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

PROGRAM PLAN

FISCAL YEARS 1989 AND 1990

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OFFICE OF ENERGY
PROGRAM PLAN
FISCAL YEARS 1989 AND 1990

TABLE OF CONTENTS

CHAPTER I:
INTRODUCTION

A. ENERGY AS AN INPUT FOR DEVELOPMENT 1
B. PROBLEMS OF ENERGY PRODUCTION AND USE 2
Economic Effects 2
Environmental Impacts 3
C. THE ROLE OF A.I.D. AND THE OFFICE OF ENERGY 4
D. BUDGET, ORGANIZATION, AND STAFFING OF THE OFFICE 8
Project Control System 12
Outreach and Information Dissemination Program 13
Support Agreements and Contracts 15

CHAPTER II:
ENERGY POLICY AND PLANNING

A. RATIONALE 17
B. STRATEGY 18
The Multi-Agency Group on Power Sector Innovation (MAGPI) 19
Investment Planning Under Capital Constraints 19
Electric Utility Performance Improvement Initiative 20
Energy Price Reform 21
PACER--The Program to Accelerate the Commercialization of Energy Research 22
Rural Power Delivery 23
Environmental Management of Energy Conversion 23

CHAPTER III:
ENERGY EFFICIENCY AND CONSERVATION

A. RATIONALE 25
B. STRATEGY 27
Energy Conservation and Demand Management in Power Systems 28
Energy Conservation and Demand Management in Industry 29
Energy Conservation and Demand Management in the Building and Transportation Sectors 31

CHAPTER IV:
RENEWABLE ENERGY FOR RURAL DEVELOPMENT

A. RATIONALE 33
B. STRATEGY 34
C. RENEWABLE ENERGY APPLICATIONS AND TRAINING 36
Targeted Project Level Support for Commercialization 36
Policy Guidelines and Institutional Framework 37
Information Dissemination and Training 38
Support to A.I.D. Field-Mission Activities 40
D. BIOMASS-FIRED ELECTRICITY GENERATION 40
Implementation of Target Projects 41
Exploration of New Potential Projects 41
Program Development 42

CHAPTER V:
INDIGENOUS FOSSIL FUELS AND ADVANCED TECHNOLOGY

A. RATIONALE 44
B. STRATEGY 44
Resource Assessment and Development 45
Technology Innovation 46

CHAPTER VI:
PRIVATE SECTOR PARTICIPATION IN THE POWER SECTOR

A. RATIONALE 49
Shortage of Public Investment Capital 49
Inefficient Parastatal Institutions 50
Inappropriate Government Policies 50
Lack of Experience with Private Power 50
High Risk and Expense of Developing Private Power Projects 51
B. STRATEGY 51
Policy Reform and Institutional Development 52
Private Energy Project Development 53
Program Coordination 54

CHAPTER VII:
TRAINING

A. RATIONALE 55
B. STRATEGY 55
Energy Policy and Analysis 56
Energy Conservation 57

Indigenous Fossil Fuel Development 57
Rural Power Systems 58
Cross-Cutting Themes 58

APPENDIX: Selected Reports of the Office of Energy 59

CHAPTER I

INTRODUCTION

The goal of the Agency for International Development (A.I.D.) is a world in which economic growth and development are self-sustaining and the extremes of poverty have been eliminated. Energy is a critical input to attaining those goals.

The Office of Energy, in A.I.D.'s Bureau for Science and Technology, shares with the Agency's Missions and Regional Bureaus the responsibility for helping assisted countries obtain appropriate energy services. This Program Plan explains the programs of the Office in pursuit of that goal and how the Office is organized to implement those programs.

This introductory chapter briefly describes the importance of energy in development and how energy pertains to the overall emphases of A.I.D. The chapter also summarizes the chief problems that LDCs encounter in obtaining sufficient energy, outlines the general role, goals, and programmatic themes of the Office of Energy, and then explains how the Office is staffed, budgeted, and organized.

A. ENERGY AS AN INPUT FOR DEVELOPMENT

Energy in its many forms provides services essential to development. Society needs energy to heat, cool, and move objects and materials, for production, communication, comfort and health, and needs a special form of energy--electricity--for lighting and power.

Primitive economies develop with human muscle; slightly more developed societies use animal muscle. The average citizen in countries assisted by A.I.D. has access to only 50 watts of electric power--less power than can be generated by one human being. In contrast, each citizen in the U.S. has access to approximately 3,000 watts, the equivalent power of forty human beings.

To lend focus to the ultimate goal of economic growth and development, A.I.D. aims its efforts at six chief problems in the less developed countries (LDCs): inadequate income growth; hunger; health deficiencies, especially infant mortality; illiteracy and lack of education; unmanageable population pressures; and environmental and natural resource degradation.[1]

Achievement of the goals for each of these six problem areas involves energy. Increased income growth means economic growth, which requires additional energy services. Allaying hunger requires energy for cooking as well as for greater agricultural productivity, and the agricultural sector requires several forms of energy input--for

[1] See *Blueprint for Development: The Strategic Plan of the Agency for International Development* (U.S. Agency for International Development, Washington, D.C.).

irrigation, for operation of on-farm equipment, for processing, and for transport and distribution. The third area--health--requires important energy input in order to deal with specific health problems (pumping of safe drinking water or refrigerated storage of vaccines, for instance) that are particular challenges when dealing with regions not connected to utility grids.

The fourth and fifth areas, education and family planning, require obvious energy services--electricity for lighting, space heating at facilities, and transportation energy for moving staff and materials around. And the last area, maintaining the environment and natural resources, requires greater energy efficiency, increased use of renewable resources and cleaner technologies for fossil fuel combustion, and the application of improved fuelwood substitutes.

Considerable amounts of energy are needed to meet income and food goals. A.I.D.'s quantitative goals for the assisted LDCs are a sustained 2 percent per capita growth in income and 3.7 percent annual growth in the agricultural sector.

Based on past trends, meeting these development targets would require the continued availability of energy services in A.I.D.-assisted countries.

- Analyses of development experience indicate that each increase of 1 percent in Gross Domestic Product (GDP) has historically required an increase of 1.3 percent or more in energy inputs. At this ratio, attaining A.I.D.'s goal of a 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 5.8 to 7.8 percent. With highly efficient energy uses, this rate can be reduced to 4.1 to 5.4 percent.

- Similarly, the Agency's goal of increasing caloric intake would require agricultural growth of 3.7 percent per year, according to the Food and Agriculture Organization. Each increase of 1 percent in agriculture requires an additional energy input of more than 2 percent. Thus, if A.I.D. 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.

B. PROBLEMS OF ENERGY PRODUCTION AND USE

Energy resources and energy conversion are not free, and the costs--economic and environmental--present a myriad of problems.

Economic Effects

Most of the swelling demand for energy will be met in the mid-term by imported oil. Three-quarters of A.I.D.-assisted countries rely on oil for 50 percent or more of their commercial energy requirements. These imports create a serious foreign exchange problem. Low-income countries use 20-30 percent of their export earnings for energy

imports. This drain, coupled with the serious debt crisis, leaves little for investment in agriculture, industrial development, and other critical development programs.

One of the fastest growing portions of the energy sector is electricity. During the past couple of decades, electricity capacity in LDCs has been growing at a rate of greater than 7 percent. India, A.I.D.'s largest assisted country, has been expanding at greater than 9 percent per year. But these rates of growth are probably unsustainable for financial reasons. LDCs invest an average 25 percent of their total development investment budget in electricity infrastructure. Because much of the equipment needs to be imported, and much of the money needs to be borrowed abroad, this represents another significant draw on foreign exchange.

An overwhelming majority of electric utilities in LDCs are operating at a loss; not only because of subsidized electricity tariffs but also because of dramatically inefficient operations. This puts added strain on government budgets that are usually already severely strained.

The fact that developing countries need more electrical power for sustainable social and economic development than they are able to produce is demonstrated dramatically by frequent power shortages, which exist in over half of A.I.D.-assisted countries. In Pakistan, for example, power shortages have reached a level of 25 percent over demand at peak hours of usage. Load shedding in Pakistan has led to a 1.8 percent decrease in gross domestic product and a 4.2 percent decrease in the country's foreign exchange earnings. In India, the current 10 percent average cut in power to the industrial sector, accomplished by load shedding, is estimated to cause an average annual production loss of over $6 billion--equivalent to 12 percent of the country's industrial output.

The Food and Agriculture Organization reports that nearly half the world's population today lives in areas where fuelwood is acutely scarce, and yet a majority of these people depend on fuelwood for the bulk of their energy needs. If current trends continue, up to 3 billion people (about half of the world's population) 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 price rises place an intolerable burden on those least able to afford it.

Environmental Impacts

Most forms of energy conversion extract an environmental cost. In economic terms, these costs are often difficult to track, but they affect the health of numerous ecosystems that in one way or another are critical to human welfare.

Particular environmental effects depend on the energy source and the technology used. For example, the construction and operation of hydropower facilities can contribute to deforestation, saltwater intrusion, and increased human diseases. The inundation caused by large dams can require significant human resettlement. Fossil fuels can pollute land and water during the extraction stage and cause atmospheric degradation--air pollution,

acid deposition, and global CO_2 buildup--and thermal water pollution resulting from the conversion process. The harvesting of fuelwood sometimes accelerates deforestation, which creates a host of additional environmental problems, including soil erosion, flooding, and the loss of species' habitats, biological diversity, and agricultural productivity. And the combustion of fuelwood and dung in enclosed spaces can pose a serious threat to human health from indoor air contamination. Taken together, fossil fuel conversion and the depletion of forests are prime culprits in the increased atmospheric CO_2 associated with global warming. The potential implications of this trend are many and dramatic. Effectively counteracting all of the negative consequences outlined above requires that environmental considerations be included in energy development plans.

C. THE ROLE OF A.I.D. AND THE OFFICE OF ENERGY

The Agency'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, A.I.D. 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 economically and environmentally wise energy-system choices and investment decisions.

The design and implementation of A.I.D. projects to help meet the development goals of assisted countries are primarily the responsibility of the A.I.D. Missions in the individual assisted countries. Numerous energy-related issues are considered and acted upon, then, at the Mission level.

Mission staffs confront a broad array of problems and face inevitable constraints on gaining access in the many relevant disciplines to the latest ideas and technologies, and lessons learned in other countries. The Office of Energy, as the other specialized offices in the Bureau for Science and Technology, plays a crucial 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 helps formulate energy policy for the Agency.

The *Foreign Assistance Act*,[2] which authorizes A.I.D.'s activities, notes that the purpose of much of the assistance provided to the agricultural, industrial, social service, and other sectors in developing countries by A.I.D. is undermined by the inability of many of these countries to satisfy their energy requirements.

The *Foreign Assistance Appropriations Act of Fiscal Year (FY) 1989*[3] elaborates this policy goal of overcoming energy shortfalls, as well as the need to reduce negative

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[2] Foreign Assistance Act of 1961, as amended.

[3] FY 1989 Foreign Operations, Export Financing, and Related Programs Appropriations Act (Public Law 100-461).

environmental impacts, especially the increasing CO_2 buildup attributable to developing nations, in order to sustain development. In addition to acknowledging their crucial role in economic growth, the Act underlines the importance of energy projects to achieving the Agency's goals in private sector development, science and technology, and trade and investment.

In response to these Congressional concerns, A.I.D.'s energy program focuses on three primary areas--energy efficiency, private sector involvement in the energy sector, and the expansion of energy supplies, especially electricity for rural areas.

Over the next twenty years, energy use in the LDCs is anticipated to grow by a factor of three to five, much faster than in the industrialized countries. A major reason for this comparatively high projected energy growth rate in LDCs is the lack of energy efficiency, or put another way, the large amount of energy expended for each dollar of Gross National Product (GNP), found in LDC economies.

As pointed out in A.I.D.'s 1988 *Report to Congress, Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector*, under a "current trend" scenario that assumes a medium economic growth rate of 4.5 percent per year, 1,500 GW (gigawatts) of additional generating capacity and related transmission and distribution facilities would be needed by the year 2008 in order to meet a projected annual electricity growth rate of 6-7 percent, costing over $125 billion per year (compared with the estimated $50-$60 billion currently being spent per year). However, under a "conservation" scenario that incorporates various efficiency measures and assumes the same medium economic growth rate of 4.5 percent per year, developing countries could satisfy their demand for electricity and reduce the need for additional generating capacity to 700 GW. This amounts to less than half the projected capacity needed if present trends continue and would cost $75-$110 billion per year. (The resulting savings in energy with conservation--800 GW--are depicted in Exhibit 1 on page 6.) Even with high economic growth assumed, additional generating capacity needs could be reduced to 1,200 GW by the year 2008.

While concluding that energy efficiency has crucial economic benefits, the *Power Shortages* report downplays the likelihood that sufficient investment capital will be available in future years from traditional sources to support a continuation of the abovementioned growth rates in electrical generation capacity. As a result of these findings, A.I.D. is targeting private sector investment to provide the necessary capital to overcome these shortfalls. The Agency's initiatives in this area are detailed in Chapter VI.

