experienced personnel. Specialized training for the staff should be defined and carried out according to individual needs and responsibilities. Provide appropriate professional and financial incentives to assure long-term commitments by the personnel receiving the training.

3. Review manpower development, training, and other technology transfer programs underway or planned in Pakistan to determine the extent to which these programs can be used to meet the training and technology transfer requirements of the Lakhra project. Take measures to ensure that Pakistan private sector corporations have the opportunity to participate in these human resource development and technology transfer programs. Consider the appropriate components of the USAID Energy Planning and Development Project as a source for this training need.

4. Begin at the earliest practical date the coordination of the Lakhra project with other activities at the Jamshoro site.

5. Provide supplementary support for the Lakhra Project Implementation Organization to enhance its capabilities in the specialized functions listed below:

   - project management and planning
   - engineering and design
   - equipment procurement, inspeciton, expediting, and transportation
   - construction management
   - acceptance testing and start-up

* Commonly referred to as the "Coal Cell" within the GOP.

- operations planning and management

Technical

The following technical activities need to be undertaken as soon as practical:

6. Obtain a representative large scale coal sample from the Lakhra Field for analysis and use in the design of the Lakhra Steam Generator.

7. Conduct detailed geological investigations required to establish the final mine area and mine design.

8. Install environmental monitoring equipment at the Jamshoro site and collect data to acquire the baseline data needed to determine subsequent requirements for plant effluent control.

9. Survey route(s) for railway, road, water and power lines to the Lakhra Mining Area.

10. Establish area contour lines and obtain preliminary soils data from the area of the Jamshoro site for use as input to foundation design and plant layout.

11. Develop equipment specifications for the steam generator, steam turbine, and electric shovels.

12. Prepare project and purchasing procedures and specifications to be used in procuring services and in purchasing the major equipment as quickly as practical.

13. Prepare schedule networks of all major project activities soon after project authorization and make the requirements for maintaining these schedules known to all management and approval authorities.

14. Decide within nine months after project ~~authorization~~ start date whether a second 300MW power plant will be included in the project, and plan the production capacity of the mine accordingly.

FINANCIAL ANALYSIS ANNEX

I. Long Term Technical Advisors

A. 1983 dollar costs of long term consultants as follows: a/

	PSC	Private Firm	PASA
Annual Recurrent Cost	$ 87,500	$ 247,100	$ 145,200
1/2 one time $ moving costs	8,700	9,570	8,700
1/5 one time $ furniture costs	3,960	3,960	3,960
1983 Average Annual $ Cost	$100,160	$ 260,630	$ 157,860

Escalate at 10% per year.

1984 Average Annual $ Cost	$110,176	$ 286,693	$ 173,646
1985 -do-	121,194	315,362	191,011
1986 -do-	133,313	346,899	210,112
1987 -do-	146,644	381,588	231,123
1988 -do-	161,309	419,747	254,235

B. 1983 Pakistani rupee costs basis Rs13.00 per $1.00

	PSC	Private Firm	PASA
Annual In-Country Travel	Rs. 98,040	Rs. 98,040	Rs. 98,040
" Home Office Backstopping.		44,876	44,876
Annual Housing Cost	233,000	233,000	233,000

a/ See memos July 2, 1981 from G.R. Van Raalte, ASIA/PD
Subject: A/AID Request for Project Papers and
February 21, 1983 from USAID/PDM - Linda N. Lion
Subject Preparation of Project Financial Plans and Budgets

	PSC	Private Firm	PASA
Annual Secretary, Driver, Telephone etc.	Rs 118,000	Rs 118,000	Rs 118,000
1/2 one time travel and moving costs	265,627	265,627	265,627
1/5 one time housing and office costs	89,460	89,460	89,460
1983 Average Annual Cost	Rs 804,127	Rs 849,003	Rs 849,003

Escalate at 10% per year.

1984 Average Annual Rupee Cost	Rs 884,540	Rs 933,903	Rs 933,903
1985 -do-	972,994	1,027,294	1,027,294
1986 -do-	1,070,293	1,130,023	1,130,023
1987 -do-	1,177,322	1,243,025	1,243,025
1988 -do-	1,295,055	1,307,328	1,307,328

C. Program Assistants

Assume Pakistan FSN Grade 12 Step 12 and add 15% for payroll costs.

Rs 161,255 Per Year X 1.15 = Rs. 185,443

Escalate at 10% per year.

1984 Annual Cost	Rs. 203,987
1985 -do-	224,386
1986 -do-	246,824
1987 -do-	271,506
1988 -do-	298,657

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D. Cost Per Long Term Advisor

1. Consultant/General Advisor
57 Months from July 1, 1983
Assume 8A Contract at 33% above
PSC for dollar cost.

	Dollar Cost	Rupee Cost	Program Asstt.Rs.	Total $ Equiv.
1983 ½ year x 1.33 for $	68,380	402,063	92,721	106,440
1984 1.33 x $	146,530	884,994	203,987	230,300
1985 1.33 x $	161,190	972,994	224,386	253,300
1986 1.33 x $	177,306	1,070,293	246,824	278,620
1987 1.33 x $	195,036	1,177,322	271,506	306,480
1988 1/4 year x 1.33 x $	53,634	323,763	74,664	84,280
	802,076	4,831,428	1,114,088	1,259,420

2. Advisors to Energy Analysis Group. U.S. Firm

a. Team Leader 36 months from Jan. 1, 1984

1984	$ 286,693	Rs 933,903	Rs 203,987	$ 374,223
1985	315,362	1,027,294	224,386	411,645
1986	346,899	1,130,023	246,824	452,810
	$ 948,954	Rs 3,091,220	Rs 675,197	$1,238,678

b. Manpowers Needs Assessment Advisor 12 Months

Say for 1985 = $315,362 + Rs 1,027,294 = $394,385 Equivalent

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3. Long Term USGS Advisor - Team Leader PASA

45 months from Jan. 1, 1984

	Dollar Cost	Rupee Cost	Total $ Equiv.
1984	$173,646	Rs. 933,903	245,500
1985	191,011	1,027,294	270,000
1986	210,112	1,130,023	297,000
1987 x .75	173,342	932,270	245,100
	$748,111	Rs 4,023,490	$1,057,600

4. Long Term Coal Development Project Advisor - U.S. Firm

a. 24 months from Jan. 1, 1984

1984	$286,693	Rs. 933,903	$358,500
1985	315,362	1,027,294	394,400
	$602,055	Rs 1,961,197	$752,900

b. Mine and Power Plant Managers

18 months each from Jan. 1, 1984

Per each, 1984	$286,693	Rs. 933,903	$358,500
Per each, 1985	157,681	513,647	197,200
	$444,374	Rs 1,447,550	$ 555,700

2 x 555,724 = $ 1,111,400

5. Energy Conservation and Renewable Energy Advisor - U.S. Firm

36 Months from Jan. 1, 1984

Same as 2.a. $ 1,238,678

II. Short Term Technical Advisors

A. 1983 dollar costs of short term advisors as follows

	PSC	Private Firm	PASA
Monthly Cost	$ 7,200	$ 18,800	$ 10,700
Post Differential	630	630	630 a/
International Per Diem	133	133	133
Total:	$ 7,963	$ 19,563	$ 11,463
1983 Rupee costs			
Monthly Cost	Rs 32,500	Rs 32,500	Rs 32,500
International Travel	11,000	11,000	11,000
	Rs 43,500	Rs 43,500	Rs 43,500
Total Monthly $ Equivalent	$ 11,310	$ 22,910	$ 14,810
Escalate 10% per year.			
1984 $ Equivalent $	12,440	$ 25,200	$ 16,290
1985 $ Equivalent	13,685	27,720	17,920
1986 $ Equivalent	15,053	30,493	19,712

B. Cost per Subcomponent

1. Advisors to Energy Analysis Group

75 PM with U.S. Firm Assume 1985

75 x 27,720 = $ 2,079,000

114 PM PSC Assume 1985

114 x 13,685 = $ 1,560,090

Assume Average 80% of these costs (2,079,000+1,560,090)x 0.8= 2,885,000

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a/ Assume average tour is 3 months so average post differential = 10%

2. Coal Resource Assessment Advisors. PASA

87 PM Assume 1986 Costs

87 x 19,712 = 1,714,944

Assume Average of 80% of these costs

$ 1,714,944 x 0.8 = $ 1,344,000

3. Coal Mine and Coal-Fired Power Generation. U.S. Firm

Phase I 163 PM in Pakistan. Assume 1984 costs

163 x 25,200 = $ 4,107,600

Assume Average of 80% of these costs

$ 4,107,600 x 0.84 = $3,452,000

Phase II 188 PM in U.S. Assume 1984 costs

188 x 20,680 = $ 3,887,840

Assume Average of 80% of these costs

$ 3,887,840 x 0.82 = $ 3,200,000

4. Coal Briquetting. U.S. Firm

37 PM in Pakistan Assume 1985 costs

37 x 27,720 = $ 1,025,640

Assume Average of 80% of these costs

$ 1,025,640 x 0.8 = $ 820,000

5. Energy Conservation Advisors

U.S. Firm 55 PM Assume 1985 costs

55 x 27,720 = $ 1,524,600

PSC 31 PM

31 x 13,685 = $ 424,235

Assume Average of 80% of these costs

($ 1,524,600 + $ 424,235) x 0.8 = $ 1,587,000

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6. Renewable Energy Advisors

U.S. Firm 23 PM Assume 1985 costs

23 x 27,720 = $ 637,560

PSC 39 PM

39 x 13,685 = $ 533,715

Assume Average of 80% of these costs

($ 637,560 + $ 533,715) x 0.8 = $931,000

III. Summary TA Costs

1. Energy Planning and Manpower Development

Long Term Advisors (1,238,678 + 394,385) =	$	1,633,000
Short Term Advisors and PSC's		2,885,000
Consultant/General Advisor (prorate)		267,000
	$	4,785,000

2. Coal Assessment

Long Term Advisors	$	1,058,000
Short Term Advisors		1,344,000
Consultant/General Advisor (Prorate)		182,000
	$	2,584,000

3. Coal Mining and Coal-Fired Power

Phase I

Long Term Advisors	$	1,864,000
Short Term Advisors		3,452,000
Consultant/General Advisor (Prorate)		404,000
	$	5,720,000

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Phase II

Short Term Advisors	$	3,200,000

4. Coal Briquettes

Short Term Advisors	$	820,000
Consultant/General Advisor (Prorate)		61,000
	$	881,000

5. Energy Conservation

Long Term Advisor (Prorate)	$	619,000
Short Term Advisors and PSC's		1,587,000
Consultant/General Advisor (Prorate)		165,000
	$	2,341,000

