Report No. 90-03

A Report of the

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

PROGRAM PLAN

FISCAL YEARS 1990 AND 1991

July 1990

OFFICE OF ENERGY
PROGRAM PLAN
FISCAL YEARS 1990 AND 1991

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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 end 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 less developed countries (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.* 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 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.

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

Allaying hunger requires energy for cooking as well as for greater agricultural productivity, and the agricultural sector requires several forms of energy input--for irrigation, for operation of on-farm equipment, for processing, and for transport, storage, 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, communications, 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 and increased use of renewable resources, cleaner liquid fuels, and environmentally more benign technologies for fossil fuel combustion.

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 increased 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 and given the expected population growth rates of 2.5 to 4 percent, attaining A.I.D.'s goal of a 2 percent real increase in per capita income would *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 has required historically 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*.

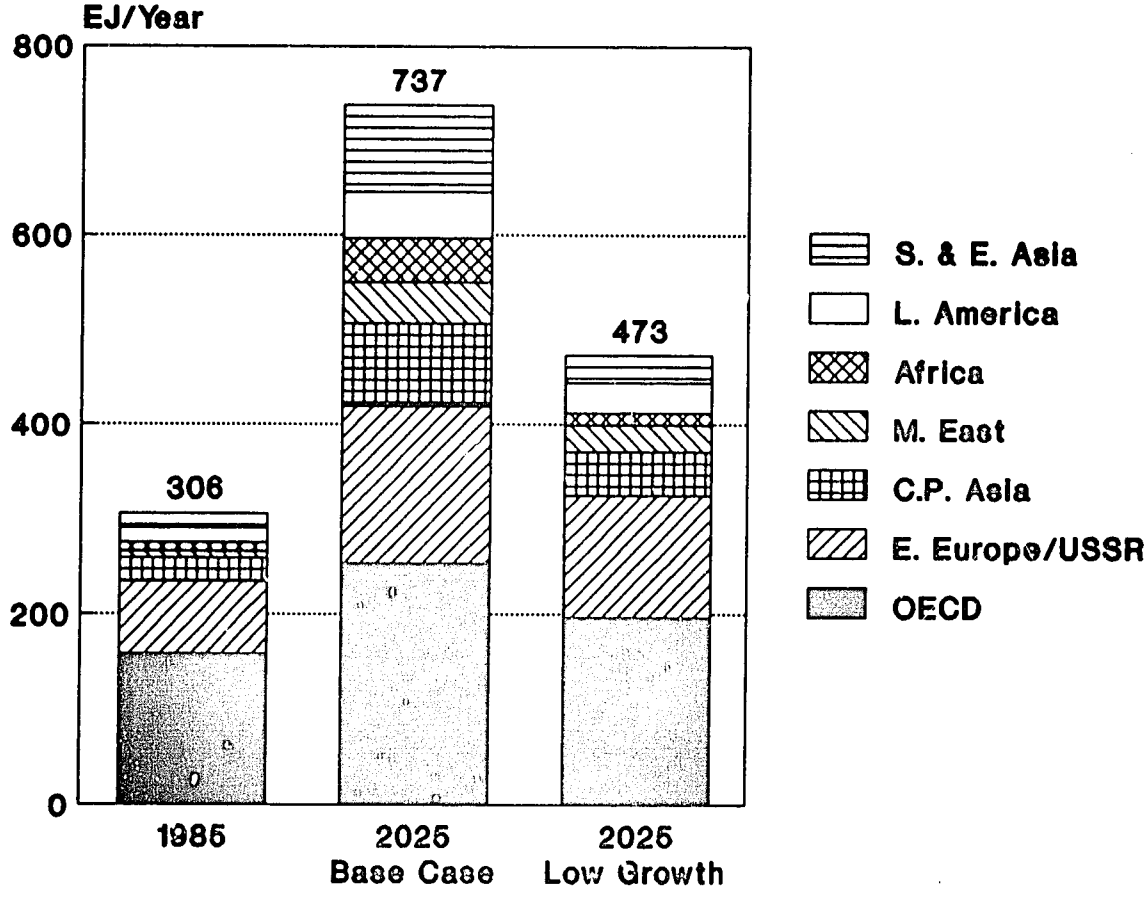
B. PROBLEMS OF ENERGY PRODUCTION AND USE

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. Figure 1 compares projected increases in primary commercial energy consumption in the developing countries with those in Organization for Economic Cooperation and Development (OECD) countries between 1985 and 2025.

Figure 1
Primary Commercial Energy Consumption



Note: EJ = exajoule: 10^{18} joules = 0.95 x 10^{15} BTUs.
Source: U.S. Agency for International Development. *Greenhouse Gas Emissions and the Developing Countries: Strategic Options and the U.S.A.I.D. Response.* A Report to Congress, July 1990.

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.* Capacity in 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. In many developing countries the largest single area of investment of national funds is the energy sector, with 70 - 85% of the investments going into the electric power subsector. *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. Power shortages in the Philippines in 1990 are costing the economy an estimated $1.1 million per day in lost production.

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.

In theory, more efficient cookstoves and industrial technologies could reduce wood requirements by 25-70 percent at very low cost. One study estimates that greenhouse gas emissions attributable to cookstoves could be halved. Another puts the reduction at 80 million tons of carbon per year, or 3 percent of greenhouse emissions from deforestation assuming that the stoves use 40 percent less fuelwood and that 175 million households used them. However, numerous past efforts to introduce improved stoves have not lived up to expectations, possibly because they did not save fuel or labor, or because wood could be gathered for free, and therefore was not highly valued, or because it was difficult to change

present cooking practices. More efficient charcoal stoves have met with more success. The effect of their use is even greater when efficient charcoal production methods are used. Mass production and marketing of improved stoves to lower unit costs would also be useful.

For women and children the use of traditional cooking fuels -- primarily firewood and animal dung -- results in severe indoor air pollution that causes serious respiratory and eye disease.

Environmental Impacts

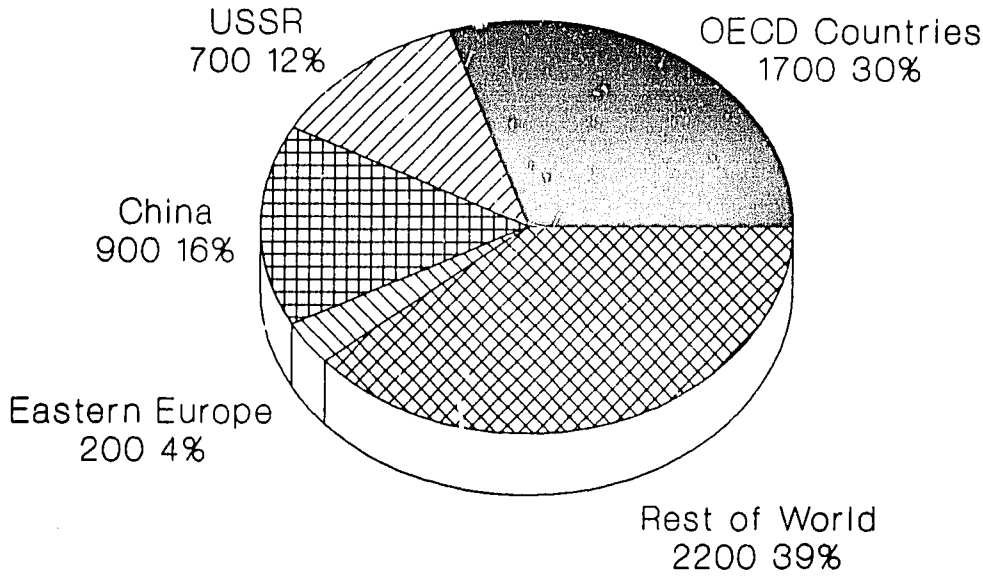
All forms of energy conversion extract an environmental cost. In economic terms, these costs are often difficult to track, but they affect the health of numerous ecosystems that in one way or another are critical to human welfare.

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 their conversion can cause atmospheric degradation--air pollution, acid deposition, and global CO_2 buildup--and thermal water pollution.

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 potential global climate change. The possible implications of this trend are many and dramatic. Currently, LDCs contribute a much larger portion (perhaps 90 percent) of deforestation-related CO_2 emissions than of energy-related emissions (about 15 percent); industrialized countries contribute the overwhelming majority of energy sector emissions now. But the energy demand growth that will accompany economic development and population growth in LDCs in future decades will change the relationship significantly. By 2025, LDCs will contribute a larger portion of the energy-related emissions than OECD countries. Figure 2 shows the relative contribution to overall increases in CO_2 emissions between 1985 and 2025.

Figure 2
Regional Contributions to Global Increases in CO_2 Emissions
1985-2025 (teragrams/year)



Note: teragram = 10^{12} (one trillion) grams
Source: A.I.D. Office of Energy, 1990. *Assessment of the Global Energy Efficiency Initiative.*

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 in energy assistance is to help ensure an adequate energy supply to meet its goals in overall income growth and 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. It helps formulate energy policy for the Agency and works with other donors to leverage their support of environmentally sound energy assistance.

These activities will become increasingly important because energy use in the developing countries is anticipated to grow by a factor of three to five over the next twenty years.

As pointed out in A.I.D.'s 1988 Report to Congress entitled *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector*, under a "current trend" scenario, in which no energy efficiency measures are implemented, with a medium economic growth rate of 4.5 percent per year, 1,500 GW[2] (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. By the year 2008, the annual cost of meeting power sector demand in developing countries will reach $125 billion (compared with the estimated $50-$60 billion currently being spent per year).

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 above-mentioned growth rates in electrical generation capacity.

The *Foreign Assistance Act*,[3] which authorizes A.I.D. activities, also 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 high costs of energy could be reduced dramatically, according to the Report, by implementing an "efficiency" scenario that incorporates various efficiency measures and

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[2] GW = gigawatt = 10^9 (one billion) watts

[3] *Foreign Assistance Act of 1961, as amended.*

assumes the same medium economic growth rate of 4.5 percent per year. Adoption of energy efficiency could enable developing countries to satisfy their demand for electricity and reduce the need for additional generating capacity to 700 GW. Figure 3 illustrates the differences in annual capital investments between the current trend and efficiency scenarios.

As a result of these findings, A.I.D. is promoting the crucial economic benefits of improved energy planning and efficiency and targets private sector investment in electricity systems. Equally as important, A.I.D. is targeting private sector investment to provide the necessary capital to overcome these shortfalls.

The substantial expenditures for and inadequate supplies of energy in developing countries are compounded by increasingly severe environmental impacts associated with energy production and use. In response to this situation, the *Foreign Assistance Appropriations Act of FY 1990*[4] mandates the A.I.D. Administrator to implement a "Global Warming Initiative" that focuses the Agency's energy assistance on helping to mitigate the increasing contribution of "key" developing countries to greenhouse gas emissions resulting from deforestation and fossil fuel combustion. As part of this legislation, the Congress appropriated additional funds that are to be used by the Agency to augment its staff with energy and environmental expertise and to focus its assistance on "improved energy efficiency, increased use of renewable energy resources and national energy plans (such as least-cost energy plans) which include investment in end-use energy efficiency and renewable energy."[5]

The strategic focus of A.I.D.'s Office of Energy has anticipated and supports this recently enacted congressional legislation. This strategy includes expanding least-cost planning activities to incorporate environmental concerns, increasing support for feasibility studies in renewable energy (through creation of a Clean Energy Technology Feasibility Study Fund) and cleaner fossil energy technologies that focus on site-specific commercial applications, launching a multilateral Global Energy Efficiency Initiative, initiating an Energy Technology Innovation Project (see Chapter VI), and enhancing training of host country nationals and A.I.D. staff in areas of energy that can help to reduce expected global warming and other environmental problems. The Office of Energy is planning to place five or six senior energy professionals in the field to serve the energy needs of A.I.D. Regional Offices and national Missions.

In combatting such expected climate change, as well as the other related environmental insults described above, technology transfer, technical innovation, and commercialization in energy efficiency are crucial. However, even if the most ambitious goals for energy efficiency can be reached, developing countries will still need more energy

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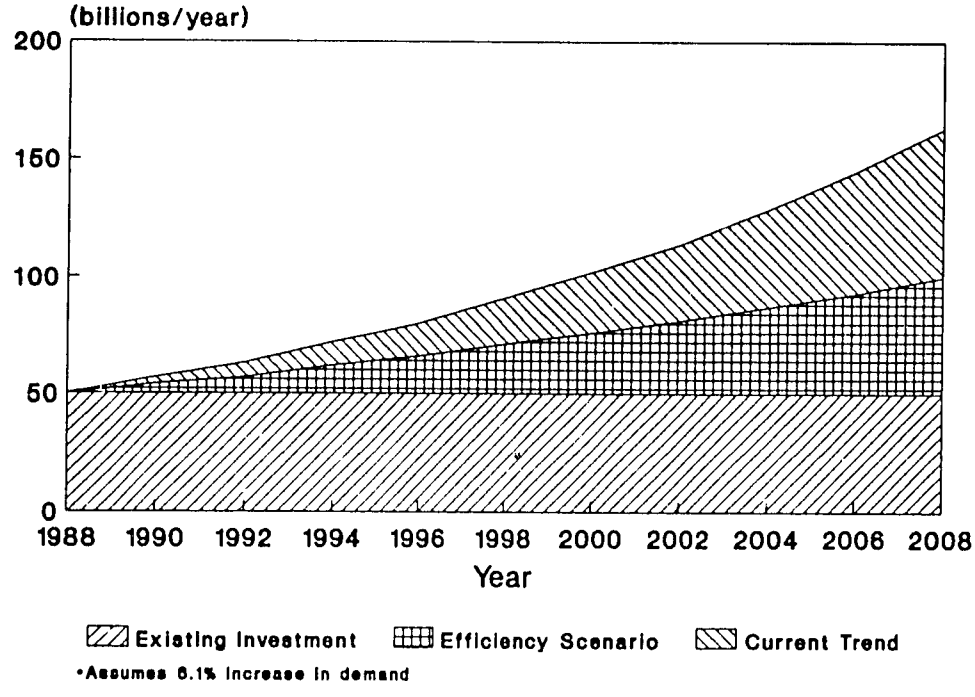
[4] *FY 1990 Foreign Operations, Export Financing, and Related Programs Appropriations Act (Public Law 100-167).*

[5] Ibid., Section 534(b)(1).

to sustain development. Therefore, the Office supports urgently needed, economically attractive, and realistically implementable alternatives to coal and other high carbon-emitting fuels. Office initiatives include furthering the use of renewable energy resources such as solar, small hydro, wind, and geothermal and increased attention to natural gas and coalbed methane as fossil fuels emitting relatively lesser amounts of carbon.

Figure 3
Annual Investment Requirement in the Power Sector
Medium Growth Scenario 1988-2008



Source: U.S. Agency for International Development. *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector.* A Report to Congress, March 1988.