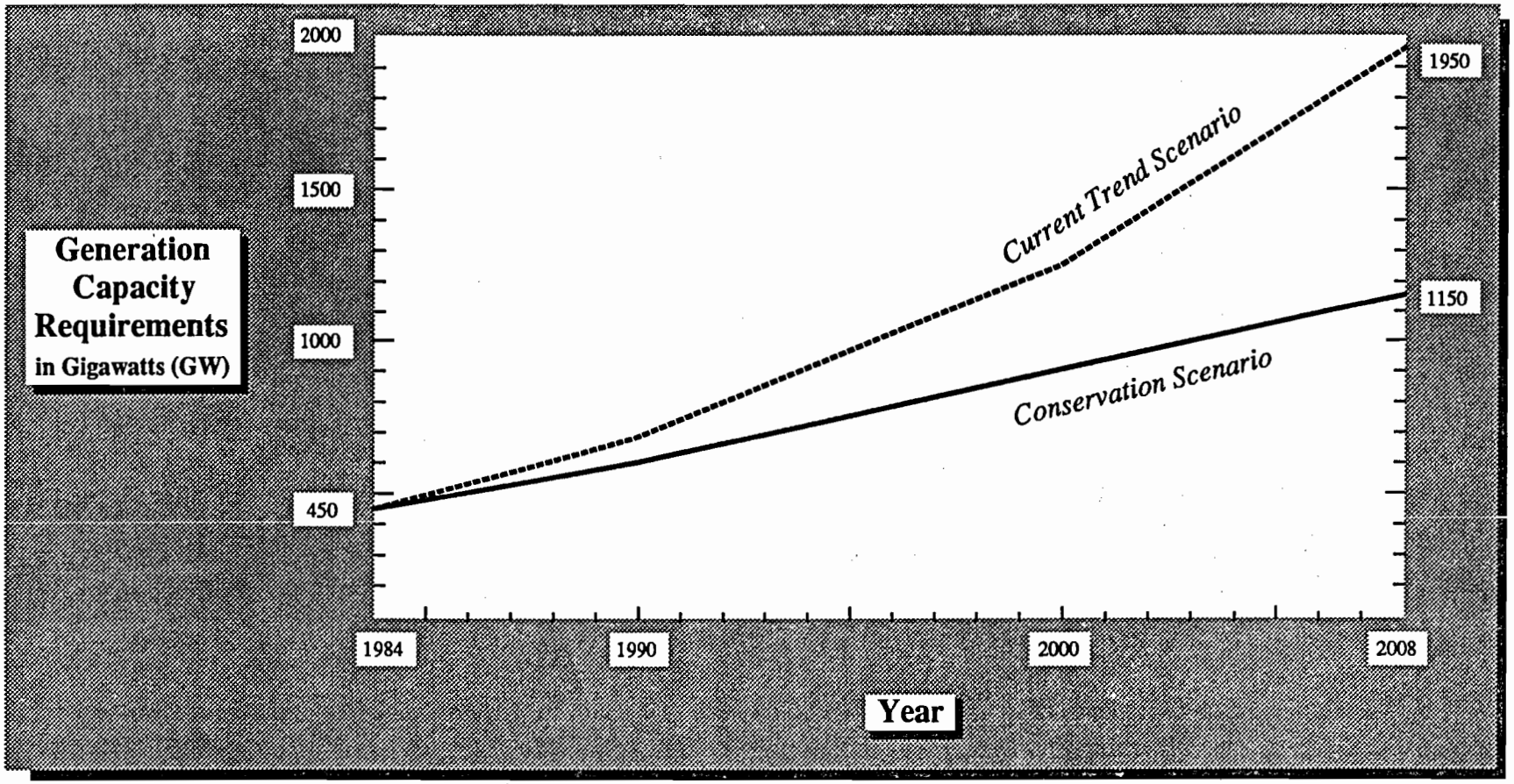
To carry out its responsibilities, the Office of Energy has set four goals and corresponding objectives:

1. **Goal: Reduce economic instability resulting from the cost of oil imports**

   Objectives: Expand use of indigenous energy, both fossil and renewable; increase efficiency of energy systems.

Exhibit 1

Projected Electricity Generation Capacity Requirements in Developing Countries to Year 2008



Source: *Power Shortages in Developing Countries: Magnitude, Impact, Solutions, and the Role of the Private Sector*, a report to Congress, U.S. Agency for International Development, Washington, D.C., March 1988.

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

   Objectives: Satisfy basic energy needs of rural populations for cooking and heating; agriculture; and for 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.

4. **Goal: Increase consideration of environmental criteria**

   Objectives: Integrate environmental criteria into the energy planning process; encourage efficient energy conversion; promote the use of less environmentally damaging energy sources and conversion processes when cost-effective.

Each of these programmatic themes is addressed in the following chapters. In some cases, cross-cutting themes such as efficiency and private power are mentioned in more than one chapter. Both of these themes are emphasized whenever appropriate in implementing the Office's other programs; efforts in these realms are described in Chapters III and VI, respectively. In addition to these programmatic themes, an important methodological approach to development assistance is training. By cutting across all of these themes, training represents a generic and integral component of the Office's individual themes and projects. Training programs help build the institutions of LDCs for the long haul, and have always been a critical part of A.I.D.'s work. The Office's training efforts are described at the end of this document in Chapter VII.

This Program Plan outlines and schedules the actions that the Office of Energy intends to take to help ensure that sufficient energy is available to meet the Agency's development targets. The plan covers the current fiscal year, FY 89, and the following year, FY 90.

The Program 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 accord with the objectives of the Agency and the Bureau for Science and Technology. It specifies near-term achievements expected of the Office. It is a guide for resource allocation among Office projects. It sets priorities for the Office and describes where special emphasis will be placed. It provides an indication of the resources available from the Office to the Missions to support initiatives with host countries. It also serves to describe the Office program to interested persons outside the Agency.

The planning of Office activities incorporates input from within and outside the Office of Energy. The Office's Director and various program managers solicit the views of other individuals in the Bureau for Science and Technology, specialists in A.I.D.'s regional Bureaus and Missions, individuals from private companies, universities, the non-profit

environmental and development communities, the National Laboratories, the World Bank, the Inter-American Development Bank, and energy experts from LDCs.

Much of this Program 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 for developing novel approaches to old problems or adapting tested solutions to new problems. Considerable additional analysis is thus required to complete the design and planning of any program activity. This analysis will continue over the coming year in the detailed program plans for each initiative, and in some cases, for major components of an initiative.

D. BUDGET, ORGANIZATION, AND STAFFING OF THE OFFICE

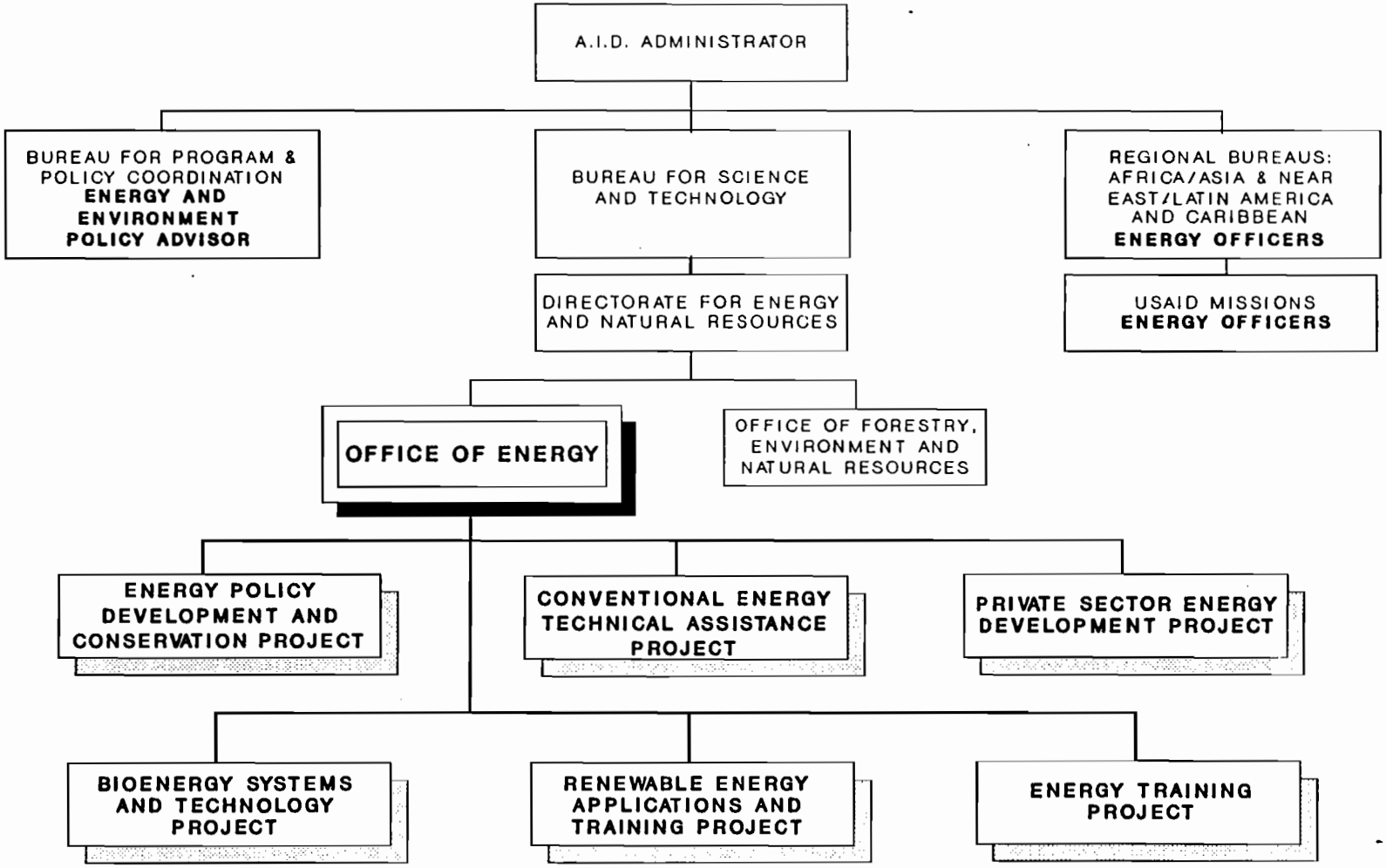
The Office of Energy's total budget for FY 89 is $10 million; the estimated budget for FY 90 is $9 million. The programmatic themes discussed above are addressed in the Office of Energy's six "active" projects, which correlate with the budgeting and organizational structure of the Office. The organizational relationship of the Office and its projects to the Agency's overall framework for energy assistance is portrayed in Exhibit 2 on page 9.

The organization of the Office provides a framework for assigning responsibilities to the staff to ensure that the objectives of the various themes, projects, and initiatives as described above are met. The Office consists of the following staff persons and project assignments:

Director:	James Sullivan
Deputy Director:	Alberto Sabadell
Senior Physical Scientist:	David Jhirad
Energy Systems Analyst:	Ross Pumfrey
Program Operations Specialist:	Shirley Toth
Program Operations Specialist:	Carolyn Kiser
Senior Energy Advisor:	John Hammond
Senior Energy Consultant:	Robert Grimshaw
Energy Policy Analyst:	Ken Feldman
Research Assistant:	William Polen

Exhibit 2

ORGANIZATIONAL CHART OF ENERGY ASSISTANCE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT



All the program themes or activities described in the following chapters comprise one or more of these projects and their relatively discrete activities:

1.(a) **The Bioenergy Systems and Technology Project** (936-5709)

Project Manager: James Sullivan

This project funds efforts to use biomass, especially the residues of common agricultural crops and woodwastes, for electricity generation. Project activities include applied R&D, commercial feasibility analysis, and solicitation of LDC private investment, as summarized in Chapter IV.
FY 89 Budget: $ 0

Years of Project Life: FY 79 - FY 89

(b) **The Biomass Energy Systems and Technology Project** (536-5737)

Project Manager: James Sullivan

This project replaces and continues the work performed under the abovedescribed Bioenergy Systems and Technology Project, which terminates at the end of FY 89.

FY 89 Budget: $ 2.17 million

Proposed FY 90 Budget: $ 1.8 million

Years of Project Life: FY 90 - FY 95

2. **The Conventional Energy Technical Assistance Project** (936-5724)

Project Manager: Alberto Sabadell

This project funds programs that apply U.S. advances in energy technology to the developing world and assists countries to develop and more efficiently utilize their indigenous conventional energy resources in order to reduce their reliance on imported oil. These activities are described in Chapter V.

FY 89 Budget: $ 0.975 million

Proposed FY 90 Budget: $ 0.7 million

Years of Project Life: FY 80 - FY 90

3. **The Energy Policy Development and Conservation Project** (936-5728)

Policy and Planning Development Project Manager: David Jhirad

Conservation Project Manager: Alberto Sabadell

This project is divided into two sub-projects: the Energy Policy and Planning Development project, which funds several areas of policy and planning work, as summarized in Chapter II, and the Energy Conservation Services project, which funds the Office's efforts in efficiency and conservation, as described in Chapter III. The planning portion of this project also contributes some of the funding for work in household fuels (described in Chapter IV).

FY 89 Budget: $ 2.655 million

Proposed FY 90 Budget: $ 2.1 million

Years of Project Life: FY 82 - FY 92

4. **The Renewable Energy Applications and Training Project** (936-5730)

Project Manager: David Jhirad

This project funds feasibility studies for commercial applications of renewable energy technology (in addition to the biomass-fired power outlined above), with an emphasis on private sector participation, various rural and agricultural activities, including household fuels, and a variety of publications to facilitate the successful diffusion of appropriate technologies. The project also funds some of the activities covered in Chapter IV and shares funding for household fuels work with the preceding project.

FY 89 Budget: $ 0.5 million

Proposed FY 90 Budget: $ 0.9 million

Years of Project Life: FY 85 - FY 92

5. **The Energy Training Project** (936-5734)

Energy Training Project Manager: Shirley Toth

This project funds the administration of the training program described in Chapter VII.

FY 89 Budget: $ 2.2 million

Proposed FY 90 Budget: $ 2.0 million

Years of Project Life: FY 87 - FY 92

6. **The Private Sector Energy Development Project** (936-5738)

Project Manager: James Sullivan

This is a new project designed to facilitate private sector investment and expertise in the energy sectors of LDCs, with initial emphasis on the electricity subsector. The project, which is directed ultimately at overcoming current and imminent power shortages in LDCs as documented in the Office's aforementioned *Power Shortages* report, is described in Chapter VI.

