THE ROLE OF AN A.I.D. PROGRAM OF TECHNICAL ASSISTANCE IN OIL, GAS AND COAL

		Page
I.	Summary	
II.	Overview of Fossil Fuel Situation	1
	Introduction Resource Base - Oil and Gas Resource Base - Coal	
III.	Obstacles to Expanded Fossil Fuel Production	5
	Oil and Gas Coal	
IV.	Current Programs	14
	Other Donors USG	
V.	Possible Areas of Technical Assistance for A.I.D.	20
	Conventional Oil and Gas Coal Non-Conventional Oil and Gas Technical Assistance Concluding Remarks	

II. Overview of the Fossil Fuel Situation

A. Introduction

Over the last several years, donor organizations and individuals involved with LDC development issues have given increased consideration to increasing the supply and efficiency of renewable energy sources. More recently, the attention of U.S. officials has also turned to conventional energy supplies for developing countries. In his energy address of April 5, 1979, President Carter pledged to consider additional measures to diversify sources of world oil supply and to stimulate fossil fuel development in relatively neglected areas, i.e., non-OPEC developing countries. The President's National Security Adviser has called upon IDCA to ensure that policies and programs affecting energy developments in developing nations are consistent and adequate to needs. The Senate Foreign Relations Committee has expressed interest in increasing the development of indigenous energy resources on a commercial scale.

This paper has been prepared to assist IDCA in responding to the Senate Foreign Relations Committee's request for a report "assessing those forms of data collection and analysis and other technical assistance most needed to permit energy development for commercial purposes in developing countries."[1] All energy resources, renewable and non-renwable, can be exploited on a commercial scale. This report, following guidelines given by SFRC staffers, will concentrate on fossil fuel resources, viz. oil, gas and coal. However, hydropower, geothermal and biomass plantations have obvious commercial potential and should not be neglected in designing an overall energy assistance program. The capital requirement of a fossil fuel program is not discussed as this is being considered by a separate IDCA-led task force. Instead, the discussion will be limited to potential areas of technical assistance.

In discussing the forms of technical assistance that donor organizations can give LDCs in determining the extent of their fossil energy resources and identifying methods for exploiting the reserves, it is important not to set unrealistic goals. Newly found, commercially exploitable LDC fossil energy resources will not change substantially the world oil supply situation in the next ten years. Nor should one expect that LDCs which do find sources of hydrocarbons of sufficient size for exports will necessarily exploit them at a rate satisfactory to large oil-consuming industrialized countries. Finally, it must be acknowledged that a serious fossil fuel assistance program requires a long term commitment on the part of donors. Exploration programs can last up to ten years; development of fossil fuel reserves can require up to five years and production typically lasts 15-25 years (although after the early stages of production little foreign technical assistance may be required).

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[1]Senate Foreign Relations Committee Report, 96-137, "The International Development Assistance Act of 1979," page 24.

An A.I.D. or IDCA fossil fuel program must recognize the long term nature of these efforts. The agencies must be prepared to accept changes in the manner in which projects are prepared and financial and manpower resources allocated since A.I.D. customarily plans for a project with a five year life and measurable results within that time.

The U.S. concern about fossil energy use in LDCs incorporates several interests. Increased indigenous production of oil, gas and coal may result in less of a seller's market, thus easing the upward spiral of fossil energy prices. It may result in increasing numbers of oil exporters and may weaken the control exercised by the current oil suppliers. These interests are important and obvious considerations for the present as future national security of the U.S.

However the availability of energy is of specific concern to those interested in promoting social and economic development in LDCS. Increased per capita energy use is an important contributor to this process in LDCs. Preliminary analyses[2] indicate that:

- GNP per capita is related strongly to commercial energy consumption

- Growth rates in GDP per capita are related strongly to growth rates in investments, employment and energy

- The Physical Quality of Life Index is related closely to commercial energy consumption and to GDP per capita

Although LDC dependence on fossil energy varies greatly among countries and regions, in all LDCs fossil energy is critically important in transport and the modern economy. Even those poorest countries which may depend on renewable energy for up to 90% of their energy needs are affected greatly by the supply and price of the remaining 10% of their energy needs.

Indeed, the overriding concern of LDCs since 1973 has been to cope with rising fossil energy prices. This concern is seen clearly in the following areas:

1. Balance of Payments

The balance of payments situation of LDCs which do not export oil has deteriorated severely since 1973. Real balance of payments deficits were roughly three times higher in 1976-77 than in 1972-73. The cost of oil imports has been largely responsible for this deterioration.

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[2]For further discussion of these points and the following statistics, see MITRE Corporation, Energy and Development: A Preliminary Analysis of Less Developed Countries, (Contract No. AID/SOD/PCD-C-0146, July 1979.)

2. Inflation

The inflation rate in non-oil exporting LDCs more than triped after 1973, rising from an annual rate of 7.7% to 25%. The inflation rate in oil-exporting LDCs increased at a slower rate from 7.5% to 14.8%.

3. Growth

Average economic growth rate of non-oil exporting LDCs dropped by more than half after 1973, from 3.1% to 1.5%. In contrast, the economic growth rate per capita of oil exporting LDCs increased from 3.7% to 4.0%. The increase in oil prices seems to have been responsible for the difference between the two groups.

4. Competition between oil import bills and development programs

The substantial increases in oil prices since 1973 have intensivied the competition within LDCs for scarce development resources. The World Bank estimates that by 1985, oil-importing LDCs will spend over $38 billion annually to buy the oil they need, up from $14 billion in 1975.[3] In the 1980's, the annual incremental cost of non-OPEC LDC oil bill will be much higher than any foreign assistance presently contempated.[4] Development programs for rural areas may well be postponed as governments cut back expenses to control inflation and meet mounting oil import bills. In the competition for scarce resources within an LDC government, those responsible for paying the oil import bill are likely to triumph over those advocating expanded development programs.

B. Resource Base--Oil and Gas

Non-OPEC LDCs currently produce less than 10% of world oil, although they account for more than 40% of the world's prospective oil areas. The sedimentary basins in the Third World are, in general, inadequately explored. Indeed, basins that are in need of further investigations probably contain 75% of all potential petroleum resources in Latin America, 80% in Africa

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[3] IBRD, Annual Report, 1979, p. 19.

[4] Rand Corporation, The Demand for Oil and Energy in Developing Countries, June 1979 (#WD-189-DOE).

and 95% of Asia and the Far East.[5] (See below (6) for the distinction between "resources" and "reserves".)