For several years the Office has placed special emphasis on biomass energy systems that use agricultural and forestry residues to generate electricity, sometimes in conjunction with process steam through cogeneration. The reasons for the emphasis are that successful energy conversion systems using agricultural residues usually provide a range of complementary benefits to agroprocessing industries, including marketable products, which enhances the self-sufficiency of the agricultural sector by increasing overall returns on investment in these systems; and the use of biomass residues, if they are truly coming from a renewable source (that is, a crop that is regrown), generates no net CO_2 to the atmosphere. CO_2 emitted during burning is re-absorbed during the growing season, (departures from this cycle are minor quantitatively). Current Office programs involve both

research and active field projects and focus on sugar cane, rice, and wood wastes. (A full discussion of the Office's biomass and other renewable energy activities and projects is found in Chapter IV).

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

1. **Goal: Increase the efficiency of energy systems**

   Objectives: Increase the efficiency of power generation, transmission and distribution, and end uses; improve energy efficiency in the industrial, buildings, and transportation sectors.

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; increase the efficient operation of energy systems, 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, private power, and environmental considerations are mentioned in more than one chapter. In addition to these programmatic themes, an important methodological approach to development assistance is training and institutional development. By cutting across all of these objectives, 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 in Chapter VIII.

This Program Plan outlines and schedules the actions that the Office of Energy intends to take to help ensure that sufficient energy, produced with minimal environmental impacts, is available to meet the Agency's development targets. The Plan covers the current fiscal year, FY 90, and the following year, FY 91.

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 Agency Director for Energy and Natural Resources together with 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, energy experts from LDCs, and other U.S. government agencies.

In a deliberate process that is partially the reverse of soliciting such input, the Office positions a number of its initiatives, especially pre-investment studies for power sector activities, so that they serve as input to investment decisions by those who provide significant financing--the utilities and banks. Carefully orchestrated initiatives, therefore, can leverage great influence.

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 budget for FY 90 is $15.4 million; the estimated budget for FY 91 is $13.3 million. These budgets reflect basic program funding, as well as funding reserved for additional global climate change activities that is disbursed among several or all of the Office's projects. The FY 91 budget also includes $600 thousand for starting up two new projects--the Energy Efficiency Project and the Energy and Environmental Planning and Policy Development project.

The programmatic themes discussed above are addressed in the Office of Energy's seven "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 Figure 4.

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:

Director:	James Sullivan
Deputy Director:	Alberto Sabadell
Senior Physical Scientist:	David Jhirad
Program Operations Specialist:	Shirley Toth
Program Operations Specialist:	Carolyn Kiser
Energy Systems Analyst:	Ross Pumfrey
Energy Training Consultant:	Jorge Perez Ponce
Energy Consultant:	Ken Feldman
Energy Consultant:	Nathaniel Brackett

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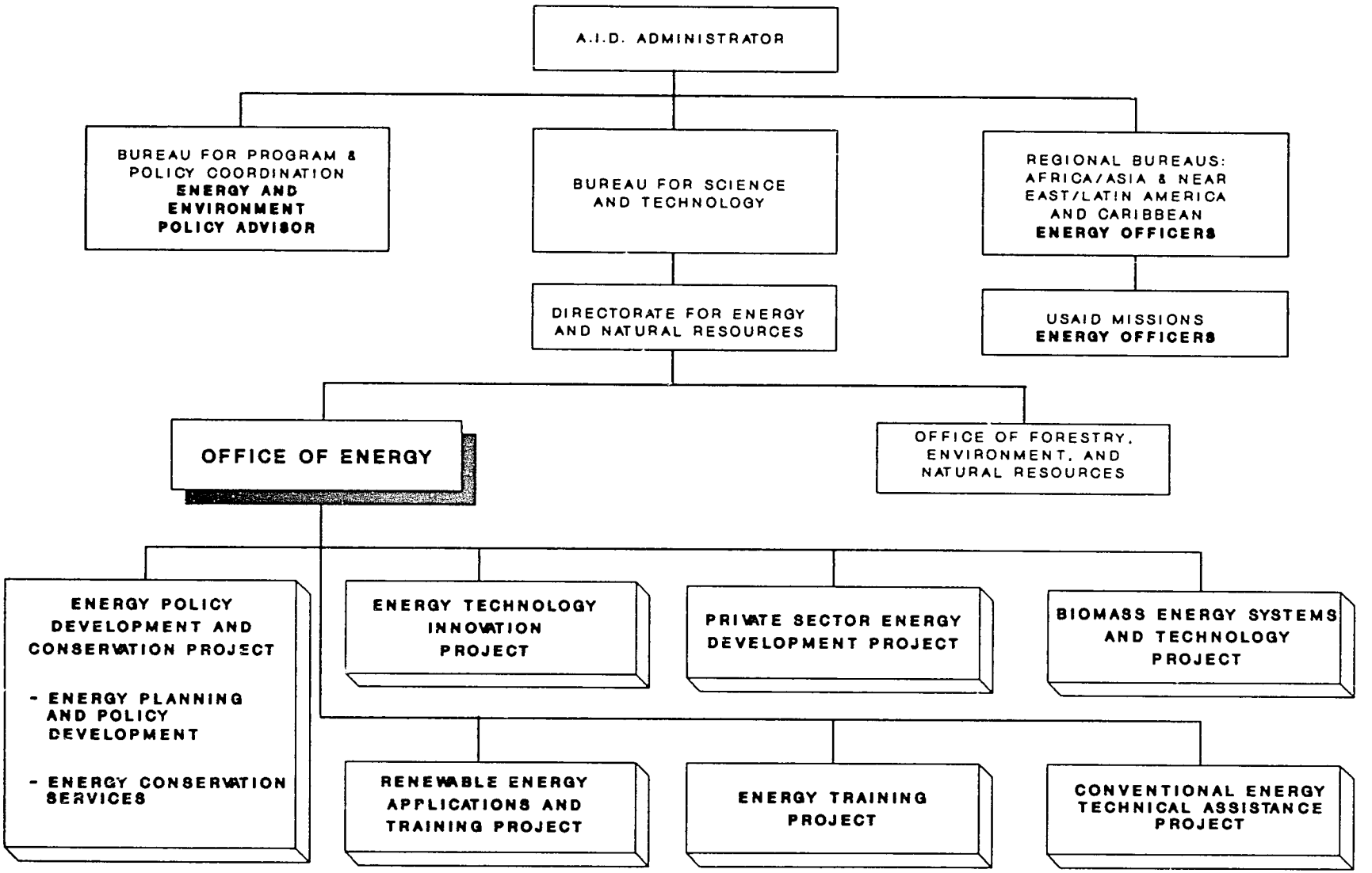
Mission staffs confront a broad array of problems and face inevitable constraints on gaining access in the many relevant disciplines to the latest ideas and technologies, and lessons learned in other countries. The Office of Energy, as the other specialized offices in the Bureau for Science and Technology, 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. All the program themes or activities described in the following chapters comprise one or more of the FY 90-91 Office projects:

- Energy Policy Development and Conservation (EPDAC)
  Sub-projects: Energy Planning and Policy Development (EPPD)
  Energy Conservation Services Project (ECSP);

- Biomass Energy Systems and Technology (BEST);

- Renewable Energy Applications and Training (REAT);

Figure 4
Organizational Chart of Energy Assistance
U.S. Agency for International Development



- Private Sector Energy Development (PSED);
- Conventional Energy Technical Assistance (CETA);
- Energy Technology Innovation Project (ETIP); and
- Energy Training Project (ETP).

These projects and their relatively discrete activities are described below:

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

   Planning and Policy Development Project Manager: David Jhirad

   Conservation Project Manager: Alberto Sabadell

   This project is divided into two sub-projects: the Energy Planning and Policy Development project, which funds several areas of planning and policy 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.

   FY 90 Budget: $ 4.9 million

   Proposed FY 91 Budget: $ 1.7 million

   Years of Project Life: FY 82 - FY 92

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

   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 90 Budget: $ 2.0 million

   Proposed FY 91 Budget: $ 2.0 million

   Years of Project Life: FY 89 - FY 96

3. **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 90 Budget: $ 1.5 million

Proposed FY 91 Budget: $ 1.0 million

Years of Project Life: FY 85 - FY 92

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

Project Manager: James Sullivan

This project facilitates 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 V.

FY 90 Budget: $ 2.8 million

Proposed FY 91 Budget: $ 2.0 million

Years of Project Life: FY 89 - FY 94

5. **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 VI.

FY 90 Budget: $ 0.7 million

Years of Project Life: FY 80 - FY 90

6. **The Energy Technology Innovation Project** (936-5741)

Project Manager: Alberto Sabadell

This new project is designed to implement innovative energy technologies and methodologies to help meet expected energy/power sector demand in LDCs in an environmentally benign and cost-effective manner. Components of the project, as described in Chapter VII, involve clean energy technologies; innovation in energy efficiency and in power generation, transmission, and distribution; technology transfer to rehabilitate current power systems; and improvement of power sector institutional structures.

FY 90 Budget: $ 0.5 million

Proposed FY 91 Budget: $ 1.7 million

Years of Project Life: FY 90 - FY 2000

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

Energy Training Project Manager: Jorge Perez Ponce

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

FY 90 Budget: $ 3.1 million

Proposed FY 91 Budget: $ 1.8 million

Years of Project Life: FY 87 - FY 92

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.

In addition to sharing expertise for specific project needs, staff responsibilities address cross-cutting programmatic themes such as environment and climate change, energy efficiency, private power, and donor coordination. Although the lead responsibility for each theme usually rests with one project manager, the combined efforts of several projects are often essential to optimize the Office's impact in these thematic areas. For example, energy-related climate change and environmental initiatives and multilateral and donor coordination are primarily the responsibility of the Project Manager for the Energy Planning and Policy Development (EPPD) project but include the active participation of several other project managers, especially those for the Energy Conservation Services Project (ECSP) and Private Sector Energy Development (PSED) project. Responsibility for the Office's energy efficiency efforts, such as implementing the Global Energy Efficiency Initiative, resides with the ECSP Project Manager; however, the overall importance and broad scope of energy efficiency requires contributions from several other project managers.

Likewise, energy activities with U.S. trade implications, such as those involving use of the Clean Energy Technology Feasibility Study Fund, will be spearheaded by the Project Manager of the new Energy Technology Innovation Project (ETIP); substantial support from the EPPD and PSED Project Managers is anticipated. And private sector energy activities, which are coordinated by the PSED Project Manager, are accomplished under several projects, including Renewable Energy Applications and Training (REAT) and Biomass Energy Systems and Technology (BEST).

In similar fashion, staff responsibilities divide along geographical regions. Although usually focusing on one region, a project manager is frequently called on to advise on project activities in other regions. For instance, while the project officer for ECSP has special familiarity with Latin America and the EPPD Project Manager's bailiwick is India, both lend their substantive expertise to issues in other regions as necessary. In addition, regional responsibilities are vested in other staff, especially in the case of Office activities in Eastern Europe.

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 $1.8 million in FY 90 and $2.5 million in FY 91.

E. INFORMATION OUTREACH

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 and energy sector 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 other U.S. agencies (such as the Department of Energy and the Environmental Protection Agency), 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 90 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. 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 1990 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, Office staff traveling to assisted countries provide briefings for Mission staff on Office activities of interest to the Missions. The Office will participate in designing training courses for A.I.D. personnel in areas related to energy technology, economics, financing, and policy, and to the environmental implications of alternative energy development paths for developing countries.

Private Sector Technology Transfer Teams: In FY 89, the Office helped to lay the foundation for increasing the involvement of the U.S. energy sectors by tapping the extensive U.S. experience with private generation of power and interactions with utility systems. As described in Chapter V, several teams comprised of Agency officials and upper-level representatives of U.S. utilities, architecture and engineering firms, and technology manufacturers were 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. The Review Group submitted a report containing its findings and recommendations to the Administrator in the Spring of 1989.

Topical Workshops and Study Tours: 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, other lending or donor agencies, or industry. 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 or conferences on the agenda for FY 90 and FY 91 are listed in Table 1.

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.

TABLE 1
WORKSHOPS, CONFERENCES, & SYMPOSIA

Workshop	Location	Date
MAGPI symposium at the World Bank on "Utility-Scale Wind Power: The California Experience and Its International Significance"	Washington, D.C.	April 1990
International conference on "Innovation in the Electric Power Sector"	India	April 1990
Workshop on private sector power for representatives of the ASEAN nations	To be determined	Spring 1990
Workshop on private power opportunities	Egypt	Summer 1990
Workshop on the current status of various relevant technical developments in Cane Energy Systems	Hawaii	Summer 1990
Conference for LDC decision makers on environmental criteria in power sector investment decision-making	Helsinki	Summer 1990
Workshops on private power	Jamaica	Fall 1990
	Bangladesh	To be determined
	Abu Dhabi	To be determined
	Latin America/Caribbean	To be determined
	South Asia	To be determined
	Eastern Europe	To be determined

TABLE 1, continued
WORKSHOPS, CONFERENCES, & SYMPOSIA

Workshop	Location	Date
Workshop on "Energy Systems for the Forest Products Industry"	To be determined	Fall/Winter 1990
Workshop on energy conservation	Ivory Coast	September 1990
MAGPI symposium on energy investments and the environment	Washington, D.C.	October 1990
Sessions on price reform at regional workshops	India Ivory Coast	1990 1990
Study tours for officials from the Philippines, Poland, Hungary, other Eastern European countries, Egypt, Morocco, Latin American and South Asian countries	United States	1990-91
Regional conference for Africa on energy demand management in the power sector	Ivory Coast	Early 1991
Workshop on private power from geothermal resources	Kenya	To be determined
Workshop at the EximBank on private power generation using geothermal energy	Washington, D.C.	To be determined
Training program in energy efficiency that includes training for Mission staff.	To be determined	To be determined

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.

Other contractual mechanisms will include PASAs with the U.S. Environmental Protection Agency and Lawrence Berkeley Laboratory, and a Cooperative Agreement with the World Bank. The Office's major contracts are listed in Table 2.

In addition to these multi-year contracts, the Office also uses purchase orders, indefinite quantity contracts, and grants to carry out unforeseen and small jobs, when necessary. Based on past experience, approximately 5 purchase orders are likely to be needed in FY 90. The Office also facilitates Missions' financial participation, or "buy-ins", in Office contracts and PASA agreements.