Proposed FY 90 Budget: $ 1.5 million

Years of Project Life: FY 90 - FY 94

Because of overlapping interests and a desire to tap available expertise in a cooperative fashion, small amounts of funds from one project are sometimes expended in providing assistance to a program that is managed by another project. The technological and financing expertise of persons working for the Conventional Energy Technical Assistance Project, for instance, is solicited to assist the Biomass Energy Systems and Technology Project in its development of sugarcane-fired electricity.

The Office's own budget is 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 estimates the level of "buy-ins" for all program activities will be approximately $3-5 million in FY 89 and FY 90.

Project Control System

The Office has a formal project control system; which tracks the status of contract obligations and expenditures; provides monthly, quarterly, and annual status reports, including tracking of deliverables and other milestones; and provides information on Mission requests and buy-ins. The system uses a D-Base III+ program format on the Office's Wang PC. The Office has prepared a manual that specifies in detail the procedures for this system and the computer hardware and software requirements.

The Office is moving in an incremental, participative manner towards a more comprehensive management information system in order to take account of the differing needs of the Office's project managers. The system will include publications and other relevant project items. Designed to be compatible with both Wang and IBM hardware, the

system will facilitate the handling and communication of a wide range of program information.

Outreach and Information Dissemination Program

The objectives of the outreach and information dissemination program are two-fold:

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

- 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:

- A program planning outreach effort;
- A publications program;
- Systematic Mission briefings;
- Private-sector technology transfer teams; and
- Regional topical workshops.

Program Planning Outreach Efforts

The Office periodically convenes small ad-hoc groups of experts from other international institutions (e.g., the World Bank, the United Nations, the Inter-American Development Bank), the private and non-profit sectors, and within the Agency to guide its program planning activities and assist in program implementation and outreach. An example is the Multi-Agency Group on Power Sector Innovation (MAGPI). During FY 89 this group will pursue better environmental management within LDC energy sectors.

Publications Program

The second major element of the outreach/information strategy is the timely and systematic publication of reports resulting from contracts issued by the Office. At least twice a year, the Office program activities are 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 employs a standard cover, irrespective of whether authorship rests with the Office, its contractors, or affiliated government organizations. A catalog of reports available from the Office is published once a year. (A list of available Office of Energy publications appears in the Appendix). As part of this activity, the Office has developed a microcomputer-based mailing list, updated as necessary,

that allows it to target its publications to specific audiences in the international development community.

In addition, the Office will publish in 1989 for the first time two high-quality brochures targeted at several internal and external audiences that explain the Office's activities, accomplishments, and major initiatives.

Systematic Mission Briefings

Periodically, the Office notifies Missions and Regional Bureaus by cable about particular kinds of support that are available from the Office (such as assistance with policy dialogues related to energy price reform and with environmental analysis for energy investment proposals). In addition, from time to time Office staff traveling to assisted countries provide briefings for Mission staff on Office activities of interest to the Missions.

Private-Sector Technology Transfer Teams

The transfer of technology is a critical element in development assistance, and for this reason the Office sponsored in 1986-87 the creation of private-sector Technology Transfer Teams to assist A.I.D. in designing projects that can be financed and implemented by the private sector. The projects were intended to serve as prototypes for other private-sector initiatives, while at the same time pursuing the transfer of know-how, technology, and financial resources between U.S. private-sector parties and those in developing countries. One of these teams, comprised of public- and private-sector experts, visited selected LDCs to discuss cogeneration, its applications, and potential benefits. The Office has identified and will hold discussions regarding potential additional business areas in which this concept could be tested.

In FY 89, the Office will implement a similar version of this concept by utilizing the extensive U.S. experience with private generation of power and interactions with utility systems. As described in Chapter VI, several teams comprised of Agency officials and upper-level representatives of U.S. utilities, architecture and engineering firms, and technology manufacturers will be assembled, under the aegis of the Administrator's Energy Industry Review Group, to conduct in-country visits to explore opportunities for privately financed and, in some cases, operated electric utilities in selected LDCs.

Regional Topical Workshops

Under the fifth component of the outreach and dissemination program, the Office of Energy either co-sponsors or actively participates in a series of workshops in collaboration with A.I.D.'s regional bureaus or other lending or donor agencies. The workshops focus on topics that are relevant, and of interest, to a specific region and are open to both public- and private-sector participants.

Workshops on the agenda for FY 89 and FY 90 include the following:

Co-Sponsorship

- o Workshop in Jordan in 1989 on oil shale-to-power, "Road Map to Commercialization"
- o Workshop in India in late 1989 or early 1990 on innovation in the power sector
- o Workshop in Indonesia in March 1989 on private power
- o Workshop in Jordan in Fall 1989 on private power
- o Workshop in India in early 1990 on the commercialization of energy research
- o Workshops in India, Kenya, or the Philippines in 1989 and 1990 on cane and/or rice energy opportunities
- o Workshop in Brazil in Fall 1989 on sugar cane-to-energy technologies

Participation

- o Workshop in California planned for Spring 1990 on private power (sponsored by the California Public Utilities Commission)
- o Workshop in West Africa in early 1990 on energy conservation and private power (initiated and organized by A.I.D.'s Regional Economic Development Support Office)

In addition to the five central components of the outreach and information dissemination program just reviewed, the Office will also pursue a number of other activities. For instance, the Office will continue to encourage its staff to publish articles for A.I.D. and external publications, and will examine the possibility of holding joint energy briefings with A.I.D.'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.

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 continually 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:

- Participating Agency Service Agreement (PASA) with Oak Ridge National Laboratory (approved through FY 92). 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 (REAT) project;

- Resources Support Services Agreement (RSSA) with Tennessee Valley Authority (approved through FY 89), which manages the Bioenergy Systems and Technology project;

- Contract with the Institute for International Education (IIE) to manage the Conventional Energy Training project (contract competitively selected in 1987 and ending June 1992);

- Contract with Hagler, Bailly & Company for technical assistance to the Energy Conservation Services Program funded under the EPDAC project (contract competitively selected in 1987 and ending July 1992); and

- Contract with Bechtel National for services to the Conventional Energy Technical Assistance project (contract competitively selected in 1985 and ending September 1990).

In addition to these multiyear contracts, the Office also uses purchase orders, indefinite quantity contracts, and 8(a) contracts[4] to carry out unforeseen and small jobs, when necessary. Based on past experience, approximately 15-20 purchase orders are likely to be needed in FY 89. The Office is also facilitating Missions' financial participation, or "buy-ins", in Office contracts and PASA agreements.

[4] 8 (a) contracts are with firms given preference in government contracting because of qualified "minority" ownership.

CHAPTER II

ENERGY POLICY AND PLANNING

A. RATIONALE

Even though the scope of the Energy Policy and Planning Development project embraces all aspects of the energy sector in developing countries, the major focus in FY 89 will be on the power sector.

Most developing countries are struggling to overcome chronic power shortages and poor power quality while supporting continued industrialization and extension of electricity services to their burgeoning populations. Inadequacies in the quality, reliability, and quantity of electricity hamper development and seriously compromise economic productivity. Yet vigorous economic growth in the developing world will require rapid growth and substantial improvements in delivered electricity services. This cannot be accomplished simply by embedding new capacity in poorly operated and managed power systems.

A.I.D.'s recent Report to Congress, *Power Shortages in Developing Countries,* which was cited in Chapter I, has highlighted the dilemma faced by many developing nations. These countries require continued growth in electric power supply to sustain economic development and modernization. Yet the traditional response to this need--that of concentrating on generation expansion--is likely to stall due to financial and capital constraints. As discussed in Chapter I, the Agency estimated that if developing countries are to meet a projected average annual electricity growth rate of 6 to 7 percent, 1,500 GW of new generating capacity will be required over the next 20 years. This implies a future annual investment on the order of $125 billion, compared with the $50-60 billion/year invested in the 1980s.

With aggressive but technically and financially feasible implementation of new efficiency measures in generation, distribution, and end-use, the 20-year need for additional generating capacity could be reduced to approximately 700 GW. Even with the maximum feasible implementation of efficiency measures, however, major expansion of fossil and hydropower capacity will still be necessary. Moreover, significant indigenous innovation will be required to increase the technical performance and financial viability of LDC electric utilities, in part through increases in power plant efficiency and capacity factors, reduced transmission and distribution losses, and significantly increased end-use efficiency in all sectors. Such measures also deliver electricity services in a more environmentally benign manner by reducing fuel use and applying advanced (i.e., more efficient and less polluting) power generation technologies.

B. STRATEGY

Introducing innovation into the LDC power sector will be the major strategic focus of this program. Innovative approaches to power sector investment planning, efficiency, environmental management, and price reform are currently underway and will continue during FY 1989.

The power sector strategy of the Office of Energy is designed to assist developing countries escape from the trap of escalating capital costs and deteriorating power system reliability, and to improve the efficiency and productivity of the electric power sector. The major emphasis will be on actual investment and policy decisions, and attention to implementation, as opposed to analysis conducted in isolation.

In addition, the program offers more general assistance to A.I.D. Missions and Offices in designing, maintaining, and evaluating energy projects and programs. For instance, the program provides assistance in designing the program energy components of Country Development Strategy Statements or in responding to inquiries or perspectives from internal or external parties.

The program's strategy will embrace the following elements:

- Strengthening and expanding the Multi-Agency Group on Power Sector Innovation (MAGPI);
- Promoting the concept of investment planning under capital constraints, including risk and uncertainty;
- Improving the performance of electric power systems in developing countries;
- Encouraging policies to ensure efficiency improvement and institutional reform;
- Developing and strengthening institutions to promote technology innovation and commercialization programs, such as the Program to Accelerate Commercial Energy Research in India (PACER). Promoting U.S./host country joint ventures in research, development, and manufacturing;
- Supporting technology assessment and prefeasibility studies, including options for rural power delivery; and
- Developing a program in environmental management.

The Office of Energy's specific programs and planned accomplishments in these areas are described separately below.

The Multi-Agency Group on Power Sector Innovation (MAGPI)

During the past year, A.I.D.'S Office of Energy has increasingly collaborated with other bilateral and multilateral donors and lenders, in helping to address the need for innovative power sector approaches under growing capital and environmental constraints. To facilitate this collaboration, the Office of Energy initiated the Multi-Agency Group on Power Sector Innovation (MAGPI) with the World Bank, the Inter-American Development Bank, the Asian Development Bank, the African Development Bank, the International Finance Corporation, and the United Nations. MAGPI is made up of about 15 senior decision-makers with operational responsibilities. At present MAGPI is restricted to bilateral and multilateral donor assistance agencies, although informal ties are maintained to private sector technology institutions.

The Office of Energy works closely within the MAGPI framework to identify and develop practical projects designed to catalyze innovation in the LDC electric power sector. In many of these activities, a technical and financial partnership with R&D (research and development) institutions and commercial organizations in the industrialized countries will be required to facilitate bankable projects.

A.I.D. is working with the multilateral development banks in identifying and conducting prefeasibility studies for specific energy projects that are innovative either in technology, application, or scale. An example is the collaboration of A.I.D., the Trade and Development Program (TDP), and the World Bank in the development of some 15 MW of minihydropower capacity in Madagascar, involving an investment of $20 million, and a collaboration with the Inter-American Development Bank involving bagasse-fired private power generation in Costa Rica.

Planned Accomplishment:

1. Conduct MAGPI meetings on environmental criteria in power sector investment decision-making.

Investment Planning Under Capital Constraints

The traditional approach of power planners in the developed and developing nations was to focus almost exclusively on finding the least-cost generation mix to meet growing power demands. Projects were deemed economically and financially sound based on traditional criteria such as the internal rate of return and the optimal power generation expansion plan. The growing reality of capital constraints, however requires a fundamental restructuring of this approach. Projects meeting the traditional criteria of economic soundness now confront these new and severe constraints.

Consequently, the notion of least-cost planning is being expanded to allow symmetrical treatment of all options, not just power generation. Conventional analytic tools for investment decision-making also require major modification. For example, the Wien Automated Systems Planning (WASP) model used throughout the world for capacity

expansion planning assumes that power demand is a given. In reality, the pace and composition of electricity demand are constrained by capital and determined by national policies on electrification. Furthermore, WASP determines the optimal capacity expansion plan for a given demand forecast and a specified "loss-of-load" probability in the generation system. Yet in many countries, outages are largely caused by distribution system failures.

The Office of Energy program is developing innovative approaches to meeting power demands in developing countries, including the use of microcomputer-based tools for comprehensive investment planning in India and Costa Rica, developed collaboratively with utilities in these countries.

Planned Accomplishments:

2. Complete comprehensive, least-cost investment planning projects in India and Costa Rica.

3. Provide tools to LDC decision-makers for evaluating public and private financing options.

4. Develop "bankable" proposals for power sector efficiency in Costa Rica as part of the Central America Energy Efficiency Initiative.

Electric Utility Performance Improvement Initiative

The level of performance of many utilities in developing countries is lower than what utilities in OECD (Organization for Economic Cooperation and Development) countries expect and routinely achieve. Maintenance, operations, accounting, billing, and planning practices all limit the ability of utilities in LDCs to deliver electricity for development. Typically, poor technical performance accounts for over 30 percent of the losses in delivered electricity in LDCs compared with 7-8 percent in the U.S.. Similarly, financial losses in LDCs often result in a negative return on assets in contrast to the positive return experienced by OECD countries. Improving these practices could allow the utility to improve service, reduce costs, and mitigate environmental impacts. Past efforts to improve performance have focused on training, and while improved training is often necessary, it has not been sufficient.

Improvement in performance will almost certainly require additional financial resources, but it is also likely to require changes in utility management practices and changes in attitudes by staff. Training courses sponsored by the Office, which are designed to facilitate such changes, are described in Chapter VI.

The Office of Energy will work closely with the World Bank and other bilateral donor agencies to gain a better understanding of organizational and institutional influences on utility performance. The findings of this study will allow A.I.D. and other donors to design effective strategies for improving organizational and management performance, including the encouragement of private sector approaches.

