PDWAC 075

# OFFICE OF ENERGY

# PROGRAM PLAN

**Fiscal Years 1986 - 1988**

October 1985

Office of Energy
Bureau for Science and Technology
United States Agency for International Development

R. Sabadell

MEMORANDUM November 27, 1985

TO: ST/EY, Alan B. Jacobs

FROM: ST/EY, James Sullivan

RE: Implementing the Office of Energy Program Plan

Attached is the Office's FY86-88 Program Plan. The document incorporates the comments of virtually everybody in the Agency actively working on energy as well as a large number of outsiders. As we have discussed, it is strictly a working document which will be revised each year or whenever else the Office considers it necessary.

We are already late in beginning initiation of the plan so we need to build momentum behind it rather quickly. I suggest the following "next steps":

1. Each initiative team leader listed in the plan should suggest to you whom else they would like on their team (each team should have at least three members, but probably not more than four) and then you need to make the final selections and finalize the composition of the teams.

2. Each team leader should then prepare a short 4 or 5 page plan on how they will achieve the accomplishments listed under each initiative. An outline for each such plan would be as follows:

   a. Restate the expected accomplishments listed in the program plan. Name countries. Be results, not activity, oriented;
   b. Describe which team member will be responsible for what accomplishments;
   c. Describe a series of activities which will achieve these accomplishments and tie each to a schedule;
   d. Estimate the resources needed for each accomplishment including contractor assistance. travel, study money etc.

   These brief plans should not be onerous, formal exercises but rather internal working documents on how to get things done. The team leaders can follow the type of planning that went into the conservation program plan (although this is far too long and detailed a document). Common sense is the key to success here.

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3. You and Jack Vanderryn should get together to decide who should be briefed on the plan; candidates include Nyle Brady, Donor Lion, Dick Derham, someone in McPherson's office. We also need to think about who outside of A.I.D. should get a copy of the plan.

4. Hagler, Bailly & Co. are waiting to hear from you to give them the go-ahead to reproduce a larger number of the documents. I recommend we make 500. So far I have only made 20 copies for you, Jack and the staff.

Attachment: a/s

cc:
S&T/EN, Jack Vanderryn

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## EXECUTIVE SUMMARY

The ultimate goal of the Agency for International Development (AID) is a world in which economic growth and development are self-sustaining and the extremes of poverty have been eliminated. One critical input to achieving this goal is energy. However, while energy problems are abating in the United States, they are growing more severe in the Third World. Indeed, to attain AID's development targets in per capita income and caloric intake will require energy growth rates of at least 7 percent per year. Therefore, without adequate attention, energy problems will continue to stifle economic growth in AID-assisted countries.

The Office of Energy of AID's Bureau for Science and Technology is responsible for ensuring that energy problems do not constrain AID's ultimate goals. In carrying out its responsibilities, the Office of Energy (the Office) has set three goals:

1. **Reduce economic instability caused by overdependence on imported oil.** This means (i) expanding the use of indigenous energy, both fossil and renewables, and (ii) increasing energy productivity.

2. **Ensure availability of energy for sustained rural development.** This means (i) satisfying basic energy needs of rural populations for cooking and heating, (ii) agriculture, and (iii) rural industries, particularly agroprocessing.

3. **Foster private enterprise energy development and management.** This means (i) promoting policy reform to improve the functioning of energy markets, (ii) building local private sector capabilities, and (iii) increasing the flow of technical and financial resources from the U.S. private sector to AID-assisted countries.

To meet these three goals and corresponding objectives, the Office has defined a three-year program of research, technology application, technical assistance, training and information dissemination activities. This program is based on extensive analysis of development needs of AID-assisted countries. It was prepared in close consultation with AID Missions and regional bureaus, international lending institutions such as the World Bank, and other parties in both the public and private sectors.

The Office's activities fall into four priority topical areas. Within these priority areas the Office has identified specific program initiatives that address energy for development problems of concern to a significant number of Missions. The Office priorities and associated initiatives are as follows:

**Energy Policy and Analysis**

1. Energy analysis and assessment
2. Energy pricing
3. Barriers to private sector participation in energy development
4. Irrigation and energy planning in river basin development

**Energy Conservation and Demand Management**

5. Energy conservation
6. Energy for irrigation pumping

**Resource Development**

7. Coal development and use
8. Natural gas development and use
9. Household fuels and fuelwood

**Power Systems Development**

10. Rural electrification
11. Industrial and village-scale power systems
12. Small utility-scale power systems.

To implement its program the Office has strengthened its internal management system, particularly its planning and budgeting procedures, and its outreach and information dissemination activities. A formal program planning process is being implemented together with a management decision support system that provides a framework for developing, assessing, and comparing proposed Office initiatives. The Office is also sponsoring the creation of private sector Technology Transfer Teams that will assist the Office in designing projects that can be financed and implemented by the private sector.

The Office's operating budget for Fiscal Year (FY) 1986, under current spending limitations, is $7.75 million. The annual budget submission for FY87 is $7 million and the Office's preliminary estimate for FY88 is $10.5 million. The

combined budgets (Office and buy-ins) used for activity planning, contracting, and control are $11.3 million, $12.6 million, and $16.3 million for FY86, FY87, and FY88, respectively.

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# I. INTRODUCTION

To meet AID's development targets, the supply of energy in AID-assisted countries must grow each year by at least 7 percent:

- Analyses of development experience indicate that each increase of 1 percent in gross domestic product (GDP) requires an increase of 1.3 percent or more in energy inputs. Attaining AID's goal of an annual 2 percent real increase in per capita income will, given expected population growth rates of 2.5 to 4 percent, require energy growth rates of 6.5 to 10.4 percent.

- Similarly, the Agency's goal of increasing caloric intake will require agricultural growth of 3.7 percent per year, according to the Food and Agriculture Organization. Each increase of 1 percent in agricultural output requires an additional energy input of more than 2 percent. Thus, if AID is to attain its goals for nutrition and agriculture, it must ensure that LDCs increase their energy supply for agricultural development by at least 7 percent annually.

This program plan outlines and schedules the actions that the Office of Energy must take to help ensure that sufficient energy is available to meet the Agency's development targets. This plan covers the current fiscal year FY86, and the next two -- FY87 and FY88. Each year, the plan will be revised to reflect final budgets for the Office for the next fiscal year and the planning horizon will be pushed forward by one year.

The plan is a means rather than an end. It is a working document to be used by Agency energy officials to define the Office program in accordance with Agency and Bureau for Science and Technology (S&T) objectives. It specifies near-term achievements expected of the Office. It is a guide for resource allocation among S&T/EY projects. It sets priorities for the Office and describes where special emphasis will be placed. It also provides an indication of the resources available from the Office to the Missions to support initiatives with host countries.

The plan incorporates input from within and outside the Office of Energy. Input from the Office -- initiatives planned by the Office's program managers -- was compiled and analyzed. Concurrently, interviews and small meetings were

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held to solicit the views of other AID energy and agriculture officers, individuals from private companies, universities, Oak Ridge National Laboratory (ORNL), Brookhaven National Laboratory (BNL), the World Bank, the InterAmerican Development Bank, and energy experts from LDCs. With this input, a draft plan was prepared by a team consisting of individuals from the Office of Energy, ORNL, BNL, and Hagler, Bailly & Company. The draft was then reviewed and revised by the Office's director and program managers, the Agency Director for Energy and Natural Resources, and energy officers in AID's geographic bureaus.

Much of this plan is based on extensive analyses of energy needs in developing countries and on experience with various technologies and approaches to meet those needs. In part, however, the plan charts new courses -- developing new approaches to old problems or adapting tested solutions to new problems. Considerable additional analysis is thus required to complete the design and planning of program activities. This analysis will result over the coming year in more detailed program plans for each initiative, and in some cases, for major components of an initiative.

A series of three "Energy for Development" papers has been prepared concurrently with this program plan. The first, on the importance of energy for development, describes the energy problems faced by AID-assisted LDCs. The other two papers -- one on policy reform and one on the private sector -- address central focal points of the Agency's development strategy. A fourth paper on energy and rural development will be finished by early 1986.

Including this introduction, the program plan consists of four sections and two annexes. Section II provides the basic rationale for the energy program within AID; section III describes the priority areas and initiatives that make up the Office's program; and section IV outlines an Office implementation strategy and plan, including budgets. The energy for development papers constitute annex A. The core of the Office's program is described in 12 "Initiative Papers" contained in annex B. Each paper summarizes a specific program initiative of the Office. It describes the development problem the activity addresses, and discusses the initiative's link to AID's development goals, the most effective strategy for achieving these goals, and the accomplishments expected in given countries in FY86, FY87, and FY88.

## II. PROGRAM RATIONALE

This program is warranted because, without it, AID will not achieve its overall development objectives.

### 1. THE IMPORTANCE OF ENERGY FOR DEVELOPMENT

While energy problems appear to be abating in the United States, energy problems in developing countries are growing more severe. The United States pays less for oil, but developing countries pay more. The U.S. economy has adapted to the high prices of energy without a serious loss of momentum, but Third World countries have not.

Several factors contribute to the energy problem in LDCs:

- Energy prices in local currencies are not declining. Since 1982, the real price of fuel oil has increased by 40 percent in Sudan, by 140 percent in Peru, and by 170 percent in Ecuador. In spring 1984, Jamaica paid J$86 per barrel of oil. In spring 1985, with a 32-percent devaluation of its currency, it paid J$127 per barrel. A January 1985 attempt by the Jamaican government to pass some of this higher cost to consumers led to widespread rioting. Many other AID-assisted countries face similar problems.

- The demand for energy in LDCs is growing at an astonishing rate. Between 1990 and 2000, the population of AID-assisted countries will grow by an average of more than 2 percent annually and, in some of the poorest African countries, by more than 4 percent annually. The urban population is growing twice that fast. In 1982, roughly one in four people in the Third World lived in a city; by 2000, that percentage will rise to one in three. This urban growth will require an 8-12 percent increase in fossil fuels annually; over 7 percent energy growth is needed for LDC economies to grow at a real per capita rate of 2 percent per year. In contrast, virtually zero growth in energy is needed in the United States to sustain the same economic growth.

- Most of the swelling demand for energy will be met in the near and mid-term by imported oil. Three-quarters of AID-assisted countries rely on oil for 50 percent or more of their commercial energy

requirements. Indigenous energy sources are not being adequately tapped. The pace of oil exploration is slow, fuel and power distribution systems are inadequate, and significant supply from alternative fuels requires long lead times. In most cases, therefore, oil imports are seen as the immediate answer to rising energy demand.

- High oil imports, however, will worsen LDCs' foreign exchange problem. A large share of developing countries' foreign exchange is drained off to pay for imported energy, leaving too little to pay for development investment. In 1980, 22 AID-assisted countries spent over 40 percent of their foreign exchange earnings to pay for oil, 25 countries spent between 20 percent and 40 percent, and only 10 countries spent less than 20 percent. This drain, coupled with the serious debt crisis, leaves little for investment in agriculture, industrial development, and other critical development programs.

- Another aspect of the energy problem is the fuelwood crisis, which has dire consequences for the poorest people in developing countries. Nearly half the world's population today lives in areas where fuelwood is acutely scarce; if current trends continue, up to 3 billion people will be living in such areas by the year 2000. The past several years have seen dramatic rises in fuelwood and charcoal prices -- a doubling in many places. These increases place an intolerable burden on those least able to afford it.

- Without adequate attention to the energy problem, therefore, economic growth in the Third World will be stifled. It is well established that growth in per capita GNP and commercial energy consumption (fossil fuels, hydropower, and other modern forms of energy) are inextricably linked. Studies show that a 1 percent rise in LDC income will typically require a 1.3 percent rise in commercial fuel consumption; without fuel, that growth will not occur.

## 2. AID'S ROLE IN ADDRESSING LDC ENERGY PROBLEMS

AID's role is to help ensure an adequate energy supply to meet its goals in agriculture, rural development, health, and other areas. Through its energy activities, AID can help to substitute indigenous energy sources for fuelwood and

imported oil, introduce more efficient ways of using existing energy resources, and help countries make wise energy system choices and investment decisions.

The Office of Energy plays a unique role within the Agency. In support of Agency energy objectives, the Office develops new approaches to energy problems through research and adaptation; it applies these new approaches worldwide in collaboration with Missions. In addition, it formulates energy policy for the Agency.

To carry out its responsibilities, the Office of Energy has set three goals and corresponding objectives:

1. **Goal: Reduce economic instability caused by overdependence on imported oil**

   **Objectives:** Expand use of indigenous energy, both fossil and renewable; and increase energy productivity.

2. **Goal: Ensure availability of energy for sustained rural development**

   **Objectives:** Satisfy basic energy needs of rural populations for cooking and heating; agriculture; and rural industries, especially agroprocessing.

3. **Goal: Foster private enterprise energy development and management**

   **Objectives:** Promote policy reform to improve functioning of energy markets; build local private sector capabilities, and increase the flow of technical and financial resources from the U.S. private sector.

# III. PROGRAM DESCRIPTION

To meet its three goals -- (1) reduce economic instability caused by overdependence on imported oil, (2) ensure availability of energy for sustained rural development, and (3) foster private enterprise energy development and management -- the Office has defined four priority topical areas for its activities during the period FY86-FY88. These are: energy policy and analysis, conservation and demand management, resource development, and power systems development. Within these priority areas, the Office has identified 12 specific program initiatives that address energy for development problems of concern to a significant number of Missions and that are carried out in close collaboration with those Missions. The Office, to the extent that budgets allow, also provides general Mission support on topics of interest to only one or two specific countries. Both these Mission-related activities are augmented with a systematic training program in the United States for LDC energy personnel.

This section describes the 12 program initiatives, general Mission support, training, and research components of the Office's overall program for FY86-FY88.

## 1. OFFICE OF ENERGY PRIORITIES

To set priorities, the Office of Energy systematically analyzed development needs of AID-assisted countries. The four priority areas defined by the Office are based on this analysis. The areas were selected in consultation with AID Missions, regional bureaus, and outside parties, and they take into account the activities of other international aid and lending institutions. Several of the initiatives listed under these priority areas are "new" and the work during FY86 is mostly of a research nature; others are a continuation and, in some cases, an expansion of existing Office activities. As shown in Figure III.1, each initiative is directly linked to the goals and objectives of the Office. But, as shown in Figure III.2, the probability of achieving these goals and objectives varies with each initiative. For example, despite the importance of energy pricing reforms, the likelihood of effecting major changes in this area is not as high as for other types of activities the Office might be engaged in. These priorities and initiatives constitute, therefore, a "portfolio" of activities that best balance the energy needs of AID-assisted countries with the resources available to the

Figure III.1

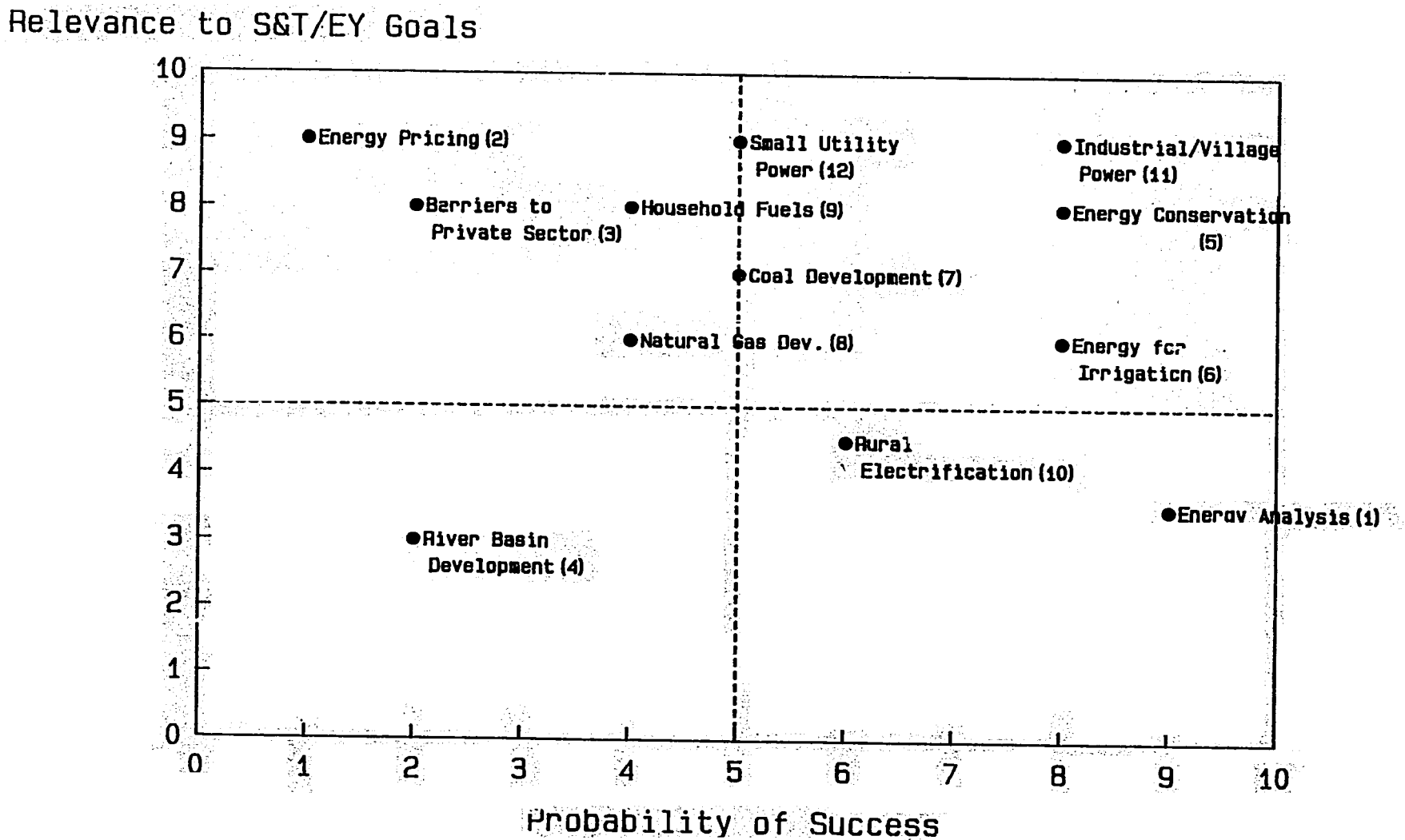
The Link Between S&T/EY Goals and the Program Initiatives

| PROGRAM INITIATIVES | AID GOAL: Self-sustained and broad-based economic growth to overcome endemic poverty | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | S&T/EY GOALS: | | | | | | | |
| | Reduce Economic Instability From Oil OverDependence | | Ensure Availability of Energy for Sustained Rural Development | | | Foster Private Enterprise Ener Development and Management | | |
| | S&T/EY OBJECTIVES: | | | | | | | |
| | Expand Use of Indigenous Energy | Increase Energy Productivity | Satisfy Cooking and Heating Needs | Satisfy Agricultural Needs | Ensure Energy for Rural Industries | Promote Policy Reform | Build Local Private Sector Capabilities | Increase Private S Participa |
| ENERGY POLICY AND ANALYSIS | | | | | | | | |
| 1. Energy Analysis and Assessment | ++ | ++ | + | ++ | + | +++ | + | + |
| 2. Energy Pricing | ++ | +++ | ++ | ++ | ++ | +++ | +++ | +++ |
| 3. Barriers to Private Sector Participation in Energy Development | ++ | ++ | + | + | ++ | +++ | +++ | +++ |
| 4. Irrigation and Energy Planning in River Basin Development | + | + | + | +++ | ++ | ++ | + | + |
| ENERGY CONSERVATION AND DEMAND MANAGEMENT | | | | | | | | |
| 5. Energy Conservation | + | +++ | + | ++ | +++ | ++ | +++ | +++ |
| 6. Energy for Irrigation Pumping | + | ++ | + | +++ | + | + | + | + |
| RESOURCE DEVELOPMENT | | | | | | | | |
| 7. Coal Development and Use | +++ | + | ++ | + | ++ | ++ | +++ | +++ |
| 8. Natural Gas Development and Use | +++ | + | + | + | ++ | ++ | ++ | +++ |
| 9. Household Fuels and Fuelwood | +++ | ++ | +++ | + | ++ | ++ | +++ | + |
| POWER SYSTEMS DEVELOPMENT | | | | | | | | |
| 10. Rural Electrification | +++ | + | + | +++ | +++ | ++ | ++ | ++ |
| 11. Industrial and Village-scale Power Systems | +++ | ++ | + | ++ | +++ | ++ | +++ | +++ |
| 12. Small Utility-scale Power Systems | +++ | ++ | + | +++ | ++ | +++ | ++ | +++ |

Scoring: impact of initiative on goal
- +++ - highest
- ++ - medium
- + - lowest

Figure III.2

# Office of Energy Initiatives
## Relevance to Goals vs. Probability of Success




0 = Lowest
10 = Highest

Office and the likelihood of success. More details on each initiative and a complete listing of planned accomplishments for each over the next three fiscal years can be found in annex B.

The Office priorities and associated initiatives are as follows:

**Energy Policy and Analysis**

1. Energy Analysis and Assessment
2. Energy Pricing
3. Barriers to Private-Sector Participation in Energy Development
4. Irrigation and Energy Planning in River Basin Development

**Energy Conservation and Demand Management**

5. Energy Conservation [1]
6. Energy for Irrigation Pumping

**Resource Development**

7. Coal Development and Use
8. Natural Gas Development and Use
9. Household Fuels and Fuelwood

**Power Systems Development**

10. Rural Electrification
11. Industrial and Village-scale Power Systems
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## 1. Energy Analysis and Assessment

For any energy action, a prerequisite for sound decisions is dependable information about the options being considered, the alternatives to them, and the conditions they address. Since AID-assisted countries are allocating up to 40 percent of their development budgets to energy, assistance in analyzing energy needs and potential investments is

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[1] The Office has prepared a detailed program plan for energy conservation which serves as a prototype for the program plans that are being prepared during FY86 for the other priority areas and associated initiatives. Refer to Strategy and Program Plan for Energy Conservation FY86 and FY87, Office of Energy, October 1985.

critically important if the waste of precious time and resources is to be avoided.

This initiative will meet needs for energy analysis and assessment of three types: (1) integrated national energy analysis as a basis for major investment decisions and policy dialogues; (2) integrated regional energy analysis, focused on regions of special interest (such as rural areas with development potential); and (3) sectoral energy analysis, focused on alternatives for particular sectors of the energy economy, such as the electric power system.

Major accomplishments are expected to include the following:

- National energy analyses in three countries selected in consultation with regional bureaus. Possible country applications for FY86: Pakistan, India, Haiti.

- One regional energy analysis project each year. Possible country application for FY86: Senegal.

- Plan for a power system policy project, focused on improving the technical quality of electric power system planning in AID-assisted countries and assessing the role of power systems rehabilitation (FY86).

- Development of a model approach to providing national energy data to private sector parties in AID-assisted countries. Possible country application for FY86: Pakistan.

- Investigations of modern data system technologies as aids to energy analysis and data dissemination in AID-assisted countries. Possible country application for FY86: Pakistan.

## 2. Energy Pricing

Although sound and realistic pricing results in the most efficient allocation of resources, energy prices in most LDCs reflect a history of widespread government intervention, generally to provide cheap energy to poorer people. Many AID-assisted countries, for instance, subsidize petroleum product prices, even when these products are imported. Gasoline prices are often used to cross-subsidize other fuels such as kerosene or diesel. In a number of countries, electricity tariffs do not even generate enough operating cash flow to cover debt service.

Dealing with the social and political problems underlying existing pricing policies is difficult. This difficulty is compounded by a number of other problems inherent to LDCs including establishing proper values for traditional energy sources such as fuelwood and charcoal.

The objective of the Office's energy pricing initiative is first, to define alternative means of moving toward more efficient energy pricing policies in LDCs without totally ignoring equity objectives, and second, to develop appropriate analytical tools to evaluate these means. To achieve these objectives, the Office has defined a two-fold strategy aimed at (1) providing technical assistance to the Missions in energy pricing policy analysis, and (2) developing host governments' ability to evaluate alternative pricing policies and engage in a constructive dialogue on energy pricing issues with the Missions and the international lending institutions.

This strategy, which will be implemented in close collaboration with the World Bank, calls for the following major accomplishments:

- "Alternative paths" for energy pricing policy dialogue in LDCs, including assessment of specific approaches (e.g., energy conservation) to mitigate the impact of energy price increases. Possible country applications for FY86: Bangladesh, Egypt, Pakistan; for FY87: Jamaica, Kenya, India, Ecuador, Peru.

- Reports on state-of-the-art methodologies for analyzing alternative energy pricing policies, particularly second and third best pricing policies in specific country settings. Possible country applications for FY86: Bangladesh, Egypt, Pakistan; for FY87: Jamaica, Kenya, India.

- Case studies documenting pricing reform successes and failures in countries where extensive pricing studies have been completed. Possible country applications for FY86: Ecuador, Egypt, Indonesia, Pakistan, Philippines, Sudan, Thailand.

### 3. Barriers to Private-Sector Participation in Energy Development

Fostering the development of private enterprise is a cornerstone of AID's development strategy. Unfortunately,

many AID-assisted countries restrain the private sector; this is particularly true in the supply, distribution, and management of energy. Some of the most common barriers to private-sector energy investments (in addition to pricing) include parastatals or authorized monopolies that have preferential status in obtaining capital or foreign exchange; restricted access to domestic markets by foreign firms; and unrealistic licensing, taxation, and import/export policies.

Although the Office recognizes that most of its projects have the potential for strong private-sector involvement and incorporates this into each project's design, three areas emerge as most important: (1) the development of decentralized power generation systems for both grid-connected and isolated applications; (2) the development of small oil and gas fields; and (3) energy conservation.

Major accomplishments planned under this initiative include:

- One case study of the barriers to development of small oil and gas reserves, showing the development options and specific obstacles to local and U.S. private-sector participation. Possible country application for FY86: Tunisia, Pakistan.

- Model small oil and gas contracts. Possible country application for FY86: Tunisia, Pakistan.

- Analysis of laws, regulations, and practices governing private decentralized electric power generation, and comparison with those in the United States and other developed and developing countries. Possible country application for FY86: Pakistan, Philippines, Thailand, India, Bangladesh.

- Organization of two to four Technology Transfer Teams to promote US and AID-assisted country private sector investment in small power systems, and energy conservation in the industrial and power sectors (FY86).

4. **Irrigation and Energy Planning in River Basin Development**

AID is currently involved in efforts to develop river basins in Africa (Senegal, Niger, Somalia), Asia (Sri Lanka), and Latin America (Haiti). AID-assisted countries in Asia will invest some $40 billion in irrigation/hydroelectric dams

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over the next 15 years. In Africa, AID-assisted countries plan to invest roughly $20 billion.

Even though these investments are massive, little attention has been directed to linking agricultural planning and the associated energy requirements of agricultural activities. This initiative will focus on research to better understand that link.

Major accomplishments include:

- Model energy analyses linking agricultural irrigation needs to energy potential of a river basin development project. Possible country applications for FY86: Mahaweli Ganga development project in Sri Lanka, Senegal for the OMVS Agency (Operation de Mise en Valeur du Fleuve Senegal).

- Project Paper approved during FY86 for the Energy for Agriculture project.

- Detailed program plan for Office of Energy activities in this area including a comprehensive strategy for irrigation and energy in river basin development.

## 5. Energy Conservation

Energy conservation offers AID-assisted countries the cheapest and quickest way to begin meeting the energy requirements necessary to attain development objectives in agriculture, industry, and other key sectors. World Bank studies and AID's own experience indicate that by 1990, developing countries can save 10 percent or more of their 1981 commercial energy consumption, mostly with investments that can be paid back within 2 years.

AID's conservation activity strives for a large and immediate reduction of an LDC's energy demand: 15 percent of commercial energy use in the industrial and power sectors. Priority focus will thus be on oil and electricity conservation. Emphasis is placed on leveraging private investment and all Office of Energy activities include the local private sector as a primary actor in the design and implementation of energy-saving programs.

Major accomplishments expected include:

- Assessments of institutional and policy barriers to energy conservation, particularly as they relate to private sector participation. Possible country applications for FY86: Egypt, Pakistan, Philippines, India, Sri Lanka, Indonesia, Thailand, Ecuador, Haiti, Peru.

- Energy conservation revolving funds for private-sector enterprises. Possible country applications for FY86: Egypt, Pakistan, Indonesia, Thailand.

- Pilot demonstration projects of "innovative" private-sector financing. Possible country applications for FY86: Dominican Republic, Jamaica, Ecuador, India, Pakistan, Philippines, Thailand.

- Model energy conservation program for small industries, particularly agroprocessing industries. Possible country applications for FY86: Sri Lanka, Haiti, Pakistan, Thailand, Indonesia.

- Model road transportation energy conservation program. Country application for FY86: Costa Rica; for FY87: Pakistan, Egypt, Thailand, Sri Lanka.

- Organization of Technology Transfer Teams for energy conservation, including cogeneration. Possible country applications for FY86: Pakistan, Egypt, Latin America/Caribbean region; for FY87: Thailand, India, Indonesia.

## 6. Energy for Irrigation Pumping

Many AID countries rely on irrigation to increase agricultural output. Gravity-fed irrigation has been largely exploited, and pumping is necessary to supply additional water to crops. For example, the green revolution in South Asia is inextricably linked to irrigation, but the large irrigation systems in those countries require awesome amounts of power. Over 23 percent of the power generated in Pakistan is used for irrigation pumping. In India, the connected load to agriculture, primarily for irrigation, increased from 118 megawatts in the early 1950s to almost 13,000 MW by the late 1970s.

Africa now faces the difficult decision of how much irrigation its drought-plagued countries can afford. While

no one questions that increased agricultural output will not occur without some increased level of irrigation, the high costs of pumps and recurring fuel costs seem to preclude irrigation in many areas. The decision to irrigate must be considered very carefully with regard to cropping patterns and appropriate pump selection, as well as the broader issues of agricultural planning, power systems planning, and appropriate pricing policies.

Under this initiative, the Office of Energy will assist Missions in improving the effectiveness of pumping systems in Asia and elsewhere, where irrigation is well established, as well as in Africa and elsewhere, where basic decisions about pumped irrigation are just being made. It will also assist Missions in examining the broader policy and planning issues associated with pumping system design.

Major accomplishments expected include:

- Research studies and conferences examining energy requirements for agricultural expansion using pumped irrigation and examining various irrigation pumping options, including centralized and dispersed power systems. Possible country applications for FY86: East Africa REDSO, Sahel, India; for FY87: Bangladesh, Indonesia, Sudan.

- Model marketing program for selected energy-efficient pumps using innovative marketing strategies (e.g., warranties, maintenance, and spare parts contracts). Possible country applications for FY86: Pakistan, Bangladesh; for FY87: Senegal.

- Model "incentives" program (e.g., import duty relief, loan programs, price subsidies) to promote energy-efficient pumps. Possible country application for FY87: Pakistan.

- Model electric utility pump testing program patterned after the PG&E model that provides free irrigation pump test services to farmers. Possible country application for FY86: Pakistan, Egypt; for FY87: India.

- An agriculture/energy resource center establishing a data base on energy requirements for agriculture. FY86 will focus on irrigation.

## 7. Coal Development and Use

Coal is the most likely choice of one-third or more of AID-assisted countries as the heart of the country's commercial energy supply when oil prices begin to rise again. In particular, for AID-assisted countries with coal resources of their own, coal is a resource that can be developed and used with readily available technology and offers abundant opportunities for private-sector initiatives. If it can be provided to decentralized users in relatively clean-burning forms, coal can play an especially broad role in meeting energy needs in these countries and other countries with ready access to coal imports. Yet, this energy source has been developed and used in very few AID-assisted countries.

The coal development and use initiative will support U.S. bilateral assistance programs in determining and realizing potentials for coal use.

Major accomplishments include:

- Coal resource inventories in two countries per year. Possible country applications for FY86: Niger and Cameroon.
- Clarification of local private-sector opportunities in coal development and use. Possible country applications for FY86 and FY87: Pakistan and Indonesia.
- In coordination with coal briquetting activities, tests of low-temperature pyrolysis as a coal utilization technology for AID-assisted countries. Possible country applications for FY86: India, Pakistan, Haiti.
- Working with the U.S. National Coal Association, study of issues and options in using U.S. coal to help meet energy needs of developing countries.

## 8. Natural Gas Development and Use

Several AID-assisted countries have natural gas reserves that are untapped or underexploited. At the same time, significant natural gas discoveries are being made. As of early 1985, AID-assisted countries had proven reserves of more than 174 trillion cubic feet of natural gas. Twelve countries have reserves of more than one trillion cubic feet, yet only five (Bolivia, Egypt, India, Indonesia, and

Pakistan) are currently producing over 100 billion cubic feet per year.