In 1978, non-OPEC LDCs produced 1.6 billion barrels of oil and 2.3 trillion cubic feet of natural gas.[7] Production estimates for 1985 are 3.1 billion barrels and 6.7 trillion cubic feet respectively. Oil production is expected to grow 9% between 1976-1985, and gas production to triple.[8]

Estimates of the potential for oil and gas production in LDCs vary greatly depending on whose projections are used. For example, for Latin America, geologist King Hubbert estimates ultimate recoverable reserves of oil and gas reserves at 190 billion barrels of oil and 550 trillion cubic feet of gas. Bernardo Grossling is more optimistic, predicting 490-1225 billion barrels of oil and 2450-6370 trillion cubic feet of gas.

For all the developing countries (including China), Hubbert, in a review for the Congressional Research Service, calculated the mean of ultimate recoverable reserves of petroleum at 1925 billion barrels and of gas at 10,000 trillion cubic feet. One thousand billion barrels of oil and 6000 trillion cubic feet of gas remain undiscovered. Hubbert's figures are not accepted by all geologists; Grossling's estimates are more than double Hubbert's.

C. Resource Base--Coal

Coal resources are widespread in LDCs. According to a recent World Bank report,[9] about 50 developing countries have geological coal resources and 19 have technically and economically recoverable coal reserves. However,

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[5] IBRD, Petroleum and Gas in Non-OPEC Developing Countries: 1976-1985, Working Paper #289, April 1978, p. 2.

[6] "Resources" vs "reserves": geological resources are geological occurrences which may acquire some economic value for market in the future; geological reserves are geological occurrences which are exploitable subject to current economic and technical conditions. Consequently, estimates of reserves are subject to significant change even in the absence of changes in the estimate of resources.

[7] From Oil and Gas Journal: Worldwide Report (December 1978) as cited in A Strategy for Oil Proliferation: Expediting Petroleum Exportation and Production in Non-OPEC Developing Countries, Congressional Budget Office, Feb. 1979.

[8] IBRD, A Program to Accelerate Petroleum Production in the Developing Countries, January 1979.

[9] IBRD, Coal Development Potential and Prsoepcts in the Developing Countries, October 1979.

most of these resources are concentrated in a few countries: Botswana, India, Brazil, Colombia and Swaziland. Current estimates place LDC coal resources at 230 billion tons (2% of world total) and recoverable reserves at 65 billion tons (10% of world total).

The ratio of reserves to resources in LDCs is 28% which is much higher than the global figure of 6%. In spite of this, coal production in LDCs is significantly less developed than it is in the world as a whole. In 1977 LDC production was 176 million tons, only 6% of the world output.

The concentration of the coal resources is an important consideration. The five countries named above possess 78% of the coal resources of the developing countries. (Botswana alone possesses 43% of the LDC resources. It is useful to compare this resource to that of the United Kingdom in order to place it in perspective; Botswana's resource equals 62% of that of the United Kingdom.) These five countries also dominate LDC coal reserves with 73% of the total.

There has been little systematic exploration for coal in developing countries and, due to the limited exploitation of known reserves, little need to analyze known occurrences to determine econnomically and technically recoverable reserves. It is reasonable to assume that comprehensive geological surveys and coal exploration programs in LDCs may significantly increase the extent of known coal reserves and augment the number of countries with such reserves.

III. Obstacles to Expanded Fossil Fuel Production

Most LDCs will need the assistance of multilateral and bilateral development agencies to hasten the production of indigenous fossil energy resources. Both technical and capital assistance will be needed. The following discussion is divided into two parts--(A) oil and gas and (B) coal. Some assistance needs are similar but frequently the areas are sufficiently different to warrant separate treatment.

A. Oil and Gas

A study commissioned by the IBRD in 1975 of 70 LDCs suggests that 23 LDCs (14 of which are nonproducers at present) have prospects of finding "high" or "very high" quantities of oil (750 to over 1500 million barrels): another 15 countries (13 of which are current nonproducers) have "fair" prospects (100-750 million barrels) of finding oil.

The IBRD and other studies all have concluded that many LDCs could benefit from assistance in all stages of petroleum development: national energy planning, data collection and evaluation, exploration and technical and managerial training.

1. Exploration

A prerequisite to preparing fossil fuel exploration and production programs is adequate knowledge of identified resources. Historically, knowledge of fossil fuel resources have increased fastest for those areas considered to be most promising to investors, i.e., North America and the Middle East. Geological, geophysical and exploratory work has lagged in most non-OPEC developing countries.

Geological and geophysical surveying covers the following areas, though not necessarily in the sequence listed. Depending on existing information in each country, all steps may have to be performed.

a. interpretation of satellite images or mosaics
b. geological/hydrologic reconnaissance
c. magnetic prospecting
d. gravity prospecting
e. interpretation of aerial photographs
f. detailed geological/hydrologic mapping
g. geochemical analysis
h. seismic prospecting
i. electrical prospecting
j. exploratory and appraisal drilling

A study commissioned by the World Bank concluded that 54 of 70 LDCs examined needed technical assistance for the re-evaluation of existing data, new surveys and/or stratigraphic test wells. However, not all 54 may need donor assistance for these activities; some countries may be able to buy the technical assistance they need.

Collection of relevant data is but a first step. Equally important is the analysis of data. Much data, especially geological data, exists which needs to be organized, re-evaluated or analysed in greater detail. Petroleum exploration data may need to be re-evaluated in the light of post 1973 crude oil price increases to determine if exploration is now economic. Enhanced recovery techniques may now be economic.

In considering geological and geophysical surveys in LDCs, it is important to bear in mind a fundamental difference between the objectives of such surveys in the past and the current objectives. When oil was cheap, the oil companies were prospecting for potentially large resources of petroleum that would contribute significantly to the global oil supply. Consequently, large geological structures were sought that could form potential traps or reservoirs of large amounts of petroleum. However, due to the high costs of petroleum imports, it is now frequently economic for LDCs to exploit small petroleum resources that would be found in small geological structures.

Searching for smaller finds will require more precise measurements than heretofore had been carried out. Such measurements might build upon past efforts but the negative findings of this work should not, a priori, preclude additional investigations. The future efforts will require more closely spaced seismic information, the use of the most accurate positioning systems available such as land and satellite navigation systems and the use of the most sophisticated data analysis procedures that have been developed.

Full use should be made of geochemical techniques that have undergone rapid development in the last twenty years, particularly the last decade. The recent progress includes theoretical advances, the development of new data collection methods, improvements in instrumentation and equipment and application of statistical and computer techniques to the data analysis process. By the use of geochemical prospecting, one can find trace evidence of the presence of hydrocarbons. A geochemical prospecting program would include a preliminary evaluation of areas known or suspected to contain hydrocarbons; reconnaissance surveys of rocks, water and soils to detect hydrocarbons; interpetation of hydrocarbon anomalies in conjunction with geological and geophysical indications to identify favorable sites for exploratory drilling.