TABLE 2
MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

Project	Contractor	Description	Completion Date	Buy-in[a] Status
CETA	Bechtel National, Inc.	Contract for Service to the Conventional Energy Technical Assistance (CETA) Project (contract competitively selected in 1985)	03/31/91	yes
EPDAC	RCG/Hagler, Bailly & Company, Inc.	Contract for technical assistance to the Energy Conservation Services Program (ECSP) under the Energy Policy Development and Conservation (EPDAC) project (contract competitively selected in 1987).	07/19/92	yes
	Oak Ridge National Laboratory	Participating Agency Service Agreement (PASA) for management assistance to energy analysis and policy development activities under EPDAC (EPPD).	05/31/92	yes
	International Development & Energy Associates, Inc.	8(a)[b] contract for services to the Energy Planning and Policy Development (EPPD) project under EPDAC (contract selected in 1989).	09/15/90	yes
	Lawrence Berkeley Laboratory	PASA[c] to cooperate on assessing greenhouse gas emissions from developing countries and Eastern Europe.	01/31/92	yes
	Environmental Protection Agency	PASA for a joint program on initiatives to reduce greenhouse gas emissions.	07/30/92	no
	World Bank	Cooperative Agreement to establish a fund to assist in preparing energy projects involving increased efficiency and private sector development.	To be determined	no
	Princeton University	Cooperative Agreement to support and help expand activities in end-use energy efficiency and efficient gas turbine power generation.	To be determined	no
REAT	Oak Ridge National Laboratory	PASA to provide management assistance to the Renewable Energy Applications and Training (REAT) project.	9/30/90	yes

TABLE 2, Continued
MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

Project	Contractor	Description	Completion Date	Buy-in Status
	International Development & Energy Associates, Inc.	8(a) contract for services to the Renewable Energy Applications and Training (REAT) project (contract selected in 1989).	9/15/90	yes
	American Wind Energy Association	Grant to support a workshop on wind energy.	10/31/90	no
	Export Council on Renewable Energy	Cooperative Agreement to collaborate on developing and implementing renewable energy information, training, and reverse trade missions.	1/31/92	no
	Geothermal Resources Council	Grant to support a symposium on geothermal energy.	9/30/90	no
	Lawrence Berkeley Laboratory	PASA to collaborate on developing a least-cost planning analysis for LDC renewable energy power generation options and a long-range strategies program for the Renewable Energy Applications and Training (REAT) project.	To be determined	yes
	World Bank	Cooperative Agreement to work within MAGPI to identify opportunities for renewable energy options in multilateral bank power sector lending.	To be determined	no
	National Rural Electrification Cooperative Association	Cooperative Agreement to develop decentralized and private sector rural power systems in developing countries.	9/30/90	no
ETP	International Institute for Education	Contract to manage the Energy Training Project (ETP) (contract competitively selected in 1987).	8/24/92	yes
	T. Head, Inc.	8(a) contract to provide qualified energy and environmental staff and recruitment services.	To be determined	no

TABLE 2, Continued
MAJOR CONTRACTS WITH THE OFFICE OF ENERGY

Project	Contractor	Description	Completion Date	Buy-in Status
	United States Energy Association	Cooperative Agreement to support development of an Energy Tour program.	04/30/91	no
BEST	Winrock International, Inc.	Cooperative Agreement to manage the Biomass Energy Systems and Technology (BEST) project.	08/30/94	yes
PSED	T. Head, Inc.	8(a) contract to provide qualified energy and environmental staff and recruitment services to manage the Private Sector Energy Development (PSED) project (contract selected in 1989).	9/29/91	yes
	K&M Engineering	Contract to provide assistance to the PSED project in evaluating and selecting feasibility study proposals and other energy/power project development activities.	To be determined	no
	National Geothermal Resources Association	Grant to help organize and conduct a conference on private power generation from geothermal resources in Kenya.	2/28/91	no
ETIP	To be determined	A new project designed to implement innovative technologies and methodologies to help meet expected energy/power sector demands in developing countries in an environmentally benign and cost effective manner. This project will include a feasibility study fund for clean energy technologies.	To be determined	yes

Notes: [a] Buy-in: The provision of funds authorized under one project for commitment to a contract authorized and funded under a different project. Buy-ins can come from Missions, Regional Bureaus, or Central Bureaus.

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

[c] PASA: Participating Agency Service Agreement.

CHAPTER II

ENERGY PLANNING AND POLICY

A. RATIONALE

Even though the scope of the Energy Planning and Policy Development project embraces all aspects of the energy sector in developing countries, the major focus in FY 90 will be least-cost investment planning in the power sector, environmental management, energy price reform, and the implementation of energy efficiency strategies related to these approaches.

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, highlights 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 were to meet a projected average annual electricity growth rate of 6 to 7 percent, 1,500 GW of new generating capacity would 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 renewables and efficiency measures, 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.

Inadequacies in the institutional and management structure and operation of developing country electric utilities have resulted in often poor technical and financial performance of these utilities. The Office is supporting efforts in collaboration with the World Bank and with several bilateral assistance agencies to assess the institutional reasons for the poor performance of electric utilities in over 20 countries. Detailed assessments of the electric power sector of key A.I.D.-assisted countries are being planned in collaboration with several multilateral development banks (MDBs). The objective is to establish the basis for new initiatives to improvement technical and financial operation and management of developing country electric utilities.

B. STRATEGY

Introducing least-cost, power sector investment planning, environmental management, energy price reform, and related energy efficiency components into the LDC power sector will be the major strategic focus of this program. Innovative approaches to these aspects of energy policy and planning are currently underway and will continue during FY 1990. These initiatives are responsive to the Congressional mandate to A.I.D. to help reduce the emissions of greenhouse gases in key countries.

The power sector strategy of the Office of Energy is designed to assist developing countries in escaping 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 energy components of A.I.D.'s Country Development Strategy Statements.

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 least-cost investment planning under capital constraints, taking into account risk and uncertainty;

- Improving the efficiency and performance of electric power systems in developing countries, and coordinating the new USAID/New Delhi $15 million power efficiency program in India;

- Encouraging price reform policies, using successful case examples;
- Developing and strengthening institutions to promote technology innovation and commercialization programs, such as the Program for the Acceleration of Commercial Energy Research (PACER) in India. 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.

C. PLANNED ACCOMPLISHMENTS: ENERGY PLANNING AND POLICY DEVELOPMENT (EPPD)

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. To reinforce the operations of MAGPI, the Office of Energy is setting up a cooperative agreement with the World Bank to implement an energy efficiency and private sector project.

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 research and development (R&D) institutions and commercial organizations in the industrialized countries will be required to facilitate bankable projects.

The MAGPI framework provides a mechanism for other Office projects to work with the multilateral development banks in identifying and conducting prefeasibility studies for

specific energy projects that are innovative either in technology, application, or scale. Examples include the collaboration of A.I.D., the U.S. Trade and Development Program (TDP), and the World Bank in the development of 15 MW of mini-hydropower capacity in Madagascar, involving an investment of $20 million, and collaboration with the Inter-American Development Bank involving both small hydro and bagasse-fired private power generation in Costa Rica (the first two are activities of the Office's REAT project and the third is an activity of the BEST project, as described in Chapter IV).

Planned Accomplishments:

1. Conduct a one-week MAGPI conference for LDC decision makers on environmental criteria in power sector investment decision-making.

2. Complete an Environmental Manual on Power Development.

3. Conduct a major appraisal of India's power sector plans for the next decade with the World Bank and the Overseas Development Administration (ODA) of Britain.

4. Conduct case studies of least-cost strategies to reduce greenhouse gas emissions in two key countries.

5. Implement a $15 million Power Efficiency Program with USAID/New Delhi, the World Bank, and the Asian Development Bank.

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 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:

1. Complete comprehensive, least-cost investment planning projects in the Indian states of Maharashtra and Gujarat and in Costa Rica.

2. Provide micro-computer based tools to LDC decision-makers for evaluating public and private financing options.

3. Develop "bankable" proposals for power sector efficiency in India and Costa Rica (the latter in conjunction with planned accomplishment #1 on page 41).

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. Often, poor technical performance results in transmission and distribution losses of up to 25-30 percent 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 the practices mentioned above could allow utilities to improve service, reduce costs, and mitigate environmental impacts. Past efforts to improve performance have focused on training, and while better 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 VIII.

The Office of Energy is working 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 collaborative 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:

1. Implement a multi-donor agency electric utility performance improvement initiative, and provide a report with 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 V 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:

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

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

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

PACER -- The Program for the Acceleration of Commercial Energy Research

PACER is a six-year, $20 million India/U.S. collaborative program in science and technology. The purpose of the program is to foster innovation in the Indian electric power sector, in part through facilitating the establishment of R&D consortia that link the industrial, commercial, R&D, and government sectors. This work focuses on advanced coal combustion technologies, renewable energy systems, advanced electric power 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.

EPPD will "fast-track" this experiment in other rapidly modernizing Asian societies, developing analogous programs in the near future.

Planned Accomplishments:

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

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

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

Rural Power Delivery

Most developing countries have policies to expand electricity services and the use of electricity 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 because revenues from isolated rural loads have not covered costs. Rural minigrids, therefore, 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.

The Office of Energy and the World Bank have conducted collaborative assessments of their experiences with rural electrification projects. A joint report is being prepared that addresses this experience, reviews the technical, financial, and institutional lessons learned, and identifies specific actions that can be initiated by A.I.D., the MDBs, and other bilateral development assistance agencies in improving the performance and sustainability of rural electrification programs.

Planned Accomplishment:

1. 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 1990s. There is already significant evidence, from deforestation to air pollution, that many developing countries are not progressing along environmentally sustainable pathways (similar to the previous experiences of industrialized countries). 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 use in developing countries often 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 policies, standards and regulations, as appropriate.

Planned Accomplishments:

1. 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.

2. Complete a report assessing A.I.D. programs related to global climate change.

3. Identify energy efficiency investment opportunities in Eastern Europe.

4. Initiate a joint program with the Environmental Protection Agency on initiatives to reduce greenhouse gas emissions.

5. Initiate a joint program with the World Bank to implement energy efficiency and private sector projects.

6. Complete IGCC feasibility study for India (performed in conjunction with planned accomplishment #3 on page 72).

CHAPTER III

ENERGY EFFICIENCY AND CONSERVATION[6]

A. RATIONALE

The rapidly increasing demand for energy in developing countries has placed a premium on increasing the supplies of energy. Electrical generating capacity in developing countries, for example, has been growing at an average annual rate of about 6 to 7 percent over the past two decades, and the demand for transportation fuels has also been increasing rapidly in these nations. While increased energy supplies are vital to the economic growth of developing countries, focusing strictly on supply side expansion, combined with the relatively low real or subsidized prices for energy, can produce a number of undesirable effects.

First, capacity expansion in the electricity sector is expensive. The investment capital required for infrastructure additions can account for the dominant portion of many countries' development budgets (averaging 25 percent, but often reaching as high as 40 percent). Compounding this situation is the observation in A.I.D.'s Report to Congress on *Power Shortages in Developing Countries* that sufficient investment capital is unlikely to be available from traditional sources to support a continuation of growth rates in electrical generation capacity. Moreover, the need to import fuels in both the transportation and electricity sectors can create a serious strain on foreign exchange for most of these countries.

Second, subsidized pricing often promotes the use of energy-inefficient systems or technologies. The cheap gasoline prices in the U.S. during the late 1960s, which encouraged Americans to buy large, "gas guzzling" automobiles, amply illustrate this phenomenon. When prices rose dramatically during the 1973 oil embargo, legislation was quickly introduced on fuel efficiency standards for automobiles, while consumers sought cars with improved gas efficiency or voluntarily adopted conservation practices.

Third, today's energy systems impose stresses on the environment, creating potential changes in the earth's climate through emissions of greenhouse gases and causing respiratory and other human illnesses by deteriorating local air quality. This situation will be exacerbated as many developing countries turn to coal and lignite to meet increasing shares of their energy needs.

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[6] Note: In this chapter, "Energy Conservation" is used to refer to efforts to reduce energy use and "Energy Efficiency" is used to refer to efforts that seek to improve the efficiency of energy use. The two terms are often interchangeable.

Increasing energy efficiency helps in reducing the impact of these undesirable effects by conserving valuable resources, controlling external debt, and protecting the environment. While numerous opportunities remain for all nations to implement cost-effective improvements in efficiency, the developing energy sectors in A.I.D.-assisted countries could benefit from implementation of these policies before they develop.

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.

Approaches to energy efficiency include loss reduction, fuel switching, the use of better technology or management, and the 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. In addition, there is consensus in the scientific community, reflected in the FY 1990 Foreign Assistance Appropriations Act, that *energy efficiency improvements represent the most important near-term response to the potential threat of global warming.*

Energy conservation focuses on influencing energy use habits by creating energy saving alternatives for consumers, such as reliable and convenient public transportation. Energy conservation can be a useful vehicle for promoting private sector development by increasing the demand for energy management equipment, insulation, and more efficient energy conversion technologies, among other things, from local private manufacturers. Also, an expansion of energy conservation activities will increase or create a demand for private energy conservation consulting engineers who are capable of identifying energy conversion measures and installing energy conservation equipment. Finally, energy conservation investments, and their related management and operational changes, can improve the financial well-being of industrial enterprises by increasing their overall efficiency, leading to a stronger industrial sector.

The proper policy, energy pricing, 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 policy signals, such as those given by energy pricing.

Fuel and electricity pricing based on economic opportunity cost are the most effective policy tools available. However, 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. This chapter traces the Office of Energy's past efforts to provide this assistance, and outlines its planned technical and management support 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. Assistance was targeted toward industrial facilities that used large quantities of imported petroleum products. However, in light of the growing concerns surrounding rapidly increasing power demand, power shortages, poor system reliability, inefficient management, the tremendous capital requirements of new capacity, the shortfall in available capital, and growing environmental concerns, A.I.D. has begun to target a large share of its energy conservation assistance toward improving efficiency in the power sector.

The goals of this assistance are to address global and regional environmental degradation from energy use and delay the increase in capital expenditures for power sector expansion.

As part of A.I.D.'s increased work in energy-related environmental and health issues, the Office of Energy has begun to link its efforts in energy conservation in industrial facilities to efforts in pollution control and waste minimization through a program of comprehensive technical audits. Through these and other programs, the Office serves as an innovator in identifying suitable projects that can be funded by other donors and developing countries to help reduce the environmental and health impacts of energy development.

Most energy efficiency and conservation measures are dramatically less expensive than capacity expansion, and can delay or reduce the need for utilities to increase their debt load. The Office of Energy is implementing a number of activities to assist developing country utilities in implementing energy efficiency and conservation programs, including training, information dissemination, and least-cost-planning.

While these efforts do result in improvements in energy efficiency, the Office recognizes that in order to institute lasting technical and management capabilities in the host countries, one needs to identify and implement energy conservation programs and an institutional and policy framework that results in continued use of energy efficiency and conservation after the technical assistance has ended.

The Office of Energy has a two-pronged strategy--a micro approach and a macro approach--to achieve these 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, particularly least-cost power sector planning.

To implement this strategy, the Office continues to use the private sector to the greatest extent possible, and will concentrate its assistance primarily on the power sector, followed by (in decreasing order of priority) the industry, buildings, transport, and agriculture sectors. The strategy is divided into specific subject areas:

- Fostering greater awareness of energy efficiency as a response to global warming;
- Assisting energy conservation and demand management in electric power systems;
- Aiding energy conservation and demand management in industry; and
- Assisting energy conservation and demand management in the building and transportation sectors.