Programs aimed at developing and using natural gas offer several benefits. They can replace imported oil in industrial and power generation; provide new sources of transportation fuels; add to rural energy supplies by developing small gas fields in remote locations; serve as a stepping-stone for industrial development; and provide an opportunity for greater private-sector participation.

The Office will concentrate its activities on (1) promoting the use of gas from fields where the reserves are too small to justify pipelines to existing markets, but which could be used economically on-site for rural enterprise development and/or decentralized power generation, and (2) developing natural gas-based transportation fuels, particularly compressed natural gas (CNG).

Major accomplishments planned include:

- Summary of current natural gas development programs in AID-assisted countries with moderate to large natural gas reserves and detailed program plan for Office of Energy activities in natural gas development and use (FY86).

- Feasibility studies of developing remote, small natural gas fields. Possible country applications for FY86: Thailand, Pakistan.

- Feasibility studies on the use of natural gas for transportation fuels. Possible country applications for FY86: Thailand (CNG), Egypt (CNG); for FY87: Indonesia (methanol), India (methanol), Bangladesh (CNG).

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## 9. Household Fuels and Fuelwood

For most of the population in most AID-assisted countries, the dominant energy source is biomass, especially fuelwood and wood charcoal. Yet fuelwood is an increasingly scarce resource, associated with advancing deforestation. To help a great many families meet their basic needs, it is essential to increase fuelwood production and/or find substitutes for fuelwood.

Complementing wood production initiatives in AID forestry and agricultural development programs, this initiative focuses on the development of fuelwood substitutes, looking first at the potential for a hydrocarbon solid fuel -- coal or biomass briquettes -- to be produced and distributed cheaply from local resources.

Major accomplishments include:

- Feasibility studies and market assessments for briquetting, including the development of a reliable feasibility study methodology. Possible country applications for FY86: Haiti, Pakistan, Sudan, Niger; for FY87: Botswana, Zambia, Indonesia, Peru, Morocco.

- Research on health risks of coal briquette use. Target for dissemination of results: FY87.

- Feasibility studies of agricultural residue briquetting (FY87).

- Feasibility study of multifuel briquettes (i.e., briquettes from both coal and biomass) supplied interchangably to the same markets. Possible country applications for FY87: India, Pakistan.

## 10. Rural Electrification

Historically, rural electrification (RE) has occured as one of two processes: (1) extending services outward from an existing supply grid serving a major urban center or region or (2) extending services from major hydroelectric projects to take advantage of low-cost or surplus power. But as the cost of expanding electricity services has increased, the attractiveness of RE has been reduced. At the same time, studies of past RE programs have begun to question the value and effectiveness of RE -- at least as it has been practiced. For example, the high reliability and other system performance standards (and concomitant costs) set by donors and lending agencies are being questioned; self- (or auto-) generation of electricity by villages, small towns, or remote industries often could provide aceptable levels of service, at lower cost, than electricity from an established, integrated supply grid. The studies also found that electricity is not as necessary or desirable for some activities as formerly believed. For instance, irrigation costs have gone up in some circumstances where electric sets have displaced diesel pumps. The potential for substituting

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electricity for firewood and other cooking and heating fuels is also much smaller than originally expected.

It is clear that RE requires more careful planning and design than it has received in the past, including more attention to matching electricity service systems to needs and more consideration of how RE fits in a larger, longer-term development context. The Office of Energy recognizes that expansion of electricity services will be appropriate in some circumstances, but that other energy sources will be more appropriate in others. It also recognizes that efficient use of available human, natural, and financial resources for RE is essential if the needs of rural populations for all forms of energy are to be met. Accordingly, the Office's activities will concentrate on (1) issues of decision-making, planning, evaluating, and assessing the operation of RE projects; (2) comparing RE and alternative systems for supplying energy to rural populations; (3) examining the potential state-of-the-art technology to support innovative approaches to RE; and (4) rehabilitating utility systems including improving management.

Major accomplishments planned include:

- Analysis of principal issues in RE and preparation of detailed program plan for RE policy project focused on improving the technical quality of RE planning in AID-assisted countries (FY86).

- Development of analytical framework for use in assessing RE alternatives and definition of innovative technological, institutional, and financial approaches to RE including utility rehabilitation and improved management (FY86).

- Case studies, including visits by assessment teams, examining innovative systems or changes in RE directions in two countries per year. Possible country applications for FY86: Indonesia, India.

- Visits by utility rehabilitation teams to two countries each year. Possible country applications for FY86: Somalia, Pakistan.

- Preparation of "Rural Electrification Guide" for AID Missions, host governments, utilities, and private firms in AID-assisted countries (FY87).

## 11. Industrial and Village-Scale Power Systems

Modest amounts of energy can breathe life into a region, but AID-assisted countries will be hard-pressed to supply even small amounts of power for rural industry to develop or to supply power for agricultural purposes. In 1985, the installed power generating capacity in AID-assisted countries averages about 50 watts per person, a pittance of power that has to be stretched over lighting, rural industry use, agricultural pumping, and a myriad of other demands. (This compares with over 3,000 watts per person in the United States.) While LDC use of power seems miniscule, just to maintain this 50-watt level given population growth will require the addition of roughly 47,000 MW of generating capacity in AID-assisted countries by the year 2000 -- at a cost of over $70 billion. Sustaining present growth trends of 6-7 percent annually will require much more, on the order of $175-250 billion. This level of capital investment will be difficult if not impossible for LDC public sectors to raise. Without mobilization of private capital for investment in private power generation, economic growth will stagnate.

Analyses by the Office of Energy and others indicate that smaller-scale systems, on the order of 5 MW or less, tied to specific end uses in rural industry or agriculture are much more likely to attract private investment than large-scale power plants of 500 MW or more.

Under this initiative, the Office will work with Missions and with the U.S. private sector to develop a small power approach to the point that private investors, other donors, and LDC governments will find such systems an attractive alternative to supply much needed power.

Expected accomplishments include the following:

- Preparation of "Small Power Guide" to be made available to Missions and LDC private-sector companies (FY86)

- Country-specific market assessments of selected power systems, with emphasis on readily available modular packages. Possible country applications for FY 86: Pakistan, Philippines, India, Costa Rica.

- Organization of a Technology Transfer Team for small power systems (<5 MW) and visits to two countries each year. Possible country applications for FY 86: Pakistan, India; for FY 87: Philippines, Costa Rica.

- Prototype assessments of the role of small power systems in power master plans as an option to supply power for rural and industrial development activities. Possible country application for FY 86: Pakistan; for FY87: India.

- Jointly with Mission and regional bureaus, a series of high level meetings with host governments on small power opportunities. Possible country applications for FY86: Pakistan, India, Egypt, Madagascar.

## 12. Small Utility-Scale Power Systems

Over the next 15 years, AID-assisted countries will require staggering amounts of capital -- $175-250 billion -- to build power generation facilities. Much of this new capacity will be based on imported oil; the resulting trade deficits will have a crippling impact on investment in other development sectors. Only a handful of AID countries are net exporters of oil; others have a variety of small energy resources that can be tapped to displace oil-fired generation. The most important of these are biomass, small natural gas fields, low-quality coal, and small hydropower.

Multilateral lending institutions do not have the capability to undertake the necessary pre-feasibility work necessary to launch LDC projects using indigenous fuels. Since the U.S. energy industry is a world leader in much of this technology, AID plays a unique role in adapting and transfering existing and emerging technologies in this area by assisting Missions and LDCs in carrying out pre-feasibility work.

Major accomplishments expected include:

- Detailed program plan for Office of Energy activities in small-scale utility power systems, including needs assessments in AID-assisted countries (FY86).

- Prototype market assessments of selected systems, with emphasis on readily available modular packages such as combined-cycle and biomass-fired steam systems. Possible country applications for FY86: Pakistan, Philippines, India.

- Organization of a Technology Transfer Team for small power systems ( 5 to 50 MW) and visits to two countries per year. Possible country application for FY86: Pakistan; for FY87: India.

- Prefeasibility studies for two or three projects, including one or two projects based on conventional fossil fuels (e.g., combined cycle using natural gas) and one or two projects using solid biomass (e.g., bagasse from fuel cane) as a fuel. Possible country applications for FY86: Jamaica, Egypt, Pakistan; for FY87: India, Latin America, and others to be determined.

- Training of personnel from USAID-assisted country in U.S. utilities such as Southern California Edison and Pacific Gas and Electric in the area of small utility-scale power.

## 2. GENERAL MISSION SUPPORT

The primary focus of the Office is the support of energy-related activities in the field. This support takes both a directed and an ad-hoc form. In its directed form, the Office works with Missions worldwide to define energy development problems and to develop and apply solutions to those problems. The 12 program initiatives described above have been developed in response to energy needs apparent in many AID-assisted countries. New approaches to fuelwood substitutes or to an energy conservation problem are developed with one or two Missions and are then used as "models" that can be applied in other countries. In applying these approaches, the Office uses the services of a multi-disciplinary team of experts composed of AID staff members and outside consultants who have extensive experience with the approach being applied. Thus, lessons learned in one Mission are built upon and transferred to other Missions.

In responding to ad-hoc Mission requests, the Office provides assistance on a wide variety of topics that may not necessarily have direct and widespread relevance to problems in other countries. For example, a natural gas development

problem in one country may be so site-specific that lessons learned there will not be of much interest to other Missions. Nevertheless, the Office has a broad range of technical assistance available to it and provides that assistance to the extent that the budget allows.

In FY86, the Office will hold a series of briefings with regional bureau energy staff responsible for activities in the countries of each region. The aim of the briefings is to tailor Office activities more closely to Mission needs in each country. A short plan will be drawn up for each region describing the energy priorities to be addressed. The spring 1985 Asian energy officers meeting in Manila will serve as a model for these regional plans. The Office will also conduct a series of "technology applications" briefings to inform regional bureau energy staff of recent developments in energy technologies and energy policy.

## 3. TRAINING

In FY86, the Office will prepare an energy training needs assessment for AID-assisted countries. Needs will be broken down by topic (e.g., financial management for utilities, energy conservation in the textile industry) and by geographic region (Asia, Near East, Africa, Latin America and the Caribbean). A precise needs assessment cannot be conducted without extensive field work, which is not possible given FY86 funding levels. In FY86, the needs assessment will be based on past experience of the Office's conventional and renewable energy training programs, on discussions with regional bureau energy staff, and on discussions with Mission staff (piggybacked onto Office project staff visits), both in the field and in Washington, D.C.

The assessment will pay special attention to an analysis of training needs in support of the Office's program and to training needs generated by the Office's goal to promote greater private-sector participation in energy development. In FY87, this assessment will be updated and revised with information acquired through additional field visits and manpower assessments carried out in AID-assisted countries.

As part of its Management Decision Support System (see Section IV.2), the Office in FY86 will compile a survey of public and private training programs for both multilateral and bilateral donors. The Office is also compiling a catalog of classroom and on-the-job energy training programs in the United States, both in academic institutions and in industrial and other private settings. The needs assessment

and the training program surveys will be conducted by the Institute for International Education, the Office's prime training contractor.

## 4. RESEARCH

Research and development activities are an integral part of the Office's program initiatives. This integrated approach ensures that research activities are focused on specific development needs of concern to the Agency. As such, research priorities in energy fall mostly in the category of "applied research" (i.e., to solve specific problems) as opposed to "basic research" (i.e., to advance understanding without concern for specific development problems).

The Office does not sponsor research aimed at developing "new" technologies or hardware. On the contrary, the bulk of energy research activities are directed at matching and, in some cases, adapting, existing or emerging technologies to specific development needs and, at the same time, developing adequate institutional mechanisms to ensure market penetration.

Within this framework, the Office's energy research priorities are divided into four areas: exploratory research, policy research, resource development, and technology adaptation and application.

### Exploratory Research

Exploratory research examines development trends in AID-assisted countries to determine where energy poses a present or future constraint to development. Priority research topics are:

- How can water resource systems planning in river basin development be better linked with energy planning?
- What will be the future role of solar energy and other renewable energy sources in development assistance projects?
- What are the impacts of urbanization on energy demand patterns in AID-assisted countries? How will these affect energy availability for rural development?
- How can effective energy conservation measures be applied to road transport?

## Policy Research

Policy research examines issues dealing with institutional, pricing, and other policy constraints to development and identifies options to reduce those constraints. Priority questions are:

- What are the most effective methods for analyzing alternative energy pricing policies?
- What are the primary barriers to private sector participation in energy development in AID-assisted countries and what are effective means to remove those barriers?

## Resource Development

Resource development research focuses on methodologies for fossil fuel exploration, beneficiation, and development, and on determining renewable energy potentials in AID-assisted countries. Priority topics are:

- What are the most appropriate coal resource investigation techniques for AID-assisted countries? What new technologies for coal beneficiation can be applied in AID-assisted countries?
- What biomass fuels offer the best potential to substitute for fossil fuels and wood? What is the specific potential for using sugar cane, rice hulls and other agricultural residues?
- What are the development options for remote and small gas fields, especially for use in power generation and transport?

## Technology Adaptation and Application

Technology adaptation and application research adapts and applies emerging energy technologies to development problems in AID-assisted countries. Priority topics are:

- What advances in modern data systems technologies are most applicable to energy analysis in AID-assisted countries?
- How can innovative "third party" financing schemes be best applied to energy development projects?

- How do centralized options for pumped irrigation compare with decentralized options?
- What advances in low temperature pyrolysis technology can be applied to use of coal and biomass fuels in AID-assisted countries?
- How applicable are combined cycle power systems using natural gas and fluidized bed boilers to energy problems in AID-assisted countries?
- What is the role of small, decentralized power systems in the power systems of AID-assisted countries?

# IV. PROGRAM IMPLEMENTATION

This section presents the Office's organization and staffing, internal management decision support system, outreach and information dissemination program, the plan for outside support agreements and contracts, and budgets for each of the next three years.

## 1. OFFICE ORGANIZATION AND STAFFING

The organization of the Office provides a framework for assigning responsibilities to the staff to ensure that the objectives of the various projects and initiatives as described in section III (Program Description), are met. From an Agency budgeting viewpoint, the Office consists of six active "projects" ending in FY87 and one new project starting in FY86 -- the Energy in Agriculture Development project (936-5731). The active projects are:[2]

- The Energy Technical Service Support Project (936-5702)
- The Bioenergy Systems and Technology Project (936-5709)
- The Conventional Energy Technical Assistance Project (936-5724)
- The Energy Policy Development and Conservation Project (936-5728)
- The Renewable Energy Applications and Training Project (936-5730)
- The Conventional Energy Training Project (936-9997).

The Office has adopted a "matrix" management organization that assigns management responsibilities for each of the projects and each of the initiatives to a specific staff member.

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[2] Two other projects, the Low Cost Energy Technology Program (936-5701) and Small Decentralized Hydropower Project (936-5715), have ended in FY85. Some activities that have already been funded will, however, be carried into FY86.

The Office of the Director has been strengthened to formalize the importance given by the Office to the improvement of planning and design activities at the start-up of program initiatives, and outreach and information dissemination at the conclusion. The Office of the Director assumes primary responsibility for implementing the management decision support and program planning and budgeting systems, and for coordinating all outreach and information dissemination and publication activities. Technical assistance to the Missions is coordinated by the Office of the Director; the assistance itself, however, is provided by the Office staff.

The FY86 staffing plan calls for eight RSSA and PASA staff to be located on the premises, in addition to the Office's eight professionals and four secretaries.[3] The staff organization is given below:

**Office of the Director**

| | |
|---|---|
| Director | Alan Jacobs |
| Deputy | James Sullivan |
| Initiative Evaluation Team | Alan Jacobs<br>James Sullivan<br>Pamela Baldwin<br>David Jhirad *<br>John Kadyszewski |
| Program Management and Outreach [4] | Shirley Toth |

[3] RSSA stands for Resources Support Services Agreement and PASA for Participating Agency Service Agreement. RSSA and PASA staff are marked with a "*".

[4] Program management and outreach responsibilities include initiating and coordinating the annual program planning exercise, managing the project control system, and coordinating all information dissemination and report publication activities. Oak Ridge National Laboratory, already responsible for the Energy Policy Resource Center, implements and maintains the decision support system and integrates its information and data bases with those of the Center.

**Program Initiative Managers**

| | |
|---|---|
| Energy Analysis and Assessment | Pamela Baldwin<br>David Jhirad * |
| Energy Pricing | Pamela Baldwin |
| Barriers to Private Sector Participation | James Sullivan |
| Irrigation and Energy Planning | Pamela Baldwin |
| Energy Conservation | Alberto Sabadell |
| Energy for Irrigation Pumping | Janine Finnell * |
| Coal Development and Use | Charles Bliss |
| Natural Gas Development/Use | Charles Bliss |
| Household Fuels/Fuelwood | Alberto Sabadell |
| Rural Electrification | David Jhirad * |
| Village-Scale Power Systems | Sam Schweitzer |
| Utility-Scale Power Sytems | David Jhirad * |

## 2. MANAGEMENT DECISION SUPPORT SYSTEM

While the program initiatives, general Mission support and training components of the Office's overall program are directed toward Missions and host governments, the management decision support system is mainly for internal Office use. The system has three basic objectives:

1. To develop and present the information needed for annual program planning activities

2. To provide timely budget, cost, and milestone information on current activities and projects to improve their management

3. To provide a framework for developing, assessing, and comparing proposed Office initiatives.

To achieve these objectives, the Office has defined four areas of activities:

1. Preparation of the annual program plan
2. Evaluation of initiatives
3. Development of a decision support system
4. Implementation of a formal project control system.

## Annual Program Plan Preparation

Preparing the annual program plan requires the participation of the entire Office. In addition, outside experts will be brought into the process on an ad-hoc basis. The format and outline of this program plan will serve as the basis for the FY87 plan. The comments received from the publication of the plan and the plan review workshop (see Section IV.3 "Outreach and Information Dissemination") will be incorporated in the next plan. A major activity will be the preparation of detailed plans for many of the program initiatives described above, similar to those that are being prepared for energy conservation, coal briquetting, and minihydro power.

## Initiative Evaluation

To ensure that proposed Office initiatives are consistent with the Office's priorities and budget, a formal yet simple evaluation process for initiatives is being implemented. As part of this process, an evaluation team will review and approve all proposed initiatives. The objective of the evaluation is not to stifle staff initiative but rather to ensure that all ideas receive equal attention and to capitalize on the experience, expertise, and resources available to the Office.

Initiatives will be presented to the team by the sponsor, who will prepare and circulate a paper on the initiative prior to the review meeting. The paper, 3 to 5 pages in length, like those contained in Annex B of this plan, will describe the purpose of the initiative, its link to Agency and Office goals, and the proposed scope and implementation strategy, together with budgets and implementation milestones.

## Decision Support System Development

A decision support system is being developed to provide the Office with (1) a comprehensive computer data base containing substantive information on AID-assisted countries, energy technologies, analysis methodologies, and other information; and (2) a procedure by which this information is incorporated in Office decisions and activities. The data base will help in evaluating both existing and proposed programs and initiatives. For each country, this data base will eventually include information on:

- AID energy projects
- Other relevant AID projects (particularly agriculture and rural development)
- Energy projects of other donor organizations
- Energy supply and demand profiles
- Energy technology data for specific applications
- General economic and business indicators
- U.S. firms and personnel with subsidiaries and expertise in AID-assisted countries
- In-country firms and private-sector and government personnel having an interest in energy
- AID-trained in-country personnel
- General economic, business, and energy forecasts
- Political information
- Reports and other documents in the Energy Policy Resource Center
- Access to other computerized bibliographic and numerical data bases having pertinent information.

The Office is currently reviewing its information needs and the resources available within AID to determine the hardware and software requirements of this system. To avoid any duplication of effort, the system will be fully integrated with the information resources being developed by the various projects, by the Energy Policy Resource Center, by the Agency's Center for Development Information's Economic

and Social Data Bank and Development Information and Utilization System, and by other international organizations such as the World Bank.

This data base information will become part of a computer-based decision support system that will incorporate, in future years, decision analysis and "expert system" techniques to assist managers in project selection and implementation.

### Project Control System Implementation

A formal project control system is being instituted in the Office. The system will track the status of contract obligations and expenditures; provide monthly, quarterly, and annual status reports, including tracking of deliverables and other milestones; and provide information on Mission requests and buy-ins. The system will be based either on a microcomputer or the Office's Wang word processing system. The Office is now preparing a manual that will specify in detail the procedures for this system and the computer hardware and software requirements.

## 3. OUTREACH AND INFORMATION DISSEMINATION PROGRAM

The objectives of the outreach and information dissemination program are twofold:

1. To disseminate, systematically and in a timely fashion, program information to AID senior staff, regional bureaus, Missions, other donor agencies, research institutions, and private-sector organizations, both in the United States and AID-assisted countries

2. To involve outside public- and private-sector parties in program definition, review, and implementation.

To achieve these two objectives, the Office has defined a program organized around five key components:

1. A formal program planning outreach program
2. A publication program
3. Systematic Mission briefings
4. Private-sector technology transfer teams
5. Regional topical workshops.

## Program Planning Outreach Program

The Office is formalizing the process it has started with this first program planning exercise (see section IV.2 "Management Decision Support System"). It will continue to use small ad-hoc groups of experts from other international institutions (e.g., the World Bank, the United Nations, the InterAmerican Development Bank), the private sector, and from within the Agency to guide its program planning activities and assist in program implementation and outreach. At the beginning of each fiscal year, the Office will sponsor a workshop to present and discuss its plan. The first workshop will be organized for the Office by the National Academy of Sciences in December 1985 or January 1986 in Washington, D.C. In conjunction with this workshop, a summary of the program plan will be published and distributed to the Missions, bureaus of the Agency, international lending institutions, and other interested parties.

## Publication Program

The second major element of the outreach/information strategy is the timely and systematic publication of reports resulting from every contract issued by S&T/EY directly or through contractors (e.g., Oak Ridge National Laboratory). A publication plan will be included in every project plan. At least twice a year, the Office program activities will be reviewed to identify publishable work and ensure that publication-related activities are properly carried out. To give these reports maximum distribution and impact, the Office will develop a simple, uniform reporting and presentation format for its contractors. A catalog of reports available from the Office will be published twice a year. As part of this activity, the Office will develop a microcomputer-based mailing list that will allow it to target its publications to specific audiences in the international development community.

## Mission Briefings

The Office will organize formal presentations for directors of Missions on the energy situation in their country and the opportunities for improving the energy supply/demand outlook. To the extent possible, the Office will schedule these energy briefings during the visits of Mission directors to Washington -- e.g., during the annual country review meetings. The format and schedule of these briefings will be reviewed with the relevant regional bureau. In

FY86, the Office expects to hold at least six briefings in Washington and another three overseas. Overseas briefings will be conducted by Office staff in conjunction with temporary duty (TDY) travel. Office contractors will be enlisted to brief Missions on special topics.

**Technology Transfer Teams**

The Office will sponsor the creation of private-sector Technology Transfer Teams (TTTs) to implement a number of "flagship" private-sector projects. These teams will assist AID in designing projects that can be financed and implemented by the private sector. The projects will then serve as prototypes for other private-sector initiatives, while at the same time starting the transfer of know-how, technology, and financial resources between U.S. private-sector parties and those in developing countries. The Office has identified a number of potential business areas in which to test this concept in FY86, including energy conservation and small-scale power generation. The objective is to organize at least two TTTs in FY86 and two more in FY87.

**Regional Topical Workshops**

The fifth component of the outreach and dissemination program consists of a series of workshops that will be sponsored by the Office in collaboration with the regional bureaus. The workshops will focus on topics that are relevant, and of interest, to a specific region (e.g., coal briquetting, energy pricing) and will be open to both public- and private-sector participants. They will use as a model the "Energy Conservation Workshop" held in Costa Rica in January 1985 for the Latin America and Caribbean region. Four workshops are planned for FY86: one on energy conservation and cogeneration (summer 1986) and one on briquettes (fall 1986) for the Asia and Near East regions, one on small and medium-size irrigation pumping in Nairobi (spring 1986), and another one (mid 1986), with a topic and region yet to be selected.

In addition to these five central components of the outreach and information dissemination program, the Office will also pursue a number of other activities. For instance, the Office will continue to encourage its staff to publish articles for AID and external publications, and it will examine the possibility of holding joint energy briefings with AID's Trade and Development Program for U.S. private companies. In addition, the Office will continue to foster

the organization of in-country professional groups and associations and work on linking them on an international basis.

## 4. SUPPORT AGREEMENTS AND CONTRACTS

The Office relies in part on outside support to implement its program activities. The objective of the Office's support agreements and contracts is to develop multidisciplinary teams of experts and continuously enhance their capabilities through repeated experience in all key areas needed for program implementation and Mission support.

The following contractual mechanisms are used to help implement the program:

- RSSA with Brookhaven National Laboratory (approved through FY86).
- PASA with Oak Ridge National Laboratory (approved through FY86). ORNL provides management assistance to the energy analysis and policy development activities under the Energy Policy Development and Conservation (EPDAC) project as well as the renewable energy program under the Renewable Energy Applications and Training project.
- RSSA with Tennessee Valley Authority (approved through FY87), which manages the Bioenergy Systems and Technology project.
- RSSA with the U.S. Geological Service (approved through FY86), which provides technical assistance to the Conventional Energy project.
- Contract with Volunteers in Technical Assistance (VITA) for the Low Cost Energy Technology program (contract ending December 30, 1986).
- Technical assistance contract with the National Rural Electric Cooperative Association (NRECA) for the Small Decentralized Hydropower project (contract ending July 31, 1987).
- Contract with the Institute for International Education (IIE) to manage the Conventional Energy Training project (contract ending June 30, 1987).

- Contract with Hagler, Bailly & Company for technical assistance to the Energy Conservation Services Program funded under the EPDAC project (contract ending September 30, 1987).

- Contract with Bechtel National for services to the Conventional Energy Technical Assistance project (contract ending September 17, 1990).

- Indefinite quantity contracts with eleven small business, minority, and other firms. These contracts will all end in December 1985. A new competitive procurement process has been initiated to select a new roster of firms.

In addition to these multiyear contracts, the Office also uses purchase orders to carry out unforeseen and small jobs, when necessary. Based on past experience, approximately a dozen purchase orders are likely to be needed in FY86. The Office is also exploring ways of facilitating Missions' financial participation -- "buy-ins" -- in Office contracts and PASA agreements.

## 5. BUDGET AND FUNDING SOURCES

The Office's budget by program activity for FY86, FY87, and FY88, under current government spending limitations, is summarized in Table IV.1. The Office's operating budget for FY86 is $7.75 million. The annual budget submission (ABS) for FY87 is $7 million and the Office's preliminary estimate for FY88 is $10.5 million. Training activities will represent the single largest program expenditure during these 3 years. Program initiatives, as opposed to cross-cutting activities such as information dissemination, training, and general technical assistance, will account for approximately two-thirds of the Office's budget.

The Office's activities will be funded through existing projects. The expected funding level for each project, together with specific program activities, is shown for FY86 in Table IV.2 and for FY87 in Table IV.3. Most program initiatives will be funded by more than one project.

The Office's own budget will be leveraged by additional funding, particularly from Missions and some regional bureaus. Based on discussions with several Missions and bureaus during this planning exercise and based on past experience, the Office has estimated the level of "buy-ins" for each program activity and for the next 3 fiscal years.

The estimates are summarized in Table IV.1. The combined budgets (Office funding and buy-ins) used for activity planning, contracting, and control are $11.3 million, $12.6 million, and $16.3 million for FY86, FY87, and FY88, respectively.

Table IV.1

OFFICE OF ENERGY (S&T/EY)
PROGRAM ACTIVITY BUDGET
FY86 - 88 ($ '000)

| PROGRAM AREA/ACTIVITY | FY 86 | | | FY 87 | | | FY 88 | | |
|---|---|---|---|---|---|---|---|---|---|
| | S&T/EY | OTHER | TOTAL 86 | S&T/EY | OTHER | TOTAL 87 | S&T/EY | OTHER | TOTAL 88 |
| General Mission Support (*) | 400 | 0 | 400 | 400 | 0 | 400 | 500 | 0 | 500 |
| Training (US based only) (*) | 1,700 | 850 | 2,550 | 1,700 | 1,050 | 2,750 | 2,250 | 1,150 | 3,400 |
| Outreach/Information Dissemination (*) | 250 | 0 | 250 | 250 | 0 | 250 | 300 | 0 | 300 |
| Decision Support System/ Program Planning and Budgeting | 150 | 0 | 150 | 150 | 0 | 150 | 200 | 0 | 200 |
| PROGRAM INITIATIVES: | | | | | | | | | |
| Energy Policy and Analysis | | | | | | | | | |
| 1. Energy Analysis and Assessment | 600 | 200 | 800 | 500 | 300 | 800 | 600 | 300 | 900 |
| 2. Energy Pricing | 250 | 50 | 300 | 200 | 100 | 300 | 300 | 100 | 400 |
| 3. Barriers to Private Sector Participation in Energy Development | 225 | 50 | 275 | 225 | 100 | 325 | 400 | 100 | 500 |
| 4. Irrigation and Energy Planning in River Basin Development | 150 | 50 | 200 | 225 | 225 | 450 | 400 | 225 | 625 |
| Subtotal | 1225 | 350 | 1575 | 1150 | 725 | 1875 | 1700 | 725 | 2425 |
| Energy Conservation and Demand Management | | | | | | | | | |
| 5. Energy Conservation | 1,000 | 500 | 1,500 | 800 | 700 | 1,500 | 1,250 | 750 | 2,000 |
| 6. Energy for Irrigation Pumping | 200 | 100 | 300 | 200 | 200 | 400 | 300 | 200 | 500 |
| Subtotal | 1200 | 600 | 1800 | 1000 | 900 | 1900 | 1550 | 950 | 2500 |
| Resource Development | | | | | | | | | |
| 7. Coal Development and Use | 500 | 350 | 850 | 400 | 600 | 1,000 | 750 | 600 | 1,350 |
| 8. Natural Gas Development and Use | 400 | 275 | 675 | 325 | 425 | 750 | 550 | 425 | 975 |
| 9. Household Fuels and Fuelwood | 350 | 100 | 450 | 275 | 275 | 550 | 450 | 325 | 775 |
| Subtotal | 1250 | 725 | 1975 | 1000 | 1300 | 2300 | 1750 | 1350 | 3100 |
| Power Systems Development | | | | | | | | | |
| 10. Rural Electrification | 150 | 50 | 200 | 200 | 200 | 400 | 500 | 200 | 700 |
| 11. Industrial and Village-scale Power Systems | 625 | 400 | 1,025 | 500 | 625 | 1,125 | 750 | 625 | 1,375 |
| 12. Small Utility-scale Power Systems | 800 | 575 | 1,375 | 650 | 800 | 1,450 | 1,000 | 800 | 1,800 |
| Subtotal | 1,575 | 1,025 | 2,600 | 1,350 | 1,625 | 2,975 | 2,250 | 1,625 | 3,875 |
| Program Initiatives Subtotal | 5,250 | 2,700 | 7,950 | 4,500 | 4,550 | 9,050 | 7,250 | 4,650 | 11,900 |
| TOTAL | 7,750 | 3,550 | 11,300 | [illegible] | 5,600 | 12,600 | 10,500 | 5,800 | 16,300 |