2. Development

If the geological, geophysical and geochemical data indicate promising fossil energy structures, the next phase would be development work. This is primarily exploratory drilling, leading to appaisal drilling (if warranted).

Exploratory drilling is a high-risk expensive activity with no guarantees that a commercial deposit will be found. A major drilling program will cost $10 to 50 million per 10,000 km^2. Two major constraints are likely to hamper exploratory drilling unless assistance is provided. These are a shortage of risk capital and inadequate incentives for investors. The large capital requirements mean that assistance in this area will come mainly from the multilateral development banks. However, bilateral organizations can provide LDCs with assistance in preparing for exploratory drilling.

Petroleum and coal agreements are complex legal documents. The discussions leading up to exploration and production agreements are conducted by highly qualified technical and legal specialists, particularly on the part of foreign investors. Equitable agreements tend to be stable ones. To promote equitable agreements, donor organizations can assist LDC governments and state corporations in finding the necessary technical and legal advice, both for drafting and negotiating agreements

Lawyers, skilled in contract negotiation and enforcement, should also have some training or experience in resource science and resource

extraction technology. In addition, donor organizations can assist LDC governments obtain legal assistance to translate contracts from English, the predominant language of international resource contracts, into the local language. This would help eliminate certain misunderstandings that may arise during implementation.[10]

3. Production

Once exploratory and appraisal drilling have confirmed the presence of an economic oil/gas field, LDCs are likely to have little difficulty in funding the capital and technical assistance needed to put the field into production.

4. General

Fossil energy exploration and production should not take place in a vacuum, ignorant of national energy needs and development objectives. Thus, technical assistance to improve general energy planning capability should be offered. The IBRD has identified institution building and energy planning as two important areas of assistance.

Energy planning groups are important assets in preparing fossil fuel exploration and production programs. The institutional needs vary among developing countries but most LDCs could benefit from assistance in either organizing or strengthening energy planning units. It is important to bring together various ministries (such as Finance, Agriculture, Industry, Labor, Economic Development) to ensure that energy planning is not an isolated activity but one integrated into general development planning. A key objective is to ensure that planning and energy officials have a comprehensive view of energy supply and demand, rather than views on just a single resource (oil, coal, gas, electricity, biomass, etc.). This will mean, in some cases, training administrative and technical personnel of existing energy bodies. In others, such as non-oil producing countries, where energy planning bodies may not exist, technical assistance can be given in helping to determine the nature of institutions which should be created and the extent of their mandate.

There is a need for general energy sector studies. These studies, performed by LDC institutions with foreign technical assistance as necessary, would examine energy demand and resource availabilities, energy pricing policies, energy demand and development objectives and associated political, economic, cultural and environmental problems.

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[10]See statement by John A. Katili, Director General of Mines, Ministry of Mines, Indonesia on need for legal assistance in: American Society for Engineering Education, Educating Engineers for World Development, 1975., pp. 45-58.

5. Training[11]

It is generally acknowledged that LDCs should have a cadre of technicians and administrators trained in fossil energy economics and extraction, conversion and utilization technologies if they are to deal on a reasonably equal basis with the multinational oil companies and other foreign investors. At a minimum, it would be desirable for LDCs intent on exploring for indigenous fossil energy resources to have a group of trained oil administrators, geologists, drilling, production and reservoir enegineers and economists, and similarly skilled personnel for coal, if appropriate.

Personnel educated in the hard sciences (physics, chemistry, biology and geology) and engineering (mechnical, electrical, chemical, civil, mining, petroleum and industrial) are necessary to establish a core of technical expertise within a state oil and coal sector. Training in engineering and applied science should take precedence over pure sciences as the former represents the application of scientific principles and research to actual conditions. In addition to scientific personnel, there is need for lawyers and economists trained in the legal and economic aspects of oil or coal exploration and development. These would form the nucleus of a group of trained administrators capable of negotiating fossil energy agreements with foreign investors.

The type of training donor agencies offer should be geared to specific LDC needs such as:

a. Long term, high level training in science and technology (Masters and Doctorate level).

b. Short term, specialized courses (technical, scientific, managerial, legal, economic).

c. Internship/apprenticeships (in industry or government).

There are numerous American and other universities which offer relevant courses in science and engineering. For internships and apprenticeships, there are non-profit government contractors, national laboratories, federal agencies and private companies.

Care should be taken in selecting candidates to assure that the individuals are committed to applying their training to the development of the

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[11] For a detailed discussion of proposed training for fossil fuel technologists see, Training Initiative in Energy-related Science and Engineering Fields, DSB, Office of Energy, 9 November 1979.

Third World and to returning to their home countries. In addition the countries, with donor assistance as appropriate, should take steps necessary to assure attractive job opportunities await the trainees when they return home. These two aspects--commitment and job opportunities at home--are perhaps the most workable approach to avoiding a drain of needed technical talent from the developing countries.

B. Coal

The second approach to providing an energy supply in the non-OPEC developing countries is to use indigenous coal deposits, or in the absence of such deposits, to consider the importation of coal. This latter option was one of the subjects of the United Nations Symposium on World Coal Prospects held in October 1979 in Katowice, Poland. The option of developing indigenous resources was the prime focus of the World Bank report on coal.[12]

1. Supply and Utilization Tasks

The energy sector of almost all developing countries is oriented to the use of petroleum products as the major energy source. The supply infrastructures, accordingly, are suited to the handling, processing, and transport of liquid (sometimes gaseous) products. The utilization equipment is designed for liquid and gaseous fuel.

With respect to greater exploitation in developing countries, coal poses problems that are significantly different than those of gas and oil. As discussed in the previous section, some LDCs have large coal deposits that are being under utilized. Even if coal were to be found in other LDCs, the full utilization of it would be hindered by the same factors that currently hinder the development of known reserves. Indeed, the problems posed by coal are not so much those of exploration and identification of resources but rather development of reserves, transportation, creation of market for the coal produced and introduction of coal-burning equipment to replace oil or gas-burning equipment.

2. Supply Tasks

A developing country may have already identified coal deposits, or justification may exist to explore for the presence for coal. The following briefly discusses the activities involved in converting indications of coal deposits to proven resources.

a. Exploration. The geological map of the country will indicate whether or not geological formations contain coal deposits. Often, if geological strata are inclined because of past upheavals in the earth's crust, coal may outcrop and be visible at the surface. If not, a trial borehole in the statistically most favorable location can lead to the determination of coal deposit.