6. Renewable Energy

Long Term Advisor (Prorate)	$	619,000
Short Term Advisors and PSC's		931,000
Consultant/General Advisor (Prorate)		118,000
	$	1,668,000

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FINANCIAL ANALYSIS

PROJECT COST SCHEDULE

($000)

Component	FY 1983				FY 1984			FY 1985			FY 1986		
	Commodities	TA Long Term[a]	TA Short Term	Training	Com	TA	Train	Com	TA	Train	Com	TA	Train
1	32	900	600	100	15	900	200	101	975	67	-	1,410	-
2 a	1,300	570	788	100	1,000	400	200	200	500	96	120	326	-
b	1,546	2,070	2,930	400	-	485	500	600	235	234	-	-	100
c	16	-	-	-	-	100	-	578	366	25	-	415	-
3 a	32	430	320	50	100	400	50	265	500	26	507	691	-
b	16	430	320	50	100	400	50	282	200	150	210	318	123
Sub-Total	2,942	4,400	4,958	700	1,215	2,685	1,000	2,026	2,776	598	837	3,160	223
Fiscal Year Sub-Total	13,000				4,900			5,400			4,220		
Evaluation	-				-			100			300		
Contingency	-				100			500			1,480		
Fiscal Year Total	13,000				5,000			6,000			6,000		

a/ Long term advisors budgeted 2 years in FY 1983

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$ & RS. COST OF COMMODITIES FOR ENERGY PLANNING AND DEVELOPMENT PROJECT (391-0478)

Contract # 1: Component-1

Description of Commodity	Year of Purchased	Source/ Place	$ Cost	Rs. Cost	Total $ + $ Equiv.
(1) Vehicles 2	FY-83	U.S.	31,000	202,000	46,538
(2) Others					
- 3 mini-computers with disc storage line printer, CRT display & graphic capability	FY-85	U.S.	69,000	-	69,000
- Energy analysis, data analysis and other relevant software	FY-85	U.S.	10,000	-	10,000
- Training seminar materials	FY 84-85	U.S. & PAK	15,000	100,000	22,692
		Total:	125,000	202,000	148,230
Contract # 3 Component-3:(a) Conservation & Renewable					
(1) Vehicles 2	FY-83	U.S.	36,000	202,000	51,538
(2) Others					
- Industrial energy auditing equipment	"	"	100,000	-	100,000
- Educational materials for auditor training	"	"	100,000	-	100,000
- Demonstration equipment, high efficiency motors, boiler controls, foam finishing equipment	"	"	652,000	-	652,000

5 & RS. COST OF COMMODITIES FOR ENERGY PLANNING AND DEVELOPMENT PROJECT (391-0478)

Description of Commodity	Year of Purchased	Source/ Place	$ Cost	Rs. Cost	Total $ + $ Equiv.
(b) Renewable Energy Technology:					
(1) Others					
- Solar radiation monitoring equipment - 6 systems	FY-84	U.S.	90,000	-	90,000
- Photovoltaic equipment and instrumentation system	FY 85-86	"	180,000	-	180,000
- Small Hydro monitoring equipment, micro-computer	FY 84-86	"	50,000	-	50,000
- Hydro Test Facility	"	"	100,000	-	100,000
- Turbine Unit (4)	"	"	40,000	-	40,000
- Combustion Test equipment for wood stoves	"	"	34,000	-	34,000
- Biogas monitoring equipment	"	"	20,000	-	20,000
- Demonstration equipment for renewables	"	"	422,000	-	422,000
(2) Vehicles 1	FY-83	"	18,000	101,000	25,769
- Wood Stoves for test marketting purpose, Small Hydro, Biogas and Solar etc.	FY 84-86	PAK	-	1,907,000	146,692
		Total:	1,842,000	2,210,000	2,012,000

$ & RS. COST OF COMMODITIES FOR ENERGY PLANNING
AND DEVELOPMENT PROJECT (391-0478)

Contract # 2 USGS PASA

Description of Commodity	Year of Purchased	Source/ Place	$ Cost	Rs. Cost	Total $ + $ Equiv.
Coal Resource Assessment & Development (Component #2)					
- Equipment to Augment Core drill capability	FY-84	U.S.	300,000	-	300,000
- Geophysical Logging	"	"	100,000	-	100,000
- 2 Core Drills	"	"	1,000,000	-	1,000,000
- Analytical Lab equipment	"	"	495,000	-	495,000
- Coal petrography	"	"	95,000	-	95,000
- Geodata centre equipment	"	"	50,000	-	50,000
- Photogrammetric equipment	"	"	100,000	-	100,000
- Publication Support equipment	"	"	100,000	-	100,000
- Aerial photography equipment	"	"	220,000	-	220,000
- Geophysical Survey equipement	"	"	130,000	-	130,000
- Rapid Surveying Equipment	"	"	25,000	-	25,000
- Text Book and manuals	FY 84-88	"	5,000	-	5,000
		Total:	2,620,000	-	2,620,000

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$ & Rs. COST OF COMMODITIES FOR ENERGY PLANNING
AND DEVELOPMENT PROJECT (391-0478)

Contract # 3: Lakhra Coal Project

Description of Commodity	Year of Purchased	Source/ Place	$ Cost	Rs. Cost	Total $ + $ Equiv.
Phase-1					
(1) Vehicles 4	FY-83	Japan/Pak	73,000	404,000	104,076
(2) Others					
- Environmental Sampling	"	U.S.	400,000	-	400,000
- Demonstration mining equipment	FY-85	"	600,000	-	600,000
- Coal Analysis and rock & coal testing	FY-83	"	166,700	-	166,700
- Aerials photographs & maps	"	Pakistan	-	1,000,000	76,923
- Truck mounted drill & accessories	"	U.S./Pak	460,243	224,000	477,474
- Geophysical logging truck	"	"	143,000	124,000	152,538
- Mine camp equipment, Generator, Communications equipment, Household, Shop and first aid equipment.	FY 83-84	"	250,000	a/ 4,000,000	403,846
- 4000 gal. tank Truck	FY-84	PAK	-	b/ 1,046,000	-
		Total:	2,092,943	3,752,000	2,381,557

Note: a/ 50% of the Rs. cost (i.e. Rs.2,000,000) will be provided by GOP and 50% from project.

b/ The total cost for tank truck will be provided by GOP
So a/ & b/ are not included in the total Rs. cost funded by project.

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D & RS COST OF COMMODITIES FOR ENERGY PLANNING AND DEVELOPMENT PROJECT (391-0478)

Description of Commodity	Year of Purchased	Source/ Place	$ Cost	Rs. Cost	Total $ + $ Equiv.
Coal Briquettes					
(1) Vehicle 1 (4 wheel drive vehicle)	FY 85-86	U.S./Pak	18,000	101,000	25,769
(2) Components for a 25 ton per day coal brequetting plant	FY-86	U.S./Pak	502,000	862,000	568,307
		Total:	520,000	963,000	594,077

Contract #1

$ & Rs ($ equivalent) Cost for Training under Energy Planning and Development Project (391-0475)

1. Energy Analysis & Manpower Development

Component # 1

Type of Courses	Place	Total No.of Participants	Total No.of person-months	Proposed Schedule	Duration of the Courses months (each)	a/- Rs.Cost/ Trip/ Participant	Total Rs. Cost	b/- Cost/ Months $	Total $ Cost	Total Cost $ + $ equivalent
						1983		1983		
Short Term Courses	U.S.	25	75	FY 84-85	3	32,500	1,012,894	3,600	260,755	338,663
Long Term Acad. Training	U.S.	2	68	FY 84-85	24	32,500	169,700	1,600	92,569	94,922
* In-country Short Term Training	Pak	210	570	FY 84-86	1 month f 20 Participa 3 months for the rest of participants.	Per Diem Rs.210/day Rs.2000/- per participant per course and Rs.10,000/- for Supplies.	Rs.4,890,357	-	-	*Rs.4,890,357

Component # 3 Training

						1983		1983		
Short Term Training	U.S.	23	104	FY 84-87	3 months for 8 Participants. 5 months for 10 Participants. 8 months for 5 Participants	32,500	Rs.1,051,172	3,600	496,950	$ 577,809
Short Term Training	Third Country	5	10	FY 85	2 months each	13,120	Rs.86,755	600	7,940	$ 14,613

355

$ & Rs ($ equivalent) Cost for Training under Energy Planning and Development Project (391-0478)

Contract # 2

Coal Resource Assessment & Development

Type of Courses	Place	Total No.of Participants	Total No.of person-months	Proposed Schedule	Duration of the Courses months (each)	Rs.Cost/ Trip/ Participant a/	Total Rs. Cost	Cost/ Months $ b/	Total $ Cost	Total Cost $ + $ equivalent
Short Term Training	U.S.	25	65	FY 83-87	2 months,3 months & 4 months each	1983 32,500	919,123	1983 3,400	262,556	$ 333,256
Long Term Training	U.S.	2	48	FY 84-86	24 months each	32,500	85,962	1,600	62,500	$ 89,112

Contract # 3 Lakhra Coal Project

Phase-I									c/	
Short Term Training	U.S.	50	312	FY 83-84	8 months,6months & 4 months	1983 32,500	1,936,025	3,400	1,167,703	1,316,628
Phase-II									c/	
Short Term Training	U.S.	23	140	FY 85-87	8 months,6 months and 4 months	32,500	1,125,247	3,400	650,142	736,699
Coal Briquettes										
Short Term Training	Third Country	3	27	FY 85	9 months	1983 13,120	Rs.39,360	600	21,425	$ 24,453

Notes: * In-country Training Cost will be funded by GOP.

a/ , b/ : Cost estimates for 1983 are raised by 15% per year compounded for inflation if the training is to take place in 1984 or beyond.

c/ : $ Cost is decreased by 10%.

Total Training $ 3,526,155
Cost Rs. 4,890,357

PRELIMINARY ENVIRONMENTAL ANALYSIS OF THE LAKHRA COAL PROJECT

1. Pollution Control Requirements

Economic growth in Pakistan will require increased energy production for industrial facilities and transportation. The increased use of coal will require appropriate environmental planning and environmental controls to mitigate unacceptable environmental impacts. Some potentially deleterious impacts associated with increased coal use are disruption of traditional land uses (such as agricultural areas appropriated for mine development), high localized concentrations of air pollutants such as sulfur dioxide, dust, and nitrogen oxides, and cooling water impacts on fisheries and the like.

The extent of control systems that Pakistan can afford is an important issue since adequate attention must be given to matters of public health, national economy, and worker safety. It should not be assumed that Pakistan needs control programs analagous to those utilized in highly industrial countries. Nevertheless, adequate environmental protection as a design consideration in new industrial facilities will be beneficial in the long-term to Pakistan.

