

PD-ABG 232

Program Plan
Fiscal Years
1993 and 1994

Office of Energy and Infrastructure
Bureau for Research and Development
U.S. Agency for International Development

PROGRAM PLAN FOR FISCAL YEARS 1993 AND 1994

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Office of Energy and Infrastructure

Mission Statement

Mission: The Office of Energy and Infrastructure helps developing countries and emerging economies find market-oriented solutions to their energy and environmental problems.

The Problem: Lack of energy is seriously curtailing economic growth in developing countries. Expansion of energy supplies places a huge financial burden on developing countries, and many countries lack the institutional capability to operate and manage these energy systems efficiently. These issues contribute to energy development being a leading environmental concern worldwide.

The Office's Two-Fold Strategy: The way out of this bind is through higher energy efficiency and a switch to renewable energy and other environmentally sound technologies. Private investment must be encouraged to finance these improvements, and technical assistance and training must be provided to build institutional capability. The Office offers a two-fold strategy to address these issues:

- **Tapping U.S. know-how:** The Office arranges cooperative relationships to promote energy efficiency and greater use of clean and innovative energy and environmental technologies. Key partners in this process include developing countries, the U.S. energy and environment industries, other federal agencies, multilateral development banks, and nongovernmental organizations.
- **Promoting private sector initiatives:** The Office helps developing countries put in place market-oriented policies and institutions to support private energy and environmental initiatives.

The Office encourages the U.S. energy and environment industries to export state-of-the-art products and services to developing countries in a manner appropriate in the developing country context. This provides developing countries with access to world-class commercially viable technology and management practices. It also helps U.S. industry become more competitive in the international marketplace.

Office Activities:

- Innovative financing mechanisms such as cost-shared feasibility studies, investment funds, and better access to multilateral sources of funds;
- policy, legislative, and regulatory development assistance;
- reports and workshops on market conditions and opportunities;
- training and information dissemination;
- engineering and other technical assistance.

GLOSSARY OF ACRONYMS

AAC	-	A.I.D.-assisted country
A.I.D.	-	Agency for International Development (refers to Washington D.C.-based offices)
AFR	-	Africa Bureau of A.I.D.
ASEAN	-	Association of South East Asian Nations
AWEA	-	American Wind Energy Associates
BEST	-	Biomass Energy Systems Technology Project
CFC	-	Chlorofluorocarbon
CORECT	-	Committee on Renewable Energy Commerce and Trade (a federal interagency group)
DSM	-	Demand Side Management
ECSP	-	Energy Conservation Services Project
EEAF	-	Environmental Enterprise Assistance Fund
EEP	-	Energy Efficiency Project (started in 1993)
EMCAT	-	Energy Management Consultation and Training
EPA	-	Environmental Protection Agency
EPDAC	-	Energy Policy Development and Conservation
EPDF	-	Energy Project Development Fund
ESCO	-	Energy Services Company
ETEC	-	Environmental Technology Export Council
ETP	-	Energy Training Project
ETIP	-	Energy Technology and Innovation Project
ExIm Bank	-	Export Import Bank
IDB	-	Inter-American Development Bank
IFREE	-	International Fund for Renewable Energy and Efficiency
IGCC	-	Integrated Gasification and Combined Cycle
IRP	-	Integrated Resource Planning
GEEI	-	Global Energy Efficiency Initiative
GEF	-	Global Environment Facility
LAC	-	Latin America and Caribbean Bureau at A.I.D.
MDBs	-	Multi-lateral Development Banks
MTP	-	Management Training Program
NGOs	-	Non-Governmental Organizations
NIS	-	New Independent States (of the former Soviet Union)
NO _x	-	Nitrogen oxides of various forms
NYMEX	-	New York Mercantile Exchange
OECD	-	Organization for Economic Cooperation and Development
OPIC	-	Overseas Private Investment Corporation
PACER	-	Program for the Acceleration of Commercial Energy Research
PSED	-	Private Sector Energy Development Project
PSDFS	-	Private Sector Development Feasibility Study Fund

- R&D/EI - The Office of Energy and Infrastructure in A.I.D.'s Bureau for Research and Development
- REAT - Renewable Energy Applications and Training Project
- ROCAP - Regional Office for Central American Programs
- SO_x - Sulphur oxides of various forms
- TDA - Trade Development Agency
- TNA - Training Needs Assessment
- TPPC - Trade Promotion Coordinating Committee (a government interagency group)
- UNCED - United Nations Conference on Environment and Development (held in June 1992 in Brazil)
- US/AEP - U.S./Asia Environmental Partnership
- USAID - U.S. Agency for International Development (refers to overseas missions of A.I.D.)
- USEA - United States Energy Association
- US/ECRE - U.S. Export Council for Renewable Energy

CHAPTER ONE: PROGRAM OVERVIEW

I. A. Introduction

The Office Approach: Six Prongs

This document presents an overview of the objectives, strategies, and planned accomplishments of the Office of Energy and Infrastructure during Fiscal Years 1993 and 1994. It provides justification for each programmatic thrust, historical context and a concise list of achievements to be carried out within each program area.