C. PLANNED ACCOMPLISHMENTS: ENERGY CONSERVATION SERVICES PROJECT (ECSP)

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

Energy Efficiency as a Response to Global Warming

The Office of Energy plans to expand its promotional and planning activities to foster greater awareness of energy efficiency as the major strategy to reducing the threat of global warming. In this regard, the Office will take the lead in educating personnel in A.I.D. Missions, particularly in countries which are, or will be, the significant contributors of greenhouse gases. Further, the Office is participating in the Global Energy Efficiency Initiative, a broad-based, world-wide program to be defined and launched jointly by several U.S. government agencies--including A.I.D., DOE, EPA, and OTA--and a number of non-governmental organizations and private voluntary organizations. The Initiative will be led by a high-level steering committee whose role will be to provide concrete ideas on policy and project interventions to assist in controlling the emissions of greenhouse gases in developing countries and Eastern Europe.

Planned Accomplishments:

1. Participate in the design and implementation of the Global Energy Efficiency Initiative (GEEI).
2. Develop a tracking system and database to monitor the status and progress of energy efficiency activities in A.I.D.-assisted countries and other countries of interest to A.I.D.

3. Design and implement a worldwide energy conservation outreach and information dissemination plan.

4. Design and develop a comprehensive training program in energy efficiency. The first phase will include training for Mission staff to promote energy efficiency as a response to the threat of global warming.

5. Conduct a feasibility study of natural gas and LNG to meet the needs of developing countries and assist in carrying out a natural gas utilization study in Egypt as a means to reduce oil consumption.

6. Design new, large-scale energy efficiency programs, focusing on the demand side. To be implemented in coordination with GEEI.

7. Establish a clearinghouse on energy use, including its contribution to global warming. Develop a database to track energy use by sector, expansion plans, and emissions.

Energy Efficiency in Electric Power Systems

Electricity demand usually increases at a greater rate than overall energy demand in a developing economy. Developing countries generally place the burden of providing increased electric generation capacity on the public sector, typically putting 20-40 percent of their annual government budget into this sector. In most of these countries, the necessary generation technology needs to be imported, thus exacerbating foreign exchange shortages and increasing external debt.

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

To increase the efficiency of the electricity sector in developing countries, the Office of Energy uses three approaches: (1) increasing the efficiency of power generation, transmission, and distribution; (2) improving power load management; and (3) improving end-use efficiency. The Office of Energy's 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. Provide assistance for the implementation of the Central America Power Efficiency Initiative (starting with Costa Rica), which will include power plant rehabilitation, line loss reduction, load management, and end-use efficiency improvements (in Costa Rica, pursued in conjunction with planned accomplishment #3 on page 30).

2. Hold the Africa regional conference on energy demand management in the power sector and design the Africa Power Efficiency Initiative as a follow-up to the conference.

3. Implement a major load management program in Pakistan.

4. Prepare an action plan to carry out feasibility studies to rehabilitate selected power plants in eight countries.

5. Review the actual performance of efficient power generation technologies with low global warming impacts, such as combined cycle using natural gas, in cooperation with the World Bank (Pakistan, Egypt).

6. Carry out preliminary electricity tariff studies designed to develop energy-efficient electricity pricing (Indonesia, Poland, Thailand).

Energy Efficiency in Industry

Industry has been an important target of A.I.D. energy efficiency programs because the industrial sector typically accounts for 20 to 35 percent of total commercial energy consumption in developing countries. Technically-proven and cost-effective energy conservation measures can save developing countries an estimated 10 to 30 percent of industrial sector energy consumption. In most developing countries, as much as 75 percent of industrial energy use is concentrated in few large industrial enterprises. Significant reductions in industrial energy use can be made by focusing assistance activities on these enterprises.

The trend toward privatization of industry in these countries gives their industrial enterprises a clear motivation for cost cutting.

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. The emphasis of these activities focuses 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.

Increasing private industry participation is a primary element of the Office of Energy's conservation program. The Office of Energy continues to build upon on-going private sector activities and launch new initiatives. Following an analysis of decision making for energy conservation investments completed in FY 89, the Office of Energy will investigate private sector responses in new countries in FY 90.

Planned Accomplishments:

1. Continue to provide interim management and technical assistance to USAID/Cairo for implementing the Energy Conservation and Efficiency Project.

2. Provide technical assistance to USAID/Amman for implementing an energy conservation program in small and medium-sized industries in Jordan.

3. Carry out combined energy, environment, and productivity audits in industries in selected countries.

4. Identify 2 cogeneration opportunities and begin a feasibility study in one country in FY 90 (Indonesia, Poland, Costa Rica, Thailand).

Energy Efficiency in the Buildings and Transportation Sectors

Much of the growth in demand for electricity in the large cities of developing countries 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 counties, with demand increasing by up to 20 percent per year. In most of these cities, there is a shortage of available electricity and 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, awareness of the need and potential for energy conservation, knowledge about energy-efficient building design, and absence of building codes and standards that ensure energy efficiency.

Experience in the United States and other OECD countries indicates the need for legally-mandated energy efficiency performance standards in non-residential buildings and the establishment of government plan checking and approval agencies with the capability of evaluating proposed building designs on the basis of projected energy and peak load requirements. The development of a trained cadre of engineering and architectural design professionals to design, build, operate, and maintain energy efficient buildings in turn will require large, sustained training programs. The same programs can be used to train the staff of the government agencies required for building plan approval.

The objective of the Office of Energy's program is to address 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 use in the transportation sector represents over 40 percent of total petroleum consumption in many developing countries. Even small improvements in efficiency can produce large savings on petroleum import bills and free up resources for more productive uses, as well as improving local air quality. 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 focus of FY 90 activities will be on identifying and implementing small, country-specific projects to test and demonstrate specific energy conservation activities in the buildings and transportation sectors.

Planned Accomplishments:

1. Identify and implement one country-specific project to analyze energy consumption in the urban buildings sector and identify priority programs to reduce electricity demand in a selected country.

2. Implement a project on energy efficiency in buildings in conjunction with the PACER program in India.

3. Assist in designing an energy-efficient building as a case study in a selected country.

4. Prepare an action plan for conservation activities in the transportation sector in coordination with the GEEI. Select a country and begin planning for implementation of the action plan.

CHAPTER IV

RENEWABLE ENERGY FOR DEVELOPMENT

A. RATIONALE

Renewable energy resources--agricultural residues, solar thermal and solar electric (photovoltaic), geothermal, wind, and hydro--are playing an increasingly important role in improving the quality and reliability of electric power in both urban and rural settings, and especially in delivering urgently needed energy services to rural areas for agricultural and small industry development, village social services, and household needs.

Several renewable energy technologies fueled by the resources listed above can compete with more conventional technologies for supplying electricity to central grids; all of them can be economical for off-grid applications under certain conditions. Being indigenous, they can reduce the strain on foreign exchange caused by imported fuels. And in almost all cases, they cause significantly less environmental impact than the more conventional alternatives.

The Office of Energy has two projects--Renewable Energy Applications and Training (REAT) and Biomass Energy Systems and Technology (BEST)--that support the development of economically and financially sustainable mechanisms to address the energy needs of development with renewable energy and hybrid (renewable/conventional) energy systems. This work is conducted in collaboration with the private sector and policy activities of the Office.

Renewable energy technologies can address some of the problems of both urban and rural regions. As part of an overall least-cost, environmentally sensitive approach to improving the technical, financial, and managerial performance of LDC electric utilities, renewable energy technologies can provide high-quality, grid-connected electric power. Under suitable circumstances, many renewable energy technologies can be economically competitive on a life-cycle basis with conventional mid- to large-scale fossil fuel options.[7] In these cases, they are serving the needs of urban areas as well as those rural areas connected to grids.

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[7] Proof of commercial maturity is provided by the diversified mix of renewable energy resources that are tapped by electric utilities in the State of California. Connected to the grid as of the end of 1988 were 2,290 MW of installed capacity from geothermal resources, 1,520 MW from wind, 644 MW from biomass, and 275 MW from solar thermal and photovoltaics (mostly solar thermal, which has become commercial; photovoltaics are not yet competitive within grids).

For a large number of rural areas not currently served by utilities, grid extension in the near future is too expensive and, even when competitive, must compete with other uses of scarce financial and technical resources. Many regions that will eventually be served by the grid must do without electricity for several decades.

Decentralized applications of renewable energy technologies are especially relevant to the needs of rural populations. Even small quantities of electricity can substantially improve and even transform the conditions of human health, sanitation, and economic development in these regions, and may help to slow urban migration. The technologies are reliable, inherently modular, and can grow in response to local needs and resources.

Power generation from selected biomass fuels offers a unique set of opportunities for developing countries, and the Office of Energy has established a separate project (BEST) for that category (see Section D of this chapter). Significant quantities of residues are generated at agricultural or wood-processing facilities, thus providing accumulations of available fuel. On-site demands exist for both electricity and steam, and the amount of available fuel allows production of surplus electricity for sale to local or centralized grids. The latter creates a new source of revenue for an existing business, and experience shows that once the more entrepreneurial private companies undertake electricity production for profit, replication within the industry quickly follows.

LDC decision makers are often unaware of the economic potential of many renewable energy options. In part this is because the means for financing renewable energy projects, whether grid-connected wind farms or large numbers of small, decentralized renewable energy applications, are not well-developed. But it is also due to the lack of adequate cost and performance data on renewable energy technologies and their applications available to these decision makers.

Renewable energy technologies can have a significant effect, of course, only if their cumulative use is widespread. One-of-a-kind technical experiments and demonstrations often lead nowhere, as the experience of A.I.D. and other donors has shown over the past two decades. There must be a coherent effort, from identification of the needs and associated markets (either commercial or donor-supported) through the development of the appropriate institutional mechanisms and sources of financing, for the introduction and diffusion of the technology to succeed.

Environmental Considerations

In addition to economic factors, environmental considerations argue for a strong effort to help LDCs identify available renewable sources of energy and the appropriate technologies and policies. Use of renewables results in significantly less degradation to the environment than fossil sources. This means much lower toxic emissions to the air, land,

and water. The potential of climate change resulting from CO_2 emissions and other greenhouse gases from fossil fuel combustion is reduced by the use of renewable energy.

Biomass resources, of course, must be used in a sustainable fashion. When crop residues are used, for instance, this criterion is met. The quantity of CO_2 emitted when the biomass is burned to produce energy is re-absorbed by the new plants grown the subsequent season, resulting in no net change in atmospheric CO_2. And controlled combustion also reduces the other emissions in addition to CO_2 that result when crop residues otherwise are disposed of through open burning.

On a global scale, a dramatic increase in the penetration of renewable-based technologies in the energy sector will require 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 immediate in those areas where site-specific conditions allow for greater relative penetration.

B. STRATEGY

The Office's renewable energy strategy for FY 90 has been broadened substantially. This reflects both the recent Congressional mandate to the Agency and the growing international commitment to the use of environmentally sound energy technologies to address developmental issues. The expanded program includes ambitious new initiatives for establishing multilateral programs that can lead to the economic use of modern renewable energy technologies on a scale unprecedented in the developing world.

Many renewable energy projects have been funded over the past two decades by A.I.D. and other donors. Few of these projects have resulted in any subsequent commercial diffusion. There were virtually no attempts by donor agencies or host government institutions to establish appropriate mechanisms for financing (including provision of hard currency), for technical assistance, for local business development, system maintenance and servicing, or for consumer credit. Donor agencies failed to establish funds of any significance to support the start up of renewable energy projects aimed at eventually achieving sustainable, widespread diffusion, and in general there remains a notable lack of donor coordination and cooperation in this field.

In 1988 the Office completed a review[8] of A.I.D.'s renewable energy activities over the last decade. The study concluded that an important reason for disappointment was un-

[8] Office of Energy, U.S. Agency for International Development. *New Directions for A.I.D. Renewable Energy Activities*. Report No. 88-01, March 1988.

realistic project planning and expectations. In a well-intentioned desire to respond to the oil price shocks of the 1970s, donor-funded 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 unexpected, dramatic reduction in oil prices following 1981 further dampened interest in renewables following the brief euphoria of the 1981 United Nations Conference on New and Renewable Sources of Energy held in Nairobi.

The Office wishes to expand the use of renewables for both grid- and non-grid-connected sources of high-quality electricity. The approach concentrates on cost-effective uses of commercially proven renewable energy technologies and focuses on economically sustainable and replicable projects using these technologies. Research is supported only in carefully selected cases (see the discussion of "Working Labs" in Section D).

The Office's 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. With regard to the dissemination of small-scale systems in rural areas, the goal of the Office is to identify and encourage institutional, financing and servicing mechanisms that can make such dissemination affordable and sustainable. The Office does not fund the actual purchase of hardware but rather plays a catalytic role in actual commercial transactions.

The Office is developing a collaborative program between its two renewable energy projects--REAT and BEST--that seeks to expand the traditional role of agricultural extension services to incorporate energy extension services as well.

To catalyze larger activities and leverage the investment of greater funds than those available to the Office, a number of project activities work with the Multi-Agency Working Group on Power Sector Innovation (MAGPI, see Chapter II) to develop innovative financing mechanisms for renewables and to implement "bankable" renewable energy projects. An additional attempt to develop financing mechanisms involves active support for the design of a business plan for a non-profit venture fund to channel resources into private renewable energy projects.

The Office will make a special effort to highlight the environmental benefits of renewable energy. Through MAGPI, the Office will play a major role in the renewable energy components of an environmental guidebook for electric power development projects. It will also prepare a series of papers focusing on the particular benefits of biomass energy systems.

Whenever appropriate, these efforts promote technology transfer from the U.S. Many of these activities, therefore, are being coordinated with the work of the inter-agency

Committee on Renewable Energy Commerce and Trade (CORECT)[9]. In the past, the Office has supported CORECT by providing information on renewable energy experience, assisting in the preparation of brochures, and working with industry associations to bring senior LDC decision makers and managers to educational and promotional events.

Much of the site-specific project development work is conducted with private sector firms, and thus there is significant interaction with the Office's private sector power efforts (see Chapter V).

The balance of this chapter describes the REAT and BEST projects in detail.

C. PLANNED ACCOMPLISHMENTS: RENEWABLE ENERGY APPLICATIONS AND TRAINING (REAT)

The goal of the REAT project is to catalyze replicable and sustainable investments in renewable energy technology that in turn can meet important rural and urban needs for reliable, high-quality electricity on a significant scale. Working with both industry and government, the REAT project tracks developments in solar, wind, small hydro, and geothermal technologies and applications in the U.S. and abroad. The REAT goals are addressed by the following project elements:

- Targeted project-level support for commercialization;
- Education, training, and reverse trade missions;
- Policy guidelines and institutional framework;
- Technical assistance to A.I.D. field Missions; and
- REAT project planning and implementation.

Targeted Project-Level Support for Commercialization

Through the MAGPI mechanism REAT works with the multilateral development banks, the International Finance Corporation (IFC), the United Nations, and other bilateral donors to catalyze bankable projects and effective commercialization strategies to support the introduction and diffusion of renewable energy technologies. The Office works with the

[9] CORECT's lead agency is the U.S. Department of Energy. CORECT includes the Department of Commerce, the EximBank, the Overseas Private Investment Corporation, the U.S. Trade and Development Program, and other federal agencies.