In Pakistan, no environmental standards have been established to protect the health of the people and to ensure clean air or water. The greatest pollutant today is vehicular exhaust, particularly in congested areas. Some pollution is also generated by cement and scattered chemical plants, but there are no programs to check emission levels or ground level considerations.

An Environmental Protection Division recently set up within the Government of Pakistan has circulated draft legislation for comments to those agencies in the country which are producing or using energy. This draft legislation will receive careful scrutiny by the GOP before it is passed.

The Asian Development Bank advised the project design team that it does not require an environmental assessment or specific emission/effluent guidelines as criteria for project funding. However, the ADB recommends incorporation of World Bank emission/effluent guidelines into facility design to mitigate potential environmental impacts caused by the project.

The World Bank's Office of Environmental Affairs (OEA) evaluates the adequacy and effectiveness of pollution control measures taken by developers of industrial projects seeking World Bank funds. Both environmental effects and worker health and safety are considered. The OEA's Environmental Guidelines (March 1981) provide an overview of specific pollutants and/or industries. They are intended to be flexible enough to allow site-specific application. The guidelines describe permissible pollutant levels but allow for some deviation from these levels if local conditions warrant.

No environmental guidelines have been developed by the World Bank specifically for steam electric generating plants although specific occupational health and safety guidelines do exist. In pollutant-specific guidelines, one set of standards is usually provided which does not vary depending on the industry producing the pollutant. Therefore, judgement must be used in applying the standards to a particular project. Finally, there are many environmental considerations which are noted, but for which no numerical standards have been developed. Such factors will guide design and construction efforts and will result in some additional cost to the project. In general, however, they represent small costs relative to total project cost.

Environmental guidelines which are relevant to the Lakhra project include: Dust Emissions; Effluents, Disposal of Industrial Wastes; Effluents, Liquid, Land Disposal, and Treatment; Electrostatic Precipitators; Mining - Strip (Surface); Mining - Underground (Coal); Noise; Secondary Environmental Effects; and, Sulfur Dioxide Emissions - General Pollution by SO_2.

In accordance with requirements of the Foreign Assistance Act, A.I.D. established procedures to ensure the integration of environmental factors into the decision-making process. These procedure (22CFR216) also are consistent with Executive Order 12114 and implement the requirements of the National Environmental Policy Act. It is important to note that these procedures are for A.I.D. use and, therefore, not directly applicable to a developer. They do, however, indicate the kind of environmental information to be considered by A.I.D. for activities which it finances.

No design criteria or performance standards are established under A.I.D. procedures. A.I.D. projects must incorporate environmental review and assessment into the facility

planning, siting, and design process. Environmental considerations have been integrated into project planning. This meets the intent of A.I.D. procedures. World Bank Guidelines alone result in the proposed design of environmental controls and will more than conform with A.I.D. guidelines.

2. Environmental Criteria

Since the Government of Pakistan has not yet established environmental standards, and the possibility exists of project funding (in part) by the World Bank, World Bank emission/effluent and impact guidelines have been used to the extent possible to identify principal environmental control items and their cost. In a few cases, more stringent EPA and other guidelines have also been applied. The following sections briefly discuss the environmental standards or design criteria applied to the conceptual designs of the mine and power plant for the Lakhra/Jamshoro project.

a. Power Generation

Environmental guidelines for power plants cover all significant environmental impacts. Potential impacts can result from air emissions, liquid effluents, solid waste, noise, and secondary factors such as population influx, social service demands, and additional water consumption.

i. Air Emissions

Air contaminants are formed by thermal oxidation of fuel impurities, such as sulfur and nitrogen, and through incomplete combustion of the fuel source's carbonaceous matter. Other fuel impurities, for example trace metals, are additional sources of atmospheric pollution. Emissions of particulate matter from coal-fired generating stations also occurs as a result of handling of the fuel and from wind erosion of the storage piles.

The primary direct emissions from a thermal power station include sulfur and nitrogen oxides and particulate matter. As the plume from the smoke stack disperses, chemical transformations of many of the stack contaminants take place, leading, for example, to formation of secondary pollutants such as sulfates, nitrates, and so-called acid rain.

Two types of air quality standards apply to power plant or coal mine facilities: emission and ambient standards. Emission standards apply to allowable concentrations at a source of the emission whereas ambient standards apply to the allowable concentrations of the pollutant at ground level. World Bank Guidelines have been established for only two pollutants: dust (particulates) and sulfur dioxide (SO_2). No criteria have been suggested by the World Bank for oxides or nitrogen emissions. Consequently, NO_2 emissions and impact were not addressed as part of this study. Both particulate and sulfur dioxide standards are considered to be achievable at reasonable costs by readily available control procedures.

Ambient standards recommended by the World Bank for dust (particulates) are presented in Table 1. Bank recommendations are based on the estimate that adverse human health effects begin when dust concentrations exceed 80 micrograms per cubic meter (ug/m³) annually. Adverse effects on materials and vegetation can begin at annual levels of 60 ug/m³.

TABLE 1

WORLD BANK AIR POLLUTION GUIDELINE STANDARDS

Pollutant	Source	Stack Emission Standard (mg/m³)	Ambient Air Quality Standards 24 Hr (ug/m³)	Ambient Air Quality Standards Annual (ug/m³)
Dust (Particulates)	Stack	100	500	100
	Outside Plant Fence	150	500	260
SO_2	Inside Plant Fence	-	1000	100
	Outside Plant Fence	-	500	100
Dust	Coal Preparation Plant (Outside Mine Fence at Ground Level)	-	260	75

To meet the guidelines, pollution controls such as electrostatic precipitators (ESP) are suggested. The required control efficiency of such a device is determined through an atmospheric dispersion modeling analysis to relate the facility's emissions to resultant ground level impacts. World Bank requirements also limit these emissions to 100 mg/m³. However, a stack emission concentration of 150 mg/m³ is acceptable under the guidelines if the plant

is located in a rural area such as Jamshoro, where the dust concentration at ground level inside the plant fence is within World Bank Guidelines, and the maximum annual concentration outside the plant is less than 260 ug/m³. The former (150 mg/m³) was selected as the design basis. Compliance with sulfur dioxide is also determined through an atmospheric dispersion modeling analysis.

Included as a factor in the dispersion modeling analysis is the height of the facility's stack. The EPA's regulations require that this height should correspond to Good Engineering Practice defined according to Section 123 of the Clean Air Act Amendments of 1977 as, "The height necessary to insure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies, and wakes which may be created by the source itself, nearby structures or nearby terrain obstacles." This definition identifies the minimum stack height at which significant adverse aerodynamic effects are avoided. This criterion was adopted in this project to establish the minimum height of the stack.

Required SO_2 emission reductions can be achieved by control techniques such as flue gas desulfurization and coal washing. Increasing stack height raises the pollutant discharge point and, in turn, reduces ground level concentrations.

ii. Liquid Effluents

The use of coal for generation of electricity will produce waste water associated with the disposal of ash and other solid wastes. Waste waters vary in quantity, quality, and the amount of treatment required for either reuse or discharge.

The World Bank effluent criteria along with U.S. standards are shown in Table 2. These standards represent limits which, in the judgement of the project design team, provide reasonable protection of ground, surface, and drinking water supplies in the project area. In each case, effluents can be collected and treated by a variety of available methods to achieve the stated limits.

In addition to chemical characteristics of liquid effluents, waste heat generated by the operation of various water-cooled equipment must also be considered. The general guidelines for World Bank projects will be conditionally

TABLE 2

RECOMMENDED EFFLUENT LIMITS: POWER GENERATION

1. Rainfall runoff from the coal pile and the solid waste disposal area:	
Total Suspended Solids (mg/l)	50
pH	6-9
2. Equipment leaks, demineralizer regenerations, system blowdowns (boiler and bottom ash), and floor drainage:	
Oil and grease (mg/l)	20
pH	6-9
Total Suspended Solids (mg/l)	30 avg 100 max
3. Equipment cleaning wastes (air preheater, boiler, chemical cleaning, etc.):	
Total Suspended Solids (mg/l)	30 avg 100 max
Total Iron (mg/l)	1.0
Total Copper (mg/l)	1.0
pH	6.9

adopted wherein the temperature of the diluted effluent should not be more than 3°C higher than that of the receiving waters except within a mixing zone defined on a case-by-case basis. However, if the receiving water temperatures are determined to be 28°C or less, the guideline allows the diluted effluent temperature to be a maximum of 5°C above that of the receiving waters except within a mixing zone, also defined on a case-by-case basis. This guideline would apply to the use of water from the Indus River. An alternative procedure is offered in the guidelines whereby a maximum allowable stream temperature is calculated from the optimum and lethal temperatures for potentially affected species. However, absence of any data on authentic currently occuring species in the Indus River and their thermal tolerances precludes the use of this option.

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iii. Solid Wastes

Solid wastes which will be produced from the combustion of coal include furnace bottom ash, economizer hopper and fly ash, and a small amount of raw water and waste water treatment sludges consisting primarily of chemical precipitants. Assuming an ash distribution of 70 percent fly ash and 30 percent furnace bottom ash, the annual ash production from a 600 MW plant has been estimated to be 395,000 tons/year of fly ash and 170,000 tons/year of bottom and economizer ash when 2.8 million tons of coal is burned per year. These wastes require proper disposal to avoid contaminating nearby watercourses, groundwater, and the air.

The design and operation of the ash and sludge landfill should minimize environmental effects. In general, a landfill (or ash deposit yard) will be located above the 100-year flood plain, if possible, and constructed so that runoff of rain water from uncontaminated areas cannot occur. The active areas of the landfill will be kept as small as possible to reduce the amount of contaminated runoff. Temporarily and permanently finished areas of the landfill will be covered with soil suitable for growth of vegetation to both minimize contaminated runoff and fugitive dust emissions. Runoff from active portions will be collected via ditches in a runoff collection pond sized for at least a 10 year-24 hour storm event. Runoff will be treated for suspended solids and pH, if required, before it is discharged. The landfill may require a bricklining or an alternative liner, depending on the quality and location of groundwater.

iv. Noise

Acoustical noise controls are recommended in order to minimize annoyance to people living in the area (property line sound level) and to minimize employee hearing loss (occupational noise exposure). Noise criteria were developed through consideration of the World Bank Guidelines, the engineering feasibility of meeting the criteria, and the occupational noise exposure criteria of the U.S. and European countries.

A noise criterion of 55 decibels (dBA) is recommended for the nearest residential area in accordance with the World Bank Guidelines. This level will protect against outdoor speech interference and will minimize, although not necessarily eliminate, annoyance. Since uncontrolled sound levels from the coal-fired plant could be 65 dBA at 300 meters, either a considerable distance between

the plant and residential property line (which can be determined through noise propagation models) or exterior noise controls will be necessary to achieve the noise criterion.