Planned Accomplishment:

5. Implement multi-donor agency electric utility performance improvement initiative, and provide project development and operational recommendations to LDC governments, donor agencies, and development banks.

Energy Price Reform

A.I.D. missions have been directed by the Administrator to conduct policy dialogues on energy pricing wherever prices are being kept artificially low by host government policies. At the same time, the World Bank and other lending agencies are urging developing countries to rationalize energy prices, in some cases making progress with price reform a condition for further development assistance. Technical assistance for these policy dialogues is a key part of the energy policy development activities of the Office of Energy.

The Office's energy price reform program is based on two perspectives about policy realities in the countries A.I.D. assists. The frequent lack of progress on energy price reform occurs not because the problem is not recognized; it arises mainly from a fear on the part of host-country policymakers that price reform will be economically and politically destabilizing. Focusing the policy dialogue concerning energy price reform almost exclusively on rational prices has not brought about much price reform. Moreover, as a donor agency with relatively small investment levels in most countries, A.I.D.'s leverage in urging energy price reform is limited.

The Office is therefore concentrating its resources on implementing price reform. Once a country agrees that energy price reform is needed, the major question becomes how to develop and implement a strategy for price reform without threatening unacceptable kinds of instability. The strategy being pursued aims at improving the operating efficiency of energy supply institutions, thus reducing the marginal cost of producing energy; improving the efficiency of energy end-use, thus reducing the cost of energy services; and effecting institutional changes in how prices are set, thereby reducing the need for external interference in energy markets.

Tariff reform is also needed to reflect the real long-run marginal costs of electricity production (including economic pricing of fuels) and eventually may incorporate peak load and time-of-day pricing. Also required is a rational and explicit set of policies, regulations, and structures to determine the technical requirements for independent power generation, grid interface, and the contractual arrangements, including tariff structures, for the purchase of electricity and capacity from private power plants. (Chapter VI expands on the Office's strategy for implementing such mechanisms in order to enhance the private sector role in power generation.) Realistic tariffs are required to sustain successful commercialization of new technology, private power, and the successful long-term operation of existing and new generation capacity and transmission and distribution equipment.

The Office of Energy will work closely with the World Bank and selected host country institutions within the context of the MAGPI to develop effective case examples of

successful pricing reform. The Office will work to create an on-call, quick response technical assistance capability to support field policy dialogues.

Planned Accomplishments:

6. Complete case study of price reform in Korea.

7. Publish a guide on successful price reform experiences in developing countries.

8. Provide technical assistance with policy dialogue in a selected country, including a cost-shared, in-country workshop to serve as a catalyst.

9. Conduct sessions on price reform at regional workshops in India and the Ivory Coast.

PACER--The Program to Accelerate the Commercialization of Energy Research

PACER is a six-year, $20 million India/U.S. science and technology collaborative program. The purpose of the program is to foster innovation with the Indian electric power sector, in part through facilitating the establishment of R&D consortia which link the industrial, commercial, R&D, and government sectors. This work focuses on advanced coal combustion technologies, renewable energy systems, electricity technologies, and improved transmission and distribution planning and technologies. Innovation and commercialization strategies of organizations like the Electric Power Research Institute (EPRI) are directly relevant to PACER's.

PACER seeks to develop a new institutional alliance between the Indian energy sector and Indian research and development. The project is predicated on the presence of a large pool of skilled human resources, an increasingly sophisticated enterprise community, and rapidly growing markets for technically advanced products.

The Office's Energy Policy Development and Conservation Project will "fast-track" this experiment in other rapidly modernizing Asian societies, developing analogous programs in the near future.

Planned Accomplishments:

10. Hold major international conference in India on "Innovation in the Electric Power Sector."

11. Explore extension of the PACER concept to one other country.

12. Review selected PACER proposals for USAID/New Delhi.

Rural Power Delivery

Most developing countries have policies to expand electricity services and use in rural areas. Implementation of these policies, especially by extending the grid into unserved areas, has contributed to the poor financial performance of some national utility systems. Rural minigrids can be attractive alternatives to grid extension. They allow opportunities for cooperatives or domestic private sector firms to extend service in a more timely and responsive fashion and to support irrigation and other productive energy uses in rural areas.

Planned Accomplishment:

13. Complete a report on lessons learned from World Bank and A.I.D. rural electrification projects and develop a new rural power lending strategy in collaboration with the World Bank.

Environmental Management of Energy Conversion

Environmental management has emerged as a major issue for international development in the 1980s. Sustainable development paths should be emphasized to avoid disruption of socio-economic progress. There is already significant evidence, from deforestation to air pollution, that many developing countries are not, however, progressing along environmentally sustainable pathways. In light of this evidence, development assistance agencies need to focus their attention on strategies addressing the environmental management issue.

In developing countries, energy production is a significant piece of the environmental management issue. Fuel and energy conversion processes using coal, wood, and petroleum-derived fuels, for example, are major sources of air and water pollutants. In virtually every developing country, energy production contributes a large proportion of the pollutants emitted through modern economic activities. In addition to pollution, fuelwood commonly used in developing countries contributes to deforestation. Over the next twenty years, energy needs are anticipated to grow by a factor of three to six. The potential environmental consequences of such growth are great, ranging from population displacement to hazardous air and water pollution problems.

As a result, making decisions regarding technologies and policies for energy production in developing countries requires careful assessment of environmental impacts. For example, environmental analyses and mitigation technologies need to be considered before making an investment decision on a proposed new energy production facility. Also, proposals for new facilities often trigger discussions on environmental standards and regulations. Consequently, knowledge of technology characteristics, alternatives for achieving developmental objectives, and the potential of environmental impacts has become critical to energy sector planning and decision-making.

Energy strategies may also affect the sustainability of economic development in more general ways. For instance, the growing concern about global climate change will

likely lead to global strategies to limit the buildup of greenhouse gases, such as CO_2 from the use of fossil fuels. Similarly, concerns about deforestation and the conservation of biological diversity may lead to reduction in the use of fuelwood for development projects. Such possibilities suggest that developing countries should try to maintain a diversified portfolio of energy options in order to achieve continued socio-economic growth.

The three principal goals of the Office of Energy's environmental initiative are providing leadership for the evolution of A.I.D. and United States policy on issues regarding international energy development and the environment; improving the state of the art for incorporating environmental management objectives into energy facility investment decision-making; and developing environmental competencies in LDCs to support siting, construction, operation, maintenance, and decommissioning of energy conversion facilities, as well as development of standards and regulations, as appropriate.

Planned Accomplishments:

14. Complete a report on the environmental impacts of projected energy expansion in developing countries, along with efficiency and other strategies for mitigation and prevention.

15. Through MAGPI, develop strategies and a handbook for incorporating environmental management objectives into power plant investment decision-making and encourage lending agency attention to the alternatives.

CHAPTER III

ENERGY EFFICIENCY AND CONSERVATION

A. RATIONALE

Increased efficiency in the various stages of energy conversion and distribution is important for both economic and environmental reasons.

The historical truism that increased energy input, or energy supplies, is critical to economic growth sometimes obscures an important insight. Over-emphasis on the growth of energy use and supply, combined with relatively low prices for energy (real or subsidized), can result in systems or technologies that use energy inefficiently when those prices increase. The energy price increases of the 1970s clarified this phenomenon. Recognition of these inefficiencies in a number of countries was reflected both in legislation (such as fuel efficiency standards for automobiles) and, when and where the increased prices were passed through to consumers, a significant degree of voluntary efficiency improvement or conservation (in terms of technological adjustment or behavioral change). People have discovered in recent years that economic development and growth in energy consumption are not necessarily inextricably linked.

As described in Chapter I, electrical generating capacity has been growing at an average rate of about 6 to 7 percent over the past two decades in LDCs. Demand for transportation fuels has also been increasing significantly. In the case of electricity, the investment capital required for infrastructure additions is a dramatic portion of the development budget of these countries (averaging 25 percent but as high as 40 percent in many cases). Moreover, in the electricity, and particularly the transportation sector, the need to import fuels creates a serious strain on foreign exchange for most LDCs. As pointed out in A.I.D.'s 1988 Report to Congress on *Power Shortages in Developing Countries*, sufficient investment capital is unlikely to be available from traditional sources to support a continuation of recent growth rates in electrical generation capacity. Therefore, energy efficiency has crucial economic benefits.

Most energy systems impose serious stresses on the environment--sometimes direct assaults on human health and other times insults to natural systems that eventually affect humans in a variety of ways. In most cases, greater efficiencies in the energy systems will result in reduced stress to the environment, usually proportionately. But environmental stress is difficult to quantify in economic terms; to the extent that efficiency improvements can be justified on economic grounds independent of environmental considerations, appropriate action is more likely. For this reason, a consensus has developed in the scientific, donor, and environmental communities, reflected in the growing number of reports issued by distinguished organizations such as the World Resources Institute, Worldwatch, and The Conservation Foundation, that energy efficiency improvements represent the most important near-term response to a host of energy-related environmental problems, including the potential threat of global warming.

All nations have numerous cost-effective improvements in efficiency that still remain to be implemented, but among the slowest to do so, unfortunately, are a majority of the LDCs. A desire to accommodate as rapidly as possible the commercial energy requirements of societies moving from "traditional" to "modern" has placed a political premium on increasing supplies.

Energy efficiency improvements and conservation represent cheap, quick, and relatively painless ways for most developing countries to stretch energy supplies, slash energy costs, and save foreign exchange. These approaches aim at increasing the efficiency of energy use through loss reduction, fuel switching, the use of better technology or management, and cogeneration of heat and power. By producing more output with the same energy cost input, energy efficiency promotes economic efficiency and improves the productivity and competitiveness of energy-consuming enterprises. The inevitable transition to higher energy prices will be easier for enterprises (and countries) that have reduced the energy system requirements of their goods and services.

Energy conservation is also an excellent vehicle for promoting private-sector development. An increasing interest in energy conservation will amplify the demand for energy management equipment, insulation, and more efficient energy conversion technologies, among other things, from local private manufacturers. Also, expansion of energy conservation activities will increase or create a demand for private energy conservation consulting engineers capable of identifying energy conservation measures and installing energy conservation equipment. Finally, energy conservation investments, and their related management and operation changes, can improve the financial well-being of industrial enterprises by improving their overall efficiency, leading to a stronger industrial sector.

The proper policy and investment climate is important to the success of energy efficiency and conservation programs. Many energy conservation projects will not succeed if energy users do not receive the correct pricing and other policy signals. If policy tools were to be ranked in terms of their general effectiveness in promoting energy conservation, correct pricing signals would be at the top of the list.

Experience has shown, however, that rational energy pricing is often a necessary but not sufficient condition for energy conservation. Substantial impediments remain, such as lack of information, trained manpower, availability of technologies, and adequate and attractive financing. Thus, economic pricing generally needs to be complemented with other types of assistance, such as training, institution-building, technical assistance, information dissemination, and often some form of financial assistance (at least during the early stages of an energy conservation program). This Chapter describes the technical and management assistance provided by the Office of Energy to promote energy conservation and demand management in the power, industry, buildings, and transportation sectors.

B. STRATEGY

Until very recently, A.I.D.'s efforts in energy efficiency and conservation were shaped primarily by the urgent need of A.I.D.-assisted countries to save foreign exchange by cutting energy waste in facilities that use large quantities of imported petroleum products. Therefore, the priority targets were large industrial facilities. However, in light of growing concern about rapidly increasing power demand, power shortages, poor system reliability, inefficient management, the tremendous capital requirements for new capacity, and the shortfall in available capital, A.I.D. has recently begun to target a large share of its energy conservation assistance toward improving efficiency in the power sector. In particular, the Office has launched a major initiative (in cooperation with other donors) to improve efficiency in the power sector in Central American countries and has planned other initiatives that include exploring the opportunities for energy efficient options in West and Central Africa. To date, activities in the buildings, transport, and agriculture sector have been very limited. However, given the large impact of the urban buildings sector on growth in electricity demand, the Office plans to increase its efforts in this sector.

Increasing emphasis will be placed on the linkages between energy conservation and efficiency and environmental and health issues. Specifically, the Office of Energy has initiated an effort to assess the present and projected environmental and health impacts of fossil energy use in developing countries, estimate the contribution that energy conservation and other efficiency improvements can make to mitigating these impacts, and make policy and program recommendations to A.I.D., other donors, and developing countries to help reduce the environmental and health impacts of energy development.

Interventions supported by the Office of Energy can contribute some immediate payoffs in improved efficiency of energy use, but the Office's long-term goal is to develop lasting technical and management capabilities in the host countries to identify and implement energy conservation programs and an institutional and policy framework to support and promote energy conservation. Achievement of the short-term goal provides immediate relief from balance of payments burdens and foreign exchange and capital shortages, enabling countries to focus their development efforts on other pressing issues, and promotes more environmentally-sound economic growth and development. Achievement of the long-term goal ensures that energy conservation will continue after technical assistance has ended.

The Office of Energy has a two-pronged strategy--a micro approach and a macro approach--to achieve its short and long-term energy conservation goals. The micro approach focuses on assisting countries to design and implement specific energy conservation and efficiency projects. The macro approach focuses on the development of a policy and institutional framework for energy conservation. An integral part of this strategy, specifically as it applies to achieving greater energy efficiency and conservation in the power sector, is the Office's promotion of comprehensive power sector planning. This technique expands the domain of traditional planning to emphasize technical improvements in all elements of the power sector. Through the development of balanced investment plans, the costs of alternative approaches to the delivery of energy services are compared, supply-side efficiency improvements and various demand-side options weighed, and

environmental costs approximated. Efficiency improvements in turn help to reduce these latter costs. The conservation and efficiency implications largely derivable from such planning are discussed below under the following strategic elements:

- Assisting energy conservation and demand management in power systems;
- Aiding energy conservation and demand management in industry; and
- Assisting energy conservation and demand management in the building and transportation sectors.