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[12] IBRD, Coal Development Potential and Prospects in Developing Countries, October 1979.

A pattern of sparse drilling over a wide area, selected to conform with a geological justification of potential coal presence, can delineate the extent of the deposit and permit a calculation of indicated reserves. The label "indicated" essentially means that the coal deposit is assumed to be continuous between bore hole locations. The assumption is reasonable if a proper evaluation of topographical and geological features is made before selecting the drilling locations; particularly to identify faults, or discontinuities in the coal seam. If not, some or all of the deposit may be classified as "potential".

The drilling activity will have produced cores from which coal samples can be analyzed for quality. Thus, concurrent with the estimation of indicated reserves, the coal is analyzed to determine moisture, ash, volatile material, sulphur and fixed carbon content. The rank of coal can be determined by comparison of analytical results with an accepted system of ranking. The highest grade coal in the conventional sense is anthracite, descending through bituminous, sub-bituminous, and lignite to perhaps peat.

At this stage, the knowledge of the deposit and the background information may be published. The quality of the anlysis will depend on the competence of the geological survey organization.

b. Development. The development task begins when an investment group, public or private, determines that a market exists for the coal in the deposit, and that production and marketing for the coal can be profitable. An indication of a reserve of coal is no longer sufficient. The reserve must be "proven".

The reserve is examined to determine mode of extraction, whether surface or underground mining is indicated, and the precise mining methods that can be employed. An area of the reserve is tentatively chosen as offering an attractive combination of low-cost extraction and low cost capital investment. The reserves in this area are proven by new drilling on a grid within the exploratory boreholes. Grid spacing is selected by judging the widest space (least number of new boreholes) that convinces the investor that the coal is continuous and that he can depend on a supply of coal from the reserves in the quantity desired for a 20-30 year period.

c. Production. Before a commitment to an investment is made, the data from the development drilling is analyzed to establish the design of the mining operations, to specify the equipment to be purchased, and to estimate the capital investment and operating costs. The mine design should allow for a minimum impact on the environment and for a healthy and safe workplace for the miners. Factors such as land subsidence or restoration and waste disposal affect the former, and a factor such as advance degressing of a coal seam in underground mining the latter.

An above ground coal beneficiation plant can be associated with a mine to clean the coal of rock and other uncombustibles, and size the coal to market specification. Coal cleaning helps reduce sulfur content by removal of any iron pyrite present.

d. Transportation. Coal is transported on land by truck or railcar; on water by river barge or ocean bulk carrier; and, in specialized cases, by slurrying fine coal in water and pumping through pipelines. The choice of a transport mode depends on the existing infrastructure, the destinations, and the quantities involved. It is probable that a major new effort to begin or increase coal production in a developing country would require investments in new infrastructure for coal transportation.

3. Utilization Tasks

The major consuming sectors for potential coal utilization already will exist in some mix; but it is likely that they will be consuming liquid fuels, and that the existing equipment will not be readily adaptable to a solid fuel. The following discusses the factors involved in adaptation:

a. Electric Power Generation. The usual equipment in a central electric power generation station will be a steam-generator, steam-turbine and an electricity-generator. Smaller outlying stations may be diesel-engine driven electric generators. Steam generators will be residual fuel oil fired while diesel engines will be fueled with a specification diesel fuel.

The conversion of a steam generator to coal is possible but expensive. Extensive alterations are required to the firebox to accommodate a coal stoker, or a pulverized coal system, and removal of coal ash. In addition, the capacity of the furnace would be reduced. The prospect of fueling a diesel engine with finely ground coal is under investigation but far from developed.

b. Industrial Steam Generation. The steam generator equipment is smaller and of different design than central station equipment. External fireboxes may be required to burn coal, and the modification is expensive, even when the space is available.

c. Motive Power. In road transport, the prime movers are internal combustion engines, fueled by gasoline or diesel-oil. For air transport, aviation fuel is usually kerosene or gasoline. Rail locomotives are driven by diesel engines, although some countries still use steam engines. The use of coal for motive power would probably be limited to steam locomotives. Even if an engine fuel were to be developed using powdered coal, most likely it would be practical only for stationary engines.

d. Domestic Fuel. In the domestic sector fuel is needed for cooking and, in some areas, space heating. Charcoal, firewood, agricultural

waste and animal dung are common fuels. In urban areas and in rural areas of some countries, kerosene or bottled petroleum gas (LPG) may be used. Although the odor and smoke from coal detracts from its desirability as a cooking fuel, local deposits have been used for cooking and heating needs for centuries. In fact, Marco Polo in his Travels expressed surprise that certain heavily-populated areas of China had escaped deforestation due to the custom of cooking with "magical black rocks" instead of wood.

4. Potential Adaptation

Technology and experience are available that can permit coal to fuel the equipment now fueled with petroleum oils. Some of this availability, however, involves technologies that are in various stages of development. In these cases, application in developing countries should await successful demonstration. The following is a brief review.

a. Conventional Combustion. If the development of a coal resource involves the installation of new steam generation equipment, the design can be selected for coal firing. Smaller units will be stoker fired and the larger units pulverized coal fired. Operators will require training in new tasks, namely the handling and feeding of solid rather than liquid fuels and the management of the ash content of the coal. The environmental effect of particulate emission can be controlled by the installation of appropriate equipment. The technologies are well developed and widely used.

b. Low-Temperature Carbonization. Coal can be carbonized in the absence of air to produce chars and tars, with enough fuel gas to operate the process. The char can be briquetted with tar as a binder to produce a fuel for space heating with low smoke emission. The briquets might also serve as a cooking fuel, but it is likely that a non-coal (i.e., starch) binder will be desirable. This is a well-developed technology which was briefly used in the past.

c. Unconventional Combustion. There are two candidates. The first, coal-oil mixture combustion, is a retrofit prospect. The second, fluidized-bed combustion, requires new equipment, but is suited to firing low grade (high-ash) coals and to controlling sulfur dioxide emissions.

(1) Coal-Oil Mixture Combustion. Coal is pulverized, or finely ground, and slurried with petroleum oil. The slurry is burned as a liquid fuel. Minimal modification to existing equipment is required. However, a preparation plant is needed. This can be an on-site facility for large consumers, or a centralized facility to supply a number of small consumers. Operational systems are now being demonstrated in the U.S. and elsewhere. The progress of these demonstrations should be carefully watched and, assuming success in these efforts, the technology should be considered for application in the near future in developing countries.