An occupational noise exposure criteria goal of 85 dBA with a maximum level of 90 dBA is recommended to minimize the potential loss of employee hearing. This level represents a compromise between the World Bank recommendation of 75 dBA for an 8-hour work day, which protects employees from all hearing loss, and the engineering feasibility of achieving these levels. The sound levels in power plants are typically 90-100 dBA without noise mitigation. These levels can be reduced to 85-90 dBA with a moderate amount of noise control engineering. The 85 dBA criteria level is used by many European countries. Although the United States Occupational Safety and Health Administration standard allows continuous exposure to 90 dBA for an 8-hour period, the 85 dBA criteria offers significantly better protection. The costs of noise control engineering would be expected to be approximately 1 percent of the cost of the plant.

v. Secondary Effects

As a result of the influx of construction and operating personnel and the presence of the power plant, significantly higher demands will be made on local services such as water supply, power, hospitals, police, and food supply. Planning should take place early in project development to anticipate and provide for these new demands. The actual means taken to mitigate potential impacts will depend on local standards. In general, urban areas tend to be less affected by these new demands than are rural, undeveloped regions of a country.

b. Coal Production

Environmental guidelines for strip mines (open pit) deal primarily with sediment and erosion control. In addition, noise, dust, and secondary effects should also be considered. For underground mines, dust, mine drainage, solid waste, and secondary effects can require control. Similar factors are relevant to coal preparation plants if steps are taken to wash or treat coal before being used in a boiler.

i. Air Emissions

Dust generated by construction and operation of the mine contributes to ambient levels of suspended particulates and other constituents associated with the

dust. The World Bank cites EPA guidelines for avoiding effects of dust (260 ug/m³ maximum 24-hour concentration, no more than once a year) and suggests ambient guidelines of 100 ug/m³ measures as an annual geometric mean and 500 ug/m³ as a maximum 24-hour concentration. The impact of emissions from coal preparation plants should be limited to 75 ug/m³ (annual geometric mean) and 260 ug/m³ (24-hour maximum) outside the mine fence at ground level. No guideline is given for dust in the underground mine, but dust suppression by conventional methods (water sprays) is anticipated. Similarly, conventional, relatively inexpensive methods will be implemented to control fugitive dust from the coal transfer operation and the coal preparation plant. These methods include partial or full enclosure of the conveyors, water sprays, baghouses, or other dust collection devices. Monitoring of dust concentrations is suggested by the Guidelines, but monitoring other than to ensure worker safety is probably not warranted for the mine site, given its remote location and the sparse population at Lakhra.

ii. Liquid Effluents

The World Bank has established effluent quality limitations for both surface and underground mines. These limitations for the quality of runoff and drainage from surface mining operations are 30-100 mg/l per total suspended solids, 4-7 mg/l for total iron, a pH of from 6 to 9 and alkalinity greater than the acidity. Monitoring of these effluents other than for use in defining operating procedures is not anticipated as effluents should be limited in quantity and readily treatable to achieve guideline values.

Acid mine drainage for underground mines and coal preparation plant effluents are subject to similar limitations and are 70 mg/l for total suspended solids, 4 mg/l for total magnesium, 6 mg/l for total iron, and a pH range of from 6 to 9.

iii. Solid Waste

Overburden initially removed from surface mines or the tunnels of underground mines and refuse from coal preparation plants represent a volume of material to be stored or permanently disposed of on land near the mine site. The potential for leachate and surface runoff will be monitored and care taken to avoid pollution of surface or groundwater. Placement and design of the disposal area provide opportunities to mitigate potential impacts. Surface drainage will be treated, if required, according to liquid effluent guidelines.

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iv. Noise

Given the nature of the proposed mine site, noise considerations are related primarily to occupational noise exposure. Residential exposure will only become a consideration if residential developments are established for workers close to the mine boundary. Based on the assumption that residences are not located close to the mine, the criteria recommended for the plant, i.e., the goal of 85 dBA for worker exposure, are recommeded.

v. Reclamation

The extent of the reclamation effort will be sufficient to permit further agricultural use at some future time. Reclamation will include restoration of basic contours and will be performed within 3 years of mining as suggested in the World Bank Guidelines. In the case of Lakhra, restoration of the disturbed land will be analyzed carefully because the area is practically a desert with few inhabitants.

vi. Secondary Impacts

Consideration of secondary impacts involves planning for people and their needs. Particularly in remote areas within a significant socio-economic structure, the area can be overwhelmed by the influx of workers, their families, and associated personnel. Basic housing and service needs are immediate and evolve over the project life. Planning, based on the local society standards, will be undertaken to satisfactorily deal with the many potential concerns.

3. Recommended Air Pollution Control

As discussed above, the World Bank has established Guidelines with respect to air pollution emissions and air quality impact for projects it supports. A preliminary, conservative atmospheric dispersion screening analysis was performed to provide an estimate of the control requirements necessary to comply with these guidelines. The specific objective of the analysis was to determine the necessary controls, if any, to preclude adverse ambient particulate and sulfur dioxide impacts from the power plant stack. These two major pollutants are discussed in some detail below.

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a. Particulates

Since the proposed plant is to be located in a rural area, the emission limit of 150 mg/m³ was used. An analysis was made to determine whether this rate is adequate to achieve compliance with the allowable ambient particulate concentrations shown in Table 1. The EPA screening model PTPLU was executed with hypothetical meteorological data to estimate maximum 1-hour particulate concentrations in the vicinity of the project site. EPA recommends that a factor of 0.4 be applied to the 1-hour concentrations to estimate 24-hour values. The dust particles existing naturally in the area, whose concentrations can vary widely during dust storms, have been ignored in the calculations. The PTPLU modeling analysis indicated that the highest ground level particulate concentration associated with the 150 mg/m³ emission limit would be 22.5 ug/m³ (24-hour average), which is well below the World Bank allowable ground level concentration limit of 500 ug/m³ (outside the plant boundaries).

b. Sulfur Dioxide

The World Bank Guidelines specify ambient standards for sulfur dioxide; there is no emission rate requirement. Uncontrolled sulfur dioxide emissions are estimated to be 17.2 pounds per million Btu, based on an average sulfur concentration in the Lakhra coal of 5.88 percent. This rate was used as an input to PTPLU to estimate the highest 1-hour sulfur dioxide impact from the plant in the project area. The EPA factor of 0.4 was applied to these predictions to estimate 24-hour concentrations. The analysis excludes consideration of the variability of sulfur in coal. A zero sulfur dioxide background was assumed in the analysis, due to the undeveloped nature of the site.

According to current EPA guidelines, the highest concentration predicted by PTPLU is used as the worst case concentration. Thus, as shown in Table 3, stability Class A at a hypothetical wind speed of 0.61 meters per second, which is considered to be unusually low, would suggest a maximum 24-hour ground level concentration of 2,462 micrograms per cubic meter. If this condition actually occurred, a stack gas cleanup system with an 80 percent removal efficiency would be required to achieve compliance with the World Bank 500 ug/m³ guideline. However, persistence of stability Class A, the most unstable mixing class of the atmosphere, for a 24-hour period is highly unlikely. Thus, a more representative

TABLE 3

UNCONTROLLED SO_2 AMBIENT IMPACT CONCENTRATION (PTPLU/SWEC)

Stability	Wind Speed (m/s)	24 Hr Concentration (ug/m^3)	Distance (km)
A	0.61	2462	1.68
D.	3.11	205	29.94
D	6.22	226	17.51

stability class, the so-called condition (D), was selected as the basis for estimating worst case 24-hour impacts. The results of this analysis are also shown in Table 3 for wind speed conditions of approximately 3 meters per second and 6 meters per second and are well below the World Bank's ambient guideline. Therefore, based on this preliminary screening analysis, no sulfur removal systems should be required for the Lakhra facility.

The study performed for WAPDA by JICA recommended use of a flue gas desulfurization system with a 90 percent removal efficiency to treat 50 percent of the flue gas. The maximum ground level concentration in that analysis was predicted to be 377 micrograms per cubic meter, only slightly above the U.S. ambient 24-hour standard of 365 micrograms per cubic meter, but well below the World Bank Guideline of 500 micrograms per cubic meter. The results of the JICA analysis are shown in Table 4. The atmospheric stability class actually used was not provided in the JICA report; however, the study was most likely performed for the D stability case.

JICA design parameters were also included in the PTPLU dispersion model to determine whether any difference in impact predictions would be achieved using this more current atmospheric dispersion modeling procedure than that employed by JICA. The maximum predicted concentration for the facility using the PTPLU model with the Japanese design parameters, is 155 micrograms per cubic meter (see Table 4), which again is considerably lower than the Japanese estimate of 377 micrograms per cubic meter. Differences occur in the dispersion model predictions because more current assumptions with regard to atmospheric dispersion techniques are incorporated in the EPA model.

TABLE 4

JICA DESIGN PARAMETERS: AIR QUALITY IMPACT ANALYSES

Stability	Wind Speed (m/s)	24 Hr Concentration (ugm/m³)	Distance (km)
		JICA	
-	3	210	29.6
-	6	377	13.9
		PTPLU/SWEC ANALYSIS	
D	3	80.4	47.08
D	6	131.1	22.85
D	15.01	155.0	11.24

In summary, no flue gas desulfurization is found to be necessary at this time. However, space for such a system will be set aside, pending a more thorough and comprehensive dispersion modeling analysis and field measurement program. A scrubber would be required if the 3-hour U.S. ambient air quality standard is used as the design basis. Consideration for the ramifications of operation of a future flue gas desulfurization system will also be considered in the design of the waste water treatment and ash handling systems and the waste disposal area.

c. Ambient Monitoring System

An ambient monitoring system will be established to determine current background air quality levels at the plant site. This baseline will be used to determine the actual impact of the Lakhra facility. The recommended network will consist of two to four fully equipped ambient monitoring stations capable of continuous measurement of sulfur dioxide, particulate matter and oxides of nitrogen at predetermined places. A single fully instrumented meteorological station will also be established at the site to obtain site specific data for use in future impact analyses.