(*) Complementary to program initiatives expenditures

Table IV.2

OFFICE OF ENERGY (S&T/EY)
PROJECT BUDGET
FY86 ($ '000)

| PROGRAM AREA/ACTIVITY | S&T/EY FY86 TOTAL | PROJECTS: POLICY DEV. & CONSERVATION (936-5728) | FOSSIL FUELS (936-5702) (936-5724) | RENEWABLES (936-5709) (936-5730) | TRAINING (936-9997) | ENERGY IN AGRICULTURE (936-5731) |
|---|---|---|---|---|---|---|
| General Mission Support (*) | 400 | 150 | 75 | 175 | 0 | 0 |
| Training (US based only) (*) | 1700 | 0 | 0 | 0 | 1700 | 0 |
| Outreach/Information Dissemination (*) | 250 | 100 | 25 | 125 | 0 | 0 |
| Decision Support System/ Program Planning and Budgeting | 150 | 75 | 0 | 75 | 0 | 0 |
| PROGRAM INITIATIVES: | | | | | | |
| Energy Policy and Analysis | | | | | | |
| 1. Energy Analysis and Assessment | 600 | 350 | 0 | 100 | 0 | 150 |
| 2. Energy Pricing | 250 | 200 | 0 | 50 | 0 | 0 |
| 3. Barriers to Private Sector Participation in Energy Development | 225 | 75 | 0 | 150 | 0 | 0 |
| 4. Irrigation and Energy Planning in River Basin Development | 150 | 0 | 0 | 0 | 0 | 150 |
| Subtotal | 1225 | 625 | 0 | 300 | 0 | 300 |
| Energy Conservation and Demand Management | | | | | | |
| 5. Energy Conservation | 1000 | 1000 | 0 | 0 | 0 | 0 |
| 6. Energy for Irrigation Pumping | 200 | 0 | 0 | 0 | 0 | 200 |
| Subtotal | 1200 | 1000 | 0 | 0 | 0 | 200 |
| Resource Development | | | | | | |
| 7. Coal Development and Use | 500 | 0 | 500 | 0 | 0 | 0 |
| 8. Natural Gas Development and Use | 400 | 0 | 400 | 0 | 0 | 0 |
| 9. Household Fuels and Fuelwood | 350 | 0 | 0 | 350 | 0 | 0 |
| Subtotal | 1250 | 0 | 900 | 350 | 0 | 0 |
| Power Systems Development | | | | | | |
| 10. Rural Electrification | 150 | 50 | 0 | 100 | 0 | 0 |
| 11. Industrial and Village-scale Power Systems | 625 | 0 | 25 | 600 | 0 | 0 |
| 12. Small Utility-scale Power Systems | 800 | 0 | 75 | 725 | 0 | 0 |
| Subtotal | 1575 | 50 | 100 | 1425 | 0 | 0 |
| Program Initiatives Subtotal | 5250 | 1625 | 1000 | 2075 | 0 | 500 |
| TOTAL | 7750 | 2000 | 1100 | 2450 | 1700 | 500 |

(*) Complementary to program initiatives expenditures

Table IV.3

OFFICE OF ENERGY (S&T/EY)
PROJECT BUDGET
FY87 ($ '000)

| PROGRAM AREA/ACTIVITY | S&T/EY FY87 TOTAL | PROJECTS: POLICY DEV. & CONSERVATION (936-5728) | FOSSIL FUELS (936-5702) (936-5724) | RENEWABLES (936-5709) (936-5730) | TRAINING (936-9997) | ENERGY IN AGRICULTURE (936-5731) |
|---|---|---|---|---|---|---|
| General Mission Support (*) | 400 | 150 | 150 | 75 | 0 | 25 |
| Training (US based only) (*) | 1700 | 0 | 0 | 0 | 1700 | 0 |
| Outreach/Information Dissemination (*) | 250 | 100 | 75 | 50 | 0 | 25 |
| Decision Support System/ Program Planning and Budgeting | 150 | 25 | 50 | 25 | 50 | 0 |
| PROGRAM INITIATIVES: | | | | | | |
| Energy Policy and Analysis | | | | | | |
| 1. Energy Analysis and Assessment | 500 | 250 | 125 | 50 | 50 | 25 |
| 2. Energy Pricing | 200 | 100 | 75 | 25 | 0 | 0 |
| 3. Barriers to Private Sector Participation in Energy Development | 225 | 100 | 100 | 25 | 0 | 0 |
| 4. Irrigation and Energy Planning in River Basin Development | 225 | 0 | 0 | 0 | 0 | 225 |
| Subtotal | 1150 | 450 | 300 | 100 | 50 | 250 |
| Energy Conservation and Demand Management | | | | | | |
| 5. Energy Conservation | 800 | 750 | 0 | 0 | 50 | 0 |
| 6. Energy for Irrigation Pumping | 200 | 25 | 0 | 0 | 0 | 175 |
| Subtotal | 1000 | 775 | 0 | 0 | 50 | 175 |
| Resource Development | | | | | | |
| 7. Coal Development and Use | 400 | 0 | 400 | 0 | 0 | 0 |
| 8. Natural Gas Development and Use | 325 | 0 | 325 | 0 | 0 | 0 |
| 9. Household Fuels and Fuelwood | 275 | 25 | 50 | 200 | 0 | 0 |
| Subtotal | 1000 | 25 | 775 | 200 | 0 | 0 |
| Power Systems Development | | | | | | |
| 10. Rural Electrification | 175 | 50 | 0 | 125 | 0 | 0 |
| 11. Industrial and Village-scale Power Systems | 525 | 25 | 200 | 200 | 75 | 25 |
| 12. Small Utility-scale Power Systems | 650 | 100 | 250 | 225 | 75 | 0 |
| Subtotal | 1350 | 175 | 450 | 550 | 150 | 25 |
| Program Initiatives Subtotal | 4500 | 1425 | 1525 | 850 | 250 | 450 |
| TOTAL | 7000 | 1700 | 1800 | 1000 | 2000 | 500 |

(*) Complementary to program initiatives expenditures

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**OFFICE OF ENERGY**
Energy for Development Paper No. 1

## ENERGY FOR DEVELOPMENT

### INTRODUCTION AND EXECUTIVE SUMMARY

Ignoring energy in the development of AID-assisted countries would be a serious mistake. When a country is trying to effect a transition from traditional to modern economic activities, a relatively rapid increase in commercial energy requirements can be expected. Although the total expenditures of developing countries on energy are not as large as expenditures on, say, capital goods or food, shortages of energy or high prices for energy can be highly disruptive to economic activities, social structures, and environmental quality during this transition.

The simplest summary measure of the importance of energy in economic development is the energy-GDP (gross domestic product) elasticity, which reports the percentage change in energy required to sustain a 1 percent increase in income per capita. The energy-GDP elasticity for a broad sample of developing countries is between 1.3 and 2.0 for modern, or "commercial," energy and around 1 for all energy -- modern and traditional. In other words, a 1 percent increase in per capita income in a typical developing country can be expected to require an increase in modern energy -- usually imported petroleum or expensive-to-develop hydroelectric or coal fired power -- of between 1.3 percent and 2 percent. Modern energy sources are more efficiently used than traditional, biomass-based fuels; so the total increase in energy -- modern plus traditional -- generally rises at about the same rate as income as less efficient fuels are replaced by more efficient fuels.

The most dramatic change in energy conditions affecting AID-assisted countries in the past decade has been the well-known rise in oil prices. Since the early 1980s, these prices on the world market -- quoted in dollars -- have stabilized; but the currencies of most AID-assisted countries have weakened with respect to the dollar, which means that the price of oil in terms of the local currency has continued to rise. Although this change in the relative value of currencies has also made exports more

competitive, reducing the impact of oil reports on net terms of trade, the overall impact has continued to be negative.

Forecasts of oil price trends during the rest of the century are widely divergent, with predicted prices for 2000 ranging from $25.50 to $97.50 per barrel (in 1981 U.S. dollars). The major point of agreement among the predictions, however, is that oil prices will not stabilize permanently. While the severity of the price disruptions of the 1970s and 1980s may not be repeated throughout the rest of the century, developing countries can anticipate a steady upward pressure on their commercial energy costs, calling for a fuller adaptation to new realities than has often been the case so far.

Developing countries share many energy-economic problems with the developed countries, but the process of economic development itself imposes special energy problems. For example, the rural sectors of most developing countries are large, and their modernization involves both the mechanization of agriculture and the expansion of rural industry. Energy demands from agriculture are not large from the national viewpoint; but mechanization, which requires modern energy, introduces new system needs and vulnerabilities for agriculture. Moreover, to produce export-quality products, rural industries often require machinery powered by modern energy sources. Small quantities of energy per capita or unit of activity, added across a large rural sector, often amount to significant quantities of energy, especially by the standards of current energy supply systems in rural areas.

Developing countries also typically undergo rapid urbanization, which most developed countries have already experienced. A 1 percent increase in the percent of the population which is urban can be expected to increase per capita energy consumption by 0.3 to 0.5 percent because of changes in personal transportation requirements, urban food delivery systems, urban public service provision, and other personal activity patterns. Urbanization is especially rapid in many developing countries now, particularly in Africa and in some Asian countries, with no significant letup predicted for the rest of the century. With national population growth rates from 2.5 to 4 percent per year, urban population growth rates in a number of countries are running at 6 percent to 10 percent, or even higher.

Most development strategies include the construction of large industrial and agricultural projects, and their operation invariably requires modern energy, often in quantities that swamp the rest of the economy's demand for modern energy. For example, single medium-sized cement plants in small West African countries, if operated near capacity and at high efficiencies, can claim as much as 33 percent to 40 percent of the modern energy consumed by an entire country in 1980. These large effects are, of course, reflections of the low level of general economic development of those countries, but the magnitudes indicate potential strains on local energy distribution systems, suggesting the possibility of system failures or destructive competition with other energy users.

One partial answer to energy supply problems in developing countries is the development of domestic oil and gas resources, where they exist, but the countries now facing the greatest energy pressures not only have the least proven or economically recoverable reserves, in most cases, but where reserves are present these countries have had the least exploration activity. Oil and gas exploration and development in most oil importing developing countries (OIDCs) is risky at any time, at least partly because of uncertainties about host cooperation. However, high interest rates and low real oil prices joined forces with these uncertainties in the early 1980s to squelch exploration and development activity in OIDCs almost completely. No easy answers to the OIDCs' energy supply problems appear to lie in this direction in the near future.

Another legacy of the oil price increases of the 1970s has been the accumulation of a large amount of foreign debt by many OIDCs. Although the entire debt accumulation cannot be laid at the door of oil price increases and energy imports, the energy price revolution of the 1970s was clearly a major contributor. It has been estimated that oil price increases since 1973 accounted for more than one-half of the foreign debt accummulated by developing countries during that period. This debt burden has reduced the financing available for development projects by adding to the risks perceived by private capital investors and diverting funds to finance balance of payments and debt service requirements. Appropriate energy policies may offer effective strategies for reducing indebtedness problems in the future.

## ENERGY-GDP RELATIONSHIPS IN DEVELOPING COUNTRIES[1]

Available evidence indicates that, in a typical developing country, each percentage increase in economic production (or income) requires between 1.3 and 2.0 percent more commercial energy, depending upon how the ratio is calculated. If total energy, not just commercial energy, is considered, the rate of increase in energy consumption is roughly equivalent to the rate of increase in economic production, because the use of less efficient traditional fuels is dropping while the use of more efficient commercial fuels is rising.

In understanding energy needs for economic development, one of the most fundamental questions is: in the aggregate, how important is energy for development? Stated simply, does economic development require a lot of energy or a little? The usual starting point for such a discussion is an examination of historical patterns of energy consumption by countries as they relate to historical patterns of economic growth. Did energy use grow faster than, at the same rate as, or slower than the economy as a whole? The answer gives one broad indicator of the importance of energy as a factor of production in a growing economy.

Clearly, actual estimates of energy/production (or income) relationships depend heavily on definitions (e.g., energy, production) and estimation techniques (e.g., cross-section or time series). In addition, such relationships are known to vary considerably from one developing country to another and perhaps from one period of development to another. These facts make generalizations risky, but the available empirical evidence does seem to indicate some fairly consistent relationships.

Several measures of a national economy's energy intensity are in common use. The simplest is the ratio of energy consumption to a measure of national income, called the energy-income ratio or the average energy-income ratio. The income measure generally preferred is gross domestic product (GDP) per capita, although gross national product (GNP) per capita is used occasionally. More often used is the energy-income elasticity, also called the energy coefficient, the incremental energy-income coefficient, or the income elasticity of demand. The energy-income

[1]Adapted from Donald W. Jones, "Energy-Income Relationships in Developing Countries," Energy Division, ORNL, July 1985.

elasticity measures the ratio of the percent change in energy consumption to a one-percent increase in income.

These elasticities are usually estimated statistically from a number of observations of energy consumption and income per capita from a cross-section of countries or from a time series for a single country. Elasticities estimated from cross-sectional samples of observations commonly are considered long-run elasticities, or the elasticity when the economy has fully adjusted to the income change.[2] Elasticities estimated from time series observations are considered short-run elasticities, indicating that adjustment to the income change is incompletely represented by the estimate.

A recent attempt to advance the state of the art has involved the use of purchasing power parity-adjusted (ppp-adjusted) measures of GDP when estimating energy-GDP elasticities from international cross-sections. (The ppp adjustment is an attempt to eliminate -- or at least reduce -- the effect of apparent international income differences which are attributable simply to price variations rather than real consumption or purchasing power differences.) In practice, the ppp-adjusted income measure yields an elasticity value about 20 percent higher than the unadjusted income measure.

In practice, however, the choice of income measures is of secondary importance, while the choice of what to include in the aggregate energy measure is of greater consequence. For example, little attention has been given to the distortionary effects of excluding traditional fuels from the measures of national energy consumption of countries which derive 75 percent to 90 percent of their energy from traditional fuels. Including traditional energy can cut the energy-GDP elasticity in half. Additionally, controlling for energy price differences among countries can markedly affect the estimates of energy-GDP elasticities.

Table 1 summarizes the range of elasticity estimates associated with different measurements and estimation methods. When only modern ("commercial") energy per capita is included in the aggregate energy consumption measure, and the simplest measure of GDP per capita is used (simply converting through the exchange rate into a common currency,

[2]The term "long-run" does not necessarily imply that a long time must elapse. Indeed, the full adjustment could occur very quickly, even immediately.

Table 1. Summary of energy - GDP elasticity estimates

| GDP Measure | Simple Energy-GDP Elasticities | | | | Estimates with Energy Price Held Constant | | | |
|---|---|---|---|---|---|---|---|---|
| | Energy Intensity Measure | | | | Energy Intensity Measure | | | |
| | Btu/$ of GDP | | Btu Per Capita | | Btu/$ of GDP | | Btu Per Capita | |
| | Modern Energy Only | Modern and Traditional Energy | Modern Energy Only | Modern and Traditional Energy | Modern Energy Only | Modern and Traditional Energy | Modern Energy Only | Modern and Traditional Energy |
| Exchange rate conversion only | --- | --- | 1.3-1.4 | 0.7 | 0.5 -- 1.1 | | | |
| PPP adjustment prior to exchange rate conversion | 2.0 | 1.2 | 1.7 | 0.9 | | | | |

without making ppp adjustments), a typical value for the energy-GDP elasticity is 1.3 to 1.4. Using the more sophisticated ppp-adjusted income measure but still excluding traditional energy from the energy consumption measure, the elasticity rises to a typical value of 1.7. If energy intensity is measured on the basis of Btu per unit of GDP rather than per capita , with traditional energy still excluded, the elasticity rises to 2.0. Including traditional energy and measuring energy on a per capita basis, the energy-GDP elasticity falls to 0.9 when ppp-adjusted GDP per capita is used as the income measure and to 0.7 when the simpler version of GDP per capita is used; measuring total energy intensity on a unit of GDP basis and income with the ppp measure, the elasticity is 1.2. These are all "simple" elasticities, or ones derived from models which contain no other variables in the explanation of energy consumption differences, and are very close to short term energy demand models estimated without price variables. Actual aggregate energy demand models which include both income and price variables yield energy-income elasticities which range between 0.5 and 1.1, but with substantial variation among world regions. These income elasticities of demand for energy are also sensitive to the choice of price measures. Additional evidence suggests that international cross-sectional estimates of a single, long-run energy-GDP elasticity mask a considerable amount of intercountry variation in elasticity values.

The exclusion of traditional fuels in the estimation of energy-GDP elasticities for developing countries is a particularly common (and serious) omission. Empirical observations of the well-publicized "development effect" in energy use, whereby a nation's energy intensity increases sharply during a period of intensive development, then peaks and gradually declines as efficiency improves and industrial structure changes, appear to be misleading because they exclude fuelwood consumption. In other words, much of the apparent peak in total energy consumption appears to involve switching from traditional fuels to modern energy sources. Including fuelwood in the energy measure smoothes out much of the peak. This suggests that development and the introduction of capital equipment which uses modern energy can actually save energy by increasing the ratio of output energy to input energy.

## IMPLICATIONS OF WORLD OIL MARKET CONDITIONS FOR DEVELOPING COUNTRIES[3]

The strength of the dollar in world currency markets in the 1980's has generally increased the price of oil imports for AID-assisted countries, measured in terms of the local currency, and this local price increase has been only partly offset by rising dollar values of exports. Although real oil prices in many countries began to decline by 1983, in nearly every case they were still higher than they had been in 1980. Forecasts of oil prices for the remainder of the century vary widely, but the median projection in the current literature forecasts a 100 percent increase by 2000 in real oil prices compared with 1981 prices.

The significance of changing oil prices for both developed and developing economies has been the subject of considerable debate, with most of the attention focused on needs to adapt to the rapidly rising prices during the 1970s, especially in OIDCs. With the more recent moderation in world oil prices, however, many observers have speculated that energy-related economic pressures are easing and, indeed, that energy conditions may have become a positive influence for development.

A review of world oil price forecasts indicates that there is pervasive uncertainty about future trends. Both the "experts" and the "modelers" among the forecasters caveat their forecasts by assuming no sudden shocks to the oil market, such as those of 1973-1974 and 1979-1980. They further caution about the great uncertainties in making point forecasts. In general, though, the forecasts tend to indicate that oil prices are likely to remain stable, or possibly decline slightly, in real terms through 1990. After 1990, an average annual real increase of 2 percent is considered quite likely. But the individual forecasts show considerable variation around these expectations, as shown in Table 2 and Figure 1.

How these future price changes will affect energy consumers in the developing world will, of course, depend heavily on numerous forces outside the control of developing countries. These trends include world prices for their exports and the level of demand for those exports. Other factors, over which the developing countries have some control (at least in the short run) --

[3]Adapted from D. P. Vogt, T. R. Curlee, and R. B. Shelton, "Implications of World Oil Market Conditions for Developing Countries," Energy Division, ORNL, April 1985.

Table 2. Median and range of oil price forecasts
(1981 dollars)

| | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1985 | 1990 | 1995 | 2000 | 2010 | 2020 |
| Median | $25.46 | $36.65 | $33.06 | $62.10 | $71.70 | $71.90 |
| Range | 17.12 - 50.73 | 19.56 - 64.00 | 24.57 - 59.62 | 25.47 - 97.50 | 45.59 - 129.70 | 53.43 - 152.30 |

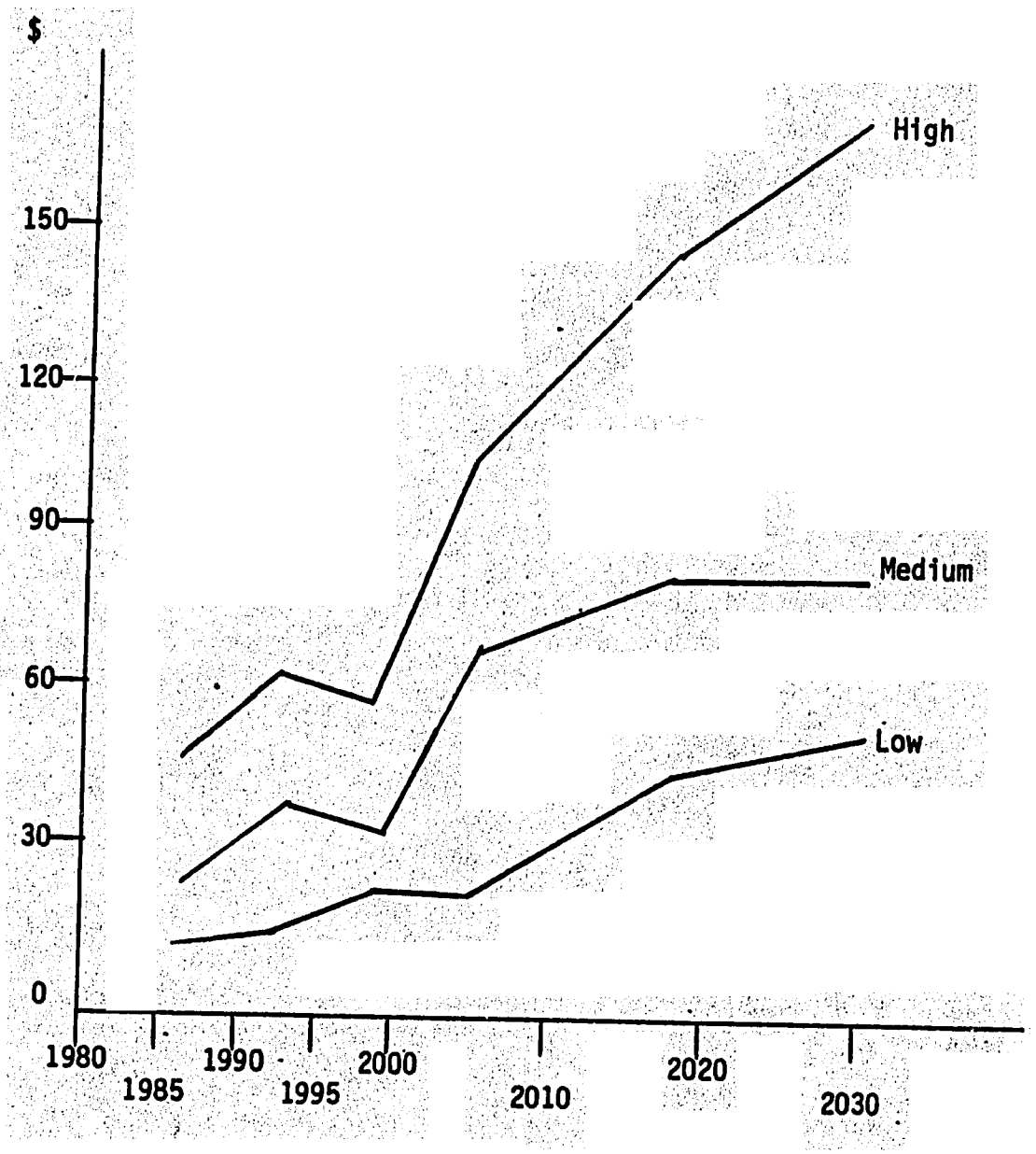


Figure 1. Median and range of oil price forecasts (1981 Dollars)

such as exchange rate policy, domestic inflation rates, and direct energy pricing policies -- also introduce uncertainty into projections of oil prices for domestic consumers and other economic impacts of changes in world oil prices.

Given these uncertainties, studies investigating the impact on developing countries of rising oil prices during the past two decades have identified examples of both insignificant and significant negative effects. A common view is that, on the average, the OIDCs may have suffered a 1 percent loss in their real GNP growth rates from the direct effects of energy shocks (i.e., from 3 percent to 2 percent). More important from a development perspective has been the potential long-term impact on the current debt structure and future ability to borrow for those countries which tried to insulate their economic growth by financing oil imports through foreign borrowing.

These domestic policy measures, however, as well as other economic forces external to the local economy, complicate th interpretation of oil price data from the developing countries, because the data reflect the impact of policy measures as well as the impact of world oil prices and other world market influences. Consequently, several measures of oil prices have been suggested in the literature. The first is the local currency price of oil, which adjusts a reference world price of oil for changes in a country's exchange rate. This is of interest because of the recent appreciation of the dollar vis-a-vis all other currencies. For most OIDCs, though, oil imports will eventually need to be financed through exports. Consequently, an alternative measure of the country's "real" oil price is derived by adjusting the local currency price for changes in the price of the country's exports. In other words, the same country paying a higher price for oil may be getting a higher price for exports which help to pay the bill. Finally, from the domestic consumer's point of view, energy consumption decisions are based on the price of oil relative to the prices of other commodities. A measure of the real user price can be constructed by adjusting the local currency price for domestic rates of inflation.

During the period since 1980, the local currency price of oil in most developing countries has indeed risen because of the appreciation of the dollar. For example, the price of Saudi crude oil to AID-supported OIDCs in Africa was four times as high in 1984 as in 1980 (Table 3). However, export prices were also quite volatile during the period. Commodity prices

Table 3. Regional averages of energy price indexes for AID-supported oil importing developing countries, 1981-1984

A. Index of Saudi Oil Price in Local Currency, 1980 = 100

| Region | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|
| Africa | 150 | 200 | 232 | 402 |
| Asia | 121 | 137 | 132 | 145 |
| Middle East | 124 | 133 | 116 | 129 |
| Western Hemisphere | 140 | 266 | 587* | 2833* |

B. Index of Saudi oil price relative to export prices, 1980 = 100

| Region | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|
| Africa | 117 | 125 | 108 | -- |
| Asia | 126 | 148 | 123 | -- |
| Middle East | 110 | 110 | 108 | -- |
| Western Hemisphere | 119 | 134 | 115 | -- |

C. Index of Saudi oil price relative to local consumer price indexes 1980 = 100 (Real user cost of oil)

| Region | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|
| Africa | 109 | 117 | 105 | -- |
| Asia | 108 | 113 | 100 | -- |
| Middle East | 110 | 106 | 86 | -- |
| Western Hemisphere | 107 | 116 | 97 | -- |

*Distortions caused by large devaluations in Argentina and Brazil.

fell from 1980 through 1982, while both the dollar and nominal oil prices were rising, causing a rise in real oil prices to the majority of OIDCs. During 1983, oil prices started to fall. This decline, along with a rise in commodity prices, somewhat mitigated the impact of the continued dollar appreciation; but in 1983, commodity prices were still below their 1980 value. In other words, the fall in oil prices was not sufficient to offset the dollar appreciation, leaving real oil prices above their 1980 value -- though far lower than if currency exchange rates alone are considered in evaluating oil purchases. Adjusting the local prices for inflation provides a similar picture of user costs, indicating that domestic inflation paralleling world oil price increases helped to ease internal oil price increases.

To summarize the available evidence, oil prices have increased for AID-supported OIDCs, but by far less than local prices would suggest. The appreciation of the dollar relative to those local currencies exacerbated the cost of oil on the one hand, but on the other it raised the dollar value of exports. Internally, the inflation of domestic currencies further reduced the internal relative prices of Saudi oil. In fact, the lower index numbers in Panel C of Table 3 indicate that individual consumers suffered less than did the national interests of their countries, since final consumption costs of oil products rose by less than the international oil costs in terms of exports. This reinforces a view that energy planning in OIDCs is important and that the coordination of energy policy with other domestic and international economic policies is an important task.

## ENERGY REQUIREMENTS FOR DEVELOPMENT

### Rural Development[4]

The modernization of agriculture and agriculture-related rural activities in developing countries requires widespread introduction of modern source of energy into activities that previously used no fuel or only traditional fuels, as well as the introduction of entirely new activities which use modern energy. Developing the nonagricultural sectors of rural areas often involves, and sometimes even requires, the introduction of machinery which uses modern energy. Because

[4] Adapted from Donald W. Jones, "Energy Requirements for Rural Development," Energy Division, ORNL, July 1985.

of the diversity of activities, equipment and operating conditions, it is difficult to generalize about rural nonagricultural energy requirements, but the relative size of this sector increases relative to agriculture as a nation develops.

Agriculture's share of national energy use is small in both developing and developed countries. In developing countries, where agriculture accounts for much larger shares of both the labor force and national income, the mechanization of agriculture and supporting activities is not extensive and fuel use is not high. Indeed, in traditional agriculture fuel use is almost nonexistent. As a nation develops and its agricultural sector develops and mechanizes, other sectors grow at relatively more rapid rates, taking labor out of agriculture and reducing agriculture's share of national income. The result is that more developed and mechanized agricultural sectors appear to claim roughly the same, or even smaller, shares of national energy consumption. This does not mean, however, that energy needs are not important -- or even critical -- in the transition from traditional to modern agriculture in developing countries.

Farm mechanization, irrigation, commercial fertilizer use and the introduction of high yielding variety seeds are the major elements of farm modernization which may be expected to increase fuel use. The actual quantities of energy used in each of these activities, however, are quite country -- and even location -- specific.

Fuel cost shares of farm equipment operation have been estimated to range between 25 percent and 45 percent of total equipment operating cost, although these estimates are only for equipment operation; i.e., they are not shares of total farming cost, which includes payments for labor, land, seed, etc. Conditions of fuel availability and spare parts and maintenance on equipment appear to be as important to successful mechanization as are low fuel prices. Evidence about energy use in on-farm postharvest mechanization is limited but suggests that fueled equipment is more likely to be used at centralized sites than in dispersed fashion at the farm level. Farm mechanization is also highly dependent on road infrastructure development.

Most opportunities for gravity flow irrigation and natural flooding appear to have been undertaken already; so most large-scale additions to irrigated acreage will have to rely on pumping, which requires modern energy sources.

Irrigation water and fuel requirements are highly dependent upon climatic regime, crop selection, and maintenance of water delivery infrastructure; but they can be substantial by the standards of a developing country. Additionally, pump operation and maintenance practices can cause two-fold variations in fuel use for a given quantity of water pumped. Fuel cost shares in pumped irrigation are roughly similar to those for equipment operation.

Commercial fertilizer production is highly energy intensive, particularly the production of nitrogen fertilizers, which are in heavy demand in tropical regions. Transportation of both feedstocks and outputs are important considerations in the location of fertilizer plants. In Egypt, for instance, costs of transporting manufactured fertilizers to local distribution points amounts to 4.5 percent to 16.5 percent for locally produced fertilizers; in other words, energy use in transport can be significant relative to feedstock and production energy costs.

Farm modernization must be supported by a wide array of agricultural and rural infrastructural developments: agricultural research and extension, agricultural marketing, credit system, legal systems dealing with farm tenure and land use, rural electrification, and of course, transportation infrastructure. Some of these infrastructural elements deliver energy, some require energy to construct and operate, and some affect how dependably energy can be delivered. Quantifying fuel magnitudes associated with these elements is not possible with available data, but their interactions with rural energy delivery and utilization systems warrant careful attention.

Agriculture accounts for only between 50 percent and 75 percent of the rural labor forces of most developing countries, the remainder being devoted largely to rural manufacturing and services. Rural manufacturing accounts for 25 percent to 50 percent of rural nonfarm labor, with agricultural processing -- including textile and wood activities -- usually accounting for the major share of these. Nationally, agricultural processing may account for roughly half of all manufacturing employment, although rural-urban assignment of these shares is difficult. Some survey information is available on energy use in rural agricultural processing, but little extrapolation to the national scale is possible at this time. As one exception to this rule of thumb, survey evidence from Kenya for 1979 indicated that food processing accounted for 18 percent of

industrial electricity consumption and 20.5 percent of industrial fuel consumption -- or 13.2 percent of total electricity consumption and 18.7 percent of industrial and commercial fuel consumption. Textile production in Kenya in the same year consumed roughly half what the food processing industry did. No rural-urban disaggregations can be made of these consumption shares, however. As another exception, cassava chipping and pelletizing apparently used 4.1 percent of Thailand's industrial oil consumption in 1980, and cassava flour milling used an additional 1.61 percent.

In summary, the modernization of agriculture and related rural activities requires widespread introduction of modern energy into activities that previously used no fuel or only traditional fuels, as well as the introduction of entirely new activities which use modern energy. As agriculture modernizes, the entire national economy modernizes, diminishing the relative shares of agriculture and agriculture-related activities in national income to levels which may cause agriculture's share of national energy consumption to appear trivially small. But such shares can be misleading. First, energy availability and/or costs can be relatively important in a number of agricultural activities. Second, the transition to more modern agricultural systems and and rural industries can require amounts of commercial energy that represent significant increases in demands from local energy systems; if the demands cannot be met, the transitions cannot occur. Additionally, while conversion to modern energy sources can substantially increase agricultural productivity, they also leave agriculture more vulnerable to system disruptions. The introduction of the new agricultural technology systems requires the simultaneous development of infrastructural support systems throughout the rural sector, without which the technical innovations will be ineffective. This puts further indirect claims on energy use associated with modernized agriculture.

**Urbanization[5]**

Urbanization is an unavoidable characteristic of development, and a one percentage point increase increase in urbanization is likely to be acompanied by as much as a half percent increase in energy consumption per capita, holding constant changes in income and industrial structure. Urbanization is

[5]Adapted from Donald W. Jones, "Utilization and Energy Use," Energy Division, ORNL, April 1985.

projected to continue at roughly double the pace of national population growth through the rest of the century in many African countries, and only slightly less rapidly in many South and East Asian countries.

Urbanization is an unavoidable aspect of economic development. Cities are centers of larger scale, modern manufacturing and serve as the foci for coordinating rural development, particularly modernizing agricultural production. The "natural" extent of urbanization varies among maturely developed countries from around 55 percent of the population to more than 90 percent. Between 20 percent and 40 percent of the populations of the developing countries live in cities, with the poorer, less developed countries falling in the lower part of that range. Clearly, this leaves considerable room for continued urbanization during the remainder of this century. The United Nations projects that the proportion of the world's population living in cities will increase from 38 percent in 1982 to 51 percent in 2000, with the greatest increases occurring in Africa and East and South Asia. U.N. projections for individual nations in 1990 had in fact already been exceeded by 1982 in four African and one Latin American country.