U.S. renewable energy industry to identify site-specific applications where interested users, sellers, and investors all exist, but where funds for pre-investment analysis are needed to catalyze the project development process. The Office is working with the U.S. Export Council for Renewable Energy (US/ECRE) to develop training materials, to conduct reverse trade missions, and to conduct seminars and workshops for developing country government and industrial decision makers and for A.I.D. staff.

During 1989 several candidate projects were identified for possible assistance. These include joint ventures in small-hydro installations and in photovoltaic manufacture in India, biomass combustion for heat applications in the Philippines, PV/diesel hybrid systems in Indonesia, wind/diesel power plants in Egypt, grid-connected wind farms in Egypt, India, and Costa Rica and small wind systems in Morocco, PV systems in the Dominican Republic, small geothermal power applications in Kenya, and multi-technology applications in rural Guatemala.

Activities in FY 90 will be a continuation of these efforts and a screening of additional candidate projects. The Office expects this ongoing 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 with these studies.

Planned Accomplishments:

1. Identify five site-specific, bankable renewable energy applications (other than small hydro) for pre-investment analysis, and pursue at least two to completion.

2. Support pre-investment studies for PV joint-venture projects in India (joint venture manufacturing) and at least one other location.

3. Evaluate investment opportunities for decentralized power systems incorporating applications of wind, PV, diesel, and renewable/diesel hybrid systems in Indonesia, the Philippines, and at least one other country.

4. Conduct pre-investment assessments for small hydro project development in Costa Rica, Indonesia, and Tanzania.

5. Provide follow-up review of a pre-feasibility study for a small geothermal application in Kenya and assist in supporting the feasibility study.

Education, Training, and Reverse Trade Missions

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 in 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 selects ways to meet those needs for information and training. Some of these activities are pursued in concert with CORECT. Meetings of CORECT and its subcommittees are regularly attended by representatives of U.S. technology manufacturers.

Office publications provide LDC decision makers, development specialists, and A.I.D. Mission personnel with information on the applications and conditions in which renewable energy technologies can be cost-effective, the lessons that have been learned about disseminating these technologies, and the products and services 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 Office's training activities facilitate sustainable commercialization of renewables technologies in LDCs and increase the opportunity for U.S. and LDC joint ventures and technology transfer. Targeted participants are LDC public or private sector individuals 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. In addition, special education and training materials will be prepared to provide A.I.D. program, Regional Bureau, and Mission staff with up to date authoritative information on the status of commercially available renewable energy products and services that can be used in support of Agency programs in such areas as health, education, agricultural development, and environmental management.

Planned Accomplishments:

1. In collaboration with the U.S. Export Council for Renewable Energy (US/ECRE), develop and implement a renewable energy information, training, and reverse trade mission program.

2. Assist US/ECRE in developing a uniform application form and streamlined process for applications from the U.S. renewable industry for Federal assistance.

3. Support the participation of nationals from A.I.D.-assisted countries in reverse trade missions and attendance at U.S. industry-sponsored symposia (including those sponsored by the American Wind Energy Association and the Geothermal Resources Council).

4. Sponsor a MAGPI symposium on "Utility-Scale Wind Energy Experience in California and its International Significance" at the World Bank in April 1990, and will sponsor at least two other symposia on renewable energy applications for the LDC power sector.

5. Sponsor the presentation at A.I.D. of two professional seminars on the technical, economic, financial, and institutional aspects of renewable energy applications.

6. Reprint and distribute the brochure *Renewable Energy for Agriculture and Health* in cooperation with the U.S. Export Council on Renewable Energy.

7. Develop videotapes on wind and PV technology options that address the questions typically asked by A.I.D. Mission personnel and LDC decision makers.

8. Participate in the design of A.I.D.'s mew training program for A.I.D. staff, incorporating information on renewable energy systems.

Policy Guidelines and Institutional Framework

The Office provides support to host-country governments, U.S. institutions, the international donor community, and others in the development of policies and institutional mechanisms to support least-cost implementation of environmentally sound energy options.

On the policy side, it is important that decision makers in the utility sector be aware of the lower environmental costs of renewable energy systems. The Office will take selected

steps during 1990 to encourage the integration of environmental considerations into investment planning.

Especially constraining to the dissemination of small-scale renewable energy systems in rural areas has been the lack of institutional frameworks required to appraise, finance, manage, operate, and maintain such systems. Financing and servicing are particularly crucial. The REAT project will continue its efforts to replicate a successful dissemination project in the Dominican Republic and will join in a specific new multi-agency initiative--the FINESSE Project (Financing of Energy Services for Small-Scale Energy Users). FINESSE will identify and establish innovative financing mechanisms to access multilateral development bank power sector loans and other sources to support widespread use of small-scale renewable energy systems. Other sponsors of this effort include the World Bank, CORECT, and the Dutch Government.

Planned Accomplishments:

1. Develop the section on renewable energy in the Environmental Manual for Power Development (a MAGPI activity).

2. Develop a least-cost power system planning analysis of the role of renewable energy power generation options in one or more specific developing country power sectors.

3. Conduct a joint U.S./Costa Rica study to establish the institutional and financial framework for public and private power investments in environmentally attractive renewable energy technologies for power generation.

4. Work within MAGPI to identify opportunities for renewable energy options, including "bundling" of small projects.

5. Pursue opportunities for replication of a commercially successful private sector venture that sells small PV systems to rural households in the Dominican Republic.

6. Participate in the FINESSE project, providing both technical and financial support for development and implementation of small-scale renewable energy project financing mechanisms, and for project identification and pre-investment analysis and assessment.

Technical Assistance to USAID Field Missions

The Office of Energy regularly responds to requests for advice on renewable energy from A.I.D.'s field Missions. 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. This may involve assistance in establishing a new program, in formally reviewing an existing project, or in providing short-term consulting for a component of an existing project. Assistance will also include development of training materials and seminars for A.I.D. Mission personnel to provide them with current information on the technical and economic status of various U.S. renewable energy products and services.

Planned Accomplishments:

1. Assist USAID/Rabat in completing a wind-powered water pumping project.

2. Assist USAID/Rabat in assessing renewable energy applications in rural health delivery.

3. Assist USAID/Cairo with development of a micro-computer based renewable energy information facility for the New and Renewable Energy Authority (NREA) of Egypt.

4. Assist USAID/Cairo in designing a new renewable energy project focused on bankable project development and implementation.

5. Prepare a joint A.I.D./U.S. Windpower paper on the commercialization experience with wind electric technology in the United States and present at the 1990 PACER Conference in New Delhi (see Chapter II).

6. Produce professional quality 35mm slides and black and white prints for PACER conference presentations by U.S. participants.

7. Establish a pilot training program in renewable energy applications with one or more Missions.

REAT Internal Project Planning and Professional Outreach

To adapt its renewables program to changing conditions, technology advances, and expanding requests for assistance, and to interact with the professional renewable energy community, the Office of Energy supports several project planning and professional outreach activities.

Planned Accomplishments:

1. Design a new long-range strategic program for the REAT project with the assistance of outside expert consultants, which will entail establishing an informal renewable energy advisory committee including representatives of the U.S. renewable energy industry, USDOE, USEPA, national laboratories, and academia.

2. Develop new in-house resources including (1) computer systems, (2) specific programs and tools (e.g., project financial analysis), (3) a library, and (4) on-line renewable energy database, plus graphics, videotapes, etc.

3. Prepare professional papers for publication in peer review journals and participate in domestic and international conferences on renewable energy.

D. PLANNED ACCOMPLISHMENTS: BIOMASS ENERGY SYSTEMS AND TECHNOLOGY (BEST)

In the rural sector of most developing nations, biomass residues abound, primarily from agricultural and forestry activities. At present, most of these residues are burned openly or left to rot. Some are burned to meet process energy requirements but the combustion technologies used are almost always inefficient.

Many of these residues could be used on a sustainable basis to produce energy products. Revenues from the sale of these products could have a significant impact on the health of the agricultural sector and enable better management of natural resources. 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 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;

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

- Net reduction in CO_2 and other greenhouse gas emissions.

The past year marked several milestones in the Office of Energy's bioenergy activities. First, the completion of the Bioenergy Systems and Technology (BST) project was followed by the design of the new Biomass Energy Systems and Technology (BEST) project. The Office of Energy used the opportunity afforded by the new project to strengthen mechanisms for working with the private sector and to clarify the avenues for transferring commercial technologies to developing countries.

Another important milestone was the first private investment in the production of electricity based on biomass residues made as a direct result of Office of Energy support. The El Viejo sugar factory has invested in equipment for its factory in Costa Rica that will enable it to sell approximately 5 MW of power to the national utility beginning in the fall of 1990. The Office of Energy provided technical assistance to help the Government of Costa Rica (GOCR), the regulatory authority, and the national utility change the regulations governing private production and sale of electricity. It also recommended the technical configuration implemented by the El Viejo factory.

The new BEST project continues the Office of Energy focus on implementing specific projects in conjunction with the private sector and aims to identify and reduce technical, economic, financial, and institutional risks. Through the implementation of specific projects, the Office of Energy expects to introduce innovative technology and continue to demonstrate the commercial viability of biomass energy systems.

The major new initiative to be undertaken by the BEST project in the coming year is the development of a "venture fund" to be supported with monies from private sources that will be able to directly support promising projects and companies with investments, loans, and/or technical assistance. Once created, this new mechanism will make it easier to finance projects.

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

- Project development and implementation;
- Working labs;
- Venture Investment Program; and
- Program support.

Project Development and Implementation

The new BEST project has restructured the approach to development and implementation of projects. Because economic, financial, and institutional risks tend to differ significantly from country to country, the Office of Energy's BEST project staff will develop project opportunities by country. The project will continue to concentrate on the sugarcane, rice, and forest products sectors.

Planned Accomplishments:

1. Costa Rica: Fund project assessments for biomass-fueled private power projects, provide policy support to GOCR institutions, and conduct research on baling of cane field residues, efficiency at sugar factories, and new biomass fuel sources.

2. Guatemala: Conduct a cogeneration pricing study to facilitate private electric generation and sale to public utilities though development of mechanisms for determining fair prices. Work with sugar industry to develop projects.

3. India: Prepare a multi-sector biomass fuel assessment for the Indian state of Tamil Nadu and a summary of the investment climate and current regulations concerning private power. Support a meeting of the Tamil Nadu "enterprise sector" to generate a flow of bioenergy deals.

4. Indonesia: Prepare a bioenergy survey of the sugarcane and palm oil industries in collaboration with Perkebunan (a parastatal organization that owns sugar and palm oil estates throughout Indonesia) and collect information on forest management policies and the forest products industry.

5. Pakistan: Assess economic and investment potential for electricity development by the private sugar industry in collaboration with ENERCON (Pakistan's Energy Conservation Program) and prepare a review of fuel ethanol economics and gasoline blending requirements for Pakistan.

6. Philippines: Support site-specific private power project assessments and provide technical assistance to the national Office of Energy Affairs in its preparation of a National Indigenous Energy Development Plan.

7. Thailand: Monitor continuation of the program to bale, store, and burn sugarcane field residues at private sugar factories in Thailand and support private power project development by sugar companies.

8. Other: Respond to private biomass power opportunities as they arise and follow up on preliminary contacts have been made with Jamaica, Honduras, Kenya, Gambia, Malawi, Panama, Nicaragua, and the Pacific Islands.

Working Labs

Many commercially proven technologies in the U.S. require adaptation before they can be applied in developing countries. Adaptation is often critical to whether a market develops for a particular technology.

Working Labs are programs of applied research carried on at multiple sites around the world in which the goal is to create knowledge that will help resolve critical problems in the deployment of biomass energy technologies. The Office of Energy will collaborate with existing centers of expertise in the U.S. and internationally to help resolve these problems.

BEST's Working Labs provide an excellent mechanism for transferring commercial technologies to developing countries. Not only do they adapt technologies, but they help create a base of technical skills and information in participating countries that can support market expansion.

The creation of the Cane, Rice and Advanced Combustion Labs formalizes research that has been supported for several years by the Office of Energy. The creation of the Forest Wastes Lab is a result of last year's program initiative to address tropical forestry issues.

Planned Accomplishments:

1. Advanced Conversion Lab: Refine assessments of BIG/STIG (Biomass-Injected Gas turbine/Steam-Injected Gas turbine) technology for the forest products and sugar industries with focus on Brazil and Indonesia (Cooperator: Princeton University).

2. Cane Lab: Launch a five-year program to assess agronomic impacts of cane residue removal. Also, support further baling trials and develop options to prepare bales for feeding to bagasse boilers. The Cane Lab will focus on Costa Rica, Brazil, Thailand, and the Philippines.

3. Forest Wastes Lab: Prepare a baseline energy analysis for the pulp and paper industry and identify candidate sites for research on sustainable tropical forest management activities linked with the forest products industry.

4. Rice Lab: Identify collaborating institutions and coordinate with the International Rice Research Institute.

5. Competitive Grants Program: Prepare scopes of work for target grants, subject to the availability of funds.

6. General Research: Analyze desirable site characteristics for establishing tropical biomass plantations (grasses, trees) and analyze the California experience with biomass power, giving attention to the structure and evolution of biomass markets.

Venture Investment Program

The goal of the Venture Investment Program is to harness the talent and energy of private enterprise to promote international development. During the next year, the Office of Energy will develop a business plan for creating a Venture Fund that will support projects using technical assistance, bridge loans, equity investment, and loan guarantees. The Fund will rely where possible on discounted debt as a source of local currency and will seek to share risk by attracting partners.

Planned Accomplishment:

1. Prepare a business plan for a non-profit Venture Fund to invest in renewable energy projects and companies.

Program Support

The Program Support component will continue to support networking, both directly and indirectly. Direct support will be provided to an existing developing country network, and one major workshop will be held at which the results of cane energy research can be shared.

The Program Support component also provides state-of-the-art computer equipment for the new BEST management team and continued information dissemination in the biomass energy area.

Planned Accomplishments:

1. In support of entrepreneurial networking, sponsor development of case studies of private bioenergy opportunities through the Biomass Users Network.

2. Procure microcomputer systems for staff, laptops for use during travel, and special purpose items (scanner, modems, networking hardware, and software).

3. Prepare, translate, produce and disseminate technical reports, prepare and distribute three additional "Bioenergy Systems Reports", and prepare and disseminate a series of "occasional papers".

4. Sponsor a global sugarcane symposium to present the state of power generation and associated issues. Sponsor a forest industries workshop to define research targets for the Forest Wastes Lab.

5. Other program support: Refine the energy strategy for wood wastes, investigate agri-waste management opportunities, and provide overall management support.

CHAPTER V

PRIVATE SECTOR PARTICIPATION IN THE ENERGY SECTOR

A. RATIONALE

As explained in Chapter I and elsewhere in this Program Plan, power shortages continue to plague the economies of developing countries and symptomize a serious and growing problem with expanding the generation capacity base to support sustainable economic growth.

Electric generation facilities are highly capital-intensive and compete for scarce public investment monies--consuming 5-30 percent of developing country public investment funds. Therefore, a growing number of developing countries are exploring new avenues to involve the private sector in helping solve the power shortage situation.