TABLE 5

AIR QUALITY ANALYSIS SUMMARY

Pollutant	Site Categorization	World Bank Guidelines: Emission Standard	World Bank Guidelines: Ambient Air Quality Stnd 24 Hour (mg/m³)	World Bank Guidelines: Ambient Air Quality Stnd Annual (mg/m³)	WAPDA/PMDC/SWEC: Emissions (mg/m³)	WAPDA/PMDC/SWEC: Highest Predicted 24 Hr Ambient Conc (mg/m³)	JICA: Highest Predicted 24 Hr Ambient Conc (mg/m³)
	POWER PLANT						
Particulates	Urban	100	500	100	Not applicable	Not applicable	Not available
	Rural	150	500	260	150	22.5	Not available
SOd	Inside Plant Fence	Not applicable	1000	100	Not applicable	Not applicable	Not available
	Outside Plant Fence	Not applicable	500	100	Not applicable	226	Without FGD 377 With FGD 207
	MINE						
Particulates	Outside Mine Fence at ground Level	Not applicable	250	75			

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TABLE 6

RECOMMENDED EFFLUENT LIMITS: SURFACE MINING OPERATIONS

Total Suspended Solids (mg/l)	30-100
Total Iron (mg/l)	4-7
pH	6-9
Alkalinity	Greater than the acidity
Soluble Toxicants	None

TABLE 7

RECOMMENDED EFFLUENT LIMITS: UNDERGROUND MINING OPERATIONS/COAL PREPARATION PLANT

Total Suspended Solids (mg/l)	70
Total Magnesium (mg/l)	4
Total Iron (mg/l)	6
pH	6-9

DETAILED TECHNICAL ANALYSIS ANNEX

1. Energy Analysis and Manpower Development

National energy investment decisions should be based on a comprehensive assessment of the costs and benefits of different investment options. While the capacity to conduct such comprehensive energy investment analyses is limited within the Pakistan Government, these analyses have received considerable attention in the U.S. Techniques used in these analyses are ones in which U.S. public and private organizations have many years of experience. This component will thus be using approaches known to be technically feasible.

The present energy analysis activity in Pakistan being undertaken by IEDC makes use of the Reference Energy System (RES) model which, in its most basic form, can be used as a hand-manipulated method of displaying energy supply-demand balances. This model will be used as the starting point for developing a GOP analysis capability. More sophisticated analytical methods may be used as both the experience of the Energy Analysis Group increases and the data base becomes better established. Enar-Petrotech, an analysis group within the Ministry of Production, has developed sophisticated energy models which will be used as well.

The Reference Energy System was developed in 1971 at Brookhaven National Laboratory and is now used widely in both industrial and developing countries. A Reference Energy System uses estimated energy demands for each sector of the economy and works through energy conversion technologies and fuel mixes to determine the energy resources required to satisfy those demands. The graphical format for the Reference Energy System is a network diagram which indicates energy flows and the associated conversion efficiencies of the technologies used in various stages of the energy production/transmission/distribution/end-use system. For each energy resource, the RES indicates the possible routes for the flow of energy from that resource to a given demand category. Alternate paths and branches show the possibility of substituting various resources and technologies for one another. Both commercial and non-commercial forms of energy can be dealt with and centralized energy systems (such as large scale electricity generation) are distinguished from decentralized systems (such as small scale solar photovoltaic electricity production).

This model is now well established and A.I.D. has sufficient experience to use it effectively. A major difficulty with any energy modeling activity is the tendency of analysts and policy makers to expect more from the model than the quality of the data and uncertainty of future

events allow. In Pakistan, considerable reliable data is collected regularly by several agencies and will be available to the Energy Analysis Group. However, the Energy Analysis Group staff as well as U.S. contractors will have to exercise caution in applying model results to actual policy making decisions.

A.I.D. has been involved in several energy policy analyses and investment planning efforts over the past three years. This experience will be applied in Pakistan to help make this component one of high technical quality. In Indonesia, an A.I.D. project is supporting an energy analysis unit within the Ministry of Mines and Energy which also serves as the secretariat to the National Energy Coordinating Body at the Cabinet level. Work under this project has helped to highlight the oil export implications of continued high rates of growth in domestic petroleum consumption and spur a presidential decision to reduce large subsidies and to increase petroleum product prices. A second-phase project will develop regional energy supply and demand balances and will link these with economic growth models. An A.I.D. program in Morocco is providing software, hardware and training in investment planning using a micro-computer. A.I.D. recently sponsored a workshop on energy planning in developing countries that reviewed major experiences with these kinds of programs. The proceedings of this meeting will be useful for the implementation of this component.

The analysis techniques and decision making procedures to be used in this project are, therefore, well developed and some have already been used successfully in Pakistan and other developing countries. A major neglected area of energy analysis is assessing the manpower implications of energy programs and options. Despite the importance of good management and technical and engineering skills to the carrying out of large national energy programs, this critical factor has received little attention. The methodologies for conducting cost-effective manpower assessments are not well-developed. Bechtel has developed a computerized model that relates energy projections for various supply areas to categories of manpower required to supply that energy. This model has been applied in Egypt and Indonesia with mixed success. This project will, therefore, help develop and improve appropriate techniques for manpower assessment.

As noted above, this component will finance short-term professional development and training based on the manpower needs assessment. The emphasis will be on practical training and internships with U.S. industry. This approach is technically well established. A.I.D.'s Conventional Energy Training program has had considerable success in arranging these kinds of programs.

2. Coal Resource Assessment and Development

a. Coal Resource Assessment

Techniques proposed under this sub-component for conducting regional coal assessments are well established and are known to be technically feasible. The U.S. Geological Survey has been active in Pakistan since 1950 when the GSP and U.S.G.S. began a cooperative program to intensify the mapping and approval of the geological resources of Pakistan. Project Design Consultants from the U.S.G.S. have helped design geological survey techniques for this sub-component which are not only technically well established but which are also technically appropriate for Pakistan. Both exploratory core drilling and geophysical logging techniques are widely used in the U.S. Geochemical characterization, photogrammetry, and remote sensing techniques are also well known in the U.S. The project proposes sufficient technical assistance from U.S. experts to ensure high technical quality for this sub-component.

b. Coal Development

i. Coal Power Generation

The Lakhra Coal Study recommends designs for coal production and power generation facilities that substitute labor-intensive designs for capital-intensive ones and minimize foreign exchange requirements whenever practicable. These designs are technically feasible and directly applicable to Pakistan. Training of operating and maintenance personnel will be required to properly prepare Pakistani coal production and power generation personnel to assume full responsibility for, and control of, the facility after a short (1-2 Yrs) transition period. The Lakhra project consists of a mining complex to produce an initial 1.4 million tons per year of Lakhra lignite, associated infrastructure and a 300 MW power plant. The Lakhra Coal Mining and Power Generation Project Review prepared by project consultants (summarized in Annex K) documents the technical feasibility and elaborates on the details of mining techniques and power plant technology used. Neither the mining, the unit train nor the power plant technologies are currently utilized in Pakistan, but are essential for developing this major domestic energy resource; the specific technologies selected are those which are most suitable for the experience level in the country.

The current plan envisions Jamshoro as the site of a large Lakhra lignite fired power complex beginning with one 300 MW unit. To support the GOP goals of expanding thermal power generation, based on domestic fuels and thus mitigating electric power shortages and balance of payments

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problems due to imported fuels, a second 300 MW unit is planned to be commissioned 1 to 3 years after commissioning of the first one. To accommodate operator training, common spare parts inventories and to further decrease costs, the second unit would be a duplicate of the first unit, with the exception of the addition of some form of flue gas scrubbing if required by environmental observations. To accommodate the second and future power units, the coal mining complex can be expanded based on reserve drilling results. It is also planned to promote private mining in the Lakhra area by a mine demonstration and encouragement program. The assured market of the Jamshoro Power Station will assist in this program.

The major technologies used for this power project and related technical issues are discussed below.

(a) Coal Production

The major technical findings of the Lakhra review for coal production, preparation, and transportation facilities are as follows: (1) The Lakhra Review found 65 million tons of proven reserves recoverable by a mix of surface and underground mining methods. This coal could supply 510 MW for 30 Yrs; (2) Well proven reliable technology is proposed for both the surface and underground mines. These mining methods have been used for years in the U.S. and can be adapted to the Lakhra area in Pakistan with a minimum amount of difficulty (3) Current mining methods in Pakistan were found to be inadequate to meet the relatively large quantities and uniform quality of coal required by the power plant. A sufficient amount of mechanization can be introduced in the new mines to meet demand while employing as much labor as practicable. The following describes the coal production preparation and transportation facilities required.

Coal production will come from two surface mines, located in the east and west blocks of the PMDC-investigated area, and an underground mine in the central block. The surface mines can produce up to 2.5 million tons per year of suitable quality coal at an average stripping ratio of 1:11 (stripping ratio describes how many cubic meters of rock overburden which must be removed to recover one metric ton of coal, here 11 cubic meters per ton of coal) or less, which was determined by the feasibility study to be the acceptable economic ratio for Lakhra coal during the first operations. The underground mine can produce 0.275 million tons per year of suitable coal at an acceptable cost.

Surface mine operations will use trucks and electric shovels for overburden removal and front end loaders and trucks for coal mining. The majority of trucks employed will be manufactured in Pakistan. By

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employing hybrid mining methods and by increasing the workable stripping ratios from a maximum of 1:15 to 1:17 as mining experience increases, the reserve base of recoverable coals increases to more than 100 million tons which could supply 715 MW for 30 years. The underground mine will produce coal from a handloading longwall coal face and a mechanized longwall face. Entry and headrift tunnels will be dug partly by a continuous miner and partly by conventional mining equipment.

The coal from the three mines will be cleaned by hand-picking. The cleaned coal will be crushed to 2-inch diameter or less for transport to the plant by a train over a dedicated railway 25 miles long. Rolling stock will consist of one imported 2000 hp diesel locomotive and approximately fifty-five 44 ton railcars manufactured in Pakistan. Coal will be delivered in two trains per day, delivering an approximate total of 4000 tons.

(b) Power Plant

The major issues addressed in the Lakhra Review concerning the generation of power with Lakhra Coal are problems associated with burning the coal and the need for flue gas desulfurization (FGD) equipment. The high levels of ash, moisture and low heating value increase capital and operating costs of burning Lakhra coal but should not directly force power plant outages. However, the high levels of sulfur in the coal and iron in the ash can cause operating problems in the steam generator if it is not properly designed. The feasibility study report concluded that with a properly designed boiler, outage rates would be acceptable. The potential operating problems of burning Lakhra coal in a conventional steam generator can be minimized by a series of analyses and the test firing of several tons of coal by a boiler manufacturer before final boiler design and manufacturing. Arrangements will be made for these tests as part of Phase I of the Coal Development portion of this project. The steam generator manufacturer would use the results of these tests to develop a customized design that would preclude operating problems, to the greatest extent possible. Many power station boilers in the U.S. and elsewhere using lower grade coals have customized designs.

A flue gas desulfurization (FGD) system is not recommended initially, for the following reasons:

(1) The modeled smoke stack emmissions are projected to be well below the World Bank established standards for SO_2; and,

(2) The currently available FGD systems are very costly, approximately $20 million and up for the proposed plant, and it

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is expected, since poorer coal qualities but higher environmental standards are used world wide, that new or improved FGD technologies will become available with the next few years.