Development itself involves a process of transforming the energy supply and use systems of a society, and in the presently developed countries it has invariably raised energy use per capita dramatically (energy use per unit of output did not rise quite as much, apparently because of efficiency improvements). The social and economic transformations involved in urbanization contribute to this increase in energy use, as well as to a major shift from traditional biomass fuels such as firewood and charcoal to modern commercial energy sources such as fossil fuels and electricity. These changes associated with urbanization are attributable to several distinct but interrelated phenomena: industrialization and shifts within manufacturing toward metals, chemicals and modern construction materials; greater transportation requirements associated with larger scale, concentrated manufacturing and larger, food-consuming populations separated from agriculture; increases in population density and the increased prominence of mechanized personal transportation in cities; and the mechanization of agriculture.

Within this framework, we have found several salient energy implications of urbanization. First, the elasticity of energy consumption with respect to the level

of urbanization in a country is between 0.30 and 0.45 (holding GDP per capita, the percent of GDP coming from industry, and population density constant) for both energy consumption per capita and per dollar of GDP. The effect is stronger for "modern" (commercial) energy than for total energy (modern plus traditional energy). In other words, for a 10 percent increase in urbanization (e.g., from 40 percent to 44 percent), energy requirements will increase by 3-4.5 percent because of the energy use characteristics of urbanization alone.

Second, several characteristics of urbanization affect energy consumption. Increases in population density shift the mix of domestic fuels away from charcoal and firewood and toward kerosene. Evidence from Hong Kong (1971), holding per capita income constant, indicates that a 10 percent increase in urban population density will reduce the traditional share of domestic fuels by 2.5 percent. Additionally, food must be delivered to urban markets and often must be processed to survive the trip, whereas farm populations provide most of their own food with no transport expense and little fuel-using processing. Evidence from Nairobi suggests transportation energy expenditures in food delivery are 9 percent to 12 percent in addition to the total embodied energy in food. Evidence from Mexico City suggests that processing and transport together may claim as much as 47 percent to 58 percent of the energy embodied in food. Once large numbers of people have reached cities, a number of urban services became requirements for physical survival rather than mere luxuries. Urban public services provision adds from 3 percent to 6 percent to privately consumed energy in Nairobi and Mexico City. A final consumption change with major energy implications involves personal transportation. Little to no fuel-using transportation is used by rural populations on a regular basis, but urban populations routinely consume from 25 percent to 45 percent of their total energy in local transportation. Roughly half of this is for commuting to work. The percent of energy used in transportation is larger in larger and wealthier cities.

Third, urbanization is accompanied by industrialization, per capita income increases, and mechanization of agriculture -- all of which lead to increased energy consumption, particularly increased commercial energy consumption. Industrialization increases energy use per capita and per dollar of GDP. Within industry, urbanization and economic development shift industrial

composition toward metal products. Metals are particularly energy-intensive industries.

Fourth, mechanization of agriculture is required to support a largely urban population. Traditional agriculture uses almost no fuels -- generally no modern fuels at all. Mechanization requires modern fuels for machinery in order to produce more crops per agricultural worker. Irrigation and the use of commercial fertilizers are often required in order for mechanization to raise agricultural productivity. Commercial fertilizers require petroleum feedstocks, and pumped irrigation requires modern energy inputs. Although Indian agriculture is not highly mechanized, for instance, evidence suggests that fuel for the tractor-hours operated in 1972 may have been as much as 17 percent of the country's petroleum imports for that year.

Fifth, per capita incomes are higher in cities than in rural areas. Greater productivity in urban occupations than in rural, particularly agriculture, suggests that urban migration will continue to raise the average income of immigrants, even if not immediately. Higher incomes increase the consumption of all energy. Income elasticities of demand for energy have almost invariably been found to be greater than one. Higher incomes cause shifts from traditional fuels to modern ones in domestic energy consumption.

Shifts of workers from agriculture to industry also entail increases in production energy use per worker. Evidence from India suggests that shifting workers from agriculture to textiles, one of the least energy-intensive manufacturing industries, could bring forth as much as a four-fold increase in production energy requirements per worker. Furthermore, the concentration of markets with urbanization permits larger-scale manufacturing. Economies of scale in capital and labor are bought with greater transportation costs in assembling inputs and delivering outputs. Evidence from Turkish cement plants indicates transport costs per ton increase 16-fold while capital and labor costs fall 60 percent with an increase of market area from a 6-km radius to a 190-km radius.

Last, a shift from traditional to modern fuels is a major event in urbanization and economic development. Virtually all of the increase in fuel use associated with urbanization is directed toward commercial fuels.

Urbanization is projected to continue at a strong pace in developing countries through the remainder of the century. It brings with it many changes in energy use patterns which are individually large enough to be documented empirically and which, in total, amount to a sizable increase in commercial energy consumption per person and per unit of GDP.

## Energy Requirements of Development Projects[6]

Large development projects in developing countries often imply significant increases in energy supply requirements. For example, single, moderate-sized cement plants can use nearly 40 percent of the modern energy consumed in an entire, small developing nation, and a modest expansion of agricultural land with large-scale irrigation projects can use from 5 percent to 9 percent of national modern energy consumption. These figures refer only to operating energy not energy used in construction.

Most strategies for economic development include the introduction of major agricultural and industrial projects, often with the assistance of international donor organizations. For example, an industrial development strategy may include one or more new steel, chemical, or cement manufacturing plants; and an agricultural development strategy may include one or more large-scale irrigation or mechanization projects. Although these are not energy projects as such, they may have significant implications for the host nation's energy requirements.

The energy requirements of pumped irrigation and cement plants have been examined as examples of the operating energy requirements of large development projects. For this purpose, we calculated energy requirements to power hypothetical large-scale, pumped irrigation projects in the Sahel and other countries just south of the Sahara and energy requirements to operate actual, recently opened, or planned cement plants in five West African countries and Sudan.

Based on conservative assumptions about the nearness of the water table to the surface and the efficiency of operating pumping systems, using pumped irrigation to increase by 5 percent the arable land area of the

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[6]Adapted from Donald W. Jones and Garland Samuels, Jr., "Energy Requirements of Development Projects," Energy Division, ORNL, April 1985.

countries studied would require energy equivalent to 4.5 percent to 8.5 percent of 1980 energy imports or commercial energy consumption of four of the countries; Somalia and Chad would require 15 percent and 22 percent of their 1980 oil import or consumption levels -- partly because of relatively large, marginally arable land areas and partly because of low energy imports (commercial consumption). Table 4 shows these estimates.

The introduction of one or (at most) two moderate-sized cement plants into five West African countries and Sudan requires from 12 percent to 40 percent of those countries' 1980 national commercial energy consumption for their operation. These calculations assume high levels of maintenance and developed country standards of fuel-efficient operation; therefore, actual fuel requirements are likely to be higher. The countries studied have few or no domestic fuel supply options other than imports. Table 5 shows the impacts of these cement plants.

These calculations are generic in the sense that they do not take into explicit account all the relevant conditions surrounding irrigation or cement production in each country, but the errors thus introduced into the calculations generally bias the projected energy requirements downward, probably substantially. Although the calculations are in the nature of examples, they indicate that new development projects of only moderate size often put substantial demands on national energy supplies.[7] For example, the cement plants' requirements are likely to be representative of the energy usage of steel and chemical plants as well. The clear implication is that economic development will almost always require substantial additional energy inputs on a continuing basis.

[7]Examination of the possibility that use of 1980 as a reference year biases the results indicates that it is a satisfactorily representative year.

Table 4. Energy requirements to increase arable land by 5% through irrigation[a]

| Mauritania | Irrigation Energy Requirements as % of 1980 Imports[b] or 1980 Commercial Energy Consumption[c] |
|---|---|
| Chad | 22.60[c] |
| Mali | 8.13[c] |
| Mauritania | 4.52[c] |
| Niger | 8.50[c] |
| Somalia | 15.86[b] |
| Sudan | 4.88[b]<br>0.75[d] |

[a]Assumes 560mm per hectare per year water coverage and 13m lift

[b]1980 Imports

[c]1980 Commercial Energy Consumption

[d]Requirement to increase currently irrigated area by 5%

Table 5. Energy requirements to operate recently opened and planned cement plants

| | Energy Input Requirements As % of 1980 Commercial Energy Consumption | Project Description: Plant Size[a] |
|---|---|---|
| Benin | 33.5 | 500,000 tons/yr; near completion, 1982 |
| Niger[b] | 16.5 | 300,000 tons/yr; scheduled for 1983 |
| Sierra Leone[b] | 3.4 | 120,000 tons/yr; open 1982 |
| Sudan | 6.5 | a. 750 tons/day (250,000 tons/yr); scheduled for 1983<br>b. 500,000 tons/yr; under study |
| Togo[b] | 39.1 | 1,200,000 tons/yr; started in 1979 to supply Tgo, Ivory Coast & Ghana |
| Upper Volta | 12.3 from limestone<br>1.4 from clinker | 150,000 tons/yr; plant under study, may be from imported clinkers |

[a]From U.S. Bureau of Mines, Minerals Yearbook 1982, Vol. III, Area Reports: International (1984).

[b]World Bank "Group 4" Countries: No proven oil and gas reserves and unsustainable supplies of fuelwood.

## OTHER ENERGY ISSUES IN DEVELOPING COUNTRIES

### Oil and Gas Exploration and Development in Developing Countries[8]

High interest rates, political risks, risky geological formations, and in the early 1980s falling real oil prices have retarded oil and gas exploration and development in developing countries which are not already producers. For these non-oil producers, the path to exploration and production is likely to be difficult and slow in the foreseeable future.

The rapid rise in oil prices and supply shortfalls during the 1970s did not bring a concomitant increase in oil and gas exploration and development to the OIDCs. To be sure, total exploratory activity in the OIDCs, as measured by the number of seismic party-months and the number of exploratory wells drilled, did in fact increase in the 1970s, but relative to the rest of the world exploratory activity actually declined. The number of seismic party-months increased worldwide by about 20 percent; however, the percentage of the world total attributable to the OIDCs declined by about 50 percent. Further, the number of exploratory wells drilled increased worldwide by over 60 percent while the number of wells in OIDCs as a percentage of the world total fell by move than 15 percent. The increase in exploratory activity that occurred became more concentrated in the developed countries and in particular the United States and Canada. Moreover, in the OIDCs exploratory activity became more concentrated in petroleum producing countries, especially Argentina, Brazil, and India.

The consensus among many investigators is that exploration and development in OIDCs was inhibited by a combination of factors. First, the geologic prospects for oil and gas were not conducive to exploration. The high cost, small-sized fields that are characteristic of OIDCs limit profit potential, increase risk, and provide for limited prospects of the exportable surpluses necessary to supply downstream operations. Second, the lack of infrastructure in many non-petroleum producing OIDCs deterred oil and gas exploration. Third, restrictive contracts provided for an

[8]Adapted from Robert D. Perlack, "Oil and Gas Exploration and Development in OIDCs," Energy Division, ORNL, May 1985.

insufficient amount of risk-sharing to attract foreign capital. Fourth, host government taxation policies discriminated against high cost, small-sized fields. Fifth, political risk and government instability did not encourage foreign investment, considering the usual 10- to 15-year petroleum exploration and development period. Finally, U.S. taxation policies following the oil embargo were designed to encourage domestic exploration and development.

The 1980s have seen a substantial decline in real prices for petroleum, high interest rates, a developing country debt crisis, and a worldwide economic recession. As expected, these forces have reduced the cash flows of the international oil companies through lower revenues and higher costs of capital, and have caused them to seek higher risk-adjusted rates of return on exploration projects. Consequently, the international oil companies have reduced their exploratory and development activity in OIDCs. Further, the debt crisis now experienced by many oil-producing OIDCs has had an impact on the amount of exploration their own national oil companies can accommodate. The 1980's conditions are likely to cause an absolute decline in exploratory activity in OIDCs that are considered high risk and where the probability of finding oil and gas is low. In the oil producing OIDCs where large reserves have been discovered, the impact on exploratory incentives will be less severe. These trends are already evident in the recent exploratory and development data highlighted in Table 6. Reversal of these trends will require (1) a general improvement in economic conditions favorable to exploration and development and (2) removal of host government obstacles and more favorable contracting and taxation policies that are commensurate with risks. The activities of the World Bank may prove to be effective in stimulating exploration by national oil companies; however, to date they have not attracted private firm participation.

## Energy Conditions and LDC Indebtedness[9]

The OPEC oil price hikes of the 1970's contributed significantly to the debt crisis which many developing countries experienced in the 1981-1982 period. It has bee estimated that oil price increases since 1973 contributed

[9]Adapted from David A. Trumble and Lawrence J. Hill, "Energy Conditions and LDC Indebtedness," Energy Division, ORNL, forthcoming.

Table 6. Exploratory wells drilled in oil importing developing countries, 1978-1983

| Region | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|
| Africa, total | 38 | 38 | 24 | 35 | 46 | 14 |
| Oil producers (4 countries) | 32 | 31 | 19 | 32 | 30 | 12 |
| Nonproducers (12 countries) | 6 | 7 | 5 | 3 | 16 | 2 |
| North Africa & Mideast, total | 38 | 40 | 59 | 65 | 83 | 65 |
| Oil producers (3 countries) | 33 | 34 | 49 | 50 | 64 | 37 |
| Nonproducers (3 countries) | 5 | 6 | 10 | 15 | 19 | 28 |
| Asia, total | 100 | 108 | 71 | 94 | 74 | 58 |
| Oil producers (5 countries) | 98 | 108 | 71 | 85 | 72 | 56 |
| Nonproducers (4 countries) | 2 | 0 | 0 | 9 | 2 | 2 |
| Latin American, total | 243 | 275 | 335 | 541 | 590 | 472 |
| Oil producers (7 countries) | 233 | 270 | 334 | 537 | 582 | 471 |
| Nonproducers (7 countries) | 10 | 5 | 1 | 4 | 8 | 1 |

Source: AAPG Bulletin, Worldwide Report Issues.

Note: Only offshore wells drilled are reported for Bangladesh in 1978, Burma in 1978, and India in 1980 and 1981.

more than one-half of the foreign debt accumulated by developing countries since that time. The 1979 price hike forced many developing countries to finance oil import bills by borrowing, thereby eroding net investment and retarding the potential for future growth. Appropriately devised energy policies may offer effective options for reducing foreign debt problems in the future.

Over the course of the past decade, economic problems confronting developing countries have been exacerbated by at least three inter-related factors. First, the typical developing country relies to a large extent on the export of a few primary products to generate foreign exchange for financing imports. The international recession of the early 1980's precipitated a marked decline in the demand for those primary commodities with a concomitant decrease in foreign exchange earnings. Second, the precipitous increase in the cost of oil has had a deleterious impact on the balance of payments of developing countries. Third, there has been a significant increase in the cost of external financing attributable to increases in interest rates internationally.

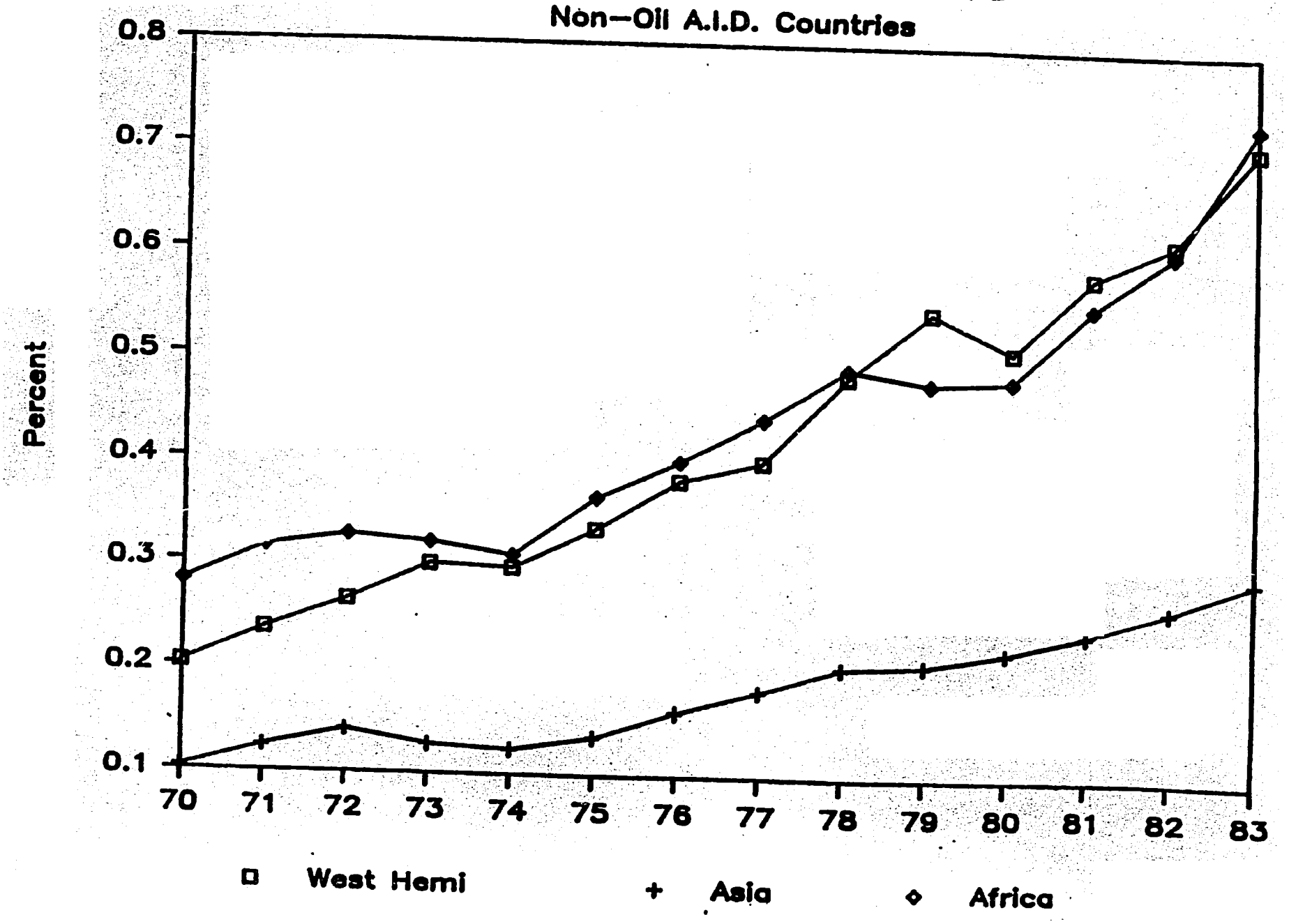
Together, these interrelated international developments have led to a serious current account financing problem for developing countries. These events have blurred the historical distinction between balance of payments financing and development financing. The former involves short run funding of current account liquidity problems, while the latter encompasses longer run capital development funding. In a world characterized by (1) pressing short-term liquidity problems, (2) an immediate need to finance vital imports, and (3) the imposition of debt ceilings, what previously were developmental loans are often used now to ameliorate short-run balance of payments financing problems.

These circumstances confronting developing countries have led to a dramatic increase in their debt exposure over the past decade. Figure 2 displays the ratio of external debt to GDP for net oil-importing AID-supported countries in Asia, Africa, and the Western Hemisphere. As the figure depicts, the debt problem has been most acute in Africa and the Western Hemisphere, with external debt increasing from less than 30 percent in 1970 to more than 70 percent in 1983. Although data problems preclude a precise determination of the contribution of the oil price shocks to debt exposure of developing countries, one experienced observer has estimated that more than one-half of the increase in nominal debt for

Figure 2

# Debt to GDP Ratio

## Non—Oil A.I.D. Countries



non-oil producing developing countries between 1973 and 1982 was attributable to the real oil price increases over the period.[10]

One of the primary consequences of the increase in external debt over this period -- which, as discussed above, is attributable in large measure to oil price increases -- has been a decline in real net investment in developing countries. Here again, the problem is particularly acute in Africa. Figure 3 indicates total investment in net oil-importing AID-supported African countries over the 1970-1983 period.[11] Nominal investment, deflated by the U.S. wholesale price index, as opposed to that deflated by a measure of purchasing power parity, declined from more than $11 billion in 1978 -- just preceding the second oil shock of the 1970's -- to a little more than $5 billion in 1983. Lower levels of investment, as development financing has been crowded out in large measure by the oil price hikes of the 1970's, have a debilitating impact on prospects for future economic output in developing countries.

Appropriately devised energy policies can help ameliorate the external debt problems facing developing countries. Such policies may include -- but are not limited to -- direct energy conservation and efficiency improvement programs, emphasizing the industrial sector; rationalization of domestic energy subsidies, particularly with respect to exporting industries and higher-income consumers; and the development of indigenous energy resources where they make sense economically.

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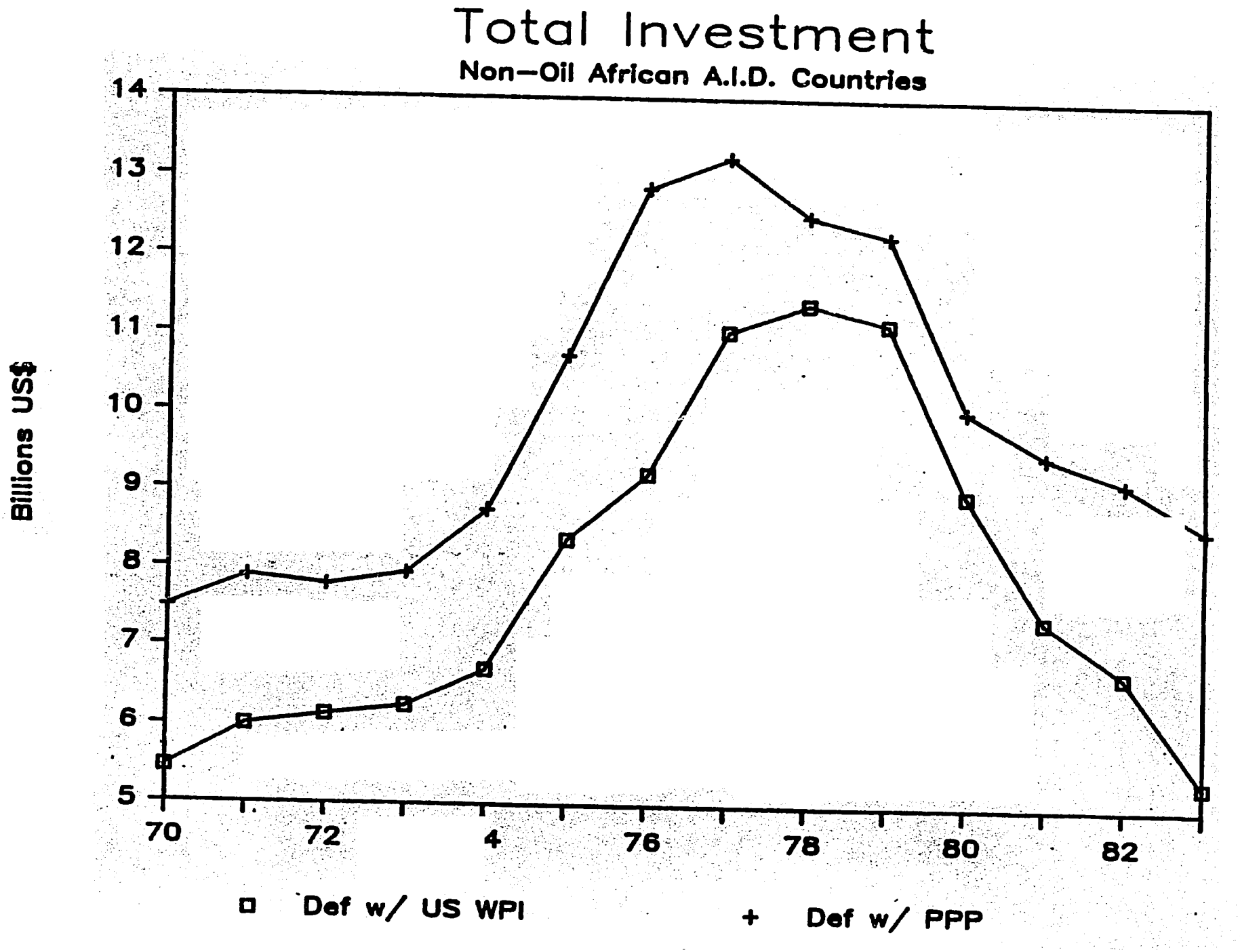
[10] William R. Cline, International Debt: Systemic Risk and Policy Response, Washington, D.C.: Institute for International Economics, 1984, Table 1.4, p. 13.

[11] Investment is measured as gross capital formation.

Figure 3


Total Investment
Non—Oil African A.I.D. Countries
Billions US$
14
13
12
11
10
9
8
7
6
5
70
72
4
76
78
80
82
Def w/ US WPI
Def w/ PPP

## CONCLUSIONS

Energy is important for the economic and social development of AID-assisted countries because it is one of the fundamental "building-block commodities" of the quality of life -- like food, materials, and information. From these building blocks are constructed such features of a desirable standard of living as personal productivity, convenience, comfort, and mobility. Generally, these commodities are means to what society wants rather than ends in themselves. They function mainly as facilitators: enablers of activities and accomplishments that people value. This supportive role, realized largely in combination with other factors, sometimes makes it difficult to prove direct and unambiguous relationships between energy conditions and economic development.

But it is a simple fact, amply demonstrated by empirical evidence, that economic and social development in AID-assisted countries will not occur without rising levels of modern energy services: combinations of non-traditional energy supplies and their equivalents in improved efficiencies in energy distribution and use. As a general rule of thumb, recent historical evidence indicates that each percentage-point of growth in GDP per capita requires a 1.3 to 2 percent increase in commercial energy supplies. But this is seldom a smooth proportional requirement. As a country makes the transition from traditional activities, technologies, and resources to the modern ones which generate higher average personal incomes -- even with national population growth -- it confronts a continuing series of situations where energy needs must be met if development is to proceed: energy for pumped-water irrigation for agricultural development, energy for moving industrial and urban development to new levels, energy options for reducing trade imbalances and national indebtedness, etc. If these needs are not met, some parts of the development engine grind to a halt.

For these reasons, if energy is not considered as an integral part of development planning for AID-assisted countries -- particularly as it addresses agricultural and industrial development needs in these countries -- the prospects for real progress in economic and social development are put at risk. By contrast, building energy planning into general development planning can facilitate progress and, in many cases, identify energy-oriented

development opportunities. Energy is not necessarily important for its own sake, and it can seldom bring about progress by itself; but energy is one of the essential ingredients in the development process.

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**AID OFFICE OF ENERGY**
Energy for Development Paper No. 2

## ENERGY AND POLICY REFORM

### INTRODUCTION

The efficient allocation of energy resources and the development of the energy sector are necessary conditions to economic development. But, energy markets which do not function properly stifle private sector initiative and actually serve to choke off development.

The purpose of this paper is to look at some of the energy policy reforms which might be promoted in developing countries and to define a strategy in this area for the Agency for International Development (AID) and for the Office of Energy (the Office). First, we will examine some of the typical barriers which have impeded (and continue to impede in many cases) economic development in AID-assisted countries. We then discuss the rationale for AID's and the Office's involvement in this area and some of the initiatives which have already been taken. Finally, we present a specific plan of action the Office is carrying out to foster better functioning energy markets and the development of the private sector in this critical sector.

### NEED FOR POLICY REFORM IN THE ENERGY SECTOR

Despite the decrease in oil prices in dollar terms, the energy bill of developing countries increased substantially during the last few years, worsening their already serious foreign exchange problems. For example, Bangladesh spent 65 percent of its export revenues on oil imports in 1981, India 70 percent, Pakistan 45 percent, and Panama 88 percent.[1] In the coming years, commercial energy consumption in AID-assisted countries will, in all likelihood, grow faster than

[1] In 1981, among 20 AID-assisted countries for which information was available, oil imports represented an unweighted average of 39 percent of export earnings. Source: Office of Energy, Strategy and Program Plan for Energy Conservation FY86 and FY87; October 1985.

their economies.[2] Factors such as population growth, rural to urban population shifts, and inadequate fuelwood supply accelerate the use of commercial energy. It is expected that by the year 2000 developing countries will more than double their current commercial energy consumption levels. Thus, these countries must implement the most effective policies to develop indigenous energy resources and increase energy productivity.

nfortunately, numerous policy barriers impede the efficient llocation of resources in the energy sectors and onsequently the economic development of AID-assisted ountries. The most common examples of policy barriers hich are briefly illustrated below, are:

- Aggregate petroleum products subsidization
- Electricity pricing policies that differ significantly from marginal cost
- Laws that restrict drilling access of foreign operators
- Tax systems that inhibit investments
- Presence of government monopolies that stifle the role of private enterprise.

In Egypt, domestic energy consumption is rising by 11-12 percent a year, and oil products constitute an artificially large proportion because their prices on the domestic market are only about 20 percent of prevailing world prices. Egypt consumed 46.5 percent of the oil it produced in the 1983-84 period, up from 42.5 percent in 1982-83. Although Egypt is an extreme example of price subsidization, most other countries also generally provide some form of subsidy, the most common being gasoline prices cross-subsidizing diesel or kerosene prices.

The fact that electricity pricing policies often often do not reflect marginal costs further distorts energy supply and demand patterns. It also jeopardizes the financial viability of utilities. In 1982, for example, a tariff study for Burma's Electric Power Company (EPC) showed that the

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2 The income coefficient for commercial fuel consumption is 1.3 in AID-assisted countries -- a 1 percent rise in income results in a 1.3 percent rise in fuel consumption. Source: Analysis of Energy Prospects and Problems in Developing Countries, Joy Dunkerley, William Ramsey; Resources for the Future, 1983.

rates charged were substantially below the marginal costs of supply. This situation resulted in 1981 in insufficient internal cash flow to cover debt service. EPC is now making adjustments to its rates in order to reflect the long-term marginal cost (the average rate will be increased by more than 60 percent over the 1982-1986 period) and improve its rate of return from a low of 4.2 percent in 1981 to 9 percent in 1986.[3]

Developing countries most commonly allocate acreage for oil and gas exploration on an arbitrary political as opposed to competitive basis. For example,in India, until recently, the most attractive acreage for oil and gas exploration was reserved to the national oil company. By reducing competition this policy has slowed down the development of India's energy resources.

Tax systems can also be a disincentive for foreign operators in small to medium-sized oil and gas reservoirs. For example, in Tunisia, small to medium-sized discoveries have not been developed because of poor rates of return caused by a "blind" tax system. This system is designed for a fixed government percentage take rather than a graduated take which would create an incentive to develop these small fields.

The wrong price signals can also be due to the existence of tariffs or other regulations. For example, import duties on equipment needed for energy conservation are often as high as 100 percent (or more) of the price of the equipment.

Monopolies and oligopolies in the energy sector have also resulted in price and incentive distortions and inequitable collection of economic rents in many countries. In Kenya, for example, the transport monopolies determine the price paid to woodfuel producers. These prices underestimate the real cost of collecting and replacing the wood. Therefore, it is financially impossible to make tree farming attractive and this market distortion causes a rapid depletion of woodfuel resources.

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[3] Source: "Energy Pricing Policy Framework and Experience in Developing Countries", Mohan Munasinghe, A Collection of Papers Commissioned for the Energy Pricing Policy Workshop, Bangkok, 8-11 May, 1984. See also Ramesh Bhatia's paper for the same workshop: "Energy Pricing in Developing Countries: Role of Prices in Investment Allocation and Consumer Choices".

Many other examples of policy barriers to the proper functicning of energy markets could be given. The conclusion, however, would remain the same: efficient allocation of resources in this sector, particularly scarce foreign exchange, will only happen if the proper price signals are given to energy suppliers and users alike and competitition for these resources is promoted. Table 1 shows how policy barriers affect the overall goals of the Office (1) to reduce economic instability caused by oil shortages, (2) to ensure availability of energy for sustained rural development, and (3) to foster private enterprise energy development and management.[4]

## NEED FOR AID INVOLVEMENT

Over the past four years, policy reform has emerged as one of AID's primary concerns to implement its development program. The recently completed first strategic plan for AID states that "long-term development depends heavily on the nature of domestic economic policies followed by developing countries " and that "the Agency must be concerned with the fundamental structures within which development occurs".[5] The only question therefore is whether energy is an appropriate sector for AID's commitment to policy reform.

AID will spend approximately $ 185 million in FY 1986 on energy projects. Even if these figures are small when compared with, for example, the World Bank's lending program in energy projects (expected to reach $ 3.8 billion in 1985), they are not negligible, and economic assistance in support of ill-conceived policies and projects would be a poor investment.