In the 1988 *Power Shortages* report, A.I.D. recognized that energy production by the private sector was frequently more efficient than state-owned utilities in developing countries. The report urged developing countries to allow the private sector a greater role in providing new sources of efficient power generation.

Since private participation in the power sector is new in developing countries and requires major initiatives on the part of governments, electric utilities, and the private sector, the progress in taking advantage of this opportunity has been slow.

The goal of the Office of Energy is to stimulate and accelerate the development of private energy projects in developing countries. This entails identifying the potential for, and the impediments to, private energy development in selected countries, providing technical support in developing and implementing private energy policies and projects, cost-sharing feasibility studies, and collecting and disseminating information pertinent to private energy.

The Office of Energy's efforts in promoting private participation in the energy sector address the following problems:

- Shortage of public investment capital;
- Inefficient parastatal institutions;
- Policy barriers;

- Lack of experience with private sector involvement;
- High risk and expense of developing private energy projects; and
- Global climate change.

The 1988 *Power Shortages* report estimated that in order to sustain a 4.5 percent per year real economic growth rate at current levels of energy system efficiency, developing countries would need to add 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.

Developing countries are experiencing a shortage of public investment funding to meet these capital expansion needs. These utilities traditionally have depended on the government for supplementary funds, especially for expensive new generating facilities. However, their governments cannot provide the needed resources from elsewhere within the public sector. Hence, almost all A.I.D.-assisted countries have been unable to fund the capital requirements of their power systems without extensive foreign aid.

Inefficiency within the parastatal utilities also has often abetted the power shortage problem. Resource allocations and prices tend to be administratively determined rather than respond 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 the inefficient operation of generating plants, transmission and distribution systems, and revenue collection systems.

In short, state-owned utilities often lack the financial, managerial, and technical resources required to develop and implement capacity expansion plans to keep pace with growing demand. For these reasons, private investment in the energy sector of developing countries could have a significant, beneficial impact, provided that several policy and institutional impediments can be overcome.

Many developing countries have public policies, regulations, and practices that act as barriers to 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. Additional barriers to investment by private foreign and domestic sources are created by other public policies such as restrictive tax policies, high import duties, restrictions on repatriation of profits, prohibitions on foreign ownership of companies, unavailability of adequate guarantees of payment on contracts and inadequate mechanisms for dispute resolution.

Governments and their public utilities in developing countries have little recent experience with private participation in the energy sector. As a result, they 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 inadequately understood. How to arrange equitable contracts, secure project loans from foreign lenders, and integrate private facilities into public power systems are additional issues that developing countries have not had to face in recent years.

Increased private sector participation in the energy sector should also have some benefits with regard to reducing the emissions of greenhouse gases. Private sector generators of electricity selling to a national grid for a contracted price will have an incentive to make their generation facilities as efficient as possible. In addition, an overwhelming majority of the private sector proposals reviewed thus far by the Office of Energy have been based on renewable energy resources.

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.

The process of developing privately owned energy projects in developing countries involves high risk and expense for private companies. Since the political and financial risks especially are perceived as very high, the result is extensive front-end project development costs and difficulty in raising and servicing project equity and debt.

In addition, many U.S. companies avoid marketing their goods and services in developing countries. Some lack experience with overseas markets, while 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 Office of Energy has adopted a strategic approach to enhancing private sector participation in LDC energy sectors that focuses on overcoming these attitudinal and practical barriers. The focus of this strategy is to create a favorable environment that encourages private financing, ownership, and operation of energy facilities in selected developing countries--one that concentrates initially on electric power.

To encourage private enterprise participation in the power sector, the Office of Energy organizes its activities around the following three broad objectives:

- Inducing policy reform and institutional development supportive of private participation in the power sector of developing countries;

- Assisting private power 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 power systems of developing countries.

To implement these objectives and the broader strategic vision described above, the Office has launched a five-year, $10 million Private Sector Energy Development (PSED) project. The project's specific initiatives and planned accomplishments are listed below.

C. PLANNED ACCOMPLISHMENTS: PRIVATE SECTOR ENERGY DEVELOPMENT (PSED)

The Office has planned a number of activities for 1990 and 1991 in pursuit of the three categories of objectives enumerated above.

Policy Reform and Institutional Development

As explained in the "Rationale" section, the energy sector, particularly its electric power component, traditionally has been a monopoly of the state. Therefore, an important first step in accommodating private power is to help developing country governments and utilities assess the constraints of the current system and to judge the appropriate roles for the private sector. The United States, of course, has significant experience with private power generation and distribution and with the regulation of such activities, especially in light of the innovations allowed by the Public Utilities Regulatory Policies Act (PURPA), which Congress passed in 1978.

The Office conducts conferences and workshops in assisted countries and in the United States that involve developing 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 power sector.

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

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

The PSED program assists utilities in developing countries to identify options for captive power (used solely by the company that produces it) and cogeneration (the simultaneous generation of heat or steam and electricity) options. The program will also develop informational profiles on each of the potential captive and cogeneration opportunities in key developing countries with an eye toward efficiency improvements and global climate change mitigation measures. The contribution of captive and cogeneration power facilities to state-owned utility generation, especially during peak demand hours, must become an integral part of the power planning process. A significant advantage of captive power is that it reduces investment costs for electricity capacity expansion because less new capacity is required, regardless of the whether captive power is considered as a reduction in load or as part of existing capacity.

Planned Accomplishments for Workshops, Study Tours, and Training:

1. Organize and conduct with the World Bank a workshop on private power in Jamaica.

2. Organize and conduct with the World Bank a workshop on private power in Bangladesh.

3. Organize and conduct with the World Bank in Abu Dhabi, United Arab Emirates, a workshop on private power project investment opportunities in developing countries.

4. Organize and conduct a workshop on private power in Latin America and the Caribbean (Guatemala, the Dominican Republic, or Brazil).

5. Organize and conduct a workshop on private power in South Asia (India, the Philippines, or Thailand).

6. Organize and conduct a workshop on private power in Eastern Europe (Czechoslovakia, Hungary, or Poland).

7. Organize and conduct a workshop on private power from geothermal resources in Kenya.

8. Develop a video-based training course for A.I.D. Missions on private power issues, rules and regulations, pricing issues, power purchase contracts, and institution building.

9. Conduct study tours for officials from the Philippines, Poland, Hungary, Egypt, Morocco, Latin American countries, South Asia, and other Eastern European countries.

Planned Accomplishments for Technical Assistance and Special Studies:

1. Provide technical assistance in private power policy development and institution building in Latin America and the Caribbean (Guatemala, Dominican Republic, or Brazil).

2. Provide technical assistance in private power policy development and institution building in Eastern Europe (Czechoslovakia, Hungary, or Poland).

3. Provide technical assistance in the assessment of private power from geothermal resources in Kenya.

4. Provide technical assistance to Indonesia in the development of rules and regulations for the implementation of Law No. 15, assessment of captive power opportunities, and assessment of private power options on Batam Island.

5. Provide technical assistance to the Philippines for the transfer of a production costing model (ELFIN) and a project financial evaluation model (PROJEV).

6. Provide technical assistance in the assessment of private power opportunities in selected countries in the Caribbean.

7. Identify environmentally sound cogeneration and captive power generation opportunities.

Feasibility Study Fund for Project Development

To cooperate effectively with the private sector, the Office works in a project-oriented manner, within the context of A.I.D.'s development goals and within the broader policy and institutional environment in which the private sector can operate.

The Office has established a Private Sector Energy Development Feasibility Study Fund that generally shares with private companies up to 50 percent of the cost of

prefeasibility and feasibility studies and other development activities for private power projects. Recognizing the importance of reducing threats of global climate change, the PSED project will attempt to select project proposals incorporating efficiency improvements and pollution mitigation measures.

The Office works closely with private sector energy associations, industry and utility representatives, and project developers to enhance their understanding of private sector power 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 regions.

Also, the PSED project provides technical support to project sponsors and can assist with advice on project development, political risk, and project financing. To provide the private sector with information on project opportunities and private power activities, the PSED project maintains a Private Power Database and publishes the *Private Power Reporter* newsletter.

Planned Accomplishments:

1. Administer PSED Feasibility Study Fund and cost share feasibility studies in Costa Rica, Dominican Republic, India, the Philippines, Turkey, and Eastern Europe.

2. Fund a feasibility study for a cogeneration/environmental upgrade project in Poland.

3. Fund a feasibility study of a hydroelectric project in Costa Rica.

4. Fund a feasibility study for an efficient combined cycle project in the Dominican Republic.

Program Coordination

The PSED project seeks to improve 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.

Planned Accomplishments:

1. Consult with technical advisors from the power industry and government representatives to advise the Office of Energy on projects and other matters pertaining to private power.

2. Disseminate information on private power including preparation and publication of a paper.

3. Expand data-gathering activities, maintain the Office of Energy Private Power Database, and publish the Office of Energy *Private Power Reporter.*

4. Disseminate information to multilateral lending institutions and non-governmental organizations on the role of private sector participation in electric power supply, on private power opportunities, and on innovative technological options and financing strategies.

CHAPTER VI

INDIGENOUS FOSSIL FUELS AND ADVANCED TECHNOLOGY

A. RATIONALE

The oil price hikes of the 1970s persuaded many countries, including LDCs, that the development of indigenous energy resources, both fossil and renewable, was important for energy security. Developing these resources can provide needed energy and generate domestic employment and income, while reducing foreign exchange expenditures for imported oil.

The Office of Energy's efforts in exploiting renewable energy were described in Chapter IV. A number of LDCs are also endowed with significant fossil resources and wish to use those resources for economic development. For both economic and environmental reasons, the Office can play an important role in assisting with this development. Keeping costs down through proper assessment, wise management, and efficient conversion technologies is in the economic interest of the country, and both efficiency and proper control technologies are important for the environment. Some of the resources are low-grade fossil fuels (e.g., lignite, peat, and oil shale).

In the U.S., combined private sector and government efforts have harnessed scientific and technological ingenuity for developing more efficient, cleaner, and less expensive ways of transforming various energy resources into useful forms of energy. In particular, great strides have been made in exploiting low-grade fossil fuels and solid wastes. A new menu of innovative technologies and tools, including fluidized-bed combustion, integrated coal gasification combined cycle (IGCC), and management information systems, has evolved from scientific concepts through pilot experiments and demonstrations into commercial reality.

Particularly significant are improvements in meeting stringent environmental requirements. Dramatic advances in computer science have also produced new tools to help decision-makers manage and operate energy facilities more efficiently and plan future energy investments more effectively. The wealth of U.S. experience with these technologies can be adapted to exploit various indigenous energy resources and improve energy self-sufficiency in A.I.D.-assisted countries.

B. STRATEGY

The Office of Energy has designed and is implementing the Conventional Energy Technical Assistance (CETA) project to apply these U.S. advances in energy technology and utilization to the developing world. Through this project the Office taps into the wellspring of U.S. industry know-how and provides technical services to: (1) assist countries to identify, evaluate, and develop their conventional energy resources; (2) utilize these resources more efficiently; and (3) reduce dependence on imported oil while improving efficiency and environmentally clean performance. Drawing on the U.S. leadership position in many energy fields, the project serves as a vehicle to provide appropriate U.S. energy and environmental expertise. Marshalling private sector interest, experience, and financing is a vital element of this approach.

As part of its strategy, the Office of Energy reviews the energy resource base and generating capacity expansion plans of key A.I.D.-assisted countries and identifies opportunities for indigenous energy resource development and private sector participation. These opportunities are then evaluated through definitional missions or preliminary technical assessments that consider overall technical and economic parameters of each opportunity. Favorable initial assessments lead to more definitive studies of project viability, the results of which 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.

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

- Strengthening efforts to assess and develop indigenous energy resources;
- Promoting technology innovation to harness indigenous energy resources;
- Transferring commercially proven and environmentally more benign U.S. energy technologies;
- Applying U.S. operating know-how and financing strategies; and
- Creating avenues of cooperation between governments and the private sector.

FY 90 is the last year in the life of the CETA project. Some of the activities identified under CETA will be continued under the Energy Technology Innovation Project (ETIP) described in Chapter VII.

C. PLANNED ACCOMPLISHMENTS: CONVENTIONAL ENERGY TECHNICAL ASSISTANCE (CETA)

The Office's specific programs and planned accomplishments under the CETA project are divided into two categories: resource assessment and development; and technology innovation.

Resource Assessment and Development

In the area of resource assessment and development, the Office of Energy expanded its involvement significantly during FY 89, and the planned accomplishments described below reflect continued support to accelerate the momentum of this program thrust.

In FY 89, the Office completed a prefeasibility study of oil-shale utilization for power production in Jordan. In addition, a successful test burn of Jordanian oil shale was conducted in a circulating fluidized-bed combustor. As a direct result of these pioneering efforts, the confidence level associated with use of this low grade indigenous energy resource was raised significantly. A workshop to be conducted in FY 90 will disseminate the results of this work. Results of the workshop could lead the Governments of Morocco and Egypt to develop their indigenous oil shale using this innovative technological approach of directly burning the shale.

The Office of Energy's strategy is to capitalize on this growing interest among countries endowed with oil shale and to assist them in exploiting this resource in an environmentally acceptable manner.

To date, the resource assessment and development of natural gas in developing countries has received scant attention. During FY 90, the Office of Energy will explore selected cases where such an effort appears to be warranted. For example, in Egypt natural gas associated with petroleum production is currently flared, thereby wasting an important energy resource that otherwise could be used productively. Acting on a request by the Egyptian Government, the Office of Energy has begun to develop a strategy for improving the use of this associated gas. Technological options that would allow economical storage and utilization of this gas from production wells are being investigated.

The Philippines is beginning a significant effort to expand its exploration and development of indigenous petroleum and other fossil resources. The first major gas deposit was discovered in late 1989. Geological data suggest that this natural gas resource, if fully developed, could significantly affect the overall energy situation of this country.

Discussions are under way to provide technical assistance to the Government of the Philippines (GOP) to rationalize the country's natural gas planning and utilization. This will

allow the GOP to identify and implement proper incentives to increase private sector investment, thereby accelerating development of this resource.

Planned Accomplishments:

1. Perform fuel assessment and initiate project development efforts based on activities generated by the FY 89-90 oil-shale prefeasibility study and private power workshop in Jordan; assess oil-shale development in Morocco and Sinai, Egypt.

2. Coordinate Office of Energy, TDP, trade association, and contractor initiatives in the Philippines.

3. Perform gas utilization planning studies in Egypt and the Philippines.

Technology Innovation

The past decade witnessed the emergence of several innovative technologies for fuel treatment, combustion, and electric power generation--many with the potential to meet developing country needs in economically and environmentally advantageous ways. The Office hopes to help disseminate these technologies in the 1990s.

Project activities in the areas of technology innovation will have several thrusts. Due to growing international environmental concern over the increasing use of coal, the Office of Energy will identify innovative clean coal technologies for application in several coal-producing and -using LDCs. Other innovative technologies that will receive special attention include a computerized energy technology screening tool for LDC energy planners and decision makers, and the tailoring of advanced management information systems for improving energy facility planning and operation.