As part of this project, prior to construction of the first unit, local air quality will be monitored to determine the impact of mining and burning Lakhra coal on the surrounding environment. Based on the analysis of the actual measurements, a decision will be made on future FGD requirements of the first unit as well as of future units.

(c) Conclusion

The proposed coal mining and power plant technologies are technically sound and feasible.

ii. Coal Briquettes

On a worldwide basis, millions of tons of briquettes are produced annually and the briquettes find a ready sale on the residential market. In Germany, the largest producer, 80% of the coal briquettes produced are sold to residential consumers and the rest is sold to industry. In West Britain, National Smokeless Fuels Ltd. produces over one million metric tons of smokeless briquettes per year. In Quetta, Pakistan, coal briquettes (non-smokeless) have been produced by PMDC since 1942; current production is about 10,000 metric tons per year. Briquetting started in Korea in 1930 and about 20 large briquetting plants are operating. A.I.D. has supported a briquetting project in India which also promotes the use of a stove which produces its own smokeless fuels from coal. Project design consultants visited and assessed these briquetting activities and have participated directly in the Indian project. The proposed briquetting activities will therefore build on experience and will benefit from lessons learned in these other countries.

The object of briquetting is to convert a low grade fuel like Pakistani lignite into one of superior quality. Lignite can be converted into a hard compact fuel with a high heat value. Briquettes may also be carbonized (heated in the absence of air to drive off the coal's volatile gases) to yield smokeless char briquettes of still higher quality. The process of briquetting consists of applying pressure to pulverized coal to form a compact agglomerate. A binder material may or may not be employed. Commonly used binders include coal tar pitch, asphalt, starchy waste materials, molasses and cement. Briquetting of coal thus involves grinding, drying, mixing with binder and pressing the coal, and cooling the briquettes before loading into trucks or wagons. Project design consultants estimate that a population of 10 million people

constitutes the potential briquette market in Pakistan. This would require approximately 500,000 metric tons of coal per year to serve the residential and small commercial markets. This level of coal production is feasible with some improvements in current mining practices and the coal briquetting plants would require an investment of about $30 million. Coal mining activities necessary to encourage greater production are discussed under the mining subcomponent of the Lakhra Coal Project. Based on experiences in other countries, the capabilities of U.S. firms to design and operate briquetting plants, the large potential market, and the programs developing in Pakistan to increase coal production, this sub-component is considered technically feasible and sound.

3. Conservation and Renewable Energy Technologies

a. Industrial Energy Conservation

Conservation refers to the efficiency with which energy is used in a process - that is, how much energy is used to produce one unit of output. This concept is sometimes also called "energy intensity". It does not imply, in any way, a reduction in output. Rather, energy conservation should allow higher levels of output for the same amount of energy expended. The industrial sector in Pakistan is an important energy consuming sector, accounting for more than 50 percent of total commercial energy consumption. During 1975/76 to 1980/81, industrial energy consumption grew at an annual compound rate of 7.1 percent. The major energy consuming industries in Pakistan are textiles, cement, steel, fertilizers, chemicals, brick, foods, and paper. Due to the concentration of energy consumption in a few industries and even in a few plants, significant potential exists for energy efficiency measures to have a quantitative impact on national energy demand. (See Table 1).

Approximately 50 percent of industrial gas consumption is in the cement and fertilizer industries. Cement plants and boilers in many factories have the potential to convert to coal, and, in most plants, large amounts of fuel can be saved by recycling, use of heat exchangers and more efficient controls. Thus, conservation and fuel substitution measures in this sector are reasonable and practical solutions for the current and projected shortage of natural gas. Energy supply-demand balances prepared by the project design team indicate that improved energy efficiency in the industrial sector (both in existing plants and in new facilities) must be an important aspect of programs which address future energy supply options and, in particular, to limit growth in oil imports to acceptable levels.

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Table 1

Industrial Energy Consumption

(Thousand Tons of Oil Equivalent - 1979/80)

Energy Source	Consumption	% of Total Sector	% of Total Fuel Use
Biomass a/	1,322	23	16
Coal b/	1,065	19	97
Oil	288	5	6
Gas	2,640	46	51
Electricity	393	7	42

In addition, industrial energy conservation is one of the few energy measures which can have measurable impacts on energy supply-demand in a short (3-5 year) time frame, and mitigate the need to import oil to make up for inadequate supplies of natural gas. These observations are consistent with the preliminary results of the energy planning activity now underway in the Planning Commission (with the assistance of IEDC) and accordingly, the GOP is giving increasing attention to industrial energy conservation issues.

Energy efficiency measures can be grouped according to cost. Low cost measures include boiler efficiency testing and correction, regular cleaning and lubrication of equipment to reduce frictional losses and careful scheduling of operation to minimize idle time. Moderate levels of capital expenditure are required to apply recuperators and high efficiency boilers and lighting, automatic process controls and variable speed electric motor drives. High cost changes include major switches in processes, such as shifting from the wet process to modern dry process kilns with preheaters and precalcining for cement making.

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a/ Largely bagasse in sugar refining

b/ Principally in brick kiln industry

Source: A.I.D. analysis and Energy Year Book 1981

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Many factors affect the feasibility and implementation of energy efficiency measures. During project design the following were identified as important: 1) pricing structure and energy supply; 2) knowledge of advanced techniques for raising energy use efficiency; 3) awareness of the needs for and potential benefits of industrial energy conservation; 4) availability of indigenous engineering skills and manufacturing capabilities; 5) capital requirements and availability; and, 6) inconsistent supply of electricity. This project concentrates particularly on obstacles 2, 3, and 4. In particular, the project design calls for undertaking energy audits, training of plant managers and planners in industrial energy conservation technology and economics, and support of selected pilot plants to accelerate commercial acceptance of newer technology options. These activities are intended to support the efforts of the GOP and private sector industries in accelerating the implementation of cost effective industrial energy conservation measures.

Over the period 1971 to 1975, U.S. industry reduced its energy use by about 15 percent (per unit of production) by implementing improvements with low initial costs. Even greater savings have been achieved at many plants. In some cases, especially high-temperature processes like cement manufacture, thermal efficiencies have dramatically increased - from less than 20 percent to as high as 60 percent. Of particular importance for this project, much of the improvement in industrial energy efficiency has taken place over a relatively short period of time (about 4 years) using low capital cost measures with payback periods of less than 1 year.

Japan has also made remarkable progress in reducing energy intensity in industry through systematic approaches to energy management at the plant and building level. In the developing world, the Philippines, India, Tunisia, South Korea and other countries are carrying out industrial energy audits and developing tax, trade, and investment incentives to improve efficiency. The Asian Development Bank has made two major loans for industrial energy conservation - to South Korea and the Philippines - and is considering a program in Pakistan. Preliminary results from the ADB funded program in the Philippines indicates energy savings from low cost "housekeeping" improvements might decrease energy use in excess of 20 percent. This is similar to experience in other developing countries.

In Pakistan, a wide variety of energy conservation practices are already in use - from steam pipe insulation and maintenance to the addition of heat exchangers to preheat feed streams as hot wastes are dumped. Plants visited during project design maintained energy use records of various kinds and sophistication. Substantial interest exists at these plants in learning about state-of-the-art techniques and about the experience of other plants in Pakistan as well as in other countries. Some professional energy audits have already been made and recommendations

implemented. At least one private consulting firm has performed energy audits. In summary, the considerable potential for energy efficiency improvements in Pakistan coupled with a notable record of success of relatively simple industrial conservation techniques in the U.S. and in other developed and developing countries, suggests that this activity is technically feasible and sound.

b. Renewable Energy Technologies

Pakistan has a good resource base in most of the renewable energy sources. Solar energy availability in most parts of the country is comparable to the southern half of the United States. The northern mountainous areas have extensive small scale hydro resources which the design team estimated as being in excess of 90 MW in one region alone. The irrigation system barrages located throughout the country have a potential for over 500 MW of small scale hydro potential. Over 27 million head of cattle in the country could provide up to 35 million tons of cow dung for operation of digester systems. Other sources of biomass include rice husks and other agricultural residues. However, wind energy resources are rather limited so that its use would be only on a specialized local basis.

From a basic resources point of view, therefore, renewable energy systems could make a significant contribution to energy balances in Pakistan, particularly in rural areas where commercial fuels and electricity are either unavailable or very costly and traditional firewood resources are being rapidly depleted. Established technologies are available to tap these resources and the United States has considerable expertise it can apply to assist the GOP in strengthening its renewables programs.

i. Solar Heating

There are over 200 firms in the United States manufacturing and installing solar heating systems for such varied applications as domestic water heating, space heating, industrial process heating, and commercial crop drying. Many other countries, notably Israel, France, Australia, Japan, and South Africa, also have extensive solar heating industries. In Pakistan the DGER has already in operation a 20 kilowatt solar installation and another out for bids. Research is underway at the Silicon Technology Development Laboratories recently formed within the Ministry of Science and Technology. In the United States alone, over 12 million square feet of solar collectors were manufactured in 1982 and worldwide production exceeded 100 million square feet. Solar heating technology is, therefore, well-demonstrated on a worldwide basis and, technically, should be well-suited for use in Pakistan.

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Most of the collectors now being manufactured are based on "flat Plate" configurations. These collectors typically use a blackened sheet of metal to absorb incident solar energy. Heat losses from the absorber plate are reduced by placing a layer of glass (or transparent plastic) over the plate and insulation behind the plate. This assembly is placed in a box (usually sheet metal) to protect it from the environment. Solar energy collected by the absorber is transferred either to water contained in tubes bonded to the plate or to air flowing behind the plate. Such collectors basically use a refined form of "greenhouse" effect to generate temperatures up to about 200°F, which are sufficient for a wide range of residential, commercial and industrial applications. Flat plate collectors do not track the sun and, therefore, can be placed in a fixed position (at a tilt of about 35°F in Pakistan) on a roof or on the ground. This simple construction and operation make them well suited for use in Pakistan.

Most of the firms manufacturing solar collectors in the United States are relatively small enterprises. Similarly, the relatively simple solar heating technologies should be well-suited for manufacture in Pakistan by small to medium scale private sector enterprises.

ii. Photovoltaics

About six firms in the United States fabricate solar cell panels and an additional twelve firms package systems to serve specialized applications. The worldwide sales of photovoltaics were about 6000 kW in 1982. The United States is the leader in this field having about 80 percent of the market. The primary commercial applications for photovoltaics are currently for remote communication and safety equipment, cathodic protection and consumer products (watches, calculators, etc.). Photovoltaic power units of 1 kW to 50 kW capacity have been installed on a pilot plant basis to demonstrate their potential for such vital functions as irrigation pumping, small scale village power, and educational television. One of these pilot plants is located in Pakistan (10 kW village power unit). Solar water pumps are also being demonstrated.