Energy is the foundation of self-sustained economic development and growth. Without an adequate supply of energy, economic development goals in other sectors such as agriculture, industry, transport cannot be met. The expected doubling of commercial energy consumption in LDCs by the year 2000, makes the formulation and execution of sound public policies, without delay, absolutely essential for development.

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[4] For full details on the Office's strategy and activities, see sections I-IV of the Office of Energy Program Plan Fiscal Years 1986-1988, Office of Energy; Bureau for Science and Technology; United States Agency for International Development; October 1985.

[5] Source: Blueprint for development. The strategic plan of the Agency for International Development, Agency for International Development, June 1985, page 4.

TABLE 1 : How general policy barriers affect the Office of Energy's goals

| Office Goals / Policy Barriers | Reduce economic instability caused by overdependence on imported oil | Ensure availability of energy for sustained rural development | Foster private enterprise energy development and management |
|---|---|---|---|
| Petroleum products subsidies and relative prices distortions | Cause faster depletion of reserves for producers Prevent transition to higher energy prices; Cause overuse of oil products | May help rural development but large budget cost; Hurt the potential of fuelwood as cash crop; Cause over-dieselization | Are a disincentive for fuel switching and conservation |
| Electricity pricing significantly different from marginal cost | Causes excessive use of electricity leading to higher imports of fossil fuels | Causes excessive use of electric vs. diesel pumping | Provides a disincentive for conservation; Prevents efficient allocation of energy resources |
| Inadequate legal, contractual and financial structures for the development of domestic energy resources | Result in sub-optimal development of indigenous resources leading to more energy imports | May impede decentralized energy development necessary for rural development | Impede private sector involvement; Discourage development of local industry and labor skill base |
| Tolerance of monopolies or oligopolies that distort prices and incentives | Causes inefficient use of capital by parastatals energy companies | Transport monopolies dictate returns to woodfuel producers and discourage tree farming and, therefore, reforestration | Impedes private sector involvement; Discourages development of local industry and labor skill base |
| Market price of woodfuel well below true economic costs | Non-replacement of woodfuel will result in higher pressure for imported energy in the future. | Prevents successful implementation of agro-forestry development projects | Prevents private rural enterprise in tree farming; Promotes excessive use of woodfuel by rural industry |
| Import duties on capital goods | Prevent replacement of inefficient oil using equipment with new energy efficient equipment | | Constrain conservation investments and development of local conservation industry |
| Constraints to the development of decentralized generation or cogeneration systems | Impede the development of indigenous resources for decentralized use; Encourage continued dependance on oil for decentralized power | Prevent decentralized power generation and distribution for rural enterprises and population | Prevent the private sector from investing in financially and economically viable infrastructures |

Although AID's leverage to promote policy reform in the energy sector may be limited as compared to the leverage the international lending institutions have, AID's unique expertise and flexibility in policy studies and research work can play a key role. This role is welcomed by the lending institutions which, generally, are tied to a narrower, loan-oriented approach.

All these arguments justify AID's involvement. Cooperation with other organizations (e.g., the World Bank, the Asian Development Bank, the International Monetary Fund, other multilateral development banks or bilateral institutions) offers an opportunity to leverage AID's efforts and avoids counterproductive and duplicative efforts.

## CURRENT ACTIVITIES OF THE OFFICE IN ENERGY POLICY

The Office of Energy has a long and varied experience in energy projects, and has developed a critical mass of expertise necessary to handle the problems of this intricate sector of developing countries. This expertise and existing relationships with policy research groups in institutions such as the World Bank make it the natural candidate to provide much needed leadership for AID in this critical sector. Policy reform is already part of the Office's activity. Many activities have been or are currently funded by the Office often in collaboration with the missions.

The Energy Policy Development and Conservation Project (EPDAC) serves as the umbrella project for the Office's policy related activities. EPDAC supports sectoral energy analyses in selected countries and short-term technical assistance in energy planning and policy development. EPDAC also addresses research problems in such areas as the effects of energy prices and supply on economic development and the linkages between energy and agricultural productivity.

As part of the EPDAC project each year the Office has been funding a number of policy research studies. The topics which have been studied thus far include (1) energy conditions and the development of key sectors of developing countries' economies, (2) energy policy and planning issues in developing countries, and (3) institution-building to meet energy needs in developing countries. Tables 2 and 3

TABLE 2 : Research Topics in Policy Development
Funded by the Office of Energy during FY 83

| INSTITUTION | PRINCIPAL INVESTIGATOR | TITLE OF STUDY | COUNTRIES |
|---|---|---|---|
| Massachussets Institute of Technology | C. Blitzer<br>R. Eckaus | Analyzing Energy-Economy Interactions: The Case of Small Oil-Importing Developing Countries | Sri Lanka |
| Arthur D. Little | P. Teagan | Barriers to Expanding Irrigated Agriculture in Sub-Saharan Africa Imposed by Pumping Cost | Senegal |
| Individual | M. Milukas | Energy Flow in an Intermediate Sized City: A Case Study of Nakuru, Kenya | Kenya |
| State University of New York (Stony Brook) | P. Meier | The Effect of Changing World Energy Prices on the Rate of Economic Growth in Developing Countries | Sri Lanka |
| Resources for the Future | J. Dunkerley | The Transition to Commercial Fuels in the Household and Commercial Sectors in Two Indian Cities | India |
| QED Research | J. Plumer | Analysis of U.S.-Indian Joint-Ventures for Transfer of Energy Technologies from the U.S. to India | India |
| Washington State University | W. Butcher | Impacts of Rural Energy Costs and Availabilities in Kenya | Kenya |

TABLE 3 : Research Topics in Policy Development
Funded by the Office of Energy during FY 84

| INSTITUTION | PRINCIPAL INVESTIGATOR | TITLE OF STUDY | COUNTRIES |
|---|---|---|---|
| Individual | E. Krapels | Oil Pricing Policies in Developing Countries: Case Studies | Sudan<br>Ecuador<br>South Korea<br>Brazil<br>Argentina<br>Thailand |
| Energy & Environmental Analysis | R. Dulla | Evaluation of the Effectiveness of Fuel and Motor Vehicle Tax-Related Policies Influencing Road Transport Consumption in Developing Countries | |
| Resources for the Future | J. Dunkerley | Transport Energy: Determinants and Policy | |
| Brookhaven National Laboratory | V. Mubavi | Economic and Policy Implications of Expanding Renewable Energy Technologies in Developing Countries | India<br>Thailand<br>Kenya<br>Upper Volta |
| Energy/Development International | B. Ross | Economics and Organizational Aspects of Private Tree Farming to Increase Fuelwood Production | Various |
| Harvard University | P. Rogers | Assessment of Benefits and Costs of Rural Electrification: The Case of Costa Rica | Costa Rica |
| International Development & Energy Associates | R. Chatterjee | Energy Use in Agriculture in Developing Countries: A Systems Approach | Dominican Republic |
| Purdue University | W. Tyner | Analysis of Photovoltaics-Based Irrigation in the Nigerian Farming System | Niger |
| East-West Center | R. Morse | Participatory Evaluation of Fuelwood Program | India<br>Thailand |

list the research topics covered since the inception of the program in FY 1983.[6]

The EPDAC assistance in Morocco and Haiti are two good examples of country specific activities:

- In Morocco, the Mission funded Energy Planning Project follows a centrally funded Office effort to directly assist the Ministry of Energy and Mines to better assess its investments, initiate and monitor conservation measures, and establish more rationale energy planning. A planning model, ENVEST, has been developed under this program to determine the best investment program.

- In Haiti, the assistance is aimed at developing local capabilities for energy planning and policy analysis. The main activities consist of institutional development, data gathering, establishment of current and projected energy balances through 1995. These energy balances provide the quantitative basis for planning and policy development.

## POLICY REFORM PROGRAM STRATEGY

The Office has formulated three interrelated goals: (1) to reduce economic instability caused by oil shortages; (2) to ensure availability of energy for sustained rural development; and (3) to foster private enterprise energy development and management. Policy reform cuts across these three goals as already shown on Table 1. Without the proper policy climate these goals, will be jeopardized.

The Office recognizes, however, that the financial and staff resources it can dedicate to this important area are limited. Consequently, the Office's strategy is to focus on specific policy targets and to work, whenever possible, in collaboration and close coordination with other institutions, particularly the World Bank and the Asian Development Bank.

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[6] The FY 1985 research program is currently being implemented with the assistance of the Oak Ridge National Laboratory.

## Areas for Policy Reform

The Office has identified three major areas for its policy-related activities:

- Integrated energy analysis and assessment
- Pricing policy distortions and inequities
- Barriers to greater private sector participation.

The selection of these three areas for the Office's focus is based on a review of the Office's activities to date and extensive discussions with the Missions, the regional bureaus, and the World Bank as well as other international development institutions.[7]

### Energy Analysis and Assessment

Because AID-assisted countries allocate up to 40 percent of their development budget to energy, assistance in analyzing energy needs and potential investment options is critically important. In most AID-assisted countries, however, effective energy analysis and assessment is hampered by an inadequate base of information and severe lack of trained and experienced personnel. The Office's challenge is to help rationalize energy decision-making by meeting three types of assistance needs. These are: (1) integrated national energy analysis as a basis for major investment decisions and policy dialogue, (2) integrated regional energy analysis, focused on regions of special interest such as rural areas with development potential, and (3) sectoral energy analysis, focused on alternatives for particular sectors, such as the electric power system.

### Energy Pricing

The benefits of properly functioning energy markets which do not distort supply and demand patterns are far reaching.

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7 In particular the AID Asia energy officers' meeting held in Manila in April 1985, and the one-day workshop on energy and policy reform held in Washington on June 7, 1985. This workshop brought together a number of leading experts from the World Bank, the Inter-American Development Bank, the United Nations, and private organizations.

Efficient energy pricing promotes the efficient allocation of resources and, with it, the viability and autonomy of the energy sector. It also fosters the efficient use of energy and stimulates energy conservation. Yet, as discussed above, energy prices in most AID-assisted countries reflect a history of widespread government intervention and subsidies. The challenge in energy pricing reform is to deal with the social and political problems underlying existing pricing policies. The difficulty resides in designing pricing policies that maximize equity and efficient allocation of resources at the same time.

Economic efficiency pricing is a good starting point, but numerous adjustments have to be made to achieve a realistic (i.e., socially and politically acceptable) pricing policy in a developing country. The Office's activities in this critical area of policy reform focus on (1) defining alternative means of moving toward more efficient pricing policies without totally ignoring equity objectives, particularly in the short-term and (2) developing appropriate analytical tools to evaluate these means.

## Barriers to Private Sector Participation

Studies have shown that countries having free markets which efficiently mobilize private savings and provide the private sector with access to capital are significantly better in stimulating real economic growth than countries having more restrictive capital markets in which the government, either directly or through parastatals, monopolizes or controls access to the available capital.[8] The energy sector, which is generally one of the larger sector of a developing country's economy, presents many opportunities to foster private enterprise in the supply, distribution and end-use management of energy. To capitalize on these opportunities and, at the same time, assist in the implementation of a major element of AID's development strategy, the Office has developed, and is implementing, a private sector program which cuts across its entire program.[9] Within its policy reform program, this third area of activities addresses non-planning and non-price barriers to private investments in the energy sector. These include, among many others:

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[8] Refer particularly to the work done by Keith Mardsen at the World Bank.

[9] For full details on the Office's private sector program, refer to the Office of Energy's Energy for Development Paper No. 3, Energy and the Private Sector, and Initiative Paper No. 3, "Barriers to Private Sector Participation in Energy Development".

excessive taxation, unreasonable restraints on private power generation, restrictive licensing, and restrictions on market access. Although the Office recognizes that all its projects have the potential for strong private-sector involvement, its policy reform initiatives focus on two areas which emerge as most important: (1) the development of decentralized power generation for both grid-connected and isolated applications, and (2) the development of small fossil fuel resources (oil, gas, and coal).

## POLICY PROGRAM IMPLEMENTATION

### Implementation Strategy

The specific activities the Office undertakes can be classified in two dimensions. One is the programmatic means to policy reform, of which there are five categories: (1) policy research, (2) methodology (tool) development and demonstration, (3) information dissemination, (4) training, and (5) technical assistance. The other dimension is the particular substantive policy problem that is the focus of the activity. As discussed above, the Office has selected three major areas for its policy-related activities: integrated energy analysis and assessment, pricing policy distortions and inequities, and barriers to greater private sector participation in the energy sector.

The Office's strategy to implement its policy reform program takes into account four basic factors. First, the program activities are "need driven" -- i.e., they support directly the needs of other areas of activities of the Office. For instance, policy reform activities in private electric power generation supports the Office's activities in energy for irrigation pumping, energy conservation and cogeneration, energy for rural industries, industrial and village-scale power systems as well as small utility-scale power systems.

Second, to the extent possible, the activities are conducted within specific country situations. In order to avoid dispersing the limited resources available, the Office will focus on a limited number of countries including Pakistan, Egypt, Bangladesh, Haiti and Tunisia. These countries will provide the framework for carrying out and integrating the activities in policy research, development and demonstration of specific policy tools, and in-country training. The experience gained will then be disseminated widely to other AID-assisted countries, AID Missions' staff, and international development assistance agencies. In cases where other AID-assisted countries and Missions wish to

undertake similar activities, the Office will provide technical assistance and training.

Third, from a program management view point, the majority of the activities fall within three Office "initiatives" which parallel closely the three major areas of policy reform activities for the Office i.e., energy analysis, energy pricing, and barriers to private sector involvement. Nevertheless, in addition to the activities carried out under these three policy reform oriented initiatives, the Office also conducts "applied" policy research under the other initiatives of its program plan. All these efforts are fully integrated in the Office's Program Plan for FY 86 - FY 88.

Finally, many of the activities will be undertaken with both formal and informal cooperation, and in some cases in collaboration with other international development agencies. This is particularly true for energy pricing studies which the Office plans to carry out in close collaboration with the World Bank.

**Selected Activities of the Policy Reform Program**

Some of the Office's specific activities in policy reform are summarized below.[10]

Major activities within the **Energy Analysis and Assessment Initiative** will include:

- National energy analyses in three countries selected in consultation with regional bureaus. Possible country applications for FY86: Pakistan, India, Haiti.

- One regional energy analysis project each year. Possible country application for FY86: Senegal.

- Plan for a power system policy project, focused on improving the technical quality of electric power system planning in AID-assisted countries and assessing the role of power systems rehabilitation (FY86).

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[10] For more details on the Office's policy reform initiatives, see Office of Energy Program Plan Fiscal Years 1986-1988, op. cit.

- Development of a model approach to providing national energy data to private sector parties in AID-assisted countries. Possible country application for FY86: Pakistan.

The **Energy Pricing Initiative** will include the following major activities:

- "Alternative paths" for energy pricing policy dialogue in LDCs, including assessment of specific approaches (e.g., energy conservation) to mitigate the impact of energy price increases. Possible country applications for FY86: Bangladesh, Egypt, Pakistan; for FY87: Jamaica, Kenya, India, Ecuador, Peru.

- Reports on state-of-the-art methodologies for analyzing alternative energy pricing policies, particularly second and third best pricing policies in specific country settings. Possible country applications for FY86: Bangladesh, Egypt, Pakistan; for FY87: Jamaica, Kenya, India.

- Case studies documenting pricing reform successes and failures in countries where extensive pricing studies have been completed. Possible country applications for FY86: Ecuador, Egypt, Indonesia, Pakistan, Philippines, Sudan, Thailand. - Define "alternative paths" for energy pricing policy dialogue in LDCs (FY 86 possible country applications: Bangladesh, Pakistan and Egypt).

The **Barriers to Private-Sector Participation in Energy Development Initiative** will be directed toward the following major accomplishments:

- One case study of the barriers to development of small oil and gas reserves, showing the development options and specific obstacles to local and U.S. private-sector participation. Possible country application for FY86: Tunisia, Pakistan.

- Model small oil and gas contracts. Possible country application for FY86: Tunisia, Pakistan.

- Analysis of laws, regulations, and practices governing private decentralized electric power generation, and comparison with those in the United States and other developed and developing countries. Possible country application for FY86: Pakistan, Philippines, Thailand, India, Bangladesh.

- Organization of two to four Technology Transfer Teams to promote US and AID-assisted country private sector investment in small power systems, and energy conservation in the industrial and power sectors (FY86).

A number of other policy related activities are carried out under other initiatives. For instance, the **Irrigation and Energy Planning in River Basin Development Initiative** explores a number of policy issues related to agricultural and energy planning. The **Energy for Irrigation Pumping Initiative** carries out research on issues pertaining to pricing of electricity and petroleum products and centralized versus dispersed systems for pumping. The **Energy Conservation Initiative** assesses institutional and policy barriers to energy conservation.

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**AID OFFICE OF ENERGY**
Energy for Development Paper No. 3

## ENERGY AND THE PRIVATE SECTOR

### INTRODUCTION

Energy has a critical role in a developing country's economy. Energy sector development is both a "means" and an "end" for promoting general economic development. It is a "means" because an adequate supply of energy at a reasonable cost is necessary for sustained economic growth; it is an "end" in itself because energy is generally one of the larger sectors of a country's economy and its development will result in significant improvements in the country's balance of payments, industrial productivity and general economic growth.

Another key factor in economic development which economists have focused on in recent years is the role of the private sector. Studies have shown that countries having free markets which efficiently mobilize private savings and provide the private sector with access to capital are significantly better in stimulating real economic growth than countries having more restrictive capital markets in which the government monopolizes or controls access to the available capital.[1] However, many developing countries continue to follow policies which restrain the private sector, particularly in energy supply, distribution, and end-use. These restraints distort the true costs of energy to the economy, resulting in an inefficient use of the country's already scarce resources.

Therefore the Agency for International Development's (AID) Office of Energy (the Office) has as a major goal the promotion of private enterprise energy development and management as one of the most effective means of ensuring an efficient allocation of energy resources. Specific objectives the Office has formulated to reach this goal include the encouragement of energy policy reforms which improve the functioning of energy markets; the upgrading of technical and managerial skills in the energy sector; and the stimulation of a flow of capital and technologies within the

[1] Marsden, Keith; "Private Enterprise Boosts Growth"; World Bank Report, 1985.

country and from the US which will increase productivity and employment in this sector.

To meet these objectives within its limited resources, the Office created a private sector development strategy as part of a comprehensive program planning exercise.[2] This strategy matches clearly defined energy needs with well-developed technology opportunities. Initially, the Office will focus on several low-risk "flagship" projects which will allow the Office to develop effective techniques to encourage more active private participation and which can be used as examples of the benefits a country can realize from such participation. To implement this strategy, the Office will identify countries with critical energy needs that already have an active private sector. Then, technology applications which can meet these needs in a cost-effective manner, which are technically proven and which the local and US private sectors can develop will be identified. Next, the projects will be implemented by private sector firms with the encouragement and technical support of the Office (but with minimal AID financial assistance). Finally the benefits resulting from the project will be assessed and the lessons learned will be summarized for the benefit of other countries considering a more active role for their own private sector in energy.

The remainder of this paper first summarizes barriers to the private sector involvement in the energy sector of developing countries and discusses the rationale and need for AID's involvement. It then describes the strategy the Office will use to develop its private sector programs, and finally presents a detailed action plan for implementing this strategy.

## NEED FOR AID INVOLVEMENT

The commercial energy sector (electric power, natural gas and petroleum products) is generally one of the largest sectors of a developing country's economy, and often is the largest single user of foreign exchange. A survey of 24 AID-assisted

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[2] This program plan is described in more detail in Office of Energy Program Plan Fiscal Years 1986-1988; Office of Energy, Bureau for Science and Technology; United States Agency for International Development; October, 1985.

countries[3] showed that three-fourths rely on oil imports for over half of their commercial energy requirements. In 1980, 22 AID-assisted countries for which reliable data is available spent on average over 40 percent of foreign exchange earnings on oil imports (with a maximum of 88 percent), 25 spent between 20 percent and 40 percent, and only 10 spent less than 20 percent.

The importance of commercial energy sources will continue to increase in the developing countries as industries develop, as populations grow, as urbanization continues and as supplies of traditional fuels such as firewood and charcoal are depleted.[4] Table 1 illustrates that fact for five of the fastest growing AID-assisted countries. These countries, which had an average annual GDP growth rate of 4.2 percent per year, had a substantially greater average growth rates for commercial energy use of 6.0 percent per year. Energy availability and its efficient use are therefore essential to broad-based and sustainable economic growth.

Meeting this increasing commercial energy demand will require flexibility and innovation on the part of developing economies. Three problems these economies have in responding to international energy markets are discussed below.

**Energy Sector Structural Constraints**

Because of the importance of the energy sector many governments are unwilling to forgo direct control and therefore create parastatals such as national oil companies or national electric and gas utilities which monopolize their respective sectors. In many cases prices are regulated and can be significantly distorted in pursuit of government social and political objectives. Once instituted such subsidies are difficult to remove: Egypt, Morocco, Ecuador, and Jamaica all experienced serious riots when energy subsidies were removed and prices jumped. Government

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[3] Office of Energy, Strategy and Program Plan for Energy Conservation FY86 and FY87; October, 1985.

[4] A study of the income coefficient of commercial fuel consumption indicates a 1 percent rise in income results in a 1.3 percent rise in fuel consumption. Sources: Analysis of Energy Prospects and Problems in Developing Countries; Dunkerley, Joy and Ramsey, William; 1983; The Energy Transition in Developing Countries; World Bank; 1983

TABLE 1. COMPARISON OF COMMERCIAL ENERGY GROWTH AND GDP GROWTH FOR FIVE AID-ASSISTED COUNTRIES

| COUNTRY | ANNUAL PER CAPITA GDP GROWTH RATE (%) | ANNUAL COMMERCIAL PER CAPITA ENERGY GROWTH RATE (%) |
|---|---|---|
| EGYPT | 4.6 | 8.3 |
| THAILAND | 4.3 | 5.3 |
| INDONESIA | 4.2 | 7.6 |
| SRI LANKA | 4.1 | 3.5 |
| PAKISTAN | 3.6 | 5.6 |
| AVERAGE (unweighted) | 4.2 | 6.0 |

Note: - Per Capita GDP Growth Rates are for 1977-1983
- Per Capita Commercial Energy Growth Rates are for 1975-1982

Sources:

<u>International Financial Statistics Yearbook 1984</u>; International Monetary Fund; January, 1985

<u>Yearbook of World Energy Statistics</u>; United Nations; New York; 1983

<u>Energy Balances of Developing Countries</u>; International Energy Agency; 1984

involvement also leads to economic misallocations since large government energy firms will get first access to capital and foreign exchange, often at rates well below "market" rates. This squeezes out smaller firms both within and outside the energy sector which could make more efficient use of the funds, thus slowing overall economic development. Government subsidies and policy preferences often have impacts exactly opposite to those intended by government planners. For example, a World Bank study[5] indicated that interest rate ceilings which are often instituted to ensure access to capital at reasonable rates for smaller firms in fact shrink the supply of capital to these firms which are perceived as riskier by the lenders and, because of the small size of the loan, unprofitable as well.

**Political and Institutional Constraints**

A wide variety of political and institutional constraints hamper the operations of energy markets in developing countries. Some countries are reluctant to enter into partnership with foreigners for development of energy resources because of lingering sensitivities about colonialism. Thus, the resources (e.g. oil and gas) remain inaccessible because the country may have neither the capital nor technical knowhow to explore for and exploit them. In countries following Islamic law, subterranean resources are considered to belong to the government and permits to develop them are given only to citizens, making investments by foreigners with the needed capital and technology difficult. Many AID-assisted countries have restrictions on repatriation of profits to foreigners, resulting in little interest on the part of foreign firms in investing significant capital or transferring important technology.

**Managerial, Informational and Technical Constraints.**

Trained personnel are in short supply in most developing countries, particularly in the energy field. The Office projects evaluating energy conservation potential in the Philippines, Sri Lanka, Pakistan and other AID-assisted countries indicated few industrial sector engineers were knowledgeable about energy conservation technologies and practices. Workers were seldom trained to operate energy

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[5] Investing in Energy Efficiency and Conservation; G.J. Gaskin; World Bank Energy Department; April, 1985.

equipment efficiently. Managers and lenders did not know how to evaluate energy conservation investments. Finally, there was a lack of information on energy end-use applications and on the costs and performances of available energy technologies.

The negative impact of these barriers on economic growth is clear in light of recent studies indicating that the private sector is a more efficient engine of growth than the public sector. A comparative study of seventeen developing countries showed that governments pursuing policies promoting private sector investments had much higher growth rates than countries pursuing policies promoting investments by the public sector.[6] The countries with active private sectors utilizing most of the domestic credit market had per capita GNP growth rates of 4.5 percent per annum, while those with public sectors utilizing most of the domestic credit market had much lower growth rates (less than 1 percent, or negative). The Office's own review of 53 AID-assisted countries reinforced this finding by showing that those countries with active private sectors (as indicated by the share of total domestic credit to the private sector) had significantly larger per capita GDP growth rates than those where the government used most of the credit. The 10 fastest growing countries where the private sector claimed an average of 80 percent of the domestic credit had an average growth rate of 7.5 percent; the 10 slowest growing countries where the private sector claimed less than half of the domestic credit had an average growth rate of -0.2 percent. (See Table 2.)

Within AID the Office of Energy is particularly well suited for leading efforts to enhance the role of the private sector in the energy field. Since its inception it has initiated many projects involving local government and private sector representatives, US private firms and consultants, and large international lending agencies. It thus has a first hand understanding of the constraints affecting the energy sector and actions necessary to overcome these constraints. In addition, the Office has developed relationships with many private sector energy firms both in the US and in developing countries, giving it a unique ability to broker joint ventures in energy technologies and services between US firms and prospective overseas partners.

Within AID the Office's focus on energy policy and pricing reform, "brokering" of joint ventures, and small to medium

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[6] Marsden, Keith; op cit.

TABLE 2. COMPARISON OF GDP GROWTH RATES AND PRIVATE SECTOR DOMESTIC CREDIT FOR AID-ASSISTED COUNTRIES

| TOP 10 COUNTRIES | | | BOTTOM 10 COUNTRIES | |
|---|---|---|---|---|
| COUNTRY | GDP GROWTH RATE (%) | PRIVATE/TOTAL DOMESTIC CREDIT | COUNTRY | GDP GROWTH RATE (%) |
| JORDAN | 9.3 | 0.71 | GAMBIA | -2.6 |
| EGYPT | 8.4 | 0.37 | CHAD | -2.6 |
| ECUADOR | 8.1 | 0.88 | UGANDA | -1.5 |
| INDONESIA | 7.7 | 1.13 | GHANA | -0.5 |
| CYPRUS | 7.3 | 0.62 | ZAIRE | -0.2 |
| THAILAND | 7.1 | 0.68 | MADAGASCAR | 0.2 |
| CAMEROON | 7.0 | 1.15 | ZAMBIA | 0.9 |
| TUNISIA | 7.0 | 0.88 | C.A.R. (*) | 1.4 |
| CONGO | 6.8 | 0.86 | BELIZE | 1.5 |
| LESOTHO | 6.6 | 0.47 | SWAZILAND | 1.6 |
| AVERAGE (unweighted) | 7.5 | 0.80 | AVERAGE (unweighted) | -0.2 |

* Central African Republic

Source: INTERNATIONAL FINANCIAL STATISTICS; International Monetary Fund; January, 1985. Growth rates were for the period 1977-1983 if available. Private and total domestic credit estimates were for the latest year available--usually 1983.

size businesses complements and reinforces the efforts of the Trade and Development Program (TDP) which focuses on a broad range of large projects which stimulate US export , and of the Bureau for Private Enterprise (PRE) which focuses on a broad range of projects stimulating local private sectors. In addition, the Office has worked closely with major international lending institutions such as the World Bank and can complement their important but narrow focus on providing large loans to these countries with its broader-based, flexible expertise in identifying cost effective energy opportunities. For example, in the Philippines the Office assisted the Mission in developing a project enabling the private sector to demonstrate and finance energy conservation investments. The Asian Development Bank is very interested in the possibility of using the organization which will handle these activities to provide loans for industrial energy conservation measures, which it finds difficult to fund directly since it is not structured to handle the large number of relatively small loans a comprehensive energy conservation program requires. In the coming months, the Office will assist the Mission in Egypt to develop a similar private sector oriented technology transfer program.

In addition, the Office's experience has indicated there is a serious lack of programs tailored to the needs of small- to medium- sized firms in the energy field. A program to develop the capabilities of these firms to provide energy services is important for two reasons. First, studies in the US and other countries indicate small- to medium-sized firms are rich sources of innovation, which will be necessary to provide the variety of goods and services needed. Second, small- to medium-sized firms alone can meet the needs of the large number of small opportunities which the energy market represents since governmental and lending organizations tend to focus on large projects. For example, an Asian Development Bank study[7] of industrial energy conservation opportunities in Thailand identified potential energy savings of over $200 million per year from an investment of $741 million. However, these investments would be spread over 45,000 factories, with average investments of $16,000 to $300,000. No organization either international or governmental is equipped to handle this large number of relatively small investments. It will require the development of an active private sector which can develop

[7] Industrial Energy Audits and Conservation Program for the Royal Government of Thailand; T.A. 507; August 1984; Asian Development Bank.

innovative financing and delivery techniques to meet energy demands and exploit energy conservation opportunities.

The Office and the Missions are currently sponsoring a variety of projects which are developing private sector capabilities to deliver energy goods and services. Examples of some of these projects are listed below.

- Development of local capabilities to deliver energy conservation services. The Office and the Mission in Sri Lanka sponsored a series of industrial energy conservation workshops which led to the establishment of a private engineering consulting firm to conduct energy audits and evaluate energy conservation opportunities. The Office is assisting two private sector companies in Ecuador conduct energy conservation audits and install energy conservation equipment. In the Philippines the Office and Mission are establishing a program to demonstrate energy conservation technologies and innovative private sector financing mechanisms.

- Access to foreign exchange. The Office is helping to set up a privately financed institution in Pakistan to give local companies loans and access to foreign exchange for purchase of energy goods and services.

- Access to US capital and technology. The Office is brokering a project between US firms and local entrepreneurs to develop fuel cane in Jamaica, and to develop coal-water mixtures for power generation in the Philippines.

- Privatization of parastatals. The Office is assisting the Sudanese government and local private firms in privatizing the government owned petroleum import and distribution firms.

- Domestic energy resource development. The Office is assisting the private financing of a coal mining and power generation project in Lakhra, Pakistan.

## PRIVATE SECTOR PROGRAM STRATEGY

One of the three goals of the Office[a] is to foster the development of an active private sector in the energy sector of the host government's economy. The strategy to reach this goal has three objectives:

- Promoting host government policy reforms which improve the functioning of local energy markets
- Developing and improving local private sector capabilities in energy development and management
- Promoting US private sector investments and flows of technical and financial resources.

To formulate these objectives and its overall strategy, the Office reviewed its previous and current work in this area, held discussions with experts both within and outside the Agency, and held a one day workshop on the AID Energy Program and the Private Sector. This workshop, which included representatives from the World Bank, US private industry, AID, and academia, discussed barriers to and successes of the Agency's goal of "privatizing" energy assistance programs.

As a result of these efforts, a three step process was developed to select initial areas to encourage private sector energy efforts:

- Step one: identify target countries
- Step two: identify target energy technologies
- Step three: select attractive projects

Questions for identifying attractive countries include:

- Does it have an active private sector generally?
- Is the host government sympathetic to enhancing the private sector's role in energy and is it willing to make necessary policy reforms?

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[a] The other two objectives are to (1) reduce economic instability caused by overdependence on imported oil and (2) ensure availability of energy for sustained rural development. See Office of Energy FY86-FY87 Program Plan, op cit.