Two recent advances in coal combustion technology--atmospheric fluidized-bed combustion (AFBC) and integrated coal gasification combined cycle (IGCC)--achieve high energy conversion system efficiency and minimize undesirable emissions to the environment.

In the area of IGCC, the Office of Energy initiated a study in FY 89 under a cooperative arrangement among USAID/New Delhi, the U.S. Trade and Development Program, and the Council for Scientific and Industrial Research of the Indian Government to review candidate gasification technologies for application to a commercial-size IGCC power plant that will be capable of using indigenous, low-grade, high-ash coal.

The development of the energy sector in many LDCs is frequently hampered by the lack of an efficient data-management system. The Office of Energy possesses relevant data-

management expertise and is currently cooperating with USAID/Cairo in assisting the Government of Egypt in developing an energy data-management system for its national petroleum company. In response to a request by the Office of Energy Affairs (OEA) in the Philippines, the Office of Energy conducted a two day seminar in Manila in October 1989 for senior OEA personnel, and jointly developed an approach to designing an information system tailored to OEA's needs. This approach will allow OEA to systematically plan for integration of an energy data-management system with compatible software and hardware, enable OEA to issue timely information needed for investment decisions, and permit data sharing with other GOP agencies and donors, as well as with the private sector. The system will also be designed to allow better coordination with the ongoing technical assistance efforts of the World Bank and the Canadian Government.

Planned Accomplishments:

1. Assess opportunities for indigenous fuel and innovative technology energy projects and provide technical and financial services to facilitate private investment in the Philippines.

2. Identify potential applications of clean coal technologies in Indonesia, the Philippines, and Thailand.

3. Perform an IGCC prefeasibility study for India (performed in conjunction with planned accomplishment #6 on page 35).

4. Apply management information system technology to the management of indigenous energy resource data in Pakistan and the Philippines.

5. Perform analysis of Japan's OECF (Overseas Economic Cooperation Fund)/Japanese Export-Import Bank energy sector loan programs in A.I.D.-assisted countries to identify areas for increased cooperation and conduct seminars and site visits to U.S. private power projects to focus on U.S. experience and project financing (performed jointly with the Energy Planning and Policy Development project).

6. Provide technical assistance to Pakistan, Egypt, and the Philippines in the areas of power sector rehabilitation, operation and maintenance and inventory control needs, oil and gas optimization studies, and hydrocarbon exploration.

CHAPTER VII

ENERGY TECHNOLOGY INNOVATION PROJECT

A. RATIONALE

An important element of power sector development is continued research in new and innovative technologies, which has led to economic expansion and improved social welfare. However, most developing countries are plagued with centralized state-owned utilities that find it difficult to implement modern power system management techniques or technologies. As discussed in previous chapters, many developing countries also have public policies, regulations, and practices that prohibit or discourage energy conservation or private power development. Other public policies often create barriers to foreign investment in energy technologies.

A longer-term view is necessary to ensure sustainable technological development of the power sector in developing countries. Support for diversified energy sources to reduce sensitivity to fuel price fluctuations, the use of more secure indigenous resources, and the transfer of advanced, innovative, clean energy technologies to limit environmental impacts are all necessary.

The current growth in demand for electricity in developing countries, the inability of those countries to fund and sustain the necessary capacity expansion, and the specter of environmental degradation--all justify support for a new initiative to guide the development of innovative and clean energy harvesting, conversion, transmission, and distribution, as well as improved power system management and technology evaluation and commercialization.

B. STRATEGY

The Office of Energy has designed its Energy Technology Innovation Project (ETIP) to assist developing countries in the use of advanced commercial energy conversion technologies, power system control and management techniques, and conventional and alternative indigenous energy resources. As part of its activities, ETIP will help to reduce the discrepancy between energy demand and power sector growth in an environmentally acceptable and cost-effective manner. ETIP will support prefeasibility studies, develop and implement innovative approaches to technology transfer, conduct management/operational assistance workshops, and catalyze economic/financial project components for private sector involvement within an acceptable institutional framework. These activities are the natural

extension of activities completed under the Conventional Energy Technical Assistance (CETA) project. ETIP will build upon the results of CETA to accomplish its goals.

Specific technologies and methodologies will be chosen for their applicability to indigenous energy resources, relevance to improving existing systems throughout the power sector, minimum impact on the environment, and economic suitability to specific conditions in developing countries. Implementation of these technologies and related activities will occur under four project components:

- Clean energy technologies;
- Innovation in energy efficiency and power generation, transmission and distribution;
- Technology transfer to rehabilitate current systems; and
- Improvement of power-sector institutional structures.

C. PLANNED ACCOMPLISHMENTS: ENERGY TECHNOLOGY INNOVATION PROJECT (ETIP)

Anticipated accomplishments under each project component are given below.

Clean Energy Technologies

The 1980s have seen the emergence of a number of innovative technologies for production, transmission, and distribution--many of them with the potential to meet LDC needs in an environmentally acceptable and cost-effective manner. A focus of ETIP is to make these technologies available so that A.I.D.-assisted countries can develop conventional and alternative indigenous energy resources in an environmentally sound way and perform prefeasibility studies for adapting various power generation systems with these technologies. A Clean Energy Technology Feasibility Study Fund (CETFSF) will be established under ETIP for this purpose.

The CETFSF could finance studies to evaluate the feasibility of an indigenous natural gas resource used for the generation of electricity. The fund could also support prefeasibility studies in clean coal technologies, such as integrated combined cycle (IGCC) and fluidized-bed combustion systems for power generation.

Planned Accomplishments:

1. Establish the Clean Energy Technology Feasibility Study Fund and finance various conventional and alternative indigenous energy prefeasibility studies such as a wellhead geothermal development including exploration and assessment for geothermal projects in the Philippines.

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

3. Conduct a definitional mission to assess the application of fluidized-bed combustion in selected developing countries.

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

5. Perform clean coal technologies project verification studies for Indonesia, the Philippines, and Thailand.

Innovation in Energy Efficiency and Power Generation, Transmission and Distribution

ETIP will focus on energy efficiency improvements in the supply and distribution stages of the power sector, to complement activities conducted under ECSP (see Chapter III), which focuses on the demand side.

ETIP will also apply innovative, commercially proven technologies, such as computer-based tools, to improve energy conversion efficiency, to measure and monitor environmental effects, and to update power system management and rehabilitation in developing countries. Cogeneration will be promoted to take advantage of its potential to cut energy requirements and carbon emissions by 25-40 percent.

Planned Accomplishment:

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

Technology Transfer to Rehabilitate Current Systems

The U.S. energy sector has a competitive advantage over foreign competition in at least five areas:[10]

- Advanced clean coal and certain other energy resource and conversion technologies, such as wind, solar, and various advanced fuel preparation and combustion methods;
- Computer hardware and software for management information systems, and process control systems;
- Financial engineering;
- Management services for complex energy infrastructure projects; and
- Power plant rehabilitation and extension of system lifetimes.

Slow demand growth for electricity and energy conservation efforts in the U.S. has caused the U.S. power industry to look to foreign markets for continuing sales growth. However, foreign competition is keen and as a result, U.S. exports currently represent less than 10 percent less than 10 percent of total power generation exports to developing countries, while they accounted for over 17 percent five years ago and over 20 percent in the late 1970s. If the current declining trend continues, the U.S. share of the developing country power market will be limited to about 5 percent of the estimated export potential during the next twenty years.[11]

Although these technologies and services are very appropriate for LDCs, sales will be governed by the issue of cost-competitiveness, including the cost of equipment and services and attractive financing. Financing is a major impediment to successful U.S. sales, because so-called "mixed credits"--grants combined with concessionary loans--are offered by foreign loans are offered by foreign businesses and their government sponsors in their commercial proposals. ETIP will provide an excellent opportunity for U.S. energy equipment manufacturers, engineering firms, utilities, and other firms with knowledge and experience in the technologies of the energy sector to work directly with LDC governments and the private sector on financing issues and hopefully encourage the application of the latest U.S. hardware and methodologies in these areas to power sector problems. ETIP will assist in promoting U.S. energy sector trade in areas such as advanced energy resource and conversion technologies (including clean coal technologies), computer hardware/software

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[10] Bechtel National, Inc., 1989. *A Potential Role for Selected U.S. Technologies in India*, prepared for A.I.D. Office of Energy.

[11] Op. cit., *Power Shortages*.

management information systems and process control systems, financial engineering, management services for complex energy infrastructure projects, and power plant rehabilitation and extension of system lifetimes.

Planned Accomplishments:

1. Co-sponsor trade missions to selected developing countries for interested U.S. participants to explore financing of business ventures and collaboration.

2. Co-sponsor reverse trade missions for key governmental decision makers and industrialists from selected developing countries to visit relevant U.S. manufacturing and power generation facilities and hold discussions with U.S. financial institutions.

Improvement of Power Sector Institutional Structures

The U.S. has one of the most efficient power sectors in the world. U.S. utility companies have gained unique experience in dispersed power systems and the integration of private power generation with existing grid distribution systems from operation under the 1978 Public Utilities Regulatory Policy Act (PURPA). Funding under ETIP will support efforts to increase the efficiency of operation in the energy/power sector of LDCs through workshops for management personnel and through the streamlining and rehabilitation of institutional organizations. ETIP components will work with U.S. companies that have been or are interested in "down-stream" involvement with developing countries to design power projects and assist in their implementation with the private sector.

Planned Accomplishment:

1. Design a management information system (MIS) and demonstrate the ability to streamline organizational infrastructure and develop more efficient managerial approaches for a Pakistani petroleum company.

CHAPTER VIII

ENERGY AND ENVIRONMENTAL TRAINING

A. RATIONALE

True development in A.I.D.-assisted countries requires that they gain those skills and build those institutions that will make the development process sustainable and predominantly indigenous.

Training--the development of human resources--has always been an important part of A.I.D.'s work in all sectors. The U.S. has a broad range of experience, expertise, and educational fora that can be made available to the citizens of developing countries.

Techniques and technologies for energy production, conversion, and utilization have reached high levels of sophistication in the industrialized world. On the demand side, they include end-use analysis, operations auditing, systematic maintenance, and efficiency-conscious management. On the supply side, they include resource-assessment methods and technologies for mining, harvesting, and conversion that accommodate environmental concerns.

These tools must be made readily available to policymakers and managers who face the complex tasks of setting priorities for the allocation and utilization of energy resources. In setting priorities, decision-makers must take into account the most pressing social and economic needs of their nations, the political system within which they must work, the extent and capabilities of their human resources, the availability of non-energy resources required to carry out energy operations, the amount of capital available for various lines of action, and the varying environmental impacts of alternative energy technologies.

With respect to environmental concerns, the U.S. has much to offer developing countries in assisting them to make these decisions. A substantial knowledge base has been developed by U.S. ecologists, engineers, planners, economists, and managers. Pathfinding results of research and development on such man-created phenomena as local air pollution, acid rain, and the potential for global warming and climate change--and the new technologies deriving from them--can be readily transferred to the developing world through technical training.

In terms of enhancing energy efficiency and of minimizing environmental damage, a pressing need of the developing nations is for technically skilled personnel in all phases of energy exploration, exploitation, production, operations, maintenance, distribution, and management. This need extends to A.I.D. field staff in Regional Offices and host country

Missions. Few A.I.D. Missions have any professional staff in the energy and electric power fields. The Office's training programs in energy, especially related to energy efficiency, renewables, and environmental management of electric power systems, will be extended to selected Regional Offices and Mission staff.

B. STRATEGY

Recognizing the need for training as long ago as 1980, the A.I.D. Office of Energy began a systematic, diversified program of training as an efficient and cost-effective way of transferring human-resource and technical skills to cooperating countries. Since then, the program has steadily expanded and improved, in response to needs identified by cooperating nations and to recommendations of program alumni, their employers, and professional evaluators.

Elements of the overall program include formal training for practicing professionals in energy management, exploration, engineering, production, utilization, policy and planning, conservation, and related topics.

Complementing the major components of all other Office of Energy programs, these courses are offered by U.S. training cooperators selected for their demonstrated competence. They include electric utilities, academic institutions, government agencies, national laboratories, proprietary training organizations, oil refineries, and exploration companies.

An important subsidiary benefit of these training programs is the establishment of close working relationships between the developing-nation professionals thus trained and their training institutions. These ties have often led to business opportunities for the U.S. organizations providing the training, as alumni have successfully advocated the purchase of their trainer's equipment or services upon returning to their home countries.

One major training effort of the Office of Energy was the Conventional Energy Training Project (CETP), which trained 721 developing-nation professionals from 1980 until its conclusion in 1987. It was succeeded at that time by the Energy Training Program (ETP), bolstered by a broader mandate.

The ETP, just as the CETP before it, designs energy-related training programs to meet the specific needs of governmental, parastatal, and private employers in developing nations. Nearly all of the training is short-term--typically from two to seven months. A small percentage of the trainees pursue Master of Science programs at U.S. universities.

Whether short- or long-term, the training is intensive, demanding, practical, and full-time. To the maximum extent, it emphasizes the "hands on" approach in actual work settings. Participants in these courses are required to return home immediately following

graduation, in order to put their newly gained knowledge and skills to work in service to the energy needs of their nations.

To increase the likelihood that newly acquired skills will actually be put to use, ETP requires each employer who nominates a candidate for training to provide round-trip international air transportation, pay full salary while the participant is in training, and guarantee employment upon return.

The expectation is that the new skills will be incorporated into long-term institutional capability. In the best of worlds, alumni transfer their skills to colleagues, who then apply them throughout their organization.

In 1988, ETP programs trained 109 participants in energy-related fields. In 1989, the number increased to 143.

In response to Congressional concerns regarding the potential dangers of global climate change stimulated by human energy use, ETP is now designing courses that both characterize the problem and identify ways to address it, to be offered to developing-nation managers, policy-makers, and technicians who are in a position to implement what they learn.