A photovoltaic power system typically consists of:

(a) solar cell panels which currently utilize single crystal silicon as the semi-conductor material which converts sunlight into electricity (about 10 watts per square foot under clear sky conditions at noon);

(b) a structure for mounting the panels and associated wiring system;

(c) a battery storage unit to allow for limited cloudy sky and night-time operation (may not be required in specialized functions such as irrigation); and,

(d) control systems to regulate solar cell array voltages, battery charging rates, and dispatch to the loads.

Photovoltaic power units are well-suited for manufacture (at least partial) and use in Pakistan. System design and packaging is well within the capabilities of the Pakistani technical community. Many of the subsystems such as controllers, batteries, and mounting structures could currently be manufactured in Pakistan. Pakistani industrial concerns can also be major participants in solar cell manufacture and/or panel assembly once the market develops to a significant level, and three U.S. firms have recently announced they intend to establish manufacturing operations in Pakistan. The systems are highly modular and can be effectively utilized in units from 10 watts to hundreds of kilowatts. This power range is of primary interest for application in rural areas of Pakistan where grid extensions are very costly. Photovoltaic panels use semiconductor technology to directly convert solar energy into electricity with no moving parts. As a result the systems are highly reliable and could be maintained by local personnel after appropriate training in basic operating and maintenance procedures.

iii. Small Scale Hydro

There are at least 3 firms in the United States manufacturing small hydro units with capacities from 1 kW to 100 kW. Extensive commercial activity also exists in Canada, Germany, and France. In addition, about half a dozen firms in the United States and Europe offer small scale hydro units with capacities from 500 kW to 50 MW. These units might be adapted for use on the irrigation system barrages. Therefore, the technology of both mini and small scale hydro power systems is well developed. Small scale hydro technologies have been implemented on a limited scale in a number of developing countries including Thailand, Peru and Nepal as well as the United States.

Pakistan (through the ATDO) has installed about 40 mini hydro units having capacities of 5-20 kW. These units have used a design which is well adapted for reliable operation in this small power range with relatively low heads of water (20 feet). In addition, about six small

hydro plants with capacities from 50 to 500 kW are currently being operated in the northern areas by the local development boards and about a dozen others are in the planning stage. The technology of small scale hydro and micro hydro systems is, therefore, well-developed and a substantial capability already exists in Pakistan in the design and use of these systems. The project includes strengthening the existing technical capability in the design of small hydro systems and providing assistance in developing the management infrastructure for project implementation. All the firms in the United States making micro hydro units are small entrepreneurial organizations. Activities in Pakistan could similarly be undertaken using the machinery and assembly capabilities of local machine shops. These systems could, therefore, readily be largely manufactured in Pakistan, possibly in cooperation with United States firms.

iv. Wood Stoves

Considerable experience has been developed in the design of high efficiency wood stoves for use in a wide range of developing countries including Senegal, India, and Indonesia. In Pakistan, Peshawar University, working with the Forestry Reserve has developed a prototype wood stove. These stoves, fabricated from locally available mud, brick and stone, could be adapted for wide use in Pakistan. Experience indicates that wood consumption used for basic cooking and space heating functions (such as required in northern Pakistan) could be reduced by factors of 2 to 4 by better stove design. These very large potential reductions in wood consumption provide a strong incentive to pursue those technologies in Pakistan where firewood resources are being rapidly depleted.

The technical merits (and potential favorable impacts) of high efficiency wood stoves have been well demonstrated. Despite these advantages, efficient wood stoves have not in general been widely utilized in any of the developing countries where they have been developed. Common reasons cited are a lack of appreciation of stove advantages by potential users, a lack of private or public sector organizations with a strong interest in promoting stove use, and excessive incremental costs for poor rural populations. The above reasons are why this program emphasizes market testing and private sector participation in order to accelerate the use of stove designs appropriate for use in both urban and rural areas of Pakista...

v. Other Biomass

Aside from firewood, the most important bio-resources in Pakistan are cow dung and various crop wastes such as rice husks.

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Many of these biomass resources are now used as cooking fuels via common direct combustion processes (to supplement or replace firewood). Most of the interest in Pakistan to increase the use of biomass as a fuel centers on using cow dung as a feedstock for anaerobic digestion systems. The output of digesters is a low Btu gas (about 500 Btu/ft^3) and a sterile sludge which can be used as a soil conditioner. The gas can be used for cooking, lighting, and as a fuel for modified internal combustion engines. Advantages of digester systems over direct combustion of dried cow dung cakes include having a clean burning fuel for use in households with associated health and comfort improvements, and maintaining or even improving the soil conditioning capability of the cow dung (which is totally lost in a direct combustion process).

For basic cooking and lighting functions, about 12-15 cubic feet of biomass is required per day per person. A family of 5, therefore, might require approximately the dung production from 3-5 cows. Many rural families have this number of cattle so that digesters could, in principle, have widespread use. Biogas digesters are being used in a number of countries including India, China, Taiwan, and Korea. Several hundred units with capacities of about 120 ft^3 have been installed in Pakistan by ATDO and the DGER. The largest base of experience exists in China where over 1 million family size units have been installed. This experience verifies the technical potential of biogas digesters. It should be noted, however, that the effective operation of digesters requires daily attention by operators (to prepare feedstock and to check pH levels) and that many systems installed in the countries mentioned above are no longer operating (including some of those in Pakistan) for a variety of technical and social reasons.

The project design has taken note of the mixed experience with digester systems and emphasizes assessing the performance of systems already in place and identifying practical social and institutional issues associated with using digester systems in Pakistan.

vi. Obstacles to Implementing Renewable Energy Resource Systems.

As indicated above, renewable energy technologies are well understood and, in most cases, a large base of experience is available in their design and performance on a worldwide basis. The primary issues are related to adapting technologies for use in Pakistan and in developing programs which will accelerate both private and public sector participation in the commercialization of economically viable systems. Each of the renewable energy system options has unique technical, social, and institutional problems which currently limit their use. During project design a number of issues which are common to most, if

not, all the system options were identified as follows: (a) low pricing of gas and other conventional fuels reducing the economic incentive to use alternative systems; (b) limited knowledge on the part of private and public sector decision makers on systems' benefits; (c) present programs which do not have sufficient coordination and supporting economic/market rationales; (d) limited availability of indigenous engineering and planning skills; and, (e) lack of financial incentives or mechanisms to allow purchase of relatively expensive equipment by potential consumers.

Present GOP policies will slowly mitigate the effects of low gas prices so that the major barriers will increasingly be institutional, marketing, and financial factors. This project seeks to directly address items (b), (c), and (d), above by providing technical support to public and private sector participants in renewable energy system analysis, project planning, and market development. It will indirectly impact on government policies and programs providing financial incentives for system manufacture and purchase by providing information (national impacts, economic benefits, and so forth) which will allow the GOP to assess the national benefits of alternative policies to accelerate the commercialization of systems which are economically viable.

vii. Feasibility of the Approach of this Project to the Introduction of Renewable Energy

A number of forms of renewable energy are clearly feasible technically in specialized situations in many countries of the world, and there is now enough experience with equipment in operation that it is no longer considered experimental. In Pakistan, some situations considered specialized in other countries are common and some of them make renewable forms of energy especially attractive. For example:

(a) A very high percentage of cloudless days with bright sunlight over most of the country. This is ideal for solar energy;

(b) A large number of small high head streams in the NWFP and of low head irrigation canals in Punjab. These are ideal circumstances for mini and micro hydro generators;

(c) Large amounts of biomass very inefficiently used. Biogas generators can efficiently use biomass currently wasted, such as dung, rice hulls and other refuse;

(d) A large part of the country not covered by the electric power grid, many parts so remote they probably never will be reached by the main grid; and,

(e) Limited resources and high real costs of conventional fuels such as oil, gas and coal.

A very large expansion in use of renewable energy (now in the embryo stage) is socially desirable and economically feasible. The approach of this project, which will work toward reduction of obstacles to expansion of renewable energy use and toward plans and programs which will greatly enlarge its use is considered technically feasible.

ANNEX O

LIST OF CONSULTANT REPORTS ON FILE AT USAID/PAKISTAN

1. Breuer, T, "Coal Utilization Issues and Prospects in Pakistan", Nov. 1982

2. Englestad,O.,C. Hewett, J. Storey, and P. Weatherly, "Pakistan Biomass Energy Reconnaissance", Nov. 1982, 33 pp.

3. Fabuss, B.M. and J.W. Tatom, "Preliminary Feasibility Study of Coal as a Domestic Fuel in Pakistan", Nov. 1982, 63 pp & appendices

4. Fox, Lee, "Energy Conservation Opportunities in the Industrial Sector of Pakistan, Nov.1982, 33 pp.

5. Hewett, J.K."Environmental Assessments for Coal and Small Hydro", Nov. 1982

6. Lawrence, W.A., A. Inversin, and M. Gellerson, "Small Hydro Report", September 1982

7. Masica, W.J."Solar Energy Project Plan", Nov. 1982 83 pp & appendices

8. Reinemund, J.A., E.R. Landis, and F.O. Simon, "Coal Resources Assessment", December 1982

9. Siddiqui, Masud, "Institutional Analysis, Energy Planning and Development", December 1982

10. Teagan, P.J., "Energy Sector Overview and Issues", Nov. 1982

11. Water and Power Development Authority, Pakistan Mineral Development Corporation and Stone & Webster Engineering Corporation, "Lakhra Coal Mining and Power Development Project Review", April 1983

12. Watson, W.I., "Assessment of the Current State and Future Development of the Coal Mining Industry in Pakistan", Oct. 1982

ELECTRIC POWER GENERATION AND DISTRIBUTION IN PAKISTAN

A. Ministry of Water and Power

This Ministry is responsible for two major subsectors of the energy sector: water and electricity. It is responsible for the 1960 Indus Basin Treaty; Indus Basin Works at the national and international level; the National Tubewell Construction Corporation, Ltd; the National Power Construction Corporation, Ltd; the Water and Power Development Authority (WAPDA); and, the Karachi Electric Supply Corporation, Ltd. (K.E.S.C.).

The organization and delineation of responsibilities in the power sector are governed primarily by two documents. The Electricity Act of 1910, as amended in 1964, governs the sector in general and enables the Government to issue licenses for generation and distribution of electric power in various areas of the country. Pursuant to this Act, K.E.S.C. was granted a license to generate and distribute power in the Karachi and Lasbella districts. The Water and Power Development Authority Act of 1958, as amended in 1959, created WAPDA as a quasi- autonomous body by transferring to it all electricity departments except K.E.S.C. WAPDA accounts for 75 percent of the total power supply and K.E.S.C. for about 25 percent.