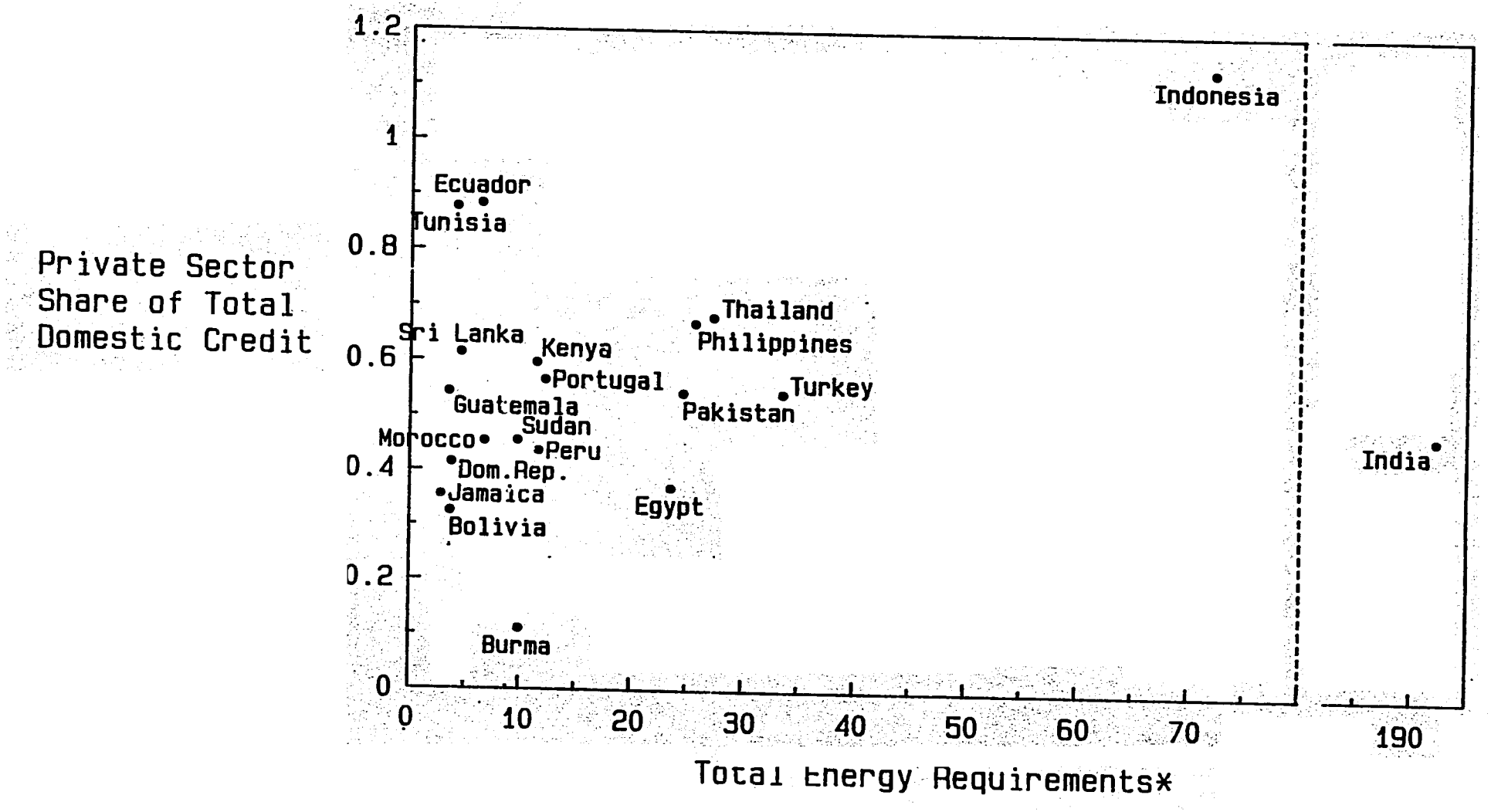
- Is its energy consumption large enough so that a successful project will have many replications within the country with significant additional energy savings or energy production?

Figure 1 summarizes potential private sector activity as indicated by the share of total domestic credit claimed by the private sector (which is a surrogate for estimating private sector activity and the governments sympathy to an active private sector) and the size of the country's total energy consumption (which is a surrogate for the replicability of successful energy projects). Using these criteria, the most attractive countries for the early phases of this project include India, Indonesia, Thailand, the Philippines, Pakistan, Turkey and possibly Egypt. Other counties have either low energy consumption thus limiting the potential for energy technology or service replication, or have relatively inactive private sectors thus requiring significant "missionary" work to gain the country's commitment to fostering a more active private sector. This does not rule out efforts in these other AID-assisted countries; however these will need to be evaluated on a case-by-case basis.

Questions to identify attractive target energy technologies include:

- Is the technology available now?
- Is the expertise required for manufacturing, marketing, installation and operation readily available or easily taught?
- Will this technology help realize other AID priorities (e.g. rural development)?
- Will the potential return-on-investment attract US or local private sector investments?
- Will a successful project be widely replicable, both within the target country and in other AID-assisted countries?

Figure 1. Potential Private Sector Energy Activity of Selected AID-Assisted Countries




*(000,000 Tons of Oil Equivalent)

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Table 3 summarizes these ratings for the energy technologies of interest to the Office. Attractive technology areas include energy conservation, industrial and commercial buildings cogeneration, smallscale fossil fuel development, biomass briquetting, decentralized small power production and fluidized bed coal combustion. Each technology area was rated against each criteria on a scale from 3 (very attractive) to 0 (very unattractive) and the ratings added to develop an overall rating.[9]

Based on the foregoing criteria, and on discussions with US and local private sector organizations and Missions, four general areas appear best suited to demonstrating the potential of an enhanced private energy sector. These are:

1. **Energy conservation products and services** (including cogeneration systems). Energy conservation is the single most important option for a developing country to reduce dependence on oil imports. A study by the World Bank indicated that 11 per cent of the energy used in the industrial sector of developing countries could be saved through simple measures having paybacks of 2 years or less.[10] The technologies are well understood and are highly developed in the US. Because the average investment is relatively small, they are particularly suitable for the local private sector with assistance from US firms. Reducing industrial energy demand will help other AID priorities such as rural development by freeing up foreign exchange and improving productivity. This effort will also demonstrate innovative private sector financing vehicles. For example, in countries following Islamic law investors cannot charge interest on loans, thus making financing difficult. However, shared savings and leasing plans are allowed and discussions with lenders in those countries indicate great interest in implementing such options for energy equipment. Successes in this area have a high probability of being replicated not only in the host country but also in many other AID-assisted countries.

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[9] More sophisticated rating schemes are possible, e.g. weighting each of the criteria differently. However, attempts to do this resulted in no significant changes in the relative attractiveness of the specific technology area.

[10] Industrial Energy Rationalization in Developing Countries (draft); spring 1985; World Bank.

TABLE 3. EVALUATION OF SPECIFIC TECHNOLOGY OPTIONS FOR ENHANCING THE PRIVATE SECTOR'S INVOLVEMENT IN ENERGY

| TECHNOLOGY | CRITERIA: IS THE TECHNOLOGY AVAILABLE NOW? | IS THE EXPERTISE READILY AVAILABLE? | WILL THIS ASSIST OTHER AID GOALS? | ARE US FIRMS INVOLVED? | ARE LOCAL FIRMS INTERESTED? | IS THE PROJECT WIDELY REPLICABLE? | OVERALL EVALUATION |
|---|---|---|---|---|---|---|---|
| COAL MINING & BENEFICIATION | 2 - 3 | 2 | 1 - 2 | 2 | 2 | 1 - 2 | 10 - 13 |
| FLUIDIZED BED COAL COMBUSTION | 2 - 3 | 2 | 1 - 2 | 3 | 2 - 3 | 2 | 12 - 15 |
| COAL-WATER MIXTURES | 1 - 2 | 1 - 2 | 1 - 2 | 3 | 1 - 2 | 1 - 2 | 8 - 13 |
| COAL BRIQUETTES | 2 - 3 | 2 - 3 | 2 | 1 - 2 | 2 | 1 - 2 | 10 - 14 |
| ENERGY CONSERVATION | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| INDUSTRIAL COGENERATION | 3 | 2 - 3 | 2 | 3 | 2 - 3 | 2 - 3 | 14 - 17 |
| NATURAL GAS USE | 2 - 3 | 2 - 3 | 1 - 2 | 2 | 1 | 1 | 9 - 12 |
| DENDROTHERMAL | 2 - 3 | 2 - 3 | 2 - 3 | 1 - 2 | 1 - 2 | 2 | 10 - 15 |
| FUEL CANE | 2 - 3 | 2 | 2 - 3 | 1 | 1 - 2 | 2 | 10 - 13 |
| RICE HUSK COMBUSTION | 2 - 3 | 2 | 2 - 3 | 1 | 1 - 2 | 2 | 10 - 13 |
| BIOMASS BRIQUETTES | 2 - 3 | 2 - 3 | 3 | 1 - 2 | 1 - 2 | 2 - 3 | 11 - 16 |
| BIOGASIFIERS | 2 - 3 | 2 | 2 | 1 | 1 | 2 | 10 - 11 |
| DECENT. SMALL PRIVATE POWER | 3 | 2 | 2 | 2 | 2 | 2 - 3 | 13 - 14 |
| SOLAR THERMAL & PHOTOVOLTAICS | 1 - 2 | 1 - 2 | 1 - 2 | 1 - 2 | 1 | 2 | 7 - 11 |
| COOKSTOVES | 3 | 3 | 3 | 0 | 1 | 2 | 12 |
| SMALL FOSSIL FUEL DEVELOPMENT | 3 | 2 | 2 | 3 | 2 | 2 | 14 |

SCORING: 3 - Very Attractive, High Interest, Very Favorable, Highly Developed, etc.
2 - Attractive, Good Interest, Favorable, Well-Developed, etc.
1 - Not Very Attractive, Little Interest, Not Very Favorable, Not Well Developed, etc.
0 - Unattractive, No Interest, Unfavorable, Not Developed, etc.

2. **Decentralized small power generating systems for both grid-connected and isolated applications.** Small power systems such as diesel, decentralized hydropower and wind offer cost effective ways to bring power to remote areas particularly if they are installed as part of an agricultural water project or rural industrial development effort. Again, the relatively small size of each investment, makes this area particularly suitable for local private investors. Successes would have a moderate to high probability of being replicated within the country and possibly also in other countries having similar energy resources and legal and regulatory environment.

3. **Development of small scale fossil fuel resources.** Many countries with small oil, gas and coal resources have difficulty exploring and developing these because of a lack of technology and capital and because of barriers raised by government policies on taxation and foreign development of domestic resources. US firms have significant expertise in this area and a project aimed at identifying mechanisms by which US and local firms can team up to exploit these small fossil energy deposits with transfers of technology and capital can benefit all parties involved. Successes would have a high probability of being replicated within the country and a medium probability of being replicated in other countries.

4. **Development of coal and biomass briquetting.** Briquetting of coal and biomass (particularly agricultural residues such as cereal, cotton, coffee, coconut, and copra) offers an alternative energy source for rural applications which can help alleviate deforestation and consequent fuelwood shortages. These briquettes offer convenient, relatively clean fuels which are easily transportable, generally usable in existing combustors, and require only readily available technology for their preparation. In addition, biomass briquettes offer the potential for "energy farming," i.e., growing crops such as sugar cane specifically for fuel such as briquettes. This can provide an alternative use for surplus cropland, provide a stable local energy source and replace some oil imports.

## PRIVATE SECTOR PROGRAM IMPLEMENTATION

### Implementation Strategy

The Office's private sector program will be implemented in two stages. The first stage will concentrate on technologies and countries where projects will have a very high probability of success. That is, where there is little or no technical risk and few barriers to private sector involvement. This will allow the Office to improve its skills in promoting the use of the private sector and will provide successful examples which can graphically demonstrate to host government policymakers the potential benefits an active private sector can bring about. Later, as the methods for enhancing the role of the private sector are refined, the Office can expand the scope of the program to include projects with technologies that are somewhat riskier to apply, and countries whose governments are not so encouraging to private sector involvement in the energy field.

### Program Management and Organization

In both the near term and long term the Office will rely on its Initiative Evaluation Committee, ad hoc advisory groups and Technology Transfer Teams to bring a private sector orientation to the selection and implementation of projects. The Office has instituted a formal yet simple evaluation process for new initiatives. A critical aspect of this evaluation is to ensure that, within the framework of its overall program plan, new projects incorporate local and US private sectors to the maximum extent possible.

The Initiative Evaluation Committee is assisted by ad hoc advisory groups consisting of four to six senior managers from private industry and representatives of private sector organizations (such as the Energy Advisory Committee of the Atlantic Council) who have extensive business experience in energy and in the Third World. These groups advise the Office on technologies and countries to be explored and suggest people to make up the Technology Transfer Teams.

The Office is sponsoring the creation of **Technology Transfer Teams** to implement "flagship" private-sector projects. These Teams are each composed of representatives of 6 to 12 private companies which have business interests in LDC energy markets. The Office will provide the Teams, once established, access to market and other relevant information

and "free" analytical and technical services. To be effective, each Team will focus on a limited set of technologies and applications. Each Team will develop a "business analysis agenda" which will be carried out by consultants to the Office and, whenever possible, by the members of the Team. These market and technical analyses will be used to identify and develop specific business and investment opportunities and, if need be, to recruit other US and local businessmen and lenders to implement the actual investments. In return for their participation in the Team's activities, the companies will receive "free" consulting services, unique market information, first hand contacts in the local and US business communities, and the possibility of influencing local laws and regulations to make investments more attractive. As the project's implementation is taken over by the private sector (in the US and host country) the Team's efforts will be reduced to monitoring the project, information dissemination, advice and possibly training for local technical and managerial personnel.

In FY86 two Teams will be formed to address opportunities in energy conservation and small power. As attractive opportunities are more clearly and narrowly defined, each Team may split to better focus on specific technologies (e.g., industrial diesel cogeneration), specific needs (e.g., small power generation for rural development) or specific countries (e.g., Pakistan). In FY87 at least two additional Teams will be formed depending on the results of the first year's efforts.

## Selected Activities of the Private Sector Program

The Office firmly believes that encouragement of local and US private sector involvement is a critical part of almost every project it undertakes. It is thus difficult to identify specific Office activities to encourage private sector participation without simply repeating all of its activities. However, some of the Office's Initiatives which are part of the Office's overall program plan[11] have more clearly identifiable activities emphasizing private sector development. These are summarized below.

[11] For more details on each Initiative, see Office of Energy Program Plan Fiscal Years 1986-1988, op cit.

The **Energy Analysis and Assessment Initiative** will develop a prototypical approach to providing national energy data to the private sector for use in evaluating energy markets and planning energy use. Possible country application for FY86: Pakistan.

The **Barriers to Private-Sector Participation in Energy Development Initiative** will, among other activities:

- Perform case studies of the barriers to development of small oil and gas reserves, showing the development options and specific obstacles to local and U.S. private-sector participation. Possible country applications for FY86: Tunisia, Pakistan.

- Develop a model for small oil and gas contracts that analyzes the options available, the expected output, and the cash flows to the developers and the government. Possible country applications for FY86: Tunisia, Pakistan.

- Develop a detailed program plan for Office activities for overcoming policy barriers to private-sector participation in energy development (FY86 target).

- Perform an analysis of developing country laws, regulations, and practices governing private decentralized electric power generation to identify barriers to cost-effective decentralized power projects that are privately financed, lessons learned from the experience of other countries, and specific recommendations for policy, legal, and regulatory changes in the countries of interest. Possible country applications for FY86: Pakistan, Philippines, Thailand, India, Bangladesh.

- Structure specific "pre-investment" proposals for development of small oil and gas reserves by local and U.S. private-sector firms. Possible country applications for FY86: Tunisia, Pakistan.

- Organize two to four Technology Transfer Teams to promote U.S. and AID-assisted country private sector investment in small power generation systems, and energy conservation in the industrial and power sector (FY86 target).

- Provide short courses for host country policy makers, AID Offices and AID Missions summarizing the lessons learned on making effective use of the private sector to implement cost-effective energy initiatives (FY86 target; refinements in FY87.

- Sponsor international workshops on private-sector development of small fossil energy resources and decentralized power systems (early FY87 target).

The **Energy Conservation Initiative** will:

- Create pilot demonstration projects using innovative private-sector financing mechanisms. Possible country applications for FY86: Latin America and Caribbean region, India, Pakistan, Philippines, Thailand.

- Organize Technology Transfer Teams for energy conservation, including cogeneration. Possible country applications for FY86: Pakistan, Egypt, Latin America/Caribbean region; for FY 87: Thailand, India, Indonesia.

The **Coal Development and Use Initiative** will investigate local private-sector opportunities in coal development and use and disseminate resulting information to other AID-assisted countries. Possible country applications for FY86 and FY87: Pakistan, Indonesia.

The **Natural Gas Development and Use Initiative** will develop a model program for private-sector participation in gas exploration and development projects. Possible country applications for FY86: Pakistan, Tunisia.

The **Household Fuels and Fuelwood Initiative** will:

- Perform feasibility studies and market assessments for briquetting, including the development of a relaible feasibility study methodology. Possible country applications for FY86: Haiti, Pakistan, Sudan, Niger; for FY87: Botswana, Zambia, Indonesia, Peru, Morocco.

- Conduct feasibility studies of agricultural residue briquetting in four countries (FY87 target).

The **Industrial and Village Scale Power Systems Initiative** will:

- Structure pre-investment packages for several decentralized power systems, including small hydro and solid biomass-fueled projects (e.g., rice husks, wood wastes). Possible country applications for FY86: Madagascar, Costa Rica, Egypt, Pakistan.

- Conduct a well-focused R&D program in conjunction with U.S. private sector firms to develop better technology options enabling AID-assisted countries to convert solid fuels (e.g., wood, agricultural residues) into shaft power on a small scale (FY87 target).

The **Small Utility-Scale Power Systems Initiative** will:

- Organize a Technology Transfer Team for small power systems and visit two countries per year. Possible country application for FY86: Pakistan; for FY87: India.

- Complete prefeasibility studies for two or three projects, including one or two projects based on conventional fossil fuels (e.g., combined cycle electric power generation using natural gas) and one or two projects using solid biomass (e.g., bagasse from sugar cane) as a fuel, which will be used to attract private investment and implementation of the projects. Possible country applications for FY86: Egypt, Pakistan, Jamaica; for FY87: India, Latin America/Caribbean region.

AID OFFICE OF ENERGY
Initiative Paper No. 1
Priority Area: Energy Policy and Analysis

# STRATEGY FOR ENERGY ANALYSIS AND ASSESSMENT

## INTRODUCTION

A prerequisite for sound energy decisions is dependable information about the options being considered, the alternatives to them, and the conditions they address. Few kinds of assistance programs in energy have as much cross-cutting value as those that help a country improve its base of energy information and its capabilities for analyzing this information to arrive at courses of action that are economically, technologically, and environmentally sensible as well as politically desirable. With AID-assisted countries allocating up to 40 percent of their development budgets to energy, assistance in analyzing energy needs and potential investments is critical.

This paper discusses the need for three types of energy analysis and assessment:

- Integrated national energy analysis: comprehensive attention to alternative paths for a nation's energy future, integrated with (a) other sectors of the national economy, (b) government policy-making, and (c) private-sector decision-making

- Integrated regional energy analysis: similar attention to regions of special interest, such as rural areas with development potential

- Sectoral energy analysis: more specific attention to alternatives for particular sectors of the energy economy, such as the electric power system.

This paper also describes the strategy proposed to carry out this initiative, and lists the target accomplishments.

## RATIONALE

Reliable energy information and analysis are necessary to reduce foreign exchange problems caused by imported oil, foster private enterprise in the energy field, and sustain

agriculture and rural development. Without effective analysis and assessment, promising options are likely to be overlooked, and dubious options may be overvalued. As a result, scarce fiscal and human resources are wasted, and confidence in associated institutions is lost. In many cases, if good analysis and documentation are lacking, a developing country will look in vain for development financing from multilateral or bilateral donor agencies or the private sector.

In most AID-assisted countries, however, energy analysis and assessment constitute a fragmented and flawed activity. The countries are hampered by an inadequate base of information about energy conditions and options, and are limited by a severe lack of training and experience among indigenous institutions, both public and private. Furthermore, both information and analytical capabilities are scattered among a variety of organizations with particular interests and agendas -- government ministries, parastatal firms, private firms, and donor agencies offering advice. Analysis and assessment are usually characterized by a dependence on external consultants who come and go and by the use of analytical tools as "black boxes" by local staff who do not fully understand them.

Another problem is that analysis and assessment are usually connected only tangentially, if at all, with the process of making important investment decisions. Generally, organizations develop proposals for action as extensions of their own agendas and compete to get their ideas accepted through the use of political influence. Not only are these ideas not subjected to careful analysis, but relevant information is often suppressed as a political strategy. Consequently, the ideas advanced by large public agencies, with their carefully nurtured political influence and large staffs to prepare documentation, have a comparative advantage over proposals based more firmly on economic and technological facts that appeal to the private sector.

AID's challenge is to help rationalize energy decision-making by meeting four needs:

- Improving the information on energy conditions, needs, and options to provide a common base of facts for evaluating energy alternatives

- Ensuring that this information is made widely available within a country, to private-sector parties as well as government agencies

- Developing a self-sustaining institutional base for energy analysis and assessment involving both organizational structures and staff capabilities in appropriate public- and private-sector institutions

- Connecting energy analysis and assessment with energy decision-making.

These activities are a logical extension of recent AID experience with energy planning and analysis projects that have contributed valuable information and perspectives on a number of AID-assisted countries. Increasingly, multilateral donors and the private sector are relying on AID to provide technical assistance in pre-investment energy portfolio analysis as a key step toward making investment decisions.

## STRATEGY

Energy analysis is clearly an area where AID can take the lead and not only meet the basic need of the countries themselves, but also those of donor agencies. Major energy programs are being developed with AID assistance in Pakistan, Egypt, the Philippines, India, Bangledesh, and other countries. Decisions involving billions of dollars are being made every year, especially in the power sector, and still little is known about demand and the intersectoral, interregional energy interfaces.

The ojective of the Office's energy analysis initiative is to increase the knowledge of key energy decision-makers, primarily in the AID countries where AID is involved in large-scale energy programs, to increase the cost-effectiveness of the energy development options selected. Naturally, achieving this objective will require the development of appropriate analytical tools.

Rather than diffusing this effort too broadly, the Office proposes to focus on three targets for analysis and assessment:

- <u>Integrated national energy analysis</u>: achieving an understanding of national energy conditions and options as they relate to other sectors of the economy to support decisions by a variety of public and private parties, including donor agencies

- Integrated regional energy analysis: developing a detailed understanding of energy conditions and options for regions that play key roles in a country's development future, with special attention to integrated rural development

- Sectoral energy analysis: emphasizing the improvement of capabilities for electric power system planning and decentralized energy system development.

To achieve its primary objective the Office has defined a two-fold strategy aimed at (1) providing technical assistance to the Missions in energy analysis and (2) developing host governments' ability to develop their energy data bases, evaluate alternative energy options, and engage in a constructive dialogue on energy policy with the Missions and the international lending institutions. This strategy encompasses five major types of activities:

- Research on modern data system technologies and energy analysis methodologies appropriate to LDCs

- Development and demonstration of national, regional and sector energy analysis approaches

- Training of host government nationals

- Technical assistance

- Information dissemination.

Although energy planning problems are country-, region-, and sector-specific, it is expected that the tools developed by this initiative will meet a broad range of needs in most AID-assisted countries.

## IMPLEMENTATION PLAN

Major accomplishments planned under this initiative include:

1. National energy analyses, including institution-building activities, in three countries. The target ; to initiate assessments in FY86 in one country in ıch of two AID regions, with countries selected in ›nsultation with regional bureaus. Possible country ›plications in FY86: Pakistan, India, and Haiti; ıe additional assessment will be initiated in FY87.

2. Two regional energy analysis projects in cooperation with the Africa Bureau focused on rural development. The target is to initiate one assessment in FY86 and one in FY87. Possible country application for FY86: Senegal; for FY87: to be determined.

3. Plan for a power system policy project, focused on improving the technical quality of power system planning in AID-assisted countries; the plan will include discussion of power system rehabilitation (FY86 target).

4. Approach to providing national energy data to private-sector parties using one AID-assisted country as a prototype. Possible country application for FY86: Pakistan.

5. Feasibility study (using above country as a prototype) of using modern data system technologies as an aid to energy analysis and data dissemination. Identify a second AID-assisted country, with less existing technical infrastructure, for further tests. Possible country application for FY86: Pakistan; for FY87: to be determined.

6. Detailed Office of Energy program plan for energy analysis and assessment (FY86 target).

7. Experimental training program in national, regional, and sectoral energy analysis, combining U.S. and in-country training in Haiti (designed by University of Pennsylvania), and evaluation to determine the transferability of the idea. Target experimental program in FY86; evaluation: FY87.

8. "Prospectus" for AID Missions on decentralized power supply -- the issue of when and at what scale to take a decentralized approach to energy supply for agricultural and industrial development (FY86 target).

9. Annual energy policy research program as a source of innovative ideas and methodologies for Office of Energy programs (Annual).

**AID OFFICE OF ENERGY**
Initiative Paper No. 2
Priority Area: Energy Policy and Analysis

# STRATEGY FOR ENERGY PRICING

## INTRODUCTION

The efficient allocation of energy resources and the development of the energy sector are both perceived as necessary conditions to economic development. However, energy markets in less developed countries (LDCs) often do not function properly because pricing policies differ noticeably from economic efficiency levels, usually to provide cheap energy to poorer people. These policies distort energy supply and demand patterns.

This paper discusses the importance of energy pricing to LDC economic development and describes how energy pricing reform may be achieved. It outlines a strategy by which AID can help implement better energy pricing structures and policies and describes a plan for specific activities.

## RATIONALE

AID's target of 2 percent annual real growth in per capita income will require, on the average, an energy growth rate of at least 7 percent. To meet AID's development goals, proper forms of energy must be available when needed and energy resources must be allocated as efficiently as possible. For these conditions to be met, energy markets must function properly and pricing mechanisms must not distort supply and demand patterns.

Sound and realistic energy pricing:

- Promotes the economically efficient allocation of resources
- Promotes the viability and autonomy of the energy sector, thus increasing the flow of private capital
- Fosters the efficient use of energy and thus stimulates energy conservation

- Can be used as a very effective tool to promote regional and sectoral development.

**What is the Energy Pricing Problem?**

Economic theory holds that to maximize national income, the price of all goods and services should be equal to their marginal social cost (i.e., the resources needed to produce the last unit of the good). This is known as economic efficiency pricing. Although this approach results (at least in economic theory) in the most efficient allocation of resources, energy prices in most AID-assisted countries reflect a history of widespread government intervention through subsidies, price controls, and other adjustments. In addition, pricing policies in LDCs are often developed for specific energy products, ignoring all other products and thus distorting substitution effects between different forms of energy.

Many LDCs, for example, subsidize petroleum product prices. In Egypt, oil prices are only about 20 percent of prevailing world prices. Gasoline prices are also often used to cross-subsidize other fuels such as kerosene or diesel; or to generate general government revenues, as in Tunisia, Sudan, the Seychelles, and Zimbabwe; or to both cross-subsidize and generate revenues. In countries like Burma, subsidized electricity tariffs (substantially below marginal costs of supply) do not generate sufficient operating cash flow for the power companies to even cover debt service. In Jamaica, Bolivia, and Sudan, drastic rises in energy prices have led to street riots, underlining the sociopolitical dilemma associated with moving toward economic efficiency pricing.

Efficiency pricing of energy in LDCs is particularly difficult. Governments must deal with the social and political problems underlying the pricing policies, as well as with a number of other problems, including the value of traditional energy sources such as fuelwood and charcoal and the value of renewable forms of energy in general. The prices of these traditional fuels usually do not include the cost of replacement. Government must also take into account other considerations -- such as the value of lowering energy imports (through conservation or development of indigenous resources), the long-term value of diversification of energy supply, or the economic penalty associated with the overpricing of domestic resources -- when developing an optimal pricing system.

## STRATEGY

AID Missions are already engaged in energy pricing discussions in Pakistan, Egypt, and Bangladesh. The major pricing issues being addressed are subsidies for kerosene, electricity tariffs, and natural gas pricing. International institutions such as the International Monetary Fund (IMF), the World Bank, and the Asian Development Bank have, in many cases, required energy pricing changes as a prerequisite for structural adjustment or energy sector loans.

Internal pressures for budgetary austerity can also prompt moves to change energy pricing, but often these efforts are sidetracked because there is no clearly defined framework for analyzing alternative pricing policies and no politically acceptable path for rationalizing prices. Economic efficiency pricing is a good starting point, but numerous adjustments have to be made to achieve a realistic pricing policy in a developing country.

The objectives of the Office's energy pricing initiative are to define alternative means of moving toward more efficient energy pricing policies in LDCs without totally ignoring equity objectives, and then to develop appropriate analytical tools to evaluate these means.

To achieve these objectives the Office of Energy has defined a two-fold strategy aimed at (1) providing technical assistance to the Missions in energy pricing policy analysis and (2) developing host governments' ability to evaluate alternative pricing policies and engage in a constructive dialogue on energy pricing with the Missions and the international lending institutions. This strategy encompasses five major types of activities:

- Research on pricing policy distortions and inequities
- Development of institutional mechanisms to adjust energy prices
- Training of host government nationals
- Technical assistance
- Information dissemination.

Energy pricing problems are particular to each country and generally depend on the existence of indigenous energy resources and/or on the level of economic development. The

Office will thus carry out its research activities within specific country situations.

## IMPLEMENTATION PLAN

AID in general and the Office of Energy in particular have less leverage to effect energy pricing changes than international institutions such as the IMF or the World Bank, who clearly have the lead in this area. The Office will therefore carry out most of its research activities in close collaboration with other multilateral or bilateral institutions, particularly the World Bank. This approach will avoid duplicative efforts and contradictory policies.

Major accomplishments planned under this initiative include:

1. Definition of "alternative paths" for energy pricing policy dialogue in LDCs, including assessment of specific approaches (e.g., energy conservation) to mitigate the impact of energy price increases. Possible country applications for FY86: Bangladesh Egypt, Pakistan; for FY87: Jamaica, Kenya, India, Ecuador, Peru.

2. Reports on state-of-the-art methodologies for analyzing alternative energy pricing policies, particularly second and third best pricing policies in specific country settings. Possible country applications for FY86: Bangladesh, Egypt, Pakistan; for FY87: Jamaica, Kenya, India.

3. Case studies documenting pricing reform successes and failures in countries where extensive pricing studies have been completed. Possible country applications for FY86: Ecuador, Egypt, Indonesia, Pakistan, Philippines, Sudan, Thailand; for FY87: to be determined.

4. Case studies and designs of alternative institutional mechanisms available to LDCs to rationalize energy pricing decisions. Possible country applications for FY86: Egypt, Bangladesh, Pakistan; for FY87: Sudan, others to be determined.

5. Detailed Office of Energy program plan for energy pricing policy reform activities (FY86 target).

6. Case studies documenting impacts of fuel and electricity price distortions. Possible country applications for FY86: Bangladesh, Egypt, Pakistan, Indonesia; for FY87: Sudan, Ecuador, Jamaica, Kenya, India.

7. In-country training programs in energy pricing analysis and policy development. Possible country applications for FY86: Bangladesh, Egypt, Pakistan; for FY87: Ecuador, Peru.

8. Presentation of results of research activities at a major professional forum each year.

9. Publication each year of two articles in refereed journals based on research funded by the Office.

**AID OFFICE OF ENERGY**
Initiative Paper No. 3
Priority Area: Energy Policy and Analysis

# STRATEGY TO OVERCOME BARRIERS TO PRIVATE-SECTOR PARTICIPATION IN ENERGY DEVELOPMENT

## INTRODUCTION

In recent years, development economists have shown that the most effective way to stimulate real economic growth is to promote free markets and facilitate access to capital. Many AID-assisted countries, however, pursue policies that restrain the private sector, particularly in the supply, distribution, and use of energy.

Recognizing the critical role that an active private sector plays in developing efficient energy markets, the Office is actively identifying host government policies that distort these markets and act as barriers to greater private-sector participation and is then recommending policy reforms to correct them. This paper discusses the rationale for AID involvement, outlines the strategy it is pursuing, and describes how this strategy will be implemented.

## RATIONALE

Fostering the development and management of private enterprises is a cornerstone of AID's energy assistance. A recent Office review of 53 AID-assisted countries showed that the 20 with the highest annual GDP growth rates (averaging 6.7 percent) had very active private sectors, as indicated by the private sector share of domestic credit (72 percent). The 20 countries with the lowest growth rates (averaging 1.1 percent) had inactive private sectors that represented less than a 50 percent average share of total domestic credit. Therefore, AID is encouraging LDCs to rely more on open, competitive markets and to foster the growth of productive, efficient, self-sustaining private enterprises.

In many AID-assisted countries, government interference is particularly great in the energy sector because of energy's impact on all aspects of economic development. The government treats energy firms as public service institutions in which economic profit motivations are often subordinated to short-term political or social objectives. This approach

leads to policies that can cause severe energy market distortions and make energy investments by local and foreign private-sector firms risky and unprofitable. Specific government policies that create barriers to private-sector energy investments include:

- Parastatals or authorized monopolies (such as national oil companies and electric utilities) that have preferential status in obtaining capital or foreign exchange
- Energy price regulations and subsidies
- Restraints on interest rates and rationing of credit and foreign exchange
- Restricted access to domestic markets by foreign firms with needed capital and technology
- Promulgation of unrealistic licensing, taxation, and import/export policies
- Other government policies such as foreign investment limitations, market entry restrictions, wage laws, and taxation policies.