The additional benefits of this planning technique are discussed in Chapter II.

To implement this strategy, the Office continues to use the private sector to the greatest extent possible, as both a means and an end of energy conservation programs, and will target its assistance primarily to the power sector, followed by (in decreasing order of priority) the industry, buildings, transport, and agriculture sectors. However, the Office will continue to respond to local Mission and country requests for assistance in promoting energy efficiency in all sectors of the economy.

The Office of Energy's specific program and planned accomplishments in those areas are described below.

Energy Conservation and Demand Management in Power Systems

Electricity demand increases even faster than overall energy demand in a developing economy. LDCs generally put nearly all the burden of providing increased generation capacity on the public sector, and this places tremendous strain on government budgets. The typical LDC puts 20-40 percent of its annual government budget into the electricity sector. In most LDCs, a majority of the necessary generation technology needs to be imported, thus exacerbating foreign exchange shortages.

LDCs must improve the use of current and new capacity by reducing system losses and increasing end-use efficiency. In many LDCs, the availability factor of power plants is below 50 percent, compared to over 85 percent in the industrialized countries. Transmission and distribution losses consume over 20 percent of total electricity generation in many LDCs, compared to 8 percent in the U.S. Clearly, there is room for significant improvement.

To increase the efficiency of the electricity sector in LDCs, the Office of Energy uses three approaches: (1) increasing the efficiency of power generation, transmission, and distribution, (2) better managing the power load, and (3) improving end-use efficiency. The program prepares generic analytical and practical tools useful to a broad range of countries, offers country-specific planning and technical assistance and training courses, and engages in country-specific studies of efficiency improvement opportunities.

Planned Accomplishments:

1. Implement Phase II of the load management project in Costa Rica.

2. Design a Central America Power Efficiency Initiative.

3. Carry out identification missions to selected countries, primarily in Africa (Gambia, Mali, Niger, Sudan, and Uganda).

4. Carry out analysis of load management potential and impediments in order to identify priority countries for load management programs.

5. Identify interest, develop agenda, and finalize times and place for an African regional conference on energy demand management in the power sector.

6. Provide assistance to the U.S. geothermal industry in identifying and developing markets in developing countries.

Energy Conservation and Demand Management in Industry

Historically, A.I.D. has focused its energy conservation assistance on the industrial sector. Industry has been an important target because the industrial sector typically accounts for 20 to 35 percent of total commercial energy consumption in developing countries, and technically-proven, cost-effective energy conservation techniques and processes can save developing countries an estimated 10 to 30 percent of industrial sector energy consumption. In addition, a few large industrial enterprises generally account for the majority of industrial energy consumption, which means that focusing on a few large industrial consumers can significantly reduce the industrial sector's energy use. Finally, with the trend toward privatization, more and more industry in LDCs is privately-owned, which gives these industrial enterprises a clear motivation for cost-cutting.

In FY 1989 emphasis will continue to be placed on leveraging private investments and developing local private-sector capabilities to design, finance, and implement programs aimed primarily at reducing fossil fuel and electricity consumption. The program will be divided into two principal components, as described below.

Private Sector Involvement in Energy Conservation

Increasing private-sector activity in energy conservation is one of the primary sub-goals of the Office of Energy's conservation project. The objectives of this program are to gain a better understanding of the energy conservation investment decisionmaking process (since it is this process that determines whether or not energy conservation measures, once identified, are undertaken), to improve the policy and investment climate for private-sector activities, and to improve private-sector capabilities to design, finance, and implement energy conservation projects.

The techniques used to accomplish the objectives include documentation and empirical analysis of past private investments in energy conservation in a number of A.I.D.-assisted countries, identification and analysis of relevant governmental policies, dialogue with governments and interested private parties, advice on financing mechanisms, planning, management, and technical assistance, and training in order to institutionalize the energy conservation process in the private sector.

The Office of Energy will build upon some on-going private-sector activities and launch some new initiatives. The energy demand management program in Morocco, designed in FY 88, is expected to begin in late FY 1989. Following earlier work on barriers to energy conservation, an analysis of how energy investment decisions are made will be completed in FY 89. Finally, the Office of Energy initiated an activity to identify and develop a strategy and program plan for energy conservation in rural enterprises. The final decision concerning the future of this activity will be made in FY 89.

Planned Accomplishments:

7. Provide technical assistance to Jordan for implementation of the Industrial Energy Efficiency Program.

8. Design and implement energy conservation/demand management programs and conservation assistance to private energy conservation activities (Ivory Coast, Thailand, Philippines, Dominican Republic, and others).

9. Complete a study on energy conservation investment decision-making in developing countries (including continued development of a database of energy conservation projects).

10. Evaluate the Dominican Republic Energy Conservation Project.

Energy Conservation and Demand Management in Large Industrial Facilities

A few large industrial facilities often dominate energy use in the total industrial sector in an LDC, accounting for 75 percent or more of the sector's use. Therefore, large facilities offer great potential for sectoral- and national-level savings. Large industrial plants were traditionally government-owned. However, the trend toward privatization in many A.I.D.-assisted countries has increased the attractiveness of large facilities as targets for conservation programs because experience has shown that private-sector, cost-conscious managers are more likely to make energy conservation investments than managers of government-owned facilities in which cost-plus pricing is the general practice. Among large private industrial plants, export-oriented ones are prime targets for energy conservation initiatives because they are the most responsive to energy cost reduction opportunities in order to be competitive in world markets.

The goal of this program, therefore, is to improve the energy management capabilities of the largest industrial energy users and facilitate private-sector energy conservation activities.

Following its design activities in FY 88, the Office of Energy will provide interim management and technical assistance to the Egypt Energy Conservation and Efficiency Project during FY 89 and FY 90. In addition, a new initiative on energy conservation and the environment (which will focus on both the industry and power sectors) will be launched and the Office will continue to be responsive to Mission requests for technical assistance, training, and information services for large industrial facilities.

Planned Accomplishments:

11. Provide interim assistance for the implementation of the Egypt Energy Conservation and Efficiency Project.

12. Conduct a study of the environmental impacts of fossil fuel combustion and the role of energy conservation and efficiency.

13. Disseminate information on industrial energy conservation and demand management.

Energy Conservation and Demand Management in the Building and Transportation Sectors

The major focus of the Office of Energy's conservation project is on the industrial and electric power sectors, where it is believed that the greatest potential for savings exist. A much smaller Office program targets the opportunities for conservation in two other sectors--transportation and buildings--described here.

Much of the growth in demand for electricity in the large cities of developing countries, such as Cairo, Bombay, Karachi, and Bangkok, is driven by the demand for air conditioning and lighting in large commercial buildings. The buildings sector is the fastest growing consumer of electricity in developing countries, with demand increasing by up to 20 percent per year. In most of these cities, there is a shortage of available electricity and of investment capital for additional capacity.

The most serious obstacles to improved energy efficiency in the buildings sector are the lack of data on energy use in buildings, lack of awareness of the need and potential for energy conservation in buildings, lack of knowledge about energy-efficient building design, and lack of building codes and standards that ensure energy efficiency. The objective of this program is to address the first obstacle -- the lack of basic energy use data. By developing a better understanding of energy use patterns in urban buildings, the needs and opportunities for conservation can be better identified and pursued.

Energy consumption for transportation represents over 40 percent of total oil consumption in most developing countries. Even small improvements in efficiency can produce large savings on oil import bills and free up resources for more productive uses. Conservation in this sector has received a lot of attention in the industrialized countries, and with significant results, but the subject has received little attention with regard to the developing countries.

Scant information exists on the effectiveness of various approaches to conservation in the transportation sector of developing countries. With a small budget, this program must concentrate on low-cost/high payback measures. The Office began this program in 1985 with two initial steps: (1) implementing a pilot project in a developing country--Costa Rica--in order to obtain field experience, and (2) funding an evaluation of the various measures available for improvements in transportation efficiency.

During FY 1989, a meeting of transportation experts will be held to provide input into an evaluation of the needs and options in the sector to determine the most appropriate role for the Office of Energy in the transportation field in the future.

Planned Accomplishments:

Buildings

14. Identify and implement one country-specific project to analyze energy consumption in the urban buildings sector and identify priority programs to reduce electricity demand (Pakistan).

15. Implement a project on conservation in buildings in conjunction with the PACER program (India).

Transportation

16. Hold a meeting of the Transport Experts Group to advise the Office of Energy on program priorities in transportation energy conservation.

CHAPTER IV

RENEWABLE ENERGY FOR RURAL DEVELOPMENT

A. RATIONALE

The majority of people in LDCs reside in rural areas, and those areas include the productive sector central to human society--agriculture. The maintenance and development of rural standards of living and rural productivity are one of the priority goals of A.I.D. Delivering energy services to rural areas for agricultural and small industry development, as well as for village social services and household needs, is thus one of the chief goals of the Office of Energy.

LDCs must overcome numerous problems with regard to supplies of both traditional and modern fuels. The traditional fuels used in households and small industry--fuelwood and charcoal--are becoming more scarce in many locations. And as Chapter I explained, LDCs are finding it difficult to expand modern energy supply systems fast enough to satisfy the needs of economic development. These problems have many ramifications:

- Agricultural areas that are served by pumped irrigation suffer lost production (dramatic at times) when energy supplies are unreliable, and most of the future increases in agricultural production will depend on the expansion of pumped irrigation.

- A.I.D.'s plans to assist in developing new rural industry or to install modern processing equipment are similarly foiled by energy shortages.

- In a number of countries, unreliable electricity supply or kerosene delivery systems have reduced the effectiveness of child health programs which rely on refrigeration for vaccines (the same is true for livestock vaccination programs).

- Continued use of fuelwood can cause serious local air pollution problems from combustion and contribute to deforestation, and fuelwood shortages themselves result in more time spent for gathering, higher prices for traded wood, or less cooking and therefore threats to nutrition.

To the extent that some of these problems can be ameliorated by interventions pertaining to existing electrical grids--increasing efficiency, increasing supplies, or better management--several of the programs of the Office of Energy described in the other chapters of this Program Plan are relevant. But for a large number of rural areas not currently served by utilities, grid extension in the near future is too expensive. For this reason, our rural-oriented programs are looking at other perspectives on meeting these energy needs.

The focus of these non-grid approaches is the cost-effective use of renewable sources of energy. A mixed record of experimentation with numerous renewable-based technologies during the late 1970s and early 1980s gave users, investors, and donors valuable lessons. The Office approach is a cautious one, but the track record of those earlier years now offers us some commercially proven technologies. Both economic and environmental considerations argue for a strong effort to help LDCs identify useful renewable sources of energy and the appropriate technologies and policies.

The economic considerations are several. Renewable sources of energy are nearly always indigenous, and thus their use leads to a reduction in foreign exchange requirements for imported oil. Under certain conditions, a number of renewable energy technologies have a lower life-cycle cost than conventional fossil fuel options; these relative economics are insufficiently recognized by many project planners. In the electricity sector, renewable energy technologies are typically smaller-scale than conventional options, and thus offer more flexibility for incremental additions to generating capacity (especially important for rural needs) at a time of capital constraints.

Environmental considerations are also important. In most cases, the use of renewables will result in less degradation to the environment during the stage of mining or harvesting, and fewer toxic emissions to the air, land, or water, during conversion, than will the use of other energy resources. The potential of climate change resulting from CO_2 emissions from fossil fuel combustion is reduced by the use of renewable energy, except for the case of a depleting use of a woodfuel stock (in which case sustainability must be addressed).

On a global scale, a dramatic increase in the penetration of renewable-based technologies in the energy sector will take many decades. The impact of renewables on atmospheric CO_2 concentrations, therefore, will occur only in the long term. But the impact on local and regional air quality, through reduction of SO_2, NO_x, hydrocarbons, and particulates, will be more immediate in those areas where site-specific conditions allow for greater relative penetration.

Our single biggest effort with regard to renewable energy focuses on using biomass--agricultural and forestry residues--for generation of electricity, because the use of available commercial technology using these energy sources can provide significant benefits to the agricultural sector in the near term. But the Office is making additional important efforts with regard to other renewable sources--solar, wind, water, and geothermal--in order to obtain the several economic and environmental benefits mentioned above.

B. STRATEGY

As mentioned above, numerous renewable energy projects were funded in previous years by A.I.D. and other donors. Many, but not all, of those past projects have had too little lasting effect. This deficiency is partly a normal result of the process of technology development and commercialization, in which the most durable and cost-effective technologies are identified through field trials, and partly a result of the unexpectedly

dramatic drop in oil prices since 1981. But there were other reasons. In 1988 the Office completed a review of A.I.D.'s renewable energy activities during the last decade.[5] The study concluded that an important reason for disappointment was unrealistic project planning and expectations. In a well-intentioned desire to respond to the oil price shocks of the 1970s, demonstrations of renewable technologies sprouted up without consistent attention being paid to real end-use needs or to long-term economic and institutional issues.

The Office's renewable energy program attempts to identify those circumstances in which matching end-uses and available technologies offers the greatest hope for near- or mid-term commercial success. The objectives are to assure that important actors have the information they need to make decisions, to bring those actors together when appropriate, to assist at the pre-investment stage in order to reduce perceived risk, and to help transfer relevant technology and skills. The Office does not fund the actual purchase of technology, but rather plays a catalytic role in actual commercial transactions. In some very limited cases (see page 42), the Office sponsors applied research.

Whenever appropriate, these efforts promote technology transfer from the U.S. Many of these activities are being coordinated with the work of the multi-agency Committee on Renewable Energy Commerce and Trade (CORECT, whose lead agency is the Department of Energy, also includes representatives of A.I.D., the Department of Commerce, and the Overseas Private Investment Corporation). In the past, the Office has supported CORECT by providing data bases on renewable energy experience, assisting in the preparation of brochures, and working with industry associations in bringing interested LDC nationals to education/promotion events.