(2) Fluidized-Bed Combustion. A bed of pulverized inert material is fluidized by upward-flowing combustion air in a

containing chamber. Pulverized coal is introduced into the bed and burned. The coils for steam generation are immersed in the bed. If the inert material is limestone, sulfur dioxide liberated during the combustion of the coal is largely absorbed before it reaches the chimney. Equipment with coal combustion at atmospheric pressure is already available from several suppliers. Pressurized combustion is under development and not yet ready for commercial use.

d. Gasification. Partial combustion of coal with either oxygen/steam or air produces fuel gases which can serve many functions. Air gasification produces a low heating value gas which can serve a concentration of small consumers in an industrial park. Oxygen/steam gasification produces a medium-heating value fuel gas which can serve more distant users. The gas can also be used as a raw material for ammonia fertilizer, methanol production and for liquid transport fuels. This option for processing coal will be capital intensive. The technology is not yet ready for immediate developing country use. It could emerge from current demonstration projects in the medium term.

e. Liquefaction. One difference between coal and petroleum oil is the hydrogen/carbon ratio, this being higher in oil. Liquefaction of coal involves the addition of hydrogen to coal (hydrogenation) to the extent required. In the production of solvent refined coal (SRC), a minimum of hydrogen is added, enough to enable the production of a liquid product at elevated temperatures (SRC-I) from which the ash and sulfur have been almost entirely removed, or a liquid product at ordinary temperatures (SRC-II) of similar purity. Other processes (H-Coal and Exxon EDS) permit larger quantities of hydrogen to be added and distillate fuels in the gasoline/kerosene/diesel fuel range to be produced.

The technologies are under development and not yet demonstrated. They could be available for developing country use in the medium term (by 1990) to supply all energy needs now supplied from petroleum sources.

IV. Current Programs

Although there is much current discussion about fossil energy potential in LDCs, donor organizations are just beginning to define how they can best assist in developing this potential. Several current programs are discussed briefly below.

A. World Bank

In July 1977, the Executive Directors of the World Bank approved a program to expand lending for the development of the oil, gas and coal resources of member countries. The decision to begin financing of oil and gas production recognized the urgent need of developing countries to exploit their indigenous sources of energy. In January 1979, an expanded petroleum development program was approved, including, for the first time, financing for exploration.

The Bank's oil and gas assistance falls into three categories:

1. National Energy Planning - The IBRD is currently assisting 35 LDCs develop national and sector energy plans and strengthen national energy planning authorities. In the next five years, an additional 25 countries will be covered. Help is also being given in the legal, technical and administrative areas.

2. Predevelopment Activities - These activities include survey work, exploratory drilling and project preparation. IBRD expects to finance 10 surveys annually and a similar number of predevelopment drilling projects.

3. Petroleum Development - The IBRD estimates that it will finance eight petroleum development projects in FY 80, rising to 12 by FY 83.

The IBRD has five petroleum development projects underway:

- development of Bombay High oil field - $150 million loan
- construction of gas transmission pipeline in Egypt - $75 million loan
- Tut project in Pakistan - $30 million loan
- natural gas development in Thailand - $5 million loan
- enhanced oil recovery in Turkey - $2.5 million loan

In the coal sector, the IBRD is assisting LDCs in coal exploration and pre-investment work and in the implementation of coal mining projects. The Bank expects to lend for 2-4 coal/lignite projects a year through 1983.

It is estimated that Bank funding on oil, gas and coal projects will amount to $750 million in FY 80 and about $1,500 million in FY 83 (in current $).

The share of project cost to be financed by the Bank in the case of petroleum production loans is expected to average about 20%, but it varies from project to project. The remaining 80% will come principally from national oil companies and the international private sectors.

The technical assistance provided by the Bank in the energy sector is the area of greatest concern to this report. The main purposes of such assistance are:

- to improve sector planning and to develop coherent program for energy development,
- to devise and introduce complementary financial policies, especially in regard to pricing, and
- to identify and prepare enrgy projects that are of high priority

The Bank's experience suggests that in many developing countries progress is retarded by:

- the lack of effective energy planning institutions and the continuing shortage of adequately trained administrators,

- the poor understanding of energy pricing issues due to an absence of energy price studies and analysis, and

- the inadequate analysis of data derived from exploration activities.

Although the Bank's fossil energy programs have been greatly expanded in the last few years, much remains undone. The Bank report (footnote 8, page 4) clearly states the need for the involvement of other donors and the desire to have international and bilateral agencies join the effort to assist the developing countries in this sector.

B. United Nations

Various organizations within the U.N. family are active in the conventional energy field, e.g., UNITAR, UNIDO, UNDP, the Regional Commissions, ILO and others.

In the area of oil and gas, assistance provided includes:

1. studies, surveys and reports on the hydrocarbon potential of the oceans, on new concepts and approaches to petroleum exploration, ownership and transfer of petroleum technology, and on training of nationals as technicians and workers in the petroleum industry,

2. feasibility studies on an African Petroleum Institute,

3. symposia on the development of regional petroleum reserves (Asia and Pacific),

4. short-term technical advisory missions to Angola, Chad, Jamaica, Turkey and Uruguay on petroleum resource development,

5. short-term legal advisory missions to Ecuador, Jamaica, Liberia, Niger, Portugal and the Philippines to provide assistance on petroleum legislation and agreements, and

6. oil exploration and production projects in Chad, India, Niger, Romania, Syria, and Turkey.

In the coal area, technical cooperation for exploration and production has been limited so far. Most of the U.N. coal activities have been centered in Europe and implemented by the Economic Commission for Europe (ECE).

However, UNIDO is undertaking a small coal production project in Tanzania and Afghanistan has received a small grant to stimulate increased coal production. The rising interest in coal production and utilization probably will result in increased coal work by other U.N. regional bodies.

C. Inter-American Development Bank (IDB)

The IDB energy program represents over 40% of its lending in FY 78. However, over 95% of the IDB's energy projects are hydro-electric, principally large-scale hydro. The IDB is currently funding two small fossil fuel projects in Barbados and Bolivia. It has proposed a billion dollar regional fund to encourage energy exploration in Latin America. The fund would provide guarantees for bank loans and insurance against political risks for investors who develop or explore for oil, gas and mineral resources in Latin America. The energy fund proposal is still being discussed within the IDB and by its members.

D. Asian Development Bank (ADB)

The ADB is financing energy projects involving coal, gas and hydropower. In the petroleum sector, it plans to support exploratory surveys short of actual drilling. In FY 79 the ADB approved $39 million to finance equipment costs and training for two coal projects, one in Korea and one in the Philippines.

E. A.I.D.

A.I.D.'s energy projects traditionally have been in conventional electrification for rural and urban areas. With the current emphasis on projects in support of basic human needs among the rural pooor, A.I.D. has been concentrating on renewable energy projects ($26 million in FY 79).