Reducing these barriers to private-sector activity will ensure that energy is available for critical economic development needs and that cost-effective alternatives to conventional energy will be developed and used.

## STRATEGY

To overcome the policy barriers to efficiently functioning energy markets, the Office of Energy is promoting policy reforms on the part of the host country. Specific reforms include:

- The improvement of the host country's energy planning and analysis capabilities
- The establishment of market-oriented pricing policies that eliminate (or at least reduce) price regulation and subsidies
- The elimination of non-price and non-planning barriers to investments in the energy sector by both local and U.S. private-sector firms.

Office initiatives addressing the first two reforms are discussed in detail in Initiative Papers No. 1 and No. 2.[1] This initiative focuses on the strategy for actions that address the third area for policy reforms. The barriers addressed in this initiative directly support many of the energy conservation and energy supply/demand activities carried out in the other initiatives.

Non-price and non-planning barriers to private investments in the energy sector include excessive taxation, unreasonable restraints on private power generation, restrictive licensing, restrictions on market access, import/export restrictions, and impediments to repatriation of profits. After reviewing these problem areas with AID and private-sector experts, the Office chose three areas that it felt could be successfully addressed given its resources:

- Development of small fossil fuel resources (oil, gas, and coal)
- Development of decentralized power generating systems for both grid-connected and isolated applications
- Energy conservation.

The Office recognizes that most of its projects have the potential for strong private-sector involvement, and incorporates this into project design. The areas above were singled out for this initiative because their main emphasis will be to identify government policies that constrain private-sector participation, rather than to focus on detailed technology and application analyses.

The Office also recognizes that its interests in this area cut across all Missions as well as other Bureaus and Agencies, particularly AID's Trade and Development Program (TDP) and AID's Bureau for Private Enterprise (PRE). The Office will closely coordinate its efforts with these organizations to ensure its efforts are complementary and that the lessons learned are broadcast as widely as possible. In addition, it will coordinate its efforts, through regular policy and program discussions, with other assistance organizations such as the World Bank.

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[1] The Office has also prepared an Energy for Development paper on Energy and the Private Sector. This paper and the Initiative Papers No. 1, "Energy Analysis and Assessment" and No. 2, "Energy Pricing," are available from the AID Office of Energy.

## IMPLEMENTATION PLAN

The activities planned under this initiative will be closely linked with the implementation of other activities, particularly those of Initiatives No. 5 (Energy Conservation), 7 (Coal Development and Use), 8 (Natural Gas Development and Use), 9 (Household Fuels and Fuelwood), 11 (Industrial and Village-Scale Power Systems), and 12 (Small Utility-Scale Power Systems). Copies of these initiatives are available from the AID Office of Energy.

Major accomplishments planned under this initiative include:

1. Case studies of the barriers to development of small oil and gas reserves, showing the development options and specific obstacles to local and U.S. private-sector participation. Possible country applications for FY86: Tunisia, Pakistan; for FY87: two additional countries yet to be identified.

2. A model for small oil and gas contracts that analyzes the options available, the expected output, and the cash flows to private developers and the government. Possible country applications for FY86: Tunisia, Pakistan; for FY87: two countries identified in previous activity.

3. An analysis of laws, regulations, and practices governing private decentralized electric power generation, and comparison with those in the United States and other developed and developing countries to identify barriers to cost-effective decentralized power projects that are privately financed, lessons learned from the experience of other countries, and specific recommendations for policy, legal and regulatory changes in the countries of interest. Possible country applications for FY86: Pakistan, Philippines, Thailand, India, Bangladesh; for FY87: Indonesia and one other country yet to be identified.

4. Organization of two to four Technology Transfer Teams to promote US and AID-assisted country private sector investment in small power generation systems, and energy conservation in the industrial and power sectors (FY86 target).

5. Detailed program plan for Office of Energy activities in overcoming barriers to private-sector participation in energy development and management (FY86 target).

6. Specific "pre-investment" proposals for development of small oil and gas reserves by local and U.S. private-sector firms. Possible country applications for FY86: Tunisia, Pakistan; for FY87: two other countries yet to be identified.

7. Short courses for AID Offices and Missions summarizing the lessons learned from the above cases and analyses and describing how they should be applied in specific projects (late FY86 target; refinements in FY87).

8. Short course for LDC government policy-makers summarizing the lessons learned and identifying specific actions that will reduce the barriers to private-sector implementation of cost-effective energy initiatives (FY86 target; refinements in FY87).

9. International workshop on private-sector development of small fossil energy resources (FY87 target).

10. International workshop on private-sector development of decentralized power systems (early FY87 target).

**AID OFFICE OF ENERGY**
Initiative Paper No. 4
Priority Area: Energy Policy and Analysis

# STRATEGY FOR IRRIGATION AND ENERGY PLANNING IN RIVER BASIN DEVELOPMENT

## INTRODUCTION

AID-assisted countries face both low agricultural output and rising oil import bills, two problems that could be addressed by harnessing their water resources. River basin development could provide LDCs with a means of irrigation as well as a source of relatively low-cost, indigenous energy -- both critically needed for development.

AID is currently involved in efforts to develop river basins in Africa (Senegal, Niger, Somalia), Asia (Sri Lanka), and in Latin America (Haiti). AID-assisted countries in Asia will invest some $40 billion in irrigation and hydroelectric dams over the next 15 years, while countries in Africa plan to invest roughly $20 billion.

Despite these massive investments, little attention has been paid to the link between agricultural planning and agricultural energy requirements. This paper outlines an Office of Energy strategy to examine this link, focusing primarily on river basin development.

## RATIONALE

AID's goal of increasing caloric intake will require, according to the Food and Agriculture Organization, agricultural growth of 3.7 percent per year. Each 1 percent growth in agriculture requires, on average, an additional commercial energy input of more than 2 percent. To achieve AID's agricultural goal, therefore, the supply of energy in LDCs must grow by over 7 percent per year. Key to this growth is power for irrigation. River basin developments can supply the bulk of this power. AID must work with LDC river basin agencies to analyze and understand a range of development issues concerning power use. One major issue is the relationship between hydropower and irrigation in river basin development.

## RIVER BASIN DEVELOPMENT



Many regions of the world have a large and generally undeveloped hydropower potential. The African continent, for instance, has about one-third of global resources. The relationship between agriculture and power generation is seldom well understood in LDCs, however.

Hydropower generation and irrigation can compete in at least three ways. First, if irrigation is developed upstream from power generation facilities, the loss of water can force a significant reduction in hydropower generation (for example, Tanzania's irrigation schemes in Mbeya Region above the Mtera and Kidata dams on the Ruaha River). Second, where power generation facilities lie on the upstream side, the need to maintain flow even in the rainy season will reduce the amount of wastes that can be stored for dry season irrigation. An extremely important issue is the effect on farmers of an end to annual flooding on rivers. In West Africa, for example, farmers practice recessional farming on the Senegal and Niger Rivers, planting their crops on river terraces as the floodwaters recede. The trade-offs between hdyropower and recessional farming constitute a significant issue in three countries that are high on AID's priority list -- Egypt, Sudan, and Senegal.

In the past, many river basin projects have emphasized power generation for the urban industrial sector at the expense of rural agricultural needs. Examples include Ghana's Volta River Basin that was developed for massive aluminum extraction from bauxite. Dams in Zambia, Tanzania, Uganda, Sudan, and Zaire were primarily designed as sources of energy for the burgeoning urban areas. It is not uncommon in developing countries to see a high voltage transmission line passing over irrigable lands where water is still pumped by diesel engines or bullocks. This trend may change as LDCs consider more carefully the balance between agricultural resources and industrial development.

## STRATEGY

The Office of Energy will focus in FY86 on research and analytical methods to better understand the link between energy and agriculture in river basin development.

## IMPLEMENTATION PLAN

Major accomplishments planned during FY86 include:

1. Model analyses linking agricultural irrigation needs to energy potential of a river basin development project. Possible country applications for FY86: Mahaweli Ganga development project in Sri Lanka, Senegal for the OMVS agency (Operation de Mise en Valeur du Fleuve Senegal).

2. Project Paper approved for the Energy for Agriculture project.

3. Detailed program plan including a comprehensive strategy for Office of Energy activities in irrigation and river basin development.

4. Information bases on selected river basins, including information on surface versus groundwater irrigation in use, expansion plans for both irrigation projects and energy projects, and existing planning studies. Possible country applications for FY86: Senegal, Sri Lanka, Pakistan, Gambia, Niger, India, and Haiti.

**AID OFFICE OF ENERGY**
Initiative Paper No. 5
Priority Area: Energy Conservation and Demand Management

# STRATEGY FOR ENERGY CONSERVATION

## INTRODUCTION

Energy conservation is a proven and cost-effective way for AID-assisted countries to increase their energy supplies, lower energy costs, and improve the management and profitability of energy-consuming enterprises. It also provides an effective mechanism for developing and improving local private-sector organizations.

This paper discusses the importance of energy conservation in meeting AID's development goals and indicates the energy savings that can be expected from conservation activities. It outlines a strategy that will allow AID to tap the benefits of energy conservation and describes a plan to implement country-specific conservation activities.

## RATIONALE

AID's target of at least 2 percent annual real growth in per capita income will require an energy growth rate of 7 percent or more. The Agency's goals for reducing hunger and other development needs require similar energy growth rates. Three-quarters of AID-assisted countries rely on imported oil for 50 percent or more of their commercial energy requirements. The high cost of needed energy imports or new energy supplies places a substantial drain -- typically 20-40 percent -- on limited foreign exchange earnings. Achieving 7 percent annual energy growth thus requires strong action to develop indigenous energy supplies and eliminate the waste of oil and other forms of energy.

Energy conservation does not mean curtailment. Rather, it aims at increasing the efficiency of energy use through waste reduction, fuel switching, and cogeneration of heat and power.

Energy conservation can have the following benefits:

- Energy conservation improves the productivity of energy use, allowing an increase in agricultural, industrial and other output without additional energy inputs
- Energy conservation eases national energy shortages and saves foreign exchange for other high-priority development needs
- Energy conservation programs and policies strengthen the overall technical, managerial, and institutional capabilities of developing countries
- Energy conservation programs ease the demand pressure on fuelwood
- Energy conservation programs offer an excellent opportunity for private business development in LDCs.

**What Can Be Achieved With Energy Conservation?**

According to recent World Bank studies, developing countries can save 10 percent of their 1981 commercial energy consumption by 1990. The necessary conservation methods have been proven in numerous applications in both industrialized and developing countries. The equipment and techniques are widely available and have been in use for many years.

AID's conservation strategy focuses on industry and power generation, which offer the greatest potential for large and immediate impact. Electricity typically accounts for 20-40 percent of the commercial energy used in LDCs; industry, including fertilizer, typically consumes 20-35 percent. Energy-intensive processes common to these sectors lend themselves to a variety of relatively simple, inexpensive, and well-proven conservation measures, and such energy-intensive activities are usually concentrated in a small number of large and easily identified facilities.

Using existing techniques, energy conservation can cut energy losses by 10-25 percent in the power sector and by 10-30 percent in the industrial sector. These savings can be immediate -- roughly 30 percent of all industry and power conservation measures can be implemented within 1 year, 50-55 percent within 2 years, and almost 100 percent within 4

years. These measures are very cost-effective, with paybacks of less than 3 years.

Examples of conservation measures vary widely from "energy conscious" practices, such as shutting off unneeded equipment (which can save 20-30 percent of electricity in some cases) to multi-megawatt cogeneration systems with efficiencies of more than 80 percent versus 30-35 percent for conventional systems.

## STRATEGY

The objective of AID's conservation activity is to achieve a large and immediate reduction of an LDC's energy demand: 15 percent of commercial energy use in the industrial and power sectors. Agricultural uses of power and other industrial fuels are priority targets.

To accomplish this objective, the Office of Energy's conservation strategy encompasses five major activities:

- Dialogue within AID and with AID-assisted countries on energy conservation and its benefits for development
- Basic and applied technical and institutional research in energy conservation policy
- Development and demonstration of energy conservation "tools" that can be applied to solving institutional and technological problems common to AID-assisted countries
- Training and general technical support to U.S. bilateral assistance programs
- Information exchange networking.

Private-sector activity is key to this strategy. The transfer of energy-saving expertise and technology developed by U.S. companies and research institutions is the technical basis of most AID-sponsored conservation projects. Emphasis is placed on leveraging private investment. All AID-supported conservation activities include the local private sector as a primary actor in the design and implementation of energy saving programs. Training, energy audits, energy awareness campaigns, and demonstrations are directed at small and medium-sized private firms.

## IMPLEMENTATION PLAN

To achieve its conservation objectives, the Office of Energy has systematically analyzed the potential contribution that energy conservation could make to solving each AID-assisted country's foreign exchange and associated development problems.

### Target Countries

As a result of an analysis of the energy needs and energy conservation potential of AID-assisted countries, the Office of Energy has divided those countries into five target groups for energy conservation activities. They are:

- Very attractive (AID involvement in energy conservation should remain very high or should be increased substantially)

  Dominican Republic
  Ecuador
  Egypt
  India
  Indonesia
  Jamaica
  Morocco
  Pakistan
  Peru
  Philippines
  Thailand
  Turkey

- Attractive (large potential for conservation, but evaluations of existing programs are needed prior to additional AID activities)

  Costa Rica
  Djibouti
  El Salvador
  Guatemala
  Haiti
  Honduras
  Kenya
  Panama
  Senegal
  Sri Lanka
  Sudan
  Tunisia

- Potentially attractive (potential for conservation, but no current AID conservation activities)

  Bangladesh
  Burma
  Malawi
  Mauritania
  Niger
  Portugal
  Togo
  Zaire
  Zambia

- Not attractive (very limited energy conservation potential)

Burundi
Botswana
Cape Verde
Gambia
Lesotho
Nepal
Rwanda
Seychelles
Uganda
Zimbabwe

- More information needed (analysis precluded by lack of data)

Belize
Burkina Faso
Cameroon
Central African Republic
Chad
Comoros
Congo
Cyprus
Equatorial Guinea
Ghana
Grenada
Guinea
Jordan
Liberia
Madagascar
Mali
Mauritania
Sierra Leone
Somalia
Swaziland
Yemen

Major accomplishments expected include:

1. Assessments of institutional and policy barriers, particularly as they relate to energy conservation. Possible country applications for FY86: Egypt, Pakistan, Philippines, India, Indonesia, Sri Lanka Thailand, Ecuador, Haiti, and Peru; for FY87: to be determined.

2. Model energy conservation revolving funds for private-sector enterprises. Possible country applications for FY86: Egypt, Pakistan, Indonesia, Thailand; for FY87: to be determined.

3. Pilot demonstration projects of "innovative" private-sector financing. Possible country applications for FY86: Dominican Republic, Jamaica, Ecuador, India, Pakistan, Philippines, Thailand; for FY87: to be determined.

4. Model energy conservation program for small industries, particularly agroprocessing. Possible country applications for FY86: Sri Lanka, Pakistan, Haiti, Thailand, Indonesia; for FY87: Peru

5. Prototype road transportation energy conservation program. Possible country applications for FY86: Costa Rica; for FY87: Pakistan, Egypt, India, Thailand, Sri Lanka.

6. Organization of private-sector Technology Transfer Teams for energy conservation, includirg cogeneration. Possible country applications for FY86: Pakistan, Egypt, Latin America/Caribbean; for FY87: Thailand, India, Indonesia.

7. Technical/economic feasibility analysis of industrial cogeneration projects. Possible country applications for FY86: Pakistan, Sri Lanka, Philippines, India; for FY87: to be determined.

8. "Bankable proposal" strategy. Possible country applications for FY86: Pakistan, Sri Lanka, Philippines, Thailand, India, Indonesia, Dominican Republic; for FY87: to be determined.

9. Detailed Office of Energy energy conservation program plan for FY87, FY88, and FY89 (FY86 target).

10. Regional energy conservaion workshops/seminars in cooperation with regional bureaus. Possible country applications for FY86: Asia/Near East; for FY87: to be determined.

11. General technical assistance to six Missions. Possible country applications for FY86: Dominican Republic, Philippines, Morocco, Egypt, Pakistan, India; for FY87: to be determined.

12. Formal briefings on energy conservation for Mission directors. Possible country applications for FY86: Indonesia, Thailand, and Peru; for FY87: to be determined).

13. Comprehensive energy conservation training program plan (FY86 target).

14. Publication of three issues of ECSP Update, and updates of cost directory and conservation/demand management manual (FY86 target).

15. Organization and promotion of energy manager associations and networks. Possible country applications for FY86: Pakistan, Latin America/Caribbean, Dominican Republic, Egypt, Morocco, Philippines, Sri Lanka; for FY87: to be determined.

**AID OFFICE OF ENERGY**
Initiative Paper No. 6
Priority Area: Energy Conservation and Demand Management

# STRATEGY FOR ENERGY FOR IRRIGATION PUMPING

## INTRODUCTION

Irrigation and water-related projects constitute a large share of AID's agricultural projects. The future growth of irrigation, and hence of food output in several AID-assisted countries, is threatened by high fuel prices and shortages of fuel and other power supplies. This paper outlines a strategy for the Office of Energy for meeting energy requirements in irrigation projects and examining energy supply options in agricultural expansion planning and pricing.

## RATIONALE

This initiative directly supports AID's goal of increasing agricultural output, with emphasis on increasing and sustaining productivity. Achieving the Agency's goal of increasing LDC caloric intake will require, according to the FAO, agricultural growth of 3.7 percent per year. Each 1-percent growth in agriculture requires an additional commercial energy input of more than 2 percent. Thus, for AID to attain its goals for nutrition and agricultural output, it must ensure that countries increase their energy supply by 7 percent annually.

Many AID-assisted countries rely on irrigation to increase agricultural output. The green revolution in South Asia is inextricably linked to irrigation. But the large irrigation systems in these Asian countries require awesome amounts of power. Over 23 percent of the power generated in Pakistan is used for irrigation pumping. In India, the connected load to agriculture, primarily for irrigation, increased from 118 megawatts (MW) in the early 1950s to almost 13,000 MW by the late 1970s. Gravity-fed irrigation is used as fully as possible in many AID countries. To supply additional water to crops, pumping is necessary, but the fuel requirements are great.

Drought-plagued countries in Africa face the difficult decision of how much irrigation they can afford.

Agricultural output will not rise without an increase in irrigation, but the high cost of pumps and the recurring fuel costs preclude such an increase in many areas. The decision to irrigate depends on cropping patterns and appropriate pump selection as well as broader issues of agricultural planning, power systems planning, and appropriate pricing policies.

In many countries, pumping is becoming increasingly critical to the overall productivity and predictability of agricultural output. Pumping, in turn, depends on a predictable supply of energy at economically justifiable costs. The reliability and assured supply of energy to rural areas is perhaps more important than cost. In periods of energy shortages, agriculture is often the first to be affected. In Somalia, for example, diesel fuel shortages prevented irrigation during a crucial flowering period, resulting in a 40- to 60-percent drop in yield.

The Office of Energy will assist Missions improve the effectiveness of pumping systems in Asia and other areas where irrigation is well established, as well as in Africa and other areas where basic decisions about pumped irrigation are just being made. It will also assist Missions in examining the broader policy and planning issues associated with pumping system design.

## Barriers to Improved Energy Use in Irrigation

Developing countries face two major obstacles in supplying energy for irrigation: distorted energy pricing and lack of resources.

Energy pricing policies can have a dramatic effect on the economics of irrigation projects and can strongly influence the choice of pumping systems. In Pakistan, for example, rural electrification expansion focused on those areas where electric pumps would displace diesel pumps for irrigation. The rationale for displacement was the lower cost to farmers of operating electric pumps and the perceived national benefits of reducing diesel fuel use. In fact, this policy was severely flawed. The rural load could be expanded only by adding costly, fuel-fired (mostly oil) generating capacity and expanding already strained transmission lines. Consequently, the real cost of electrifying the pumps was considerably higher than the cost of continuing to use diesel pumps. As this example illustrates, donor assistance can inadvertently encourage inappropriate policies in both the agricultural and energy sectors.

Some experts estimate that as much as 90 percent of irrigated land expansion in Africa may require pumping, either from aquifers and rivers, or to supplement surface water supplies. More resources must be targeted to water management and corresponding energy resources to increase food supplies. Sector-wide planning for irrigation is needed to husband resources carefully. Such planning is uncommon in Africa. On the whole continent, there are perhaps only four countries with sufficient resources to allow sector-wide planning: Kenya, Senegal, Sudan, and -- possibly -- Zimbabwe.

## STRATEGY

AID's strategy seeks to ensure the availability of energy for water pumping. The Office of Energy's program activities will concentrate on research, technology transfer, training, and institutional development. Target countries are those with food deficits that rely on pumping to provide their irrigation needs or may do so in the future. Several high-priority countries have been identified, including India, Bangladesh, Pakistan, Senegal, Mali, and Chad.

To implement this strategy, the Office of Energy will carry out five major activities:

- Conduct dialogue within AID and with AID-assisted countries on energy for irrigation pumping and its benefits for development
- Carry out research on issues pertaining to pricing of electricity and petroleum products, and on centralized versus dispersed systems for irrigation
- Engage in technology transfer encouraging energy-efficient pumping techniques
- Provide training and general technical support to Missions
- Carry out networking among irrigation and power specialists.

The Office of Energy will encourage private-sector involvement in investment and technical assistance activities.

## IMPLEMENTATION PLAN

Major accomplishments expected include:

1. Research studies and conferences on energy requirements for agricultural expansion using pumped irrigation, and on pumping options, including centralized and dispersed power systems for irrigation.Possible country applications for FY86: East Africa REDSO, Sahel, India, Burma; for FY87: Bangladesh, Indonesia, Sudan.

2. Model marketing program for selected energy-efficient pumps using innovative marketing strategies (e.g., warranties, maintenance and spare parts contracts) Possible country applications for FY86: Pakistan, Bangladesh; for FY87: Senegal.

3. Model LDC "incentives" program (e.g., import duty relief, loan programs, price subsidies) to promote energy-efficient pumps. Possible country applications for FY86: Pakistan, Bangladesh; for FY87: Senegal.

4. Model electric utility pump testing program patterned after the PG&E model that provides free irrigation pump test services to farmers. Possible country applications for FY86: Pakistan, Egypt; for FY87: India.

5. Agriculture/Energy Resource Center establishing a data base on energy requirements for agriculture (FY86 will focus on irrigation).

6. Detailed program plan for the Office's irrigation pumping activity (FY86 target).

7. Program incorporating energy-efficient small and medium pumping systems (which pump less than 1,000 gallons per minute) in existing pumping projects; to be accomplished in collaboration with agricultural and irrigation specialists. Possible country applications for FY86: Senegal, Mauritania, Niger.

8. Energy for Irrigation Pumping research network to collect data, undertake analyses, and exchange information on LDC irrigation needs, pumping costs and efficiencies, and irrigation projects (FY86 target).

**AID OFFICE OF ENERGY**
Initiative Paper No. 7
Priority Area: Resource Development

# STRATEGY FOR COAL DEVELOPMENT AND USE

## INTRODUCTION

Coal is the world's most abundant remaining fossil fuel and the one most likely to be chosen by both advanced and less developed countries as the major transitional energy source between the era of petroleum and the era of renewable energy systems. Fifteen AID-assisted countries are known to have coal reserves of 5 million tonnes or more. Nine AID-assisted countries have known reserves of 500 million tonnes or more. More than a dozen additional countries lack sufficient information to make even an initial estimate.

Clearly, many of these countries will want to develop and use their coal resources wherever economically, technologically, and institutionally feasible. Moreover, many countries without significant coal reserves of their own are considering coal imports as an alternative to oil imports for industrial energy supply and electricity generation. Consequently, it is essential that AID's bilateral assistance programs include technical assistance in the development and use of coal. This paper outlines the rationale and strategy for an initiative by the Office of Energy in this area, together with the expected achievements.

## RATIONALE

AID's development goals require annual energy growth rates of 7 percent or more. The key to such growth is development of indigenous energy resources. AID-assisted countries with coal resources can develop and use them, displacing imported oil as a source of energy for industry and electricity generation, and thus helping to improve foreign exchange balances. Using domestic energy instead of imported oil will also provide income and jobs. Other domestic energy resources can have similar effects, but coal is the best choice in many countries because it is abundant, economically competitive with oil in sectors that represent a significant proportion of the nation's energy consumption, and associated with a variety of long-established technologies.

Coal development and use is especially attractive because it offers plentiful opportunities for private enterprise. Coal use flourished in Europe when technological levels and technical skills were similar to those of most developing countries today -- largely because of a combination of wood shortage and industrial development needs. Many of the coal technologies in use today developed in that era through private-sector initiative and were implemented by private-sector actions. Even with obvious cultural differences and increased environmental sensitivity, a considerable amount of this experience could be replicated in AID-assisted countries, because the development of coal is relatively labor-intensive, has moderate technical skill and capital requirements, and is relatively decentralized.

Coal use can also contribute to sustained rural development, especially in countries endowed with a coal resource or countries facing scarce fuelwood supplies. In the rural areas of many countries, the central energy issue is finding a non-oil alternative to scarce fuelwood and wood charcoal. In the more advanced AID-assisted countries, sustained rural development depends on adequate energy supplies at acceptable prices. Coal is an important option in countries with coal reserves or ready access to coal imports, especially if the coal is provided in a relatively clean-burning form so its decentralized use does not pose health hazards.

## Challenges in Achieving the Potential for Coal Development and Use

Despite the relatively widespread availability of coal in AID-assisted countries, this energy source has not been extensively developed. In only four countries (India, Thailand, Pakistan, and Zimbabwe) is current coal production above 1 million tonnes per year. In six others, production is at a level of 200,000 tonnes or more per year (a little more than 500 tonnes per day). In 11 of the 21 AID-assisted countries with known or estimated coal resources of 5 million tonnes or more, coal production is negligible (100,000 tonnes per year or less).

To identify and realize the potential of coal to meet energy needs in these and other AID-assisted countries, the following issues must be resolved:

- What are the characteristics of the indigenous coal resources? Technologies for using coal cannot be evaluated confidently without good information on the chemical characteristics of the coal, and the

economic competitiveness of coal cannot be assessed without good information on mining conditions. Determining whether (or how) coal can benefit a particular country depends on such information, which is usually sparse and unreliable.

- How can coal be used cheaply and reliably on a small scale? The use of coal in relatively large-scale applications, such as power generation and the largest industrial plants, is an important energy source in national energy systems, but these applications are not necessarily of greatest concern in meeting basic needs, supporting rural development, and reducing pressures for deforestation. To achieve these objectives, technologies are needed that can deliver energy from coal on a small scale and often at a simple level.

- How will environmental and health hazards be controlled? Coal is known to pose problems to both people and the environment, ranging from sulfur emissions to dangerous hydrocarbon compounds that may be created in combustion or conversion. In its approach to coal use, AID must be sensitive to environmental and health concerns, and it must provide information to answer questions on possible impacts.

### AID Experience with Coal Development and Use

The Office of Energy is conducting a Conventional Energy Technical Assistance Project and Conventional Energy Training Project covering such topics as coal exploration and production, coal conversion, and coal utilization. Ongoing activities include the assessment of coal markets and studies of fluidized-bed combustion, coal/water mix fuels, and other coal technologies. Close relationships have been established with AID-assisted countries such as Pakistan and the Philippines, with other donor agencies, and with the private sector.

## STRATEGY

To increase the use of coal in LDCs, AID will concentrate in the next 2 to 3 years on (1) increasing the knowledge of selected LDCs in the characterization of the low-grade indigenous coals, and (2) helping develop markets for coal briquettes in the residential and industrial sectors. In

parallel with these two thrusts, efforts will be made to improve institutional capabilities and private-sector involvement for coal development as part of the Office's initiatives in energy analysis, energy pricing, and policy barriers to private-sector participation in energy development.[1]

Implementation activities will focus on the development of improved characterization of low grade coal resources, demonstration of well-targeted projects (e.g., coal briquettes), dialogue with other donors on coal use options, technical assistance to Missions and governments, and dissemination of program findings and results.

The private sector will be the primary means of implementing this initiative. Local private companies are expected to take the lead in developing and operating most proposed alternatives, especially coal briquetting projects, and the U.S. private sector is likely to have an increasing role in providing technical assistance in coal characterization and beneficiation and financial participation in some projects. In some specific cases, the U.S. coal industry may also benefit from direct sales to AID countries, especially in transition periods.

## IMPLEMENTATION PLAN

Major accomplishments expected include:

1. Coal resource inventories in two countries per year. Possible country applications for FY86: Niger, Cameroon; for FY87: to be determined.

2. Clarification of local private-sector opportunities in connection with coal development and use and dissemination of resulting information to other AID-assisted countries. Possible country applications for FY86 and FY87: Pakistan, Indonesia.

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[1] Initiative papers No. 1 -- "Energy Analysis and Assessment," No. 2 -- "Energy Pricing," and No. 3 -- "Policy Barriers to Private-Sector Participation in Energy Development" are available from the AID Office of Energy.

3. In coordination with coal briquetting activities, current bilateral relationships, and U.S. industry, test of low-temperature coal pyrolysis as a coal utilization technology for AID-assisted countries. Possible country applications for FY86: India, Pakistan, and Haiti.
4. Working with the U.S. National Coal Association, a study of issues and options in using U.S. coal to help meet energy needs of AID-assisted countries (target FY86).

5. Conference on coal resource development in AID-assisted countries. Possible country applications for FY86: Pakistan, for FY87: Africa region.

6. Detailed Office of Energy program plan for coal development and use (FY86 target)

**AID OFFICE OF ENERGY**
Initiative Paper No. 8
Priority Area: Resource Development

# STRATEGY FOR NATURAL GAS DEVELOPMENT AND USE

## INTRODUCTION

The development and use of indigenous natural gas resources in AID-assisted countries can help ensure the availability of energy for continued economic growth, reduce the need for energy imports, and promote the involvement of the private sector in energy development and management.

This paper describes the potential for natural gas in meeting AID's development goals. It also proposes a specific strategy and implementation plan for AID activities to support greater natural gas development and use in LDCs.

## RATIONALE

To sustain the AID goal of 2-percent real annual growth in per-capita income, most developing countries will need to increase their energy consumption by 7 percent or more per year. Most of this increase in energy use must be met by either indigenous or imported conventional sources -- oil, gas, coal, hydro. With the cost of energy imports already absorbing 20-40 percent of the foreign exchange earnings of many AID-assisted countries, the use of indigenous energy resources must be maximized.

Larger supplies of conventional energy are needed both to help alleviate severe shortages of traditional fuels and to meet growing modern sector energy needs. Expanding traditional fuel supplies is usually a long-term process and, in any case, these fuels cannot meet the growing demand for commercial energy, particularly liquid fuels.

Transportation and power generation are key growth sectors and major commercial markets for liquid fuels. Typically, transportation accounts for 30-50 percent of all oil used in AID-assisted countries, and oil-fired power generation uses an additional 10-25 percent of oil supplies.

Programs aimed at developing and using natural gas in AID-assisted countries offer several benefits. They can:

- Replace imported oil currently used in industrial and power generation applications
- Provide new sources of high-value transportation fuels -- compressed natural gas -- and liquid fuels such as methanol, ethanol, and gasoline
- Add to rural energy supplies by developing and using small gas fields in remote locations
- Serve as a stepping-stone for industrial development (e.g., feedstock for fertilizer production)
- Provide an opportunity for greater private participation in the development of conventional energy resources.

**What is the Potential for Increased Natural Gas Use?**

Several developing countries have natural gas reserves that are untapped or underexploited. At the same time, significant natural gas discoveries are being made. As of early 1985, AID-assisted countries had natural gas reserves estimated at over 174 trillion cubic feet. Twelve AID-assisted countries had reserves of 1 trillion cubic feet or more (numbers below are displayed in trillion cubic feet):

| | | | |
|---|---|---|---|
| Bangladesh | 7.0 | India | 15.0 |
| Bolivia | 4.3 | Indonesia | 40.0 |
| Cameroon | 4.2 | Pakistan | 15.8 |
| Congo | 2.1 | Peru | 1.1 |
| Ecuador | 3.0 | Thailand | 5.9 |
| Egypt | 7.0 | Tunisia | 2.2 |

Of these 12 countries, however, only 5 (Bolivia, Egypt, India, Indonesia, and Pakistan) are currently producing over 100 billion cubic feet of natural gas per year. A major reason for the relatively low ratio of production to reserves is the need for expensive gathering and pipeline systems to bring gas in remote areas to existing markets.