A majority of the site-specific project development work is with private sector firms or persons who themselves need the bulk of the energy to be produced. There is significant interaction, therefore, with the Office's private sector power efforts (see Chapter VI).

The Office of Energy performs the bulk of its rural energy activities through two Office projects: (1) Renewable Energy Applications and Training; and (2) Biomass Energy Systems and Technology (the 1989 successor to the Bioenergy Systems and Technology project). The balance of this chapter is divided into two subsections, describing those two projects, respectively. Some, but not all, of our efforts in household fuels are funded by the Energy Policy Development and Conservation project, and these are included in the first of these two subsections.

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[5] Office of Energy, *New Directions for A.I.D. Renewable Energy Activities* (Office of Energy Report 88-01), March 1988.

C. RENEWABLE ENERGY APPLICATIONS AND TRAINING

The Office attempts to help identify those economically justified applications that can meet the expressed needs of rural areas. Leaving most biomass applications to the project described in the subsequent subsection (with the exception of household fuels and process heat), the Renewable Energy Applications and Training project keeps abreast of developments in solar, wind, small hydro, and geothermal technologies and applications, and to some extent with improved cookstoves and briquetting techniques, and transfers knowledge about success stories. The strategy has four components:

- Targeted Project-Level Support for Commercialization;
- Policy Guidelines and Institutional Framework;
- Information Dissemination and Training; and
- Support to A.I.D. Field-Mission Activities.

The strategies and near-term plans for each of these components will be described in turn.

Targeted Project Level Support for Commercialization

The objective of activities in this category is to provide models of "bankable" commercialization of renewable energy technologies. The Office works with extensive contacts, including many in U.S. industry, to identify site-specific applications where interested users, sellers, and investors all exist, but where some initial infusion of funds for pre-investment analysis appears to be necessary as the crucial catalyst. The likelihood that the project will serve truly as a model, with near-term replication, is an important criterion. Whenever possible and appropriate, the potential for U.S. sales of services or equipment is also important.

During 1988 a number of candidate projects were identified for possible assistance, including joint ventures in small-hydro installations and in photovoltaic manufacture in India, biomass combustion for heat applications in the Philippines, small geothermal power applications in Kenya, and multi-technology applications in rural Guatemala.

Information and expressions of interest were solicited and assessed, and in the case of small hydro in India a formal analysis of the potential for joint ventures was prepared and distributed to U.S. industry.

Activities in FY 89 will be a continuation of these efforts and a screening of additional candidate projects. The Office expects this on-going process to result in two or three formal pre-investment studies being prepared each year. In some cases, specified policy actions by the host government will need to be encouraged by the Office simultaneously.

Planned Accomplishment:

1. Identify at least six site-specific, bankable applications for pre-investment analysis, and pursue at least three to completion.

Policy Guidelines and Institutional Framework

The purpose of this component is to incorporate informed energy strategies within existing rural development programs and projects and to assist in developing appropriate institutional approaches to the dissemination or selection of renewable energy technologies. The former includes consideration of both renewable and non-renewable energy sources, as appropriate.

In some cases, activities in this component focus on specific applications, technologies, or energy sources; in other cases the aim is broader. An example of the first category is the Office's efforts in the household fuel sector. Examples of the second are various efforts to assess rural electrification options or build appropriate institutions for such options. The two categories may overlap, of course, and in both cases the objective is to encourage applications that are sustainable under existing institutional and financial constraints, or to introduce innovative mechanisms to overcome these barriers to rural development. It is envisioned that support of these activities will serve large potential markets and/or have substantial potential for replicability.

In most rural areas of LDCs, fuelwood is the major, often the only, source of fuel for household uses (principally cooking, followed by space heating and lighting). As populations increase and forest areas decrease (chiefly as a result of clearing for agriculture and pasture), scarcities occur in more and more regions. The work of the Office in the household fuels sector has emphasized improved cookstoves and substitute fuels.[6] The goals in both cases are to reduce the stress on fuelwood supplies and to reduce the sometimes severe impact on local (particularly house-specific) air quality.

An assessment of the lessons learned in a successful stove dissemination project in Kenya (partially funded by the Bureau for Africa) will be completed early in FY 89, confirming these insights. The Office wishes to transfer these lessons (and project design methodologies) to other regions and to fund selected other promising projects with similar goals.

Such work was begun in 1988 in the Sudan and in Central America. In the former, the Office is assisting in the design of a World Bank-sponsored program (also with active

[6] Because wood has many non-energy uses, the issues of wood *supply* are under the jurisdiction of the office of Forestry, Environment, and Natural Resources, a sister office in the Bureau of Science and Technology. The Office of Energy looks at the *demand* side of the fuelwood problem.

Mission involvement), and in the latter the Office is assisting a regional NGO (the Central American Center for the Study of Appropriate Technology, or CEMAT).

Efforts in site-specific and application-specific electrification were described in the previous subsection. To assist missions and host countries at a more generic level of rural electrification, the Office will begin preparing occasional strategy and policy papers in 1989. Complementary efforts in this area are pursued by both the Energy Policy and Planning Development project (see Chapter II, p. 23) and the Renewable Energy Applications and Training project.

In another category of effort in rural electrification, the Office assesses institutional models for dissemination of very small-scale electricity systems to households and small entrepreneurs, again with the purpose of encouraging the replication of successful experiences. Provision of information and credit and availability of technology and servicing are considered critical elements.

Planned Accomplishments:

2. Provide consulting based on lessons learned in previous work in Kenya for the design of an investment-oriented household fuels program in the Sudan.

3. Assist a regional non-governmental organization (NGO) in Guatemala in implementing a market-oriented improved cookstoves project.

4. Prepare general and region-specific strategy papers on rural electrification for use in Office and Mission planning.

5. Develop financing and/or servicing mechanisms for dissemination of photovoltaics.

Information Dissemination and Training

Appropriate information and useful skills are necessary at all levels of technology development, transfer, and application. Technical and economic information on renewable energy technologies that are available to meet user needs in the developing world is needed by A.I.D. staff in Washington and the field, and by public and private sector actors in the host countries. Information on LDC needs and on the important characteristics of international trade and project development in LDCs is needed by many U.S. industrial concerns. To make certain that the renewable energy projects supported by A.I.D. or others can be sustained, LDC nationals must have the necessary skills in planning, operations, and maintenance.

Each year the Office of Energy selects specific ways to meet those needs for information and training. Some of these activities are pursued in concert with, or with the prior advice of, the CORECT committee mentioned above. Meetings of the CORECT and

its subcommittees are regularly attended by representatives of U.S. technology manufacturers.

Publications are an important element of the Office program. The goals of the publishing effort are to inform LDC nationals and development specialists regarding the particular applications and conditions in which renewable-based technologies can be cost-effective, the lessons that have been learned about disseminating these technologies, and the technologies that are available from U.S. manufacturers.

The various U.S. industry associations periodically sponsor workshops and site visits, which provide an opportunity for LDC nationals to observe and discuss the extensive U.S. experience with these technologies. The Office funds the participation of several A.I.D. host-country nationals to one or two of these events each year.

The objective of the Office's training activities is to facilitate the sustainable commercialization of renewables technologies in LDCs and to increase the opportunity for U.S. and LDC joint-ventures and technology transfer. Targeted trainees will be those in the LDC public or private sector who could be significant players in commercial implementation of technology, local personnel involved in promotion, assessment, or applied research in support of applications, and public sector officials whose understanding and support is needed. During 1988 the Office began to take a new look at appropriate audiences and subjects, and intends to select and introduce some new courses in 1989. The Office has been assessing the relative near-term needs for skill development with regard to geothermal, photovoltaic, and wind technology, and also the usefulness of cooperating with the Peace Corps in training its own volunteers and host country nationals.

Planned Accomplishments:

6. Publish and distribute a catalogue of U.S. renewable energy technology vendors, and provide assistance for including information on U.S. exporters in other publications.

7. Assist in the publication and distribution of a booklet describing experience with U.S. renewable energy technology in A.I.D. countries.

8. Publish and distribute a guide to technology selection for vaccination refrigeration, including assessment of photovoltaic-powered equipment, and select topic for a second guide useful to Mission personnel or others.

9. Publish and distribute an assessment of Kenya's successful program in disseminating improved cookstoves.

10. Provide support to at least one industry-sponsored event (trade shows, site visits, workshops) held in the U.S.

11. Assist in establishing training programs in renewable energy technology for host country nationals or U.S government employees working in A.I.D. countries.

Support to A.I.D. Field-Mission Activities

The Office of Energy regularly responds to requests for advice on rural energy and renewable energy from A.I.D.'s missions in the host countries. Most of these exchanges are routine, but each year the Office is asked by a few missions for more extensive help in order to fulfill their objectives. Typically, this involves assistance in establishing a new program, in formally reviewing an existing project, or in funding a mission energy officer when local budget constraints exist.

Planned Accomplishments:

12. Assist the Egypt mission in assessing and possibly re-designing the Renewable Energy Field Test project.

13. Co-fund with A.I.D.'s Regional Economic Development Support Office for East Africa a staff position specializing in activities relating to energy and natural resources.

D. BIOMASS-FIRED ELECTRICITY GENERATION

In the rural sector of most developing nations biomass residues abound, primarily from agricultural activities. Some LDCs have additional and considerable biomass residues associated with the wood-products industry. At present, most of these residues are burned openly or left to rot. In some cases the decaying residues serve a positive role as soil nutrients, but in many cases the environmental impact is a negative one. In the latter case, converting these residues to products that can be sold could have significant impact on the financial health of the agricultural sector and increase interest in improved resource management. The use of biomass residues for energy production provides several benefits:

- Revenues to farmers, agricultural processors, owners of forest land, and/or wood-products companies from the sale or use of electricity, steam, or liquid fuels produced from residues;

- Electricity and/or liquid fuels for the local community or national grid;

- Incentives to attract new investment to the production and processing of traditional commodities;

- Additional employment, income, and value-added in rural areas; and

- Potential for displacement of petroleum imports and concomitant savings in foreign exchange.

During the past year, the Office of Energy supported a number of biomass energy projects aimed at identifying and reducing technical, economic, financial, and institutional risks. This year, the Office of Energy's new follow-on biomass project will focus more tightly on the implementation of specific projects in conjunction with the private sector. Removing barriers to project financing for specific projects will be critical.

Through the implementation of specific projects, the Office of Energy expects to introduce innovative technology and demonstrate the commercial viability of biomass energy systems. At the same time, the biomass energy project will identify new potential applications and continue to promote innovation to reduce project risks. Information dissemination activities will be restructured to better publicize program results and to broaden the base from which innovation may come.

The Office has categorized its biomass efforts into the following three components:

- Implementation of Target Projects
- Exploration of New Potential Projects
- Program Development

Implementation of Target Projects

Planned Accomplishments:

14. Costa Rica Cane Energy: Provide expertise to identify and analyze financial "packaging" options for investment, the best utility contracting arrangements, the least-cost options, and off-season fuel options. Provide project management for cane residue power plant.

15. Thailand Cane Energy: Complete current field trials. Provide expertise to identify and analyze financial "packaging", sugar industry market stability and diversification, and off-season fuel options. Help national utility overcome technical obstacles to using private power.

16. Prepare a site-specific, cost-shared feasibility study as a precursor to the implementation of a privately financed plant in Costa Rica and/or Thailand.

Exploration of New Potential Projects

Exploration of new projects will be focused in about a dozen countries across all three A.I.D. geographic regions. This exploration will take several forms. The Office of

Energy plans several prefeasibility and/or follow-on analyses. Stronger links will be developed with private agribusiness through support for the Agri-Energy Roundtable. In addition, the Office plans to initiate at least one cost-shared, site-specific feasibility study.

Planned Accomplishments:

17. Analyze cane/rice/wood residue power production potential at specific sites. Country application: Malawi, Swaziland, and Costa Rica.

18. Design and implement international biomass energy meetings in cooperation with the Agri-Energy Roundtable, in order to stimulate interest. Country application: India, Kenya.

19. Prepare a site-specific, cost-shared feasibility study as a precursor to the implementation of a privately financed plant in India and the Philippines.

Program Development

Program development primarily includes research, information dissemination, and outreach activities such as continuation of research into improving existing biomass energy conversion technologies, development and dissemination of information about biomass energy efforts, and continuation of the development of analytic tools designed to aid in the identification of technically, financially, and economically sound biomass energy projects.

In this component, the Office of Energy plans one new major program initiative to address tropical forestry issues. The Office believes that providing ways for people to earn income from managing tropical forests is a critical component of efforts to preserve tropical forests. Energy markets offer one valuable source of revenues. Recognizing strong environmental concerns and the importance of forest products companies to improved forest management, the Office of Energy plans to establish an advisory committee in FY 89 to help select, design, and implement sustainable, ecologically sound, commercial wood energy projects.

Planned Accomplishments:

Research

20. Perform applied research on collection and storage of cane trash for combustion in power-plant boilers and bagasse drying and storage.

21. Support technology assessment and research on gasification systems, advanced gas turbines, and ethanol production technologies.

22. Support research on a new institution for biomass energy systems and technology implementation.

Information Development and Dissemination

23. Produce and disseminate three reports in the Bioenergy Systems Reports series, reviewing topical issues.

24. Produce and disseminate up to ten technical or economic studies and other promotional material.

25. Facilitate investment in cane/rice/wood powered systems by implementing an industrial outreach program.

26. Sponsor cane energy experts to participate in the meeting of the International Society of Sugar Cane Technologists in Brazil in October 1989.

27. Develop user-friendly computer programs designed to aid in the selection of technically, financially, and economically sound private cane energy power projects.

28. Establish an advisory committee to help in the selection and implementation of sustainable and ecologically sound commercial wood waste energy projects.