C. PLANNED ACCOMPLISHMENTS: ENERGY TRAINING PROGRAM (ETP)

The following energy activities provide the framework for ETP courses planned as training accomplishments for FY 90:

I. Energy Policy and Analysis

1. **National Energy Policy and Planning** (7 months) - for mid- to senior-level energy managers and planners. Prepares participants to solve national and institutional energy-planning problems in efficient and cost-effective ways. (January 16 - July 27, 1990)

2. **Economic and Financial Analysis of Energy Projects** (10 weeks) - for mid- to upper-level management personnel who develop, evaluate, recommend, or approve energy investments. Provides participants with relevant, practical experience concerning modern-day industrial and governmental procedures for analyzing the economic and financial viability of energy investment projects. This is an applications-oriented program with emphasis on case studies to illustrate concepts throughout the training. (February 5 - April 16, 1991)

II. Indigenous Fossil Fuel Development

1. **Applied Petroleum Exploration and Production Technology** (12 weeks) - for junior to mid-level oil and gas technical professionals. Applies the principles and techniques of geology, geophysics, and engineering to petroleum exploration and production. (Dates TBA)

2. **Lignite-Coal Utilization** (10 weeks) - for mid- to upper-level managers, supervisors, and engineers working on the development and utilization of lignite and sub-bituminous coal for power or steam generation. Covers the complete coal cycle and combines classroom work with practical internships. (July 5 - September 14, 1990)

3. **Structure and Management of the Natural Gas Industry** (12 weeks) - for mid- to upper-level managers, providing practical information necessary for intelligent decision-making in exploration and development, production, processing, transportation to markets, utilization, and computer applications. (Dates TBA)

4. **Fluidized-Bed Coal Combustion** (8 weeks) - designed to provide engineers with the fundamentals of fluidized-bed combustion, the information needed to evaluate technologies currently available, and methods for determining the technology that best fits a particular application. (May 15 - July 13, 1990)

5. **Management of a National Petroleum Enterprise** (10 weeks) - for senior-level officials. Covers how to promote cooperative oil and gas ventures with international oil companies and financial institutions and to negotiate productive and equitable contracts. (September 25 - December 7, 1990)

6. **Petroleum Management** (9 weeks) - for new and mid-level managers, providing an overview of the petroleum industry, from geology and exploration to production and refining, followed by an examination of key managerial functions such as principles of management, economics, accounting, finance, computer applications, decision-making, organization, and supervision. (Dates TBA)

III. Power-Industry Development

1. **Electric-Utility Engineering** (14 weeks) - for electric-utility engineers. Covers engineering practices and technologies for generation, transmission, and distribution of electricity by fossil-fuel and hydro-power systems, with attention to long-term planning. (July 31 - November 2, 1990)

2. **Power-Systems Protection** (9 weeks) - for electric-power design and maintenance engineers. Provides hands-on training in all effective techniques of power-systems protection, including microcomputer-based protective relay systems. (June 5 - August 10, 1990)

3. **Mechanical Maintenance of Electric-Power Plants** (12 weeks) - for mechanical engineers engaged in the maintenance and operation of power plants. State-of-the-art procedures and practices for optimizing mechanical efficiency and reliability of electric-power plants. (April 3 - June 29, 1990)

4. **Diesel-Based Electric-Power Generation** (8 weeks) - trains engineers in skills and techniques required to maximize the availability, reliability, and performance of diesel-powered generators. (July 17 - September 15, 1990)

5. **General Management of Electric Utilities** (12 weeks) - for mid- to senior-level technical managers from utilities and other companies which produce or utilize energy as a primary commodity. Demonstrates how to manage a company as a total enterprise, by combining technical capabilities with general managerial skills in order to optimize performance of men and machines. (September 11 - December 7, 1990)

6. **ASEAN Private Power Workshop** - Designed for senior executives in the electric-power industry in Southeast Asia, the ASEAN Private Power Workshop will provide training in technical, financial, policy, and institutional aspects of cogeneration and Independent Private Power (IPP) projects. Participants will learn how to plan for cogeneration, analyze projects, and develop power purchase agreements for independent cogeneration and IPP facilities. The Workshop is a cooperative enterprise of the Office of Energy and the Bureau for Asia, the Near East, and Europe, with funds provided by the latter. (April 22 - May 12, 1990)

IV. Energy Conservation and Efficiency

1. **Utility and Industrial Energy Conservation** (8 weeks) - for utility and industrial plant engineers and supervisors. Covers implementation of in-house energy conservation programs. (June 19 - August 17, 1990)

2. **Refinery Energy Conservation** (10 weeks) - for refinery engineers. Provides comprehensive, hands-on training in pinch technology and other techniques to reduce energy consumption and improve operational efficiency of refinery and petrochemical plants. (August 21 - October 26, 1990)

V. Alternative Energy Systems

1. **Solar Electricity (Photovoltaic) Technologies** (4 weeks) - for engineers. Comprehensive, hands-on training in all aspects of designing and utilizing photovoltaic (PV)-powered equipment, as well as technical, economic, and practical information necessary to design a PV-based project or to set up a PV-based commercial enterprise. (July 17 - August 15, 1990)

2. **Geothermal Exploration** (12 weeks) - for exploration geologists. Covers the development and utilization of geothermal energy resources, with focus on locating, assessing, and exploiting geothermal sites. (Dates TBA)

VI. Alumni Network

ETP has been actively developing an Alumni Network for International Training, to promote long-term professional relationships among course graduates and to provide opportunities for periodic updating of their knowledge and skills.

1. **Workshop** - A Regional Workshop in Costa Rica, originally planned for April 1990, has been postponed at USAID recommendation because of national elections being held. It is currently being planned for September 1990.

   The workshop will focus on practical, readily available means of promoting energy efficiency and energy conservation within their organizations. Invitees will include all alumni residing in Central America, Caribbean nations, and northern nations of South America. (September 1990)

2. **The ETP Newsletter** - Published semiannually, keeps alumni up-to-date on colleagues who have recently graduated from ETP courses, on the content and critical dates of upcoming courses, on alumni activities, and on any other developments which will encourage their ongoing involvement in the program. The next edition is scheduled for publication in June 1990.

VII. Other Accomplishments

1. **Egypt Energy Manpower Development Project (EMD)** - The EMD's goal is to improve the technical and managerial capabilities of the country's petroleum and electricity sectors by assisting three agencies--the Egyptian General Petroleum Corporation, the Egyptian Electrical Authority, and the Electrical Distribution Authority--in the design, use, and adaptation of human resource and career development systems for human resource planning.

2. **Academic Training** - During 1990 nine engineers (all from Pakistan) are expected to complete their Master of Science programs at various U.S. universities. An additional engineer (from Uruguay) and a geologist (from Pakistan) will continue in M.S. programs, and eleven new M.S. candidates (from Pakistan) are expected to begin studies.

3. **Internships** - Approximately half of the 149 energy professionals from Pakistan who are expected to come to the U.S. for training during 1990 will be slated for individual "hands-on" internships in highly-specialized fields. Each intern will be matched with a carefully selected U.S. company in order to meet the training requirements of specified by his or her employee.

D. PLANNED ACCOMPLISHMENTS: ETP ACTIVITIES IN ENVIRONMENTAL TRAINING

The potentially life-threatening magnitude of global environmental problems makes it imperative that the limited resources available to deal with them be marshalled quickly and managed judiciously.

The beneficial impact of the resources thus invested can be multiplied in two practical ways: (1) by improving *cooperation among domestic and international agencies, both public and private, with shared environmental concerns*; and (2) by stressing the *development of human resources*. Enhanced cooperation with colleague agencies is particularly necessary because they contribute a large share of development funds, and the lion's share of facilities and equipment.

The two themes mentioned above--developing the human resource base and interagency cooperation--underlie all projected efforts under the Environment Activities.

I. Manpower Development

1. **Environmental Policy and Regulation** (12 weeks) - training in alternative approaches and methodologies for pollution control and enforcement. Examination of economic and physical (mass balance) aspects of pollution externalities; goals of regulation; alternative pollution-control instruments, including statutory regulation, command-and-control strategies (performance and technology-based standards), and revenue-based programs (fees, taxes, and subsidies); and the role of risk assessment in standard-setting. The use of interim standards based on other-country standards and research will also be evaluated. (Dates TBA)

2. **Pollution-Control Systems** (12 weeks) - training in media-specific pollution control technologies. Air-pollution control, targeted at particulates and gaseous stationary-source emissions from fossil-fuel energy conversion; combustion chemistry; physical and chemical removal processes; fan equations; in-stream sampling; cyclone, precipitator, scrubber and baghouse design; regenerative systems; sizing pollution-control equipment; retrofitting of existing boilers; energy penalties for pollution-control systems; and disposal of pollutants. (Dates TBA)

3. **Data Collection and Analysis** (6 weeks) - training in all aspects of empirical-data management for environmental regulation. Emphasis on designing data-survey instruments; data-collection and sampling techniques; statistical processing of data; and choosing, maintaining and upgrading databases. Data-collection costs, training of technicians for basic data collection and maintenance, and remote-sensing applications. Program is applicable to both single-medium and multi-media pollution control. (Dates TBA)

Of course, the list of environmental courses above is not exhaustive and represents only an initial effort. The Office of Energy has also begun development of three additional courses that will be offered in the future as funds become available:

- Institution-Building for Environmental Management;
- Resource Allocation for Environmental Management; and
- Waste Disposal.

II. Training of USAID Staff

The Office of Energy will assist in the development of training programs for USAID personnel to upgrade their qualifications on environmental topics and enable them to identify needs, evaluate programs, and design projects with an environmental focus. From an energy perspective, much of the training will address the relevance of least-cost planning, efficiency, and renewable resources. Training will be made available to personnel in Washington and in the overseas Missions.

Given the time constraints imposed on managers and policymakers, the Office of Energy further proposes to design courses as brief as feasible without compromise of the integrity and utility of the material presented.

III. Environmental Training-Needs Assessments

Prerequisite to a concerted training effort in any institution is the systematic assessment of the human resources required to meet stated goals.

The assessment process entails definition of the total body of knowledge and skills required to meet stated goals, measurement of the extent to which employees possess such knowledge and skills, and design of a strategy of training and recruitment to fill any gaps.

Within the developing nations--and in the Eastern European nations only now opening their doors to the world community--there is a critical shortage of professional personnel attuned to the environmental "downside" of economic development and technically competent to deal with it.

To help alleviate that shortage within national energy sectors, the Office of Energy now proposes to conduct training-needs assessments (TNAs) within key industries and institutions of those nations responsive to the twin notions that environmental protection is an important, even indispensable component of economic development, and that other nations can contribute toward that end without compromising host-nation or indigenous-institution integrity.

The first step is to win agreement, through representations of USAID Missions in developing nations and U.S. embassies in Eastern European nations, on the utility and desirability of TNAs within key energy organizations, followed by invitations to conduct such assessments.

The objective would be to measure institutional strengths, weaknesses, and training needs of agencies and companies engaged in the production and use of energy derived from petroleum, natural gas, coal, and renewable resources such as sunlight, water, wind, and biomass.

The electric-power industry will be a prime target, in its unintended role as polluter of water, soil, and air, and as major generator of carbon dioxide contributing to potential climate change.

Within each organization mutually agreed upon, a joint team of ETP and host-nation energy/environment specialists will conduct a preliminary institutional-capability and training-needs assessment, identifying those production goals whose attainment will generate adverse environmental impacts and estimating the extent to which the organization is equipped to take remedial actions.

These preliminary assessments will enable ETP and host-country managers to identify and designate a few pilot companies in which to demonstrate the techniques and practical benefits of TNAs. Company personnel trained by ETP will conduct rigorous

energy/environment TNAs, with guidance from ETP upon request. All data thus collected will be analyzed by the same personnel, again with ETP guidance, and reported for use by managers in formulating manpower-development programs characterized by annual training and recruitment plans.

The Office of Energy has developed with the U.S. Department of Energy a cooperative initiative to implement TNA/manpower-development activities in Poland. The Office of Energy will conduct similar activities in other nations considered critical, at a later date.

IV. Study Tours

The Office of Energy, through the ETP, will develop and conduct observation-and-consultation programs in the United States for energy/ environment professionals from Third World and Eastern European nations, to acquaint them with available technologies, processes, and successful institutional policies and programs for dealing with environmental problems.

These carefully crafted programs will provide opportunities for frank and open discussion and exchange of information with professional counterparts across the United States: policymakers, planners, managers, and other professionals charged with addressing environmental problems.

To the extent feasible, each program will serve energy/environment officials from more than one nation. ETP has found in the conduct of its training courses that opportunities to establish personal relationships and to engage in substantive dialogue with counterparts from other nations are perceived by participants as major bonuses to their training experience.

This networking process can be further enhanced through seminars, conferences, and workshops designed to encourage and facilitate exchanges among U.S. citizens and group members.

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 Oak Ridge Nat'l 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, Fiscal Years 1988 and 1989	Office of Energy	May 1988	PD-AA4-768

Report No.	Title of Report	Prepared By	Date	Document No.
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
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

Report No.	Title of Report	Prepared By	Date	Document No.
89-01	Energy Efficient Stoves In East Africa: An Assessment of the Kenya Ceramic Jiko (Stove) Program	Oak Ridge National Laboratory and Kenya Energy and Environmental Organization	January 1989	PN-ABD-072
89-02	Prefeasibility Study Oil Shale Utilization for Power Production in the Hashemite Kingdom of Jordan, Volumes I - VI	Bechtel National, Inc.	May 1989 Appendices 1-4 Appendices 5 Appendices 6 Appendices 7-12	PN-ABD-619 PN-ABD-620 PN-ABD-621 PN-ABD-622 PN-ABD-623 PN-ABD-624
89-03	Electric Power from Cane Residues, A Technical and Economic Analysis	RONCO Consulting Corp.	September 1986	PN-ABA-930
89-04	Summary Report of the Philippine Seminar and Roundtable on Private Power Generation Through Build-Operate-Transfer (BOT)	Bechtel National, Inc.	May 1989	PN-ABD-617
89-05	The Sugar Industry in the Philippines: An Analysis of Crop Substitution and Market Diversification Opportunities	RONCO Consulting Corp.	December 1986	PN-ABA-959
89-06	Fuel Alcohol Production in Honduras: A Technical and Economic Analysis	RONCO Consulting Corp.	April 1986	PN-AAW-502
89-07	Energy Inefficiency in the Asia/Near East Region and its Environmental Implications	RCG/Hagler, Bailly, Inc.	June 1989	PN-ABF-134
89-08	Program Plan, Fiscal Years 1989 and 1990	Office of Energy	June 1989	PN-ABA-910
89-09	Costa Rica Load Control Demonstration Project	RCG/Hagler, Bailly, Inc.	July 1989	PN-ABD-618

Report No.	Title of Report	Prepared By	Date	Document No.
89-10	Jamaica Cane/Energy Project, Feasibility Study, Volume I	RONCO Consulting Corp.	September 1986	PD-AAV-308
89-11	Technical, Economic, Financial and Commercial Considerations of the San Miguel Corporation Private Power Program	Bechtel National, Inc.	August 1989	PD-ABE-113
89-12	Steam-Injected Gas-Turbine Cogeneration for the Cane Sugar Industry, Optimization Through Improvements in Sugar-Processing Efficiencies	Princeton University	September 1987	PN-ABC-988
89-13	Electroplan: A New Spreadsheet Model for Comprehensive Power Systems Planning in Developing Countries	IDEA, Inc.	July 1989	PN-ABD-616
89-14	Handbook for Comparative Evaluation of Technical and Economic Performance of Water Pumping Systems	Oak Ridge National Laboratory	November 1988	PN-ABF-135
89-15	Screening Study to Determine the Feasibility of Small Non-Centralized Electric Generating Stations Using Indigenous Fossil Fuel to Supply Energy Needs in Rural Areas in Developing Countries	Energy and Environmental Engineering, Inc.	November 1989	PN-ABE-114
89-16	Energy Conservation Investment Decision-Making in Developing Countries	RCG/Hagler, Bailly, Inc.	December 1989	PN-ABD-858

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