Even in urban areas, the projected demand for natural gas in industry and power generation is often below the potential production capacity of existing natural gas reserves. In such cases, replacing expensive -- and often imported -- petroleum-based transportation fuels with natural gas-based substitutes could increase the use of domestic natural gas and reduce oil import requirements.

Based on economic analysis and discussions with Missions and AID-assisted countries, the Office of Energy has determined that in several countries with substantial gas reserves, the underutilization of natural gas resources can be improved by (1) developing some remote area gas fields to meet specific energy needs in adjacent areas, and (2) increasing capabilities to use natural gas-based fuels as supplementary energy sources in the transport sector. Both of these alternatives also offer an excellent opportunity for increasing local and U.S. private-sector participation in the energy sectors of those LDCs.

Approximately 30 percent of LDC natural gas reserves consist of fields that are too small and too far from existing urban or industrial centers to permit economic exploitation. However, under certain circumstances, many of these fields could be developed to meet current or future energy needs in nearby areas. In coordination with other agricultural and rural development activities, some remote gas fields could become sources of reliable and low-cost energy for decentralized power generation, irrigation projects, and rural industries.

The use of natural gas or gas-based fuels in vehicles is already an established energy supply option in several industrialized countries and some LDCs. Several natural gas-based technologies are currently in use in the transport sector of a number of countries. About 500,000 vehicles are running on either compressed natural gas (CNG) or liquefied natural gas (LNG). Italy, Brazil, Egypt, Canada, Bangladesh, and the Soviet Union all have active programs in this area. Proven technologies also exist for directly converting natural gas to liquid transport fuels. In addition, natural gas liquids and liquefied petroleum gases can be used as automotive fuels.

By 1995, the additional exploitation of small gas fields and the increased use of natural gas to supply transport fuels could cut projected oil demand in the AID-assisted countries by 5 to 15 percent.

## STRATEGY

To increase the use of natural gas in LDCs, AID will concentrate in the next 2 to 3 years on: (1) promoting the use of gas from small and/or remote fields whenever economically feasible, and (2) developing natural gas-based transport fuels to supplement petroleum products,

particularly CNG. In parallel with these two thrusts, efforts will be made to enhance the institutional setting and investment climate for natural gas development as part of the Office's initiatives in energy analysis, energy pricing, and policy barriers to private-sector participation in energy development.[1]

Implementation activities will focus on the development of widely applicable analysis modules and prototype demonstration projects, dialogue with other donors on natural gas use options, technical assistance to Missions and governments, and dissemination of program findings and results.

The private sector will be the primary means of implementing this initiative. Local private organizations are expected to take the lead in developing and operating many of the proposed alternatives, and the U.S. private sector is likely to have an important role in providing technical assistance and financial participation in some projects.

## IMPLEMENTATION PLAN

Specific program activities will be closely coordinated with the natural gas- and transport-related activities of other donor organizations, particularly the World Bank. During the first 2 years, activities will be targeted at AID-assisted countries that have proven reserves of natural gas and are net importers of oil; particularly Bangladesh, India, Pakistan, Peru, and Thailand.

Major accomplishments planned include:

1. Summary of current natural gas development programs in AID-assisted countries with moderate to large natural gas reserves (FY86 target).

2. Feasibility studies of developing remote, small natural gas fields. Possible country applications for FY86: Thailand, Pakistan; for FY87: to be determined.

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[1] Initiative papers No. 1 -- "Energy Analysis and Assessment," No. 2 -- "Energy Pricing," and No. 3 -- "Barriers to Private-Sector Participation in Energ Development" are available from the AID Office of Energy.

3. Feasibility studies on the use of natural gas for transportation fuels. Possible country applications for FY86: Thailand (CNG), Egypt (CNG); for FY87: Indonesia (methanol), India (methanol), Bangladesh (CNG).

4. Model program for private-sector participation in gas exploration and development projects. Possible country applications for FY86: Pakistan, Tunisia; for FY87: to be determined.

5. Detailed program plan for Office of Energy activities in natural gas development and use (FY86 target).

6. Prototype demonstration projects of small, remote natural gas applications. Possible country applications for FY87: Thailand, Pakistan.

7. Prototype demonstration projects for CNG transport fuel programs. Possible country applications for FY86: Thailand or Egypt; for FY87: Bangladesh.

8. International conference on natural gas development and use in LDCs (FY87 target).

**AID OFFICE OF ENERGY**
Initiative Paper No. 9
Priority Area: Resource Development

# STRATEGY FOR HOUSEHOLD FUELS AND FUELWOOD

## INTRODUCTION

The use of energy in industry, electricity generation, and transportation accounts for most of the total consumption of commercial energy in a developing country. However, for most of the people and over most of the land area, the dominant energy source is biomass, especially fuelwood and wood charcoal. In most AID-assisted countries, fuelwood is an increasingly scarce resource and is associated with advancing deforestation. Clearly, this trend poses problems for households, which need energy to meet basic needs. In turn, household energy requirements for fuelwood make reforestation more difficult to implement.

There are two principal options for improving the supply of household energy in most AID-assisted countries: (1) increase fuelwood production, or (2) find substitutes for fuelwood. Developing substitutes for fuelwood is especially important in areas that are the focus of reforestation efforts, where pressures on the young wood resource must be reduced. The development of fuelwood is a logical AID energy initiative, complementing wood production initiatives in its forestry and agricultural development programs. However, if the substitutes are intended for extensive use in small industry, commerce, and the residential sector, they must be cheap, convenient, and capable of use without widespread replacement of present burners and stoves. The substitutes must therefore be hydrocarbon solid fuels that can be produced and distributed cheaply from local resources.

This paper presents the rationale and thrust of an Office of Energy initiative to determine the potential of coal and biomass briquettes as fuelwood substitutes, and lists the specific activities planned under the initiative.

## RATIONALE

AID's development goals require an energy growth rate of 7 percent or more per year. In more than two-thirds of the AID-assisted countries, fuelwood and wood charcoal supply

more than half of the energy consumed per year, but most of these countries face serious fuelwood shortages. According to the FAO, 20 AID-assisted countries are no longer able to meet minimal fuelwood supply requirements in all or substantial parts of their territory. Twenty-nine others are being forced by fuelwood scarcity to overexploit their wood resources. And some will face a fuelwood crisis by the end of the century. Few issues bear as strongly as this one on the challenge of sustained rural development in developing countries.

Reforestation, including agroforestry and social forestry, is one way of meeting the challenge. However, while an equilibrium is being reestablished, fuelwood shortages are unlikely to be reduced in many areas by growing more wood. An essential part of a household energy strategy must be the development of fuelwood substitutes.

Most of the consumers of fuelwood and wood charcoal in these countries have little capital for investment in new burners or stoves. Consequently, wood energy consumption cannot be reduced significantly by major changes in end-use delivery forms, e.g., from a hydrocarbon solid to a liquid or gas fuel, or to solar energy. The best prospect is to supply an alternative hydrocarbon solid, ideally one that can be used interchangeably with fuelwood or wood charcoal in existing combustors.

Such a prospect suggests two solid hydrocarbon fuel alternatives to wood: (1) coal and (2) agricultural residues, including cereal, cotton, coffee, coconut, and copra production products. These feedstocks can be produced using readily available technology and relying on private-sector initiative and management, and can be delivered to users in the form of a relatively clean-burning and efficient form comparable to wood charcoal. Agricultural residues are considered by the World Bank to make economic sense in several parts of the developing world, at least for agroprocessing, and coal briquettes seem especially attractive in wood-scarce countries with a coal resource.

## STRATEGY

To improve the fuelwood and wood charcoal situation in AID-assisted countries, AID's Office of Energy will concentrate

[1] See Initiative Paper No. 7 -- "Coal Development and Use" available from the AID Office of Energy.

its efforts in the next 2-3 years on (1) promoting the use of viable substitute fuels wherever economically and socially feasible, and (2) helping develop self-sustaining markets for these fuels. In parallel with these two thrusts, efforts will be made to raise private-sector interest for their development. The private sector will need assistance in the early stages of market development but is expected to be in a position to continue and expand the use of these substitute fuels in the medium term.

Implementation activities will focus on the development of reliable and environmentally sound briquetting technologies through basic and applied research, feasibility studies of coal and agricultural waste briquetting, training of host country personnel, technical assistance to Missions and governments engaged in household fuels programs, and dissemination of program findings and results.

## IMPLEMENTATION PLAN

Specific program activities will be closely coordinated with those of other donor organizations (e.g., the World Bank, the UNIDO) in the same areas. During the first 2 years, activities will be targeted to AID-assisted countries that have the most acute fuelwood problems, particularly in Haiti and Africa.

Major accomplishments include:

1. Feasibility studies and market assessments for briquetting, including the development of a reliable feasibility study methodology. Possible country applications for FY86: Haiti, Pakistan, Sudan, Niger; for FY87: Botswana, Zambia, Indonesia, Peru, Morocco.

2. Research on health risks of coal briquette use. Target for research: FY86; for dissemination of results: FY87.

3. Feasibility studies of agricultural residue briquetting in four countries (FY87 target).

4. Feasibility study of multifuel briquette feasibility study -- briquettes from both coal and biomass, supplied interchangeably to the same markets. Possible country applications for FY87: India, Pakistan.

5. Detailed Agency fuelwood/household fuels program plan for FY86, FY87, and FY88 (FY86 target).

6. Regional workshops on fuelwood substitutes in cooperation with regional bureaus. Possible country applications for FY86: Asia/Near East region.

**AID OFFICE OF ENERGY**
Initiative Paper No. 10
Priority Area: Power Systems Development

# STRATEGY FOR RURAL ELECTRIFICATION

## INTRODUCTION

Growth in agriculturla productivity and rural incomes are key AID development goals. Achieving these objectives requires new energy supplies. In the past, rural electrification (RE) has been an important mechanism for bringing new energy supplies to rural areas. However, judging the relative cost and effectiveness of RE projects is difficult, since it often involves social, political, and economic considerations.

Growing questions about the effectiveness and efficiency of RE in developing countries highlight the complexity of the RE issue and the need for more careful planning and design of RE projects. Future RE projects must include more planning and analysis aimed at matching electricity service systems to consumer needs, and integrating RE projects into the larger, long-term development context.

Based on recent assessments of RE projects and experiences, the Office of Energy has developed a strategy to identify and evaluate new approaches to RE for possible application in AID-assisted countries.

## RATIONALE

Historically, RE has occured as one of two processes:

- Extending service outward from an existing supply grid serving a major urban center or region; or
- Extending service outward from major hydroelectric projects to take advantage of low-cost or surplus power.

However, the increasing cost of expanding electricity service, and the higher transmission and distribution costs per user in rural areas both reduce the attractiveness of RE.

In addition, several studies of past RE programs have questioned the value and effectiveness of many aspects of RE programs. These studies raise the following issues:

- Donor support for RE has oftrn set management and performance standards based on donor experience rather than on the needs and values of the host country. For example, efforts have been made to develop coopeeratives to manage RE systems when other institutions would have been more appropriate. Many RE systems are also designed to operate at a level of reliability that is not necessary or cost-effective in most LDC applications.

- Self-generation of electricity by villages, towns, or remote industries often can provide acceptable levels of service, at lower costs, than electricity from an integrated grid. Self-generating systems can also develop with lower risks of failure and in shorter periods of time, and allow testing of local market demand before making larger investments.

- New electricity supplies will not necessarily be used. Consumers still need to invest in appliances, tools, and other equipment to make use of electric power. Rural users may lack the money to make these investments, and agencies which provide related services may not coordinate their efforts with RE projects.

- Electricity is not necessarily the best or cheapest energy source for some uses. For example, electric irrigation sets can displace diesel consumption, but may cost far more than diesel-powered equipment.

- Although one objective of some RE projects is to substitute electricity for other fuels, in many cases low-income rural households do not substitute electricity for firewood and other cooking and heating fuels. Poor households value electricity mainly for illumination and for powering small appliances.

## STRATEGY

It is clear that RE requires more careful planning and design than it has received in the past, including more attention to matching electicity service systems to needs, and more

consideration of how RE fits in a larger, longer-term development context. The Office of Energy recognizes that expansion of electricity services will be appropriate in some circumstances, but that other energy sources will be more appropriate in others. It also recognizes that efficient use of available human, natural, and financial resources for RE is essential if the needs of rural populations for all forms of energy are to be met. Accordingly, the Office's activities will concentrate on:

- Decision-making,planning, evaluating, and assessing the operation of RE projects
- Comparing RE and alternative systems for supplying energy to rural populations
- Examining the potential state-of-the-art technology to support innovative aproaches to RE
- rehabilitating utility systems, including improving management.

To implement this strategy, the Office will carry out the following activities:

- conduct research on issues pertaining to planning, decision-making, and evaluating RE projects
- identify potentially useful, innovative approaches for RE and support work to evaluate specific applications
- identify technologies to support the efficient provision of electricity services to rural areas
- provide training and general technical support to Missions and host governments
- disseminate information on RE alternatives.

## IMPLEMENTATION PLAN

Major accomplishments planned under this initiative include:

1. Analysis of principal issues in RE and preparation of detailed program plan for RE policy project focused on improving the technical quality of RE planning in AID-assisted countries (FY86 target).

2. Development of analytical framework for use in assessing RE alternatives and definition of innovative technological, institutional, and finaicial approaches to RE including utility rehabilitation and improved management (FY86 target).

3. Case studies, including visits by assessment teams, examining innovative systems or changes in RE directions in two countries per year. Possible country applications for FY86: Indonesia, India.

4. Visits by utility rehabilitation teams to two countries each year. Possible country applications for FY86: Somalia, Pakistan.

5. Preparation of "Rural Electrification Guide" for AID Missions, host governments, utilities, and private firms in AID-asssisted countries (FY87 target).

6. Seminar on the role of RE in development (FY87 target).

7. Training of AID staff and host country utility personnel in evaluating altenative approaches to RE (FY87 target).

**AID OFFICE OF ENERGY**
Initiative Paper No. 11
Priority Area: Power Systems Development

# STRATEGY FOR INDUSTRIAL AND VILLAGE-SCALE POWER SYSTEMS

## INTRODUCTION

Modest amounts of energy can breathe life into a region, but AID-assisted countries will be hard-pressed to supply even small amounts of power for rural industry to develop or to supply power for agricultural purposes. The installed power generating capacity in AID-assisted countries averages about 50 watts per person: this has to be stretched over lighting, rural industry use, agricultural pumping, and a myriad of other demands. (This compares with over 3,000 watts per person in the United States.) Just to maintain this 50-watt level given population growth will require the addition of roughly 47,000 MW of generating capacity in AID countries by the year 2000 -- over $70 billion would be needed. Sustaining present electric power growth trends of 6-7 percent will require much more -- on the order of $175-250 billion. This level of capital investment will be difficult if not impossible for LDC public sectors to raise.

Private investment is necessary if growth in the power sector is to approach the 7 percent or more needed to attain AID's rather modest development targets in agriculture and other sectors. Analyses by the Office of Energy and others indicate that smaller-scale sytems (on the order of 5 MW or less) tied to specific end uses in rural industry or agriculture are much more likely to attract private investment than are large-scale power plants of 500 MW or more.

In many LDCs, decentralized power systems offer an economically attractive alternative to extending transmission and distribution lines long distances from centralized hydro or thermal stations, especially for small or widely dispersed loads.

Regional power needs are frequently in the range of 1 to 50 megawatts (MW). Five MW, for instance, would support a medium-sized industrial town of 5,000 people in Pakistan.

This paper discusses the importance of decentralized power systems -- up to 5 MW[1] -- in furthering AID's development goals. It outlines a strategy by which the Agency can harness the benefits of these power systems and describes plans for major accomplishments in a country-specific context.

## RATIONALE

Energy shortages are a serious bottleneck to development. Achieving AID's goals of a 2 percent increase in per capita income and a rise in critical caloric intake for 90 percent of the population will require a growth in commercial energy (including power) of at least 7 percent per year. Because 80 percent of the population in AID-assisted countries is rural, the rapid implementation of energy supply projects in rural areas will be required to meet AID's development goals.

Modular approaches that result in accelerated deployment of power generation are mandatory for a number of reasons:

- They can be installed three to ten times faster than large systems
- They do not require extensive and costly transmission and distribution networks
- They can use local energy resources (e.g., hydro, biomass) even when available in small quantities
- They are "modular;" that is, they are available as shop-fabricated, pre-packaged systems that can be shipped to the site and easily assembled
- They can be cheaper on a total cost basis when transmission and distribution infrastructure costs and construction lead times are considered.

Because of these advantages, decentralized power systems are attractive to local governments that are eager to find ways of making a significant and viable impact on productivity and employment.

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1 Larger, predominantly grid-connected systems, from 5 to 50 MW, are discussed in Initiative Paper, No. 12 -- "Small Utility-Scale Power Systems" available from the AID Office of Energy.

An Energy Office initiative in decentralized power systems is warranted for two other reasons.

- Markets for small, modular power systems exist in both rural and urban areas of most AID-assisted countries. For example, the demand for power in small agroprocessing units and other rural industries is expected to grow by almost 10 percent per year.

- Traditional supply options are not meeting rural demand well. Traditionally, rural loads have been satisfied by extending the grid or relying on individual power units such as diesel engines. The former option is very capital-intensive, while the latter option depends on expensive imported fuels and requires a maintenance and spare parts infrastructure.

In addition, both options emphasize electricity rather than other needed energy forms, such as mechanical energy, low- and high-temperature thermal energy, and transport fuels.

Small and medium-sized power generation provides an economic alternative to both these options. Power-sector investments of more than 100 billion are being made in AID-assisted countries to meet anticipated demand by the year 2000, only a small fraction of which covers systems of less than 5 MW. With the energy sector able to consume up to 40 percent of an LDC investment budget, small modular power systems are of enormous strategic and economic significance.

**What Role for AID?**

AID and other donor organizations have focused on the two extremes of the power spectrum -- large centralized power plants of several hundred megawatts requiring long lead times and major capital investments, and a few kilowatt-scale systems that rarely make a significant impact on the development needs of a region. However, recent studies by AID and the World Bank suggest a significant role for small, modular power generation in developing countries.

Over the years, the Agency has developed substantial experience in understanding the energy needs of development, in planning energy supply and conservation options to meet demand, and in proposing policy, institutional and training measures to implement economically attractive options. This

experience provides a sound framework for comparing decentralized power systems with other options in an effort to meet important development objectives.

The Office of Energy is the appropriate organizational unit to implement a project that is global in character and involves close collaboration with the U.S. private sector and U.S. utilities.

The U.S. private sector has acquired a great deal of experience in designing, manufacturing, and using modular power generation systems. Indeed, small power systems are the most rapidly growing sector of the power market in the United States.

AID can transfer to LDCs the experience of the U.S. private sector, primarily in those systems burning wood, wood wastes, coal, peat, or natural gas. U.S. expertise also covers small power systems using renewable resources such as hydropower, geothermal, solar, and wind. This expertise also includes hybrid systems using conventional diesel power in conjunction with any of these fuel sources.

Although decentralized power systems are attractive from many viewpoints, investment in them is still limited. In addition to the reluctance of multilateral donor organizations to participate in their financing because of their small size and perceived managerial risks, several barriers exist in the countries themselves, including financing, and energy pricing and regulatory policies. In most AID countries, large electric utilities are not very interested in decentralized power systems and hesitate to provide outside operators with adequate incentives, such as reasonable buyback rates.

## STRATEGY

AID Missions are becoming increasingly involved in power generation and concerned about the enormous financial and managerial problems of developing new electricity supplies. AID is planning considerable expenditures to help Pakistan, Egypt, and the Philippines handle their power expansion programs. In this context, decentralized power options appear increasingly attractive, but very little information and experience is available.

The objective of the Office's decentralized power initiative is to help remove bottlenecks to power supply for rural and small industry development in a timely and cost-effective manner. To achieve this objective, the Office of Energy has

defined a twofold strategy aimed at (1) providing technical assistance to Mission in small power planning and (2) developing host governments' understanding and ability to evaluate, together with the Missions and the international lending institutions, the benefits of small power systems. This strategy entails five major activities:

- Research and development of selected technologies in which the U.S. private sector is well positioned, especially in those technologies using local solid biomass resources to produce shaft power
- Demonstration of selected technology packages that can be widely disseminated
- Training of host government personnel
- Technical assistance to Missions and host governments
- Information gathering and dissemination.

Although most problems of power supply are site specific, some solutions can be sufficiently generalized to result in the development and dissemination of "packaged" systems applicable to many situations in different countries.

Implementation activities will focus on the preparation of bankable projects to be presented to lending institutions and widely publicized among AID countries.

The private sector will be the primary means of implementing this initiative. U.S. private organizations are expected to cooperate with local private organizations in developing durable business relations leading to self-sustaining activity. Traditional business arrangements such as joint ventures, complemented by opportunities to use innovative financing mechanisms such as third-party financing, are expected to ensure the development of decentralized power industries in a large number of AID-assisted countries.

## IMPLEMENTATION PLAN

Specific program activities will be closely coordinated with activities in the power sector of other local and donor organizations, particularly the World Bank and its affiliates. The implementation plan has been designed to develop the decentralized power alternatives to the point that private investors, other donors, and LDC governments

find them to be attractive alternatives to supply needed power.

Expected accomplishments include:

1. Preparation of a "Small Power Guide" to be made available to Missions and LDC private-sector companies (FY86 target).

2. Country-specific market assessments of selected power systems, with emphasis on readily available modular packages. Possible country applications for FY86: Pakistan, Philippines, India, Costa Rica; for FY87: to be determined.

3. Organization of a Technology Transfer Team for small power systems (<5 MW) and visits to two countries each year. Possible country applications for FY86: Pakistan, India; for FY87: Philippines, Costa Rica.

4. Prototype assessments on the role of small power systems in power master plans as an option for supplying power for rural and industrial development. Possible country applications for FY86: Pakistan; for FY87: India.

5. High level policy seminars on the role of decentralized power systems in development. Jointly held with Missions, regional bureaus, and host governments. Possible country applications for FY86: Pakistan, India, Egypt, Madagascar. (FY86 and FY87 target).

6. Development of a detailed program for small power systems (up to 5 MW) in AID countries (FY86 target)

7. Pre-investment packages for several decentralized power systems, including small hydro and solid biomass-fueled projects. Possible country applications for FY86: Madagascar, Costa Rica, Egypt, Pakistan; for FY87: India, Latin America, and others to be determined.

8. R&D program conducted in conjunction with U.S. private sector to develop better technology options enabling AID-assisted countries to convert solid fuels (e.g., wood, agricultural residues) into shaft power on a small scale (FY87 target).

**AID OFFICE OF ENERGY**
Initiative Paper No. 12
Priority Area: Power Systems Development

# STRATEGY FOR SMALL UTILITY-SCALE POWER SYSTEMS

## INTRODUCTION

The LDC market for modular power systems in the 5-50 MW range is dominated by diesel engines, followed by conventional oil-fired boiler/steam turbine systems. Low- and medium-speed diesels are the prime movers most frequently used in the thermal generating plants of small power systems. Diesels are used extensively because they have cost and efficiency advantages over gas turbines and steam engines in the same size range. In addition, more developing country personnel are skilled in diesel plant operation than in the operation of competing systems.

This paper discusses how AID's development goals will be served by power systems using indigenous energy sources that compete directly with systems using imported fuels such as light distillates and residual fuel oils. The paper outlines a strategy to implement the benefits of predominantly grid-connected modular power systems. and describes plans for major accomplishments in specific countries. This initiative shares many features with initiative 11, "Industrial and Village-Scale Power Systems," but the larger scale and higher level of investment require substantially greater resources for pre-investment and pre-feasibility work.

## RATIONALE

A rapid increase in the supply of power will be required to meet AID's development goals and remove energy bottlenecks to development. Increasing power supplies by conventional approaches, such as building centralized stations and transmission and distribution systems or deploying more diesel engines, is prohibitively expensive for most AID-assisted countries. Small utility-scale power systems, however, can play an important role in meeting the power needs of large rural and urban populations. These systems have several advantages:

- They can be installed twice as fast as larger, centralized systems

- They can use local energy resources (e.g., hydro, biomass) even when available in limited quantities
- They are available as shop-fabricated, pre-packaged systems, which can be shipped to the site and easily assembled
- They do not require extensive and costly transmission and distribution networks.

In addition, an individual system can provide enough power to meet the needs of hundreds of thousands of people. Because of these advantages, small utility-scale power systems are attractive to local governments eager to find ways of making a significant and viable impact on productivity and employment.

The Office of Energy, through its involvement in Jamaica, Pakistan, the Philippines, and other countries, has acquired expertise in integrating power sources with important development needs. For example, the Office is working with the Africa Bureau and REDSO/East Africa to leverage investment in small to medium hydropower in Madagascar, and is working to bring about investment in "fuel cane" production in Jamaica and other Caribbean countries.

Through the Energy Planning Development and Conservation (EPDAC) project, the Office of Energy has access to expertise in power systems planning, marketing, pre-investment analysis, financing, private-sector involvement, and policy formulation. In cooperation with the appropriate regional bureaus, the EPDAC project is involved with power-sector planning and rehabilitation in Liberia and Somalia, with an assessment of rural electrification in Bangladesh, and with policies to promote private-sector investment in power generation in Pakistan, India, and the Philippines.

## System Fuel Options

The indigenous resources that can fuel small utility-scale power systems are biomass, coal, gas, hydropower, and hybrid combinations of this group with diesel.

These options are briefly described below.

## Biomass

Studies sponsored by the World Bank and AID indicate that power can be produced economically and in significant quantities from bagasse, the fibrous residue from sugar cane extraction. Bagasse has been traditionally burned by sugar mills to produce process steam and generate power. Recent studies have identified several ways to greatly increase the overall efficiency of existing mills, produce more bagasse per acre of sugar cane, and generate electricity for sale to the grid. In the World Bank study, the economic returns from bagasse power generation were well over 10 percent at a selling price of 6 cents per kilowatt hour. Bagasse power generation projects are being planned by the World Bank and AID in Jamaica, Guyana, Mauritius, and other sugar-producing countries. Power from bagasse combustion is currently used by the sugar industry in some 76 countries to meet its own requirements, but there is significant potential to meet public power needs as well.

In Jamaica, for example, a preliminary study sponsored by AID concluded that the Jamaican sugar industry can become highly profitable by managing cane production for electricity generation as well as for sugar and molasses production. The study recommended a pilot project entailing the introduction of agricultural practices that could double the yield on 20,000 acres of land, the improvement of milling facilities, and the construction of a high-efficiency, 45-MW power plant. The project will transform a deeply distressed sugar estate to profitable status, and is expected to save approximately $27 million per year in foreign exchange by the fifth year.

The use of wood and crop wastes as fuel for power generation is well established in the wood and food processing industries, but new efforts are required to harness these resources for public power. Power generation from urban waste should also be explored.

## Coal

The economics of coal-based generation systems will depend on plant size, technology (such as atmospheric fluidized beds), and the opportunity cost of coal. Smaller coal units are competitive with diesel-fired units under very good pit-head conditions. World Bank figures show that about 30 developing countries are expected to use coal to generate electricity by 1995, with about a dozen of these countries relying on coal for over one-third of their electricity requirements.

## Natural Gas

Natural gas reserves exist in about 50 developing countries, including 30 that import oil. The World Bank projected a four-fold increase in natural gas production in developing countries between 1980 and 1985. In Bangladesh and Pakistan, gas is expected to supply about half the growth in commercial energy consumption over the next decade. Over this period, developing countries are expected to use more than 50 percent of their gas to produce electric power. Increased and more efficient use of natural gas can greatly reduce oil imports and help increase oil exports in AID-assisted countries.

Gas turbines are economic for peaking purposes in gas-producing countries. Base-load electricity from gas-fired steam turbines can cost less than 3 cents per kilowatt hour when gas is priced at $2.50 per million Btus. Combined-cycle power plants could be even more cost-effective. Combustion turbines located near wellheads could be used to produce electricity in gas-rich AID-assisted countries such as Bangladesh and Indonesia.

Hundreds of megawatts of low-cost electricity for West Africa could be produced from gas that is currently flared in Nigeria. An AID-sponsored workshop in West Africa identified this as an area worth pursuing.

The use of natural gas for power production should occur within the context of an overall natural gas strategy. Aspects of this strategy are discussed in the initiative on natural gas use.

## Small to Medium-Scale Hydropower

Decentralized hydropower is among the most promising of the renewable energy technologies. It is a resource found in a wide geographical area, including a significant number of AID-assisted countries. For example, the decentralized hydropower potential of Thailand has been estimated by the government to exceed 1,000 MW, which is almost as much as the total installed capacity from all sources and plants. Of this decentralized power potential, only 20 MW have been or are being developed. Burundi, which has a small hydropower potential of 460 MW, including about 30 MW of capacity currently operational and under construction, relies on small hydropower to meet virtually all its electrical power needs.

The versatility of hydropower and the spin-off benefits associated with this technology significantly broaden its potential. It can serve many purposes other than merely generating additional electrical power for developing countries.

Large-Scale Solar and Wind

Solar and wind systems producing megawatt-scale power -- solar thermal power plants, solar photovoltaic installations, and wind farms -- are likely to have restricted application in developing countries over the next decade.

## STRATEGY

AID Missions are becoming increasingly involved in power generation and increasingly concerned about the enormous financial and managerial problems caused by the extension of power networks. AID plans considerable expenditures to help Pakistan, Egypt, and the Philippines handle their power expansion programs. In this context, small utility-scale power systems appear increasingly attractive, but little information and experience are available about their application in LDCs.

The objective of the Office's small utility-scale power initiative is to succeed in demonstrating the viability of small utility-scale projects in LDCs. To achieve this objective, the Office of Energy has defined a twofold strategy aimed at (1) providing technical assistance to Missions in small utility-scale power planning and (2) developing the understanding and ability of host governments, Missions, and international lending institutions to evaluate the benefits of such systems. This strategy entails five major activities:

- Market research for selected technologies in which the U.S. private sector is well positioned, especially in those technologies using local solid biomass resources to produce shaft power
- Demonstration of selected technology packages that can be widely disseminated
- Training of host government personnel

- Technical assistance to Missions and host governments, especially in the preparation of pre-investment packages

- Information dissemination.

Although most problems of power supply are site specific, there are lessons that can be sufficiently generalized to the development and dissemination of systems in different countries.

Strategy implementation activities will focus on the preparation of prefeasibility studies to be presented to lending institutions and widely publicized among AID countries. These prefeasibility studies will be prepared with the objective of being used by other parties to prepare bankable projects.

The private sector will be the primary means of implementing this initiative. The Jamaica 45-MW project based on field cane will be used as a pilot. U.S. private organizations, including U.S. electric utilities, are expected to cooperate with local private organizations in developing durable business relations leading to a self-sustaining activity. Traditional business arrangements such as joint ventures, complemented by opportunities to use innovative financing mechanisms such as third-party financing, are expected to ensure the development of decentralized power industries in a large number of AID-assisted countries.

## IMPLEMENTATION PLAN

AID in general and the Office of Energy in particular have less leverage to affect decisions related to power-sector development than international lending institutions such as the World Bank. These institutions clearly have the lead in this area, especially for the higher range of power considered here (e.g., 25-50 MW). The Office will therefore carry out most of its activities in close collaboration with these institutions, and will search for co-funding for some of the most costly activities (e.g., demonstrations). This approach will avoid duplicative efforts and increase the chance that bankable project proposals will find investors.

Major accomplishments expected include:

1. Detailed program plan for Office of Energy activities in small utility-scale power systems, including needs assessments, in AID-assisted countries (FY86: target).

2. Prototype market assessments of selected systems, with emphasis on readily available modular packages such as combined-cycle and biomass-fired steam systems. Possible country applications for FY86: Pakistan, Philippines, India; for FY87: to be determined.

3. Organization of a Technology Transfer Team for small power systems (5-50 MW) and visits to two countries per year. Possible country applications for FY86: Pakistan; for FY87: India.

4. Prefeasibility studies for two or three projects, including one or two projects based on conventional fossil fuels (e.g., combined cycle using natural gas) and one or two projects using solid biomass (e.g., bagasse from sugar cane) as a fuel. Possible country applications for FY86: Egypt, Pakistan, Jamaica; for FY87: India, Latin America, and others to be determined.

5. Training of personnel from AID-assisted country utility systems trained in small utility-scale power at U.S. utilities such as Southern California Edison and Pacific Gas and Electric (FY86 and FY87 target).

6. Participation in one or two prototype demonstration projects selected from results of technology transfer team visits. Possible country applications for FY87: Pakistan, India.