CHAPTER V

INDIGENOUS FOSSIL FUELS AND ADVANCED TECHNOLOGY

A. RATIONALE

Despite the decline in oil prices in dollar terms, many developing nations continue to pay a disproportionate amount of available foreign exchange for oil imports to meet rising energy demands. These ongoing expenditures, coupled with mounting interest payments on foreign debt, leave insufficient foreign exchange for new investment in energy projects. Yet, these projects are vital to agricultural improvement, rural development, industrial growth, and sustained economic progress.

Many of these same LDCs burdened with energy dependency are endowed with indigenous energy resources that have not been exploited. These resources include low grade fossil fuels (e.g., lignite and oil shale), renewable sources, geothermal energy, natural gas, and combustible waste materials (agricultural residues and municipal solid waste). Development of these resources can provide needed energy and generate domestic employment and income, while reducing foreign exchange expenditures for imported oil. These development projects are critical to stimulating economic growth and reducing energy constraints to development. Judicious steps must be taken, however, to minimize any environmental impacts, especially those associated with the production and use of low grade fossil energy resources.

In the aftermath of the energy crisis in the U.S., a combined private sector and U.S. Government effort has turned U.S. scientific and technological ingenuity toward developing more efficient, cleaner, and less expensive ways of supplying and using energy. A new menu of innovative technologies and tools, including fluidized-bed combustion, coal gasification, and management information systems, has evolved from conceptual design through proof-of-concept demonstrations into commercial reality. Significant progress has also been achieved in meeting environmental requirements. As a result of these innovations, U.S. energy producers are now able to expand their fuel options to include low grade or waste fuels, previously considered to be unsuitable for power generation. The comparative costs of these new technologies is decreasing as economies of scale increase and operating experience broadens. New tools based on computers are helping decision-makers manage and operate existing energy facilities more efficiently and plan future energy investments in a more rational manner. Much of this U.S. experience can be adapted to exploit the various indigenous energy resources and improve energy efficiency in A.I.D.-assisted countries.

B. STRATEGY

The Office of Energy has designed its Conventional Energy Technical Assistance (CETA) project to apply these U.S. advances in energy to the developing world. Through

this project the Office provides services to assist countries to identify, evaluate, and develop their conventional energy resources and to utilize them more efficiently to reduce dependence on imported oil. With the U.S. in a leadership position in many energy fields, the project serves as a vehicle for the provision of appropriate U.S. energy and environmental expertise. A basic focus of the Office's efforts involves the continuous monitoring and analysis of technology advances, including innovations in the areas of low grade fossil fuels, gasification, advanced turbines, biomass, and municipal solid waste. These emerging technologies are evaluated from the standpoint of their technical and economic suitability for application in developing countries.

As part of its approach, the Office of Energy reviews the resource base and generating capacity expansion plans of key A.I.D.-assisted countries and identifies opportunities for indigenous fuel based development. These opportunities are then evaluated through the performance of definitional missions or preliminary technical assessments wherein the overall technical and economic parameters of the project are considered. Favorable initial assessments lead to performance of project feasibility studies for a more definitive assessment of the projects viability. Study results are then shared with potential project financing agencies such as the World Bank, the International Finance Corporation, commercial banks, private corporations, and within A.I.D. in order to attract the financing necessary to implement the project.

The Office of Energy's strategy consists of the following elements:

- Strengthening efforts to assess and develop conventional energy resources; and
- Promoting technology innovation to harness conventional energy resources.

The Office specific programs and planned accomplishments are described below.

Resource Assessment and Development

In the area of resource assessment and development, the Office of Energy's efforts will focus on oil shale development, extrapolating from the FY 88 successful test burn of Jordanian oil shale in a circulating fluidized-bed combustor. In addition, other low-grade energy resource materials such as municipal solid waste and lignite coal will be assessed for direct firing in fluidized-bed combustion. A study of the potential utilization of oil shale in power production in Jordan, completed in FY 88, is a prime example of this energy project development strategy.[7]

[7] Bechtel National Corporation, *Prefeasibility Study of Oil Shale Utilization for Power Production in Jordan*, Office of Energy Report No. 89-02, May 1989.

In 1986 a series of factors related to Jordan's economic growth rate, expanding energy requirements, and lack of traditional energy resources such as oil, gas, or coal, supported the idea of an USAID evaluation of an oil shale project in the country. Results of a prefeasibility study show that a 400 MW oil shale fired power plant compares favorably to imported oil or coal alternatives. As a result of briefings by the study team, the World Bank is now including the oil shale option in its energy plan for Jordan. With appropriate technology, oil shale offers great promise as one of the undeveloped indigenous fossil fuel resources that can support the growing energy needs of a number of countries, including Jordan, Morocco, China, Zaire, Thailand, and Burma.

Key to successfully exploiting oil shale energy potential is the use of appropriate technology that meets technical, economic, and institutional requirements. Until recently, such technology has not been available. However, the use of unconventional direct burning technologies, such as circulating fluidized-bed combustion (CFBC), have become attractive, commercially available alternatives.

Planned Accomplishments:

1. Complete the oil shale prefeasibility study in Jordan.

2. Perform the oil shale-to-power project feasibility study in Jordan.

3. Conduct a definitional mission to assess the application of circulating fluidized-bed combustion to oil shale development in Morocco.

4. Conduct an oil shale-to-power workshop, "Road Map to Commercialization," and an oil shale combustion operational case study for Jordan and Morocco.

5. Perform a municipal waste-to-energy project assessment in India and/or the Philippines.

6. Conduct a fluidized-bed combustion test for low grade lignite in Thailand.

Technology Innovation

The 1980s have seen the emergence of a number of innovative technologies for power production, distribution, and use--many of them with the potential to meet developing country needs in economically and environmentally advantageous ways.

For example, advanced gas turbine units have been developed by the General Electric Company that have overall energy conversion efficiencies of 50 percent, requiring 20 percent less fuel than the most efficient conventional large thermal power plants. These units combine modularity, short lead times for planning and commissioning, and attractive costs. A.I.D. will support assessment of this technology for LDC applications in India and elsewhere.

Project activities in the area of technology innovation will have several thrusts. Due to the growing international environmental concern over the increasing use of coal, the FY 89 effort will seek out innovative clean coal technologies and match appropriate applications in several target coal producing LDCs. Other innovative technologies that will receive special attention in FY 89 include well-head geothermal power generation, a computerized energy technology screening tool for LDC energy planners and decision-makers, and the tailoring of an advanced management information system for the Egyptian General Petroleum Company.

Two recent advances in coal combustion technology--atmospheric fluidized-bed combustion (AFBC) and integrated gasification combined cycle systems (IGCC)--combine superior technical and environmental performance with modular design.

The IGCC technology is inherently modular, with commercial units projected to be in the range of 100--250 MW. This range is especially suitable to the current LDC utility environment and coal infrastructure. This modularity implies improved financing and improved plant availability relative to larger (500-1,000 MW) conventional coal generation units. The economics of mature commercial IGCC systems in the United States are projected to be competitive with conventional coal plants equipped with scrubbers, but present experience is limited to a single prototype plant.

An example of this approach is a recently implemented study to investigate the application of IGCC technology in India to generate power from its poor quality, high-ash indigenous coal. As a world leader in coal gasification technologies, the U.S. is in a position to provide critical expertise and operating experience to India's planned 100 megawatt IGCC power plant. Under a cooperative arrangement among USAID/New Delhi, the Office of Energy, and the Trade and Development Program, the Office is leading an effort to provide IGCC technical assistance to India. A preliminary study indicated that IGCC has advantages over pulverized coal fired boilers in meeting emissions standards, minimizing water requirements, burning coal efficiently, operating reliably, and providing chemical by-products--all factors of interest to the Government of India. The Office of Energy is now undertaking a more comprehensive assessment of IGCC technology that will be used as input to India's Eighth 5-Year Plan, currently being formulated. A successful example of this technology in developing countries could meet important trade, development, and environmental objectives.

Planned Accomplishments:

7. Complete a prefeasibility study of IGCC technology in India in collaboration with the Indian Council for Scientific and Industrial Research.

8. Perform DOE/A.I.D. clean coal technologies project verification studies for Indonesia, the Philippines, and Thailand.

9. Perform an integrated gasification combined cycle power plant prefeasibility study for India.

10. Develop a computer-based energy technology screening tool for the Asia and Near East Region.

11. Conduct a seminar on fluidized-bed combustion commercialization potential, and conduct site and technology orientation visits in support of Thailand's lignite development.

12. Perform a prefeasibility study on well-head geothermal development and conduct resource exploration and assessment in support of geothermal projects in the Philippines.

13. Perform a management information system design and demonstration for the Egyptian General Petroleum Company.

CHAPTER VI

PRIVATE SECTOR PARTICIPATION IN THE POWER SECTOR

A. RATIONALE

Electricity, as an especially high-grade form of energy, plays a large role in the development process. Between 1970 and 1980, Gross Domestic Product in developing countries grew at rates of 3.5-5.5 percent per year while total energy consumption grew by 5.9 percent and electricity consumption essential for growth in the industrial and commercial sector, increased by over 7 percent per year.

Developing countries, however, need more electrical power for sustainable social and economic development than they are able to produce. As discussed in Chapter I, power shortages exist in over half of A.I.D.-assisted countries. These shortages can have severe economic impacts on the Gross Domestic Product, foreign exchange earnings, and industrial productivity.

Previous activities supported by the Office of Energy have indicated that private sector power generation is a viable option for increasing the electricity generation capacity and improving the reliability of power supply in developing countries. Private sector investment in power projects can reduce the need for government financing of public utilities. Since such power generation activities are new in developing countries and require major initiatives on the part of governments, electric utilities, and the private sector, the progress in taking advantage of such opportunities has been considerably slower than expected.

The goal of this effort, then, is to stimulate and accelerate the development of private power projects in developing countries by identifying the potential for, and the impediments to, private power development in selected countries, by providing technical support in developing and implementing private power policies and projects, by cost-sharing feasibility studies, and by collecting and disseminating information pertinent to private power in developing countries.

The efforts of the Office of Energy in promoting private participation in the energy sector are designed to address the problems outlined below.

Shortage of Public Investment Capital

As pointed out in Chapter I, the 1988 A.I.D. Report to Congress on *Power Shortages in Developing Countries* estimated that to sustain a 4.5 percent per year real economic growth rate at current levels of energy system efficiency, developing countries will need to build 1,500 gigawatts of new generating capacity over the next 20 years. That would mean an investment of $125 billion each year, compared to the $50-60 billion a year that developing countries are currently investing in electricity supply.

Due to inappropriate pricing and inefficient operation, many utilities in developing countries do not generate enough revenue to cover their operating and capital expansion needs. They traditionally have had to depend on the government for supplementary funds, especially for expensive new generating facilities. Almost all A.I.D.-assisted countries have not been able to fund the capital requirements of their power systems without extensive foreign aid.

Due to their financial problems, many utilities in developing countries are having difficulty qualifying for loans from international development banks or private commercial banks. In recent years foreign lending from private banks for energy projects has dropped dramatically.

Inefficient Parastatal Institutions

Resource allocations and prices tend to be administratively determined rather than responsive to market forces. As entrenched government bureaucracies, many utilities have become over-staffed with poorly paid employees and are unable to attract qualified personnel. Such organizations find it hard to adopt modern management techniques or modern power technologies. The result is inefficient operation of generating plants, transmission and distribution systems, and revenue collection systems.

These state-owned utilities lack the financial, managerial, and technical resources needed to expand their supply systems fast enough to keep pace with growing demand. Also, the governments of developing countries cannot provide the needed resources from elsewhere within the public sector.

Inappropriate Government Policies

Many developing countries have public policies, regulations, and practices that prohibit or discourage private sector involvement. In many countries only the state-owned utility can generate, distribute, and sell electric power. Before private investment can take place, policy issues must be resolved. Other public policies often create additional barriers to investment by private foreign and domestic sources, such as restrictive tax policies, high import duties, restrictions on repatriation of profits, prohibitions on foreign ownership of companies, unavailability of adequate guaranties of payment on contracts and inadequate mechanisms for dispute resolution.

Lack of Experience with Private Power

For developing countries, the re-entrance of private companies into the energy sector, particularly the power sector, is nothing short of institutional revolution. Limited participation of privately owned or operated electric utility systems or facilities is still the exception rather than the rule. Prior to World War II, the development of electric power

systems in these countries had been accomplished primarily through privately owned and financed power companies that were later taken over by state owned public utilities.

Governments and their public utilities in developing countries do not clearly understand what the private sector needs to successfully design, finance, build, and operate privately owned electric power facilities. Appropriate laws, regulations, and guidelines for private power are not in place. How to solicit and evaluate project proposals and how to set a fair purchase price for power are not adequately understood. How to arrange equitable contracts, secure project loans from foreign lenders, and integrate private facilities into public power systems are issues that developing countries have not had to face in recent years.

High Risk and Expense of Developing Private Power Projects

The process of developing privately owned energy projects in developing countries is complex and difficult for private companies. The political and financial risks are seen as very high. This results in very extensive front-end project development costs and difficulty in raising and servicing project equity and debt.

Many U.S. companies avoid marketing their goods and services in developing countries. Some lack experience with overseas markets. Others lack the resources and the contacts to market overseas. Some are unaware of U.S. government assistance and financing programs that are available to assist them.

B. STRATEGY

The efforts of the Office are aimed at creating a favorable environment to encourage private financing and operation of energy facilities in selected developing countries, concentrating initially on electric power. The implicit assumption of these efforts is that the increased participation of the private sector in the provision and distribution of energy both increases efficiency in the energy sector and helps to attract new sources of private capital for energy development.

To enhance private sector participation in the energy sector, the Office organizes its activities around the following three broad program objectives:

- Inducing policy reform and institutional development supportive of private participation in the energy sectors of developing countries;
- Assisting private energy project development, especially in the electric power sector; and
- Improving coordination and use of U.S. government resources by private firms seeking involvement with the energy and power systems of developing countries.