A.I.D. has no significant fossil fuel program. There is a very small ($300,000) training project in Tunisia which will permit up to 15 petroleum engineers to spend 8-9 months in the U.S. pursuing specialized petroleum training.

A.I.D., through its Office of Science and Technology (DS/ST) has two projects for LDCs in remote sensing, both of which were designed to address non-energy concerns.

1. Remote Sensing for Resource Assessment - This project, funded at $3,729,000, aims to develop new procedures and techniques for using remote sensing in agricultural and other natural resource planning. Help is provided to LDCs in acquiring and using remote sensing technology and earth resource satellite data. The project has supported remote sensing centers in LDCs, trained technicians in remote sensing and provided Landsat data. Remote sensing applications were tested in the following countries:

Bolivia - iron exploration
Thailand - crop production
Philippines - resource mapping
Bangladesh - agricultural mapping
Pakistan - port identification and coastal sediment mapping
Sri Lanka - agricultural mapping
Peru - forest mapping
Egypt - crop production

Technicains from Nepal, Sudan, Sengal, Mauritania, Peru, India, Ecuador and Liberia have received remote sensing training. In addition, regional training centers were established in Nairobi, Bangkok and Ouagadougou.

2. Remote Sensing for Agriculture - This project, funded at $1,400,000 is related to the project described above. Its purpose is to improve crop production estimates in nine LDCs - Costa Rica, Dominican Republic, Jamaica, Bolivia, Ecuador, Morocco, Thailand, The Philippines and Indonesia. The project will comprise four phases:

- area frame construction
- field enumeration and national agricultural statistics totals
- computer classification
- agricultural meteorological modeling

Training of technicians in remote sensing will be an important part of the project.

While these two projects are not directed at fossil energy exploration, the relevance of remote sensing in the search for new energy sources is evident. With a trained cadre in selected LDCs, the potential exists for expanding A.I.D. remote sensing activities to include fossil fuel exploration. This will be discussed in greater detail below.

F. Overseas Private Investment Corporation

The agency offers political risk insurance and loan guarantees for U.S. investments in oil and gas exploration, development and production in LDCs. Oil and gas programs started two years ago.

1. Political Risk Insurance: As an internal working guideline OPIC is considering devoting between $800 million and $1 billion of its insurance portfolio (but no more than 25% of its insurance portfolio) to investments in oil and gas exploration, development and production in LDCs. It has presently issued three contracts for investments in Jordan and Ghana. It has received 45 expressions of interest in OPIC Insurance from 26 companies regarding 24 countries.

2. Loan Guarantees: OPIC has just begun a program of all-risk loan guarantees for projects in oil and gas development and production in LDCs.

Two guarantees are now in the final processes of approval, and the extent of the program will be more apparent after it has been underway for a time. It is not in competition with commercial banks, and is often in projects with them.

G. Export-Import Bank

The EXIM Bank has no special program for energy-related exports. Requests for loan authorizations for energy-related products and services are reviewed like any other request. Gross authorizations for the six-month period April 1, 1978 to September 30, 1978 were $1.31 billion, but this included $732 million for nuclear power equipment. For the six-month period October 1, 1978 to March 31, 1979, authorizations totaled $164 million. For the three month period April 1, 1979 to June 30, 1979, authorizations totaled $146 million.

H. Department of Energy

The Department of Energy is studying how it can best contribute to a USG program of LDC oil exploration and production. Until DOE completes its study, we cannot comment on the relationship between DOE and IDCA in promoting fossil fuel development in non-OPEC LDCs. However, there will have to be close cooperation between the two agencies, cooperation which is more than pro forma. The DOE-managed International Energy Development Program (IEDP) has conducted energy assessment in Peru and Egypt. Assessments are underway in Argentina and Portugal.

I. National Government Programs

France - The French Government, through the Institute Francais du Petrole (IFP) and the Ecole Nationale Superieure du Petrole et des Moteurs (ENSPM) provides LDCs with training in petroleum, technology R&D and feasibility studies (both in France and in LDC Institutions). Training ranges from specialized post-graduate studies to general petroleum courses. Roughly $4 million annually is allocated in this effort (exclusive of UNDP-IBRD funds). In addition to IFP programs, French oil companies (Compagnie Francaise des Petroles and Elf-Aquitaine) have technical assistance programs with LDCs, particularly in the training area.

Germany - The German Government has granted the semi-State company Deminex exploration loans of up to 75% of expenses for projects outside the European Community. Loans are repayable only if a discovery is made. The 1975-80 budget for this assistance is roughly $460 million.

Japan - Japanese efforts have emphasize large energy assistance projects. Since 1967, the Japan National Oil Corporation has invested $1.4 billion overseas, both in equity and direct loans. The thrust of Japanese assistance is to find more energy resources (such as uranium in Niger) and substitutes for fuel oil in electricity generation. Japanese assistance is primarily for conventional energy projects with little emphasis given to renewable energy for rural development.

V. Possible Areas of Technical Assistance for A.I.D.

This section discusses how A.I.D. can contribute most effectively in assisting non-OPEC LDCs develop indigenous energy resources for commercial purposes. Clearly, any A.I.D. fossil energy program should be coordinated with similar initiatives by other USG agencies, such as the Department of Energy, and by multilateral development banks, especially the World Bank. True coordination entails resolving a host of institutional issues. This is beyond the scope of the paper but, clearly, resolving these issues has high priority.

Those who advocate examining the possibilities of developing conventional energy supplies (mainly oil, gas and coal) in developing countries should be aware that there is divergent opinion on what consitutes appropriate assistance. Among the LDC development community in the U.S., there are those who argue that conventional energy assistance has no place in an assistance program geared to meeting basic human needs among the rural poor. They argue that such a program would require large funds to have an impact. Since the USG assistance budget has been declining in recent years (in real terms), this would mean diverting funds from basic human need activities such as food production, nutrition, health, etc. While agreeing that energy is a critical constraint to development, they argue that the focus should be placed on renewable energy, particularly firewood, on which the majority of LDC inhabitants are dependent. The small-scale, renewable energy proponents have a sympathetic audience. For example, the Senate Appropriations Sub-committee has urged A.I.D. to concentrate its energy activities at the lower end of the energy technology scale. It is argued that the USG does not have the technical personnel and resources required to run a conventional energy program and that the benefits of such a program would not accrue to the majority poor in LDCs. It is further argued that activities in the conventional energy field are best left ot the private sector and to the multilateral development banks such as the World Bank.