1. Water and Power Development Authority (WAPDA)

WAPDA is headquartered in Lahore and is responsible for coordinating nationwide development of water and power resources. In these areas, it often undertakes design, construction, and operational activities for the federal and provincial governments.

WAPDA derives funds from the following sources: federal and provincial government grants and loans, proceeds from bonds issued under GOP authority, loans obtained with special or general sanction of the government, grants and loans from foreign donors, and sale of electricity.

WAPDA is organized into three "Wings". The Water Wing is responsible for: water resources planning, use, and measures to combat waterlogging and salinity and to reduce their effects; surface and ground water planning, investigation, and design; flood control; inland navigation; and, the Indus Basin settlement plan. This Wing constructs projects on behalf of the federal and provincial governments and, upon completion, turns them over to the sponsoring government body for operation. The Finance Wing is responsible for financial administration and review of the power sector, balance sheets, and personnel. The Power Wing is Pakistan's major "electric utility" and is responsible for construction and operation of power generation, transmission, and distribution facilities, including rural distribution.

WAPDA's governing body or board is called the "Authority". It consists of a Chairman and the Managing Directors of the three wings known as "Member - "Member Power", and "Member Finance". All are government appointees. According to the statute creating WAPDA, the Authority was to be a policy-making institution. However, it has become involved in daily operations so that its members act more like senior managers making decisions of less than major importance than as Managing Directors functioning as chief executives overseeing their respective divisions. The Authority also has been characterized by rapid turnover of Members and by the absence of a reporting system to provide managers with reliable and meaningful information needed to effectively execute their responsibilities.

2. The Power Wing of WAPDA

The Member Power is assisted by six general managers responsible for different departments in the Power Wing: General Manager (Generation); General Manager (Transmission and Grid Station); General Manager (Computer); General Manager (Finance); General Manager (Distribution); and General Manager (Planning, Design and Protection). A chief engineer responsible for material inspection and surveillance also reports directly to the Member Power. Estimates of the personnel in the Power Wing range from 77,650 to 86,000.

Since 1960, there has been a major shift in WAPDA's priorities. Initially, the focus was on large capital projects such as the Indus Basin Project, and the development of 1,200 MW in thermal generating capacity, 300 transmission grid substations, 13,000 KMS of high voltage transmission lines, and a large number of other works. In 1958, when WAPDA took over the electricity department of the GOP, its facilities totalled about 119 MW. In September 1981, its generation capacity was 3225 MW. In PFY 1980/81, WAPDA's total energy generation was 13,206 GWH. At present, there still is considerable development activity, with construction of over 1,200 MW of hydro-electric and thermal generation capacity, 1000 KM of high voltage transmission lines, and 200 transmission grid substations.

B. Power Generation

1. Current Power Generation Situation

The power section involves generation, transmission, and distribution. Generation is the harnessing of power for the creation of electricity from hydro (water) or thermal (steam, gas turbines and diesel) units. Generation is concerned with the planning, design, construction, operation, and maintenance of a relatively small number of large, highly technical facilities required to generate at minimum cost the electric

energy demanded. Since the 1960's, generating capacity has nearly quadrupled, from just under 900 MW in 1965 to 3,225 MW in 1981, and the hydro based share of this capacity has risen from 30 percent to 57 percent. Hydro energy is even more important than these figures indicate because hydro plants require no costly fuel and comparatively little maintenance. Their major limitation is the varying availability of water. Even with that limitation, however, hydro energy accounted for 68.5 percent of the total units of electricity actually produced in PFY 1980/81. It is anticipated that as fuel prices increase, hydro sites which have not been developed will become increasingly attractive. Accordingly, WAPDA is proceeding with plans for several major hydro schemes.

As stated above, the bulk of hydro power is derived from the harnessing of the large potential of the Indus and Jhelum Rivers in North Pakistan, a process which began after the 1960 signing of the Indus Water Treaty between India and Pakistan and the undertaking of the $2.7 billion Indus Basin Project. That project includes two of the largest earth-rockfill storage dams in the world, one at Tarbela which in 1980 generated 45 percent of the nation's hydro power, and one at Mangla which generated 38 percent in the same year. Four generating units totalling 1,050 MW in capacity are currently being installed at Tarbela, and seven other units totalling 2,842 MW are scheduled for installation between 1988 and 1992.

This hydro generation is characterized by several phenomena. One is the seasonal variation in water flow with about 72 percent of the Indus flowing in the four months between June and September. During that time, the Tarbela reservoir fills to the top of the dam, and each of the dam's eight 175 MW generation units achieves an output of 200 MW. From October through May, however, there is little rain and little run-off. By January, irrigation demand reduces the level of water in the Tarbela reservoir so much that the output of each of the 175 MW generators is reduced to less than 60 MW. That is the origin of the large seasonal differences between generation capacity and capability and the resultant power generation shortfall. Another factor is the relatively high siltation rates which may limit the life of hydro plant reservoirs. Little is known about this factor to date, but it is estimated that the Tarbela reservoir could lose 90 percent of its storage capacity within the next fifty years and Mangla 50 percent over the same period. These limitations notwithstanding, hydro electricity is a major source of commercial energy and offers promise for further development at both existing and new sites.

Thermal electricity is generated at 22 power stations in central and southern Pakistan. Since the early 1950's, indigenous natural gas has been the main fuel. Before the petroleum price rise in 1973, reliance on oil had been increasing, but the GOP took steps to halt this trend and now natural gas is used almost exclusively.

2. Additions to Generating Capacity

Pakistan currently faces an electrical supply crisis. One aspect of this crisis relates to insufficient generation capacity, which is a problem even though total installed generation capacity exceeds peak demand. This discrepancy arises from generating facilities being unable to perform at rated capacity due to age, low water levels in reservoirs (especially during February to May), and because they must be withdrawn from service for routine maintenance. To prevent overloading and damage to generators during periods when demand exceeds available capacity, entire circuits must be disconnected, otherwise known as load shedding. The power system generation shortfall and resultant load shedding is an acute problem at present, and installation of new generation capacity is urgently needed.

The question of where large amounts of electric power to feed Pakistan's electric grid must come from is answered by the process of elimination. Large amounts of new hydel, besides being a decade or more away even if started soon, will exacerbate the present seasonal variations in supply and cannot be considered for base load. The gas supply is diminishing and can be considered only for peaking and imported oil can be considered as a last resort for peaking or stand-by only, because of its high cost in foreign exchange. The Pakistan electric grid at this stage is not large enough to sustain an economical size nuclear station (about 600 MW minimum) because of the excessive disruptions created during shut downs. The IEDC Consultant's study of energy for the Sixth Five Year Plan states that after detailed analysis of all fuel prospects they concluded that coal is at present the only domestic fuel which can be mobilized relatively quickly, can make an important contribution to fuel substitution at modest levels of public expenditure and can show tangible results by the end of the Sixth Plan.

C. Power Transmission

The transmission system conveys electricity at relatively high voltages from the point of generation to substations where the voltage is reduced for delivery of energy to the distribution feeders. The transmission subsection plans, designs, constructs, operates, and maintains a relatively small number of high voltage transmission lines and substations required to transmit bulk energy from generating plants to grid substations. Its work also involves expansion and rehabilitation of transmission facilities to provide an efficient high voltage network. Neglect or insufficient investment in upgrading existing lines results in costly losses of energy.

In 1947, Pakistan had only 1190 kilometers of transmission lines comprised of 66 KV, 33 KV and 11 KV lines. Today, the transmission network consists

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of 500 KV, 220 KV, 132 KV, and 66 KV lines which totalled 15,291 kilometers in July 1981. Currently, a major expansion program is underway to add 2700 miles of single and double circuit transmission lines and 216 grid stations. These facilities will augment the existing power system by an aggregate capacity of 4800 MVA.

The transmission subsector has an important role to play in ameliorating the electrical supply problem. The long distances over which electricity must be transmitted from place of generation to place of consumption, combined with inadequate distribution facilities, has produced high transmission and distribution losses and reduced revenues. Several measures must be taken to reduce these losses: higher voltage transmission lines to transfer large blocks of power; conversion of existing 132 KV lines to 220 KV, and 66 KV lines to 132 KV; and, additional substations to reduce the length of existing 11 KV circuits in order to increase their capability. In this respect, the findings of a recent Extra High Voltage (EHV) System study justified a 500 KV transmission system or "bulk power expressway" being built from Tarbela to the Karachi/Hyderabad area. This system will integrate the hydro electric sources in the north with the thermal plants and major consuming markets in the center and south of the country. Such an "expressway" will permit full and more efficient use of hydro capability during the July-September high water period and will give thermal support to the system from the center and south during the February-May low water months. It also will reduce fuel expenses for spinning reserves (i.e. running standby units) and generating capacity requirements.

D. Electric Power Distribution

The power distribution subsector is the interface of the power sector with the users of electricity. During the year ending June 30, 1981, the Pakistan power sector, through its power distribution subsector 1/ sold about 11 billion KWh of electric energy to 3,839,165 customers located in approximately 11,300 cities, towns and villages throughout Pakistan for an estimated Rs.5.5 billion or the equivalent of $423 million.2/

1/ These figures cover both WAPDA which accounts for 75 percent of the total power supply and the Karachi Electric Supply Corporation, Ltd. (K.E.S.C.) which accounts for the remaining 25 percent.

2/ At the exchange rate of $1.00=Rs13.00

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Despite an average annual customer growth rate of 11.8 percent during the past five years, (19.6 percent last year alone), as of June 30, 1981, there was a backlog of over 180,000 applications for service. Of that number, 9,765 and 9,627, respectively, were applications to WAPDA for industrial and irrigation tubewell connections. With an average connection rate of about 550 connections per month for each type of connection, the average new industrial and tubewell customer would have to wait almost a year and a half from the time an application is filed until service is actually provided.

While new customers suffer long delays before they are connected, most existing customers suffer prolonged scheduled interruptions (load shedding) because demand is growing faster than new power generation facilities can be placed in service. During the six-month period ending June 30, 1982, there was load shedding almost every day, often from 5:30 A.M. to 8:30 A.M. and from 5:30 P.M. to 9:00 P.M. The worst period was from February 28, 1982 through March 2, 1982 when 750 MW (more than 25 percent of the peak load) had to be disconnected.

Growth statistics indicate that the power sector in Pakistan has had difficulty keeping ahead of demand for service ever since WAPDA was formed in 1958. The additional demand created by the accelerated village (rural) electrification program that was started in 1972 and which was intensified in 1977 has tended to aggravate the problem.