To implement these objectives, the Office of Energy is currently developing the Private Sector Energy Development (PSED) Project. The purpose of the proposed project is to create a favorable environment to encourage the financing and operation of private energy facilities in selected developing countries, concentrating initially on electric power. A technical advisory group will be established under this project, with representation from the U.S. Government agencies mentioned above.

Previously, actions to promote private power have been undertaken by the Office of Energy's Conventional Energy Technical Assistance (CETA) Project, the Energy Conservation and Services Project (ECSP) component of the Energy Policy Development and Office of Energy's Conservation Policy Development (EPDAC) Project, and the Energy Training Project (ETP). The Private Sector Energy Development Project will focus the efforts of the Office on promoting private power under one project. In the interim, and as the project is phased in, certain planned accomplishments will continue to be funded under other Office of Energy projects. The Office's specific initiatives and planned accomplishments are listed below. Each accomplishment is followed by an acronym indicating the Office project that will implement that task.

Policy Reform and Institutional Development

As explained in the "Rationale" section, the energy sector, particularly electric utilities, is traditionally a monopoly of the state. Important first steps, therefore, are to help LDC governments and utilities assess the constraints of the current system and to judge the appropriate roles for the private sector. The U.S., of course, has significant experience with private power generation and distribution and regulation of such activities, and especially with the innovations allowed by the Public Utilities Regulatory Policies Act passed by Congress in 1978.

The Office conducts conferences and workshops in assisted countries that involve host-country ministers and utility officials, private power experts from banking and utility institutions, and project developers. These meetings act as catalysts to promote interest in policy changes that will permit private sector entry into the energy sector.

Technical assistance is offered in drafting private power legislation and in developing regulatory frameworks and financing mechanisms. The Office also sponsors study tours of host country officials to visit the U.S. to meet experts and tour private power facilities.

The Office has established a data base of information on private power initiatives in A.I.D.-assisted countries. The data base includes sections on project opportunities, U.S. vendors of private power and cogeneration technology, and country-specific laws and regulations. Information from the data base is periodically disseminated to interested persons through the *Private Power Reporter.*

Planned Accomplishments:

1. Conduct workshops for U.S. private power developers (Summer '89). --PSED

2. Conduct a private power workshop in the Latin America and Caribbean Region. --ECSP

3. Conduct a seminar on private power proposal evaluation in Indonesia. --ECSP

4. Organize and conduct a workshop on private power in Indonesia. --ECSP

5. Conduct private power seminars focused on U.S. experience in the development, regulation, and purchase of privately generated power. (Pakistan and Jordan). --CETA

6. Conduct study tours for energy officials from the Philippines, a second country from the Asia and Near East region, and a country from the Latin America and Caribbean region, to come to the U.S. to meet experts and tour appropriate private power facilities. --PSED

7. Conduct orientation site visits and on-the-job training assignments at U.S. private power projects for LDC decision makers/energy planners. (Dominican Republic, India, Costa Rica, the Philippines, Pakistan, Indonesia, and Thailand). --ECSP

8. Develop and implement in-country training program on private power generation (worldwide). --ECSP

9. Provide technical assistance in private power policy development (Dominican Republic, India, and the Philippines). --ECSP

10. Prepare analytical and practical tools on interconnection of power systems to the grid and develop software for determining avoided cost pricing. --ECSP

11. Provide Project financial advisory services and BOT (Build-Own-Transfer) contract evaluations to LDC private power purchases worldwide. --CETA

12. Dispatch private power experts to countries requesting technical assistance on private power. --PSED

13. Expand and maintain the Office of Energy private power database and publish the Office of Energy *Private Power Reporter*. --ECSP

Private Energy Project Development

The Office will identify several private energy projects and cost-share prefeasibility and feasibility studies. The Office wishes to work closely with private sector energy associations, industry and utility representatives, and project developers to assist them in understanding the opportunities and in developing specific electric power generation and

distribution facilities. Project activities will be conducted in Asia/Near East, Latin America/Caribbean, and Africa. Initially, two to three countries will be targeted for emphasis in each region. The project will also develop cooperative agreements with leading U.S. research centers.

To work effectively with the private sector, A.I.D. plans to work in a project-oriented manner, while retaining overall concern with A.I.D.'s development goals and with the broader policy and institutional environment in which the private sector can operate.

Planned Accomplishments:

14. Establish guidelines for and implement the Private Sector Energy Feasibility Study Fund to share with U.S. private power project developers the cost of prefeasibility and feasibility studies in the Philippines and the Latin America and Caribbean Region. --CETA

15. Carry out prefeasibility studies of providing private power to the grid (Swaziland, Guatemala). --ECSP

16. Perform private power project identification study and analysis in the Philippines. --CETA

17. Perform private power project feasibility study in the Philippines. --CETA

18. Assist the Administrator's Energy Industry Review Group. --CETA and EPDAC

Program Coordination

Improved coordination between A.I.D., other U.S. government agencies (such as OPIC, EXIMBANK, the Departments of Energy and Commerce, and the Trade and Development Program), other bilateral donors, multilateral development banks, and the private sector is another anticipated achievement.

Planned Accomplishments:

19. Establish a Technical Advisory Group of energy industry and government representatives to advise the Office of Energy on projects and other matters pertaining to private power. --PSED

20. Disseminate information on private power and demand management, including preparation and publication of a paper. --ECSP

21. Establish a core staff to administer and conduct the Private Sector Energy Development Project. --PSED

CHAPTER VII

TRAINING

A. RATIONALE

True development in the countries assisted by A.I.D. means the acquisition of skills and the building of institutions that make the development process sustainable and predominantly indigenous.

Numerous skills are needed in the energy sector. On the demand side, end-use analysis, auditing capacity, maintenance, and management are important. On the supply side, the exploitation of specific energy sources requires knowledge of resource assessment methods and of technologies for mining or harvesting and then conversion. With regard to electricity generation, knowledge of maintenance techniques to ensure durability and reliability of equipment is needed. System managers and planners must possess a combination of such technical knowledge, a facility with economic issues, and an understanding of various environmental impacts of different energy technologies, as well as basic management skills. Government policymakers must have some similar broad familiarity with these various areas.

B. STRATEGY

LDCs typically lack persons who possess these various skills. One obvious way to accomplish the important transfer of knowledge is through formal training programs. A technically trained cadre of energy professionals is critical in helping countries make the best possible energy investment decisions. Although U.S. "trainers" cannot fully understand the needs and culture of each LDC, the transfer of useful skills would enable nationals of those LDCs--who do know their own cultures--to make better energy-related decisions. The trained individuals become an indigenous resource in their own countries, strengthen the private and public institutions with whom they work, and, it is hoped, in turn transfer their knowledge to fellow nationals.

To accomplish these educational goals, the Office of Energy has administered since 1980 a program offering formal training to nationals of LDCs. This program complements the major components of all other Office of Energy programs. Most of the courses comprising the program have been organized by U.S. contractors, including universities and private sector firms. A by-product of some of the training courses, then, has been to establish a friendly relationship between participating U.S. firms and trainees that can result in business for that firm after the graduates return to their country.

From 1980 to 1987 the Conventional Energy Training Program (CETP) sponsored 721 participants. This training program placed participants from the LDCs in academic and technical training programs at universities, private energy companies, non-profit institutions,

and national laboratories. The duration of training ranged from two months to two years, in such fields as energy conservation, chemical, civil, and electrical engineering, and petroleum engineering. In 1988 CETA was superseded by the Energy Training Program (ETP). The primary focus of the ETP is to expand and augment the benefits of energy projects that are beginning financed by A.I.D. in approximately 35 countries. Other countries will be included as needs change. ETP will fund target training to help build technical, managerial, research, and institutional capacities. The program supports the Office of Energy, Mission and Regional Bureau energy plans and activities, as well as the policy reform, private sector, institution-building, and technology transfer pillars of A.I.D.'s development strategy. Under this new program, less emphasis is placed on academic degree programs and more on relatively short courses in technical training that include, wherever possible, "hands-on" experience. Some participants maximize the latter by being placed in internships that are totally work-oriented.

To increase the probability that the skills acquired by a participating individual are actually put to use when the participant returns to his or her country, the project requires that the individual provide a guarantee of a job when he or she returns. This also assures that the skills acquired will become part of the capability of an institution, with increased likelihood of their widespread application and transfer to additional persons.

The program has assisted the placement of LDC nationals in traditional academic programs, provided matriculation costs are covered by Mission or other non-Office funds (only in rare circumstances can the Office program budget be used for such purposes). Five participants will start such an academic program in FY 1989 as a result of their participation in program courses.

In FY 1988, the Office of Energy sponsored various courses that helped train 150 participants in various energy fields, policy and analysis, and in energy conservation and demand management. In 1989 approximately 250 participants will be trained in various courses. These are only short-term courses, ranging from 1-7 months. Additional courses can be designed to meet the expressed needs of any particular A.I.D.-assisted country.

The Office of Energy's training strategy embraces the following five major elements:

- Energy policy and analysis;
- Energy conservation;
- Indigenous fossil fuel development;
- Rural power systems; and
- Cross-cutting themes.

These elements provide the framework for the Office's planned accomplishments (courses) for FY 89 and FY 90 that are described below.

Energy Policy and Analysis

Energy policy and analysis includes power systems planning, integrated national energy planning and institution building, and information dissemination and outreach.

Planned Accomplishments:

Power Systems Planning

1. Advanced School in Power Systems Engineering
2. Effective General Management of Electric Utilities
3. Private Power Executive Seminar
4. Power Systems Engineering

Integrated National Energy Planning and Institution Building

5. Energy Policy and Planning
6. Managing a National Petroleum Enterprise

Information Dissemination and Outreach

7. ETP Alumni Follow-up, Training Conference, and Newsletter

Energy Conservation

Energy conservation covers utility, industrial, and refinery conservation.

Planned Accomplishments:

8. Overhauling of Large Steam Power Plants
9. Refinery Energy Conservation

Indigenous Fossil Fuel Development

Indigenous fossil fuel development includes applied petroleum exploration and production technology, lignite coal utilization, and management programs in petroleum and gas.

Planned Accomplishments:

10. Applied Petroleum Exploration and Production
11. Coal Utilization Technology

12. Petroleum Management Program

13. Gas Management

Rural Power Systems

Rural power systems training covers all forms of alternative energy (e.g. wind, solar, hydro, and geothermal) and includes identifying and assessing potential resources and technologies.

Planned Accomplishments:

14. Alternative Energy Training

Cross-Cutting Themes

Cross-cutting training mechanisms include various activities that supplement training in the abovementioned areas.

Planned Accomplishments:

15. Internships (various facilities)

16. Academic (various institutions)

APPENDIX

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

Office of Energy Report No.	Title of Report	Prepared By	Date	Document No.
88-01	New Directions for A.I.D. Renewable Energy Activities	Office of Energy and and Oak Ridge Laboratory	February 1988	PN-ABB-532
88-02	Rice Residue Utilization Technology, International Market Prospects for U.S. Industry	Louisiana State University Agricultural Center	January 1988	PN-ABB-533
88-03	Cane Energy Utilization Symposium, A Report from the 2nd Pacific Basin Biofuels Workshop, Volume I: Summary	Tennessee Valley Authority	April 1987	PN-AAZ-727
88-04	Cane Energy Utilization Symposium, A Report from the 2nd Pacific Basin Biofuels Workshop, Volume II: Presented Papers	Tennessee Valley Authority	April 1987	PN-AAZ-727
88-05	Potential for Private Investment in Rice Residue Power Generation, Indonesia 1987, Preliminary Analysis	Tennessee Valley Authority	May 1988	PN-AAZ-728
88-06	Assessment of Integrated Coal Gasification Combined Cycle Technology for India	Office of Energy	May 1988	PN-AAZ-893
88-07	Project Evaluation and Implementation	RCG/Hagler, Bailly, Inc.	April 1988	PN-AAZ-769
88-08	Energy Standards Directory for the Process Industry	RCG/Hagler, Bailly, Inc.	March 1988	PN-AAZ-740
88-09	The Hashemite Kingdom of Jordan, Recommendations for an Industrial Energy Efficiency Program	RCG/Hagler, Bailly, Inc.	May 1988	PN-ABB-534
88-10	Program Plan, FYs 1988-89	Office of Energy	May 1988	PD-AA4-768
88-11	Trial Year Program Proposal, Nong Yai Sugar Mill, Thailand	Tennessee Valley Authority	August 1987	PN-ABA-332
88-12	Energy in West and Central Africa: Issues, Problems and Donor Activities	RCG/Hagler, Bailly, Inc.	July 1988	PN-ABA-256
88-13	Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector	A.I.D.	March 1988	PN-AAZ-552

Office of Energy Report No.	Title of Report	Prepared By	Date	Document No.
88-14	The A.I.D. Experience with Independent Power Generation	Office of Energy	August 1988	PN-ABB-535
88-15	Options to Increase Private Participation in Electric Power Development in A.I.D.-Assisted Countries	Office of Energy	December 1987	PN-ABB-536
88-16	A Financial Model for Evaluating Proposed Private Power Projects in Developing Countries	RCG/Hagler, Bailly, Inc.	April 1988	PN-ABB-537
88-17	A Prefeasibility Assessment of the Potential of Wood Waste Power Systems for the Indonesian Wood Products Industry, Phase I Report	Tennessee Valley Authority	November 1988	PN-ABB-341
88-18	Electric Power from Sugarcane in Costa Rica, A Technical and Economic Analysis	Tennessee Valley Authority	July 1988	PN-ABB-444
88-19	Summary of the Central American and Caribbean Workshop on Electric Power	RCG/Hagler, Bailly, Inc.	December 1988	PN-ABB-538
88-20	Report on Roundtable for Private Participation in the Electrical Sector of the Dominican Republic	K & M Engineering and Consulting Corp.	August 1988	PN-ABB-539
88-21	Electricity and Ethanol Options in Southern Africa	Tennessee Valley Authority	September 1988	PN-ABB-540

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