It is not within the scope of this paper to evaluate these arguments. However, they are important and need to be addressed as the USG attempts to fashion a comprehensive energy program for non-OPEC LDCs. Clearly, an energy program based totally on either renewable or conventional energy resources would be deficient. There needs to be balance in the energy program just as there is balance among energy resources in developing countries and elsewhere.

The rationale for an A.I.D. fossil energy program is clear. In the next 10-15 years, fossil energy will become more important, not less, in providing the energy needed for LDC subsistence, much less development. Growth and economic development of non-OPEC LDCs - a general objective of U.S. foreign policy - are likely to entail higher demand for fossil energy, especially oil. Unless indigenous supplies of fossil fuel are found, there will be increased competition for oil supplies on the world market, with rising price a likely consequence. Even were the most optimistic projections for energy supply from renewable sources to be met, fossil fuels will remain an important bridge to any hoped for renewable energy future.

Another reason for a fossil fuel assistance program is to support current U.S. assistance activities and investments in LDCs. Table 1 lists the non-OPEC LDCs grouped according to their potential for oil and gas production. Group A are those countries currently producing oil and gas, including both net oil importers and exporters. Group B are those countries with proven reserves and announced commercial discoveries but with no production as of yet. Group C are those countries with favorable geological prospects for oil and gas deposits. Group D are those countries whose geological prospects are not very favorable based on existing knowledge. For those countires which received USG economic assistance during FY 1979, the amount of this assistance is indicated. (The figure represents Development Assistance and Economic Support, in $1,000,000.)

Table 1

OIL AND GAS PROSPECTS IN LDCs

	Group A	Group B	Group C	Group D
AFRICA	Gabon Nigeria Angola Zaire (9.9) Congo	Burundi (1.8) Chad (7.1) Rwanda (4.1) Tanzania (15.5) Ivory Coast Cameroon	Benin (1.2) Ethiopia (10.5) Gambia (1.9) Ghana (7.1) Guinea Bissau (2.4) Guinea (2.5) Mali (13.0) Niger (9.6) Senegal (9.7) Sierra Leone (3.2) Somalia (4.0) Togo (1.4) Madagascar Central African Rep.	Botswana (13.9) Kenya (19.8) Lesotho (5.1) Upper Volta (8.7) Mauritius (0.3) Malawi (3.3) Uganda Zambia (20.5
LATIN AMERICA AND CARIBBEAN	Argentina Brazil Barbados Colombia Chile Peru Boliva (25.7) Ecuador (0.1)	Guatamala (15.0)	Jamaica (15.8) Guyana (6.0) Paraguay (1.6) Dominican Republic (22,4) Nicaragua (1.2) Costa Rica (12.0) Panama (11.7) El Salvador (10.0) Honduras (16.9) Haiti (15.6) Surinam Uruguay	---
ASIA	Bangladesh (88.1) Burma India (90.0) Pakistan (40.0) Indonesia (72.9) Brunei	Papua New Guinea Philippines (44.8) Thailand (12.2)	Sri Lanka (22.8) Korea	Nepal (13.1)

NEAR EAST				
	Afghanistan (14.9)	---	Jordan (93.0)	---
	Syria (90.0)		Yemen AR (13.5)	
	Tunisia (38.0)		Yemen PDR	
	Egypt (750.0)			
	Morocco (6.3)			

Source: Compiled from various documents, principally
Petroleum & Gas in Non-OPEC Developing Countries: 1976-1985,
World Bank Staff Working Paper #289, April 1978;
U.S. Economic Assistance, Military Assistance and Credit Sales
AID/PPC/PB February 1979

A - Current oil/gas producers, including net oil importers.

B - Current non-producers of oil/gas but with proven reserves and announced commercial discoveries to be exploited as of November 1977.

C - Non-OPEC LDCs with favorable geological prospects for potential oil/gas discoveries.

D - Non-OPEC LDCs whose geological prospects for oil/gas at present rate of technical knowledge are not very favorable.

Table 2 summarizes the above information according to the four groups.

Table 2

LDC OIL AND GAS PROSPECTS AND USG ASSISTANCE

Group	Countries	Countries Receiving USG Assistance	Total Assitance ($1,000,000)	Average Assistance per Country ($1,000,000)
A	24	13	1245.0	95.8
B	10	7	100.5	14.4
C	31	25	309.0	12.4
D	9	8	84.7	10.6

Table 2 indicates that USG assistance is provided to countries in all groups, with a significant difference between Group A (current producers) and the others.

Among the countries that are not current producers, USG assistance is relatively evenly distributed with some correlation between level of assistance and potential attractiveness of oil and gas investments (as measured by average level of assistance given to the countries in the several groups).

The analysis above indicates there is ample opportunity for the USG to enhance its current investment in LDCs by helping selected countries locate and develop their fossil fuel potential.

A serious sustained effort to promote the commercial development of LDC fossil energy resources would involve both direct financial support and technical assistance and also relevant indirect support.

(1) Conventional Oil and Gas

There appears to be general agreeement on three points:

- Large amounts of oil and gas remain to be discovered in non-OPEC LDCs.

- If this potential can be tapped, it will usually be cheaper than any alternative energy

- The primary bottleneck is in exploration, including drilling, for new fields.

A principal deterrent to expanded exploration is the lack of adequate financing. This is due to capital shortages, the inability to reach acceptable contractual agreements and the possible political instability in many LDCs. The World Bank program is designed to overcome those obstacles and to increase oil and gas production. However, it was not primarily designed to finance a high risk exploration program and, as a consequence, is an insufficient mechanism for this end. For several years and in several fora, there have been discussions about creating a special fund to help LDCs drill for new oil. At this time, an IDCA-lead task force is considering possible USG actions in this area. It is not appropriate to analyze this issue in this report. We note however the need to find a workable mechanism to provide the financing and protection that an oil exploration program requires.

Within a comprehensive approach to expanding oil and gas production in LDCs, the need for appropriate technical assistance looms large. Geological and geophysical data needs to be reviewed thoroughly in order to determine potential petroleum-bearing sites. Geochemical information and additional geological and geophysical measurements will enhance the initial determination. Data from prior exploration activities needs to be reevaluated in light of current petroleum economics. Skilled negotiators are required to work with the LDCs in order to develop petroleum agreements acceptable to both the host countries and international oil companies. In all areas the technical capacity of the LDCs usually needs to be augmented by effective training and institution building activities.

(2) Coal

Coal is distinguished by country specific technical and institutional problems, and by the general problem in all LDCs of penetrating markets dominated by petroleum products. The diversity of institutional and technical problems include: (a) excellent market situation but difficult

extraction conditions in Bangladesh; (b) poor market situation but excellent extraction conditions in Botswana; (c) a long established coal industry in Nigeria but poor market conditions; (d) Indonesia's desire to displace domestic petroleum consumption with indigenous coal in order to increase petroleum exports.

The common problem is to convert coal to products that can displace similar oil and gas products in existing markets. Environmental and coal conversion problems need to be solved. These problems are being studied in the United States where increased coal use is seen as a major alternative to oil imports. U.S. coal research and development, where appropriate, can have wide application in LDCs having indigenous coal deposits or wishing to import coal as an alternative to oil.

Identification of new reserves and resources may not be of great importance in many LDCs for the near-term, but U.S. technical assistance could provide a sound base for longer-term energy planning in LDCs with coal potential.

(3) Non-Conventional Oil and Gas

This category includes oil shale, tar sands, heavy oil, geopressured gas, and tight gas formations. Several points of interest to policy making should be made at the outset. In contrast to conventional oil and gas, the extraction technologies may not be as well developed or as widely used. Thus, although such a non-conventional resource may be well defined and substantial in a developing country, the extraction problem may be insolvable without external technical assistance.

In addition, when the resource has been extracted, processing may be required before the resource can be used in LDCs. Shale oil requires a hydrogenation treatment to remove nitrogen and reduce viscosity before it can substitute for crude oil. Disposal of spent shale may be a problem. The heavy oil from tar sands and heavy oil deposits requires thermal cracking before it can be pumped to a refinery. In an LDC, these are unique problems which lend themselves to effective technical assistance.

Geopressured gas requires specialized drilling techniques, which are only now being developed in the United States. Eventually, the technologies can be transferred to LDCs wherever similar gas deposits are found.

The contribution of non-conventional oil and gas resources in the next 10-15 years is still uncertain, even in the United States. But the U.S. Government has and is developing more technical expertise in these areas than in conventional oil and gas, which has been the domain of the private sector. This may influence the comparative advantage of IDCA (and DOE) vis-a-vis the multilateral development banks as the appropriate agency for rendering assistance in nonconventional oil and gas.

(4) Technical Assistance

The components of an effective technical assistance program would be:

- Preliminary assessment of known fossil energy resources and potential for finding additional resources.

- Assessment of institutional status, including staffing, equipment, capabilities and post records.

- Educational and technical training in the U.S. or a third country, including on-the-job training.

- Development of overall plans and details of individual projects by U.S. experts and counterparts to initiate new energy resource programs.

- In-country advisory services and training on specific projects, with U.S. experts working closely with nationals for periods of months or even years.

- Where appropriate, management of contracts for data collection activities, including photogeology, gravity, magnetic and seismic surveys, drilling of test bore wells and necessary data analysis.

Some of the above activities would lead to immediate results, such as the management of data collection contracts. Others would have a longer-term payback as indigenous institutions are created or strenghtened. Both kinds of activities are importrant to finding solutions to the energy problems faced by the LDCs.

To the maximum extent possible, these activities should build upon existing programs of AID and existing capabilities of the USG. For example, the Agency's remote sensing program could be expanded to include training in mineral resource identification for participants from LDCs. The U.S. Geological Survey (USGS), with its capability and experience in this area, would be an essential source of technical skill in evaluating data, building institutions and perhaps managing contracts. The Department of Energy would be able to provide expertise in enhanced oil recovery and new technologies.

An A.I.D. program in fossil fuels, once coordinated within the USG, should also be coordinated with the multilateral development banks, particularly the World Bank. While there is so much to do in promoting fossil fuel development that there is little likelihood of duplication, a coordinated program would enable maximum effort to be placed in the most promising countries. Coordination will require joint efforts in selection of countries.

A division of labor among A.I.D., other bilateral agencies and the multilateral development banks makes eminent sense from a program perspective. If the program is coordinated with and complements what the World Bank is doing, use of public funds will be enhanced. Certain phases, such as data collection, institution building, training and even geological surveying are easier to establish with grant funds. The World Bank, with its emphasis on loan activities, might experience greater institutional constraints in approving projects which may not result in loan

projects than would A.I.D. In some countries with a shortage of World Bank (IDA) funds, A.I.D. might be an especially appropriate source of the needed grant funds. In summary, there is a natural complementarity in a joint AID/World Bank conventional energy project which has both grant and loan phases.

As an example, a joint A.I.D./World Bank project might be pursued as follows:

(a) data collection and analysis	- A.I.D./IDCA
(b) geological/geophysical surveys	- A.I.D./IDCA/USGS
(c) exploratory drilling	- IBRD
(d) appraisal drilling	- IBRD
(e) production loan	- IBRD
(f) technical training/institution building	- A.I.D.

For non-conventional oil, gas and coal, A.I.D. in collaboration with DOE would be able to apply new concepts and undertake field testing of emerging technologies. These efforts would provide the needed operational and cost information which would be required by the multilateral development banks before they would be able to finance these new technical approaches.

(5) Concluding Remarks

An A.I.D. conventional energy program would fill a void in the current A.I.D. energy program which is now primarily focussed on renewable energy projects. A comprehensive A.I.D. energy program, providing energy assistance in both conventional and non-conventional energy sectors, would permit the agency to contribute to a country's national energy need. A comprehensive energy program need not mean the Agency would lessen its commitment to basic human needs or the rural poor constituency. (Although there would be increased competition for funds if there is no additional money.) Indeed, to ignore the programs geared to providing basic human needs will not achieve their objectives. Transport is dependent on fossil fuels, even in areas such as Africa where overall consumption of fossil fuel may be low. Reforestation programs are unlikely to be successful soon enough to prevent a shift to kerosene or butagas for cooking. Development programs for rural areas may well be postponed as governments cut back expenses to meet mounting oil import bills. A reassessment of the importance of fossil fuel in providing basic human needs will point out the complementarity of renewable and conventional energy.

In discussing a fossil fuel assistance program, A.I.D. must be realistic about the objectives of such a program and of the problems, institutional and financial, of setting one up. Assuming that a fossil fuel program makes sense, both for the U.S. and LDCs, it is not evident that the present structure of A.I.D. is adequate to the task. A serious energy program, renewable and non-renewable, may well require a new approach to planning and approving energy programs within IDCA. It will certainly require a long term commitment, both from Congress and A.I.D., to implement a fossil energy program (as well as a significant renewable energy

program). A.I.D. will have to plan with a horizon of ten to fifteen years. A.I.D. will need management and technical skills which are scarce within the organization. Finally, such a program will require genuine collaboration with other agencies of the USG, such as DOE and USGS, and with the multilateral development banks. With these caveats in mind, we feel the potential exists for A.I.D. to make a significant new contribution to the U.S. foreign assistance program.