Each chapter introduces one of the six thrusts the Office has adopted in response to energy and energy-related environmental problems in developing countries and the New Independent States (NIS) of the former Soviet Union. These themes; **Energy Efficiency, Renewable Energy, Private Sector Energy Development, Energy Technology Innovation, Training/Technical Exchange, and Project Development** are interrelated. The Office realizes that problems as complex as the world's energy and environment situation can only be solved with a major collaborative effort by a variety of dedicated agents. Cooperation among Office projects is common, and the Office actively seeks collaboration with other projects sponsored by field branches of the Agency (USAID missions and regional A.I.D. bureaus) and other international donor and service organizations. The latter include multi-lateral development banks (MBDs), host country government representatives, private investors, U.S. industry, other U.S. government organizations and non-governmental organizations (NGOs).

The direction the Office has chosen, its scope, and the six-pronged approach, grew out of our understanding of international energy needs, constraints to sound energy development, concerns for minimizing the environmental impacts of necessary energy development, and the budgetary and manpower limitations of the Office. The resulting portfolio reflects the concerns of the U.S. Congress, which provides oversight to the Agency and constant discussions among colleagues within the Agency and from collaborating institutions.

Energy, Development and the Environment

Energy is a primary ingredient of economic success (Figure 1). Our ability to harness energy in its variety of forms is the basis of our control over the resources in our environment. The accelerating rate of technological advance and access to resources, most notably energy, reinforce one another, and have reached levels previously unknown in human history. Human population has also climbed to unprecedented levels.

Today, this combination of record population and resource consumption rates are creating environmental stresses and social problems that are also of previously unimagined proportions. The global dimensions of these problems have resulted in a recent flurry of international dialogue, several important multi-lateral agreements and cooperative initiatives addressing environmental problems.

Expanding energy production and consumption, in response to growing population size and economic expectations, is the leading cause of major threats to the environment, including global climate change (due primarily to burning carbon-based fuels) (Figure 2), and local effects such as air pollution and ground contamination from mining and acid rain.

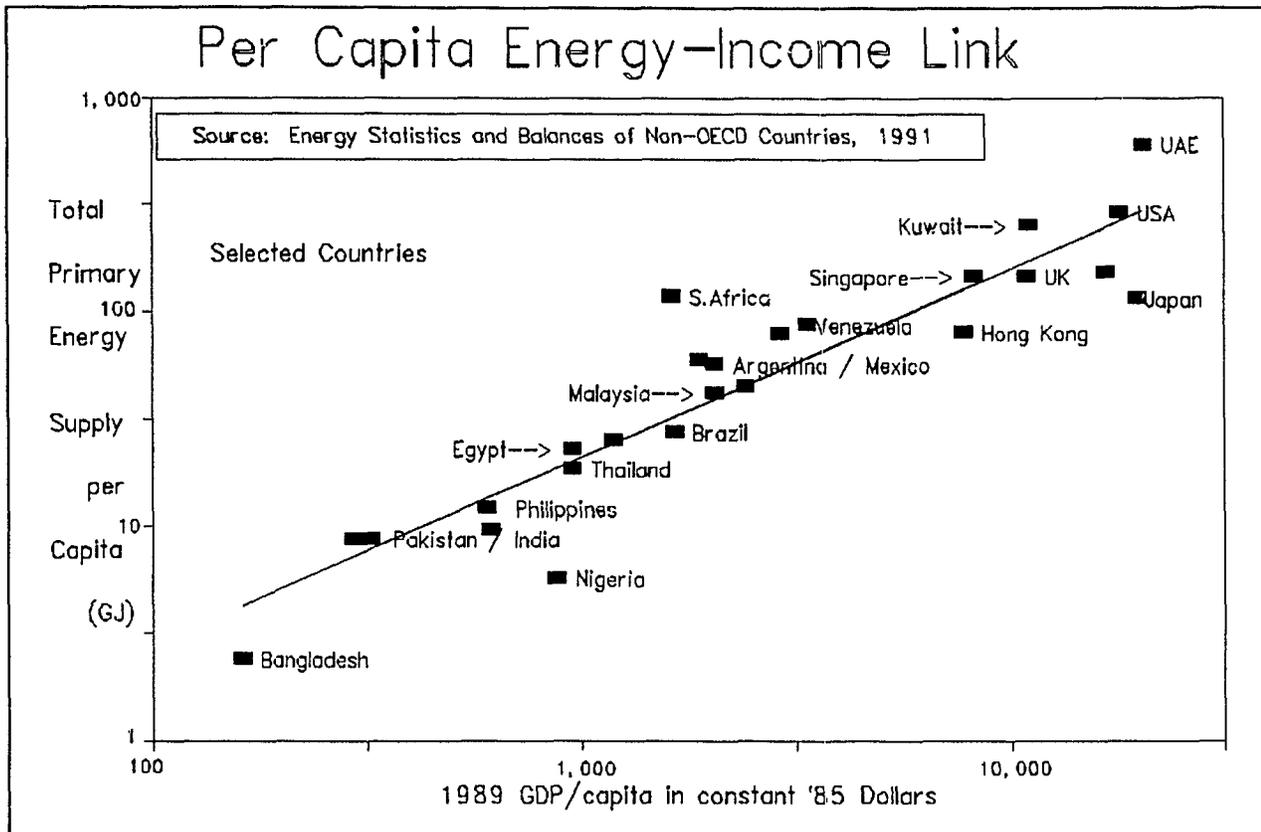


Figure 1. The Empirical Relation Between Energy Use and Economic Output.

On the other hand, many solutions to developing nations' most dire social needs, such as employment and securing ample food supply and shelter, demand additional energy inputs. Meeting a shrinking world's growing expectations for better quality of life requires intelligent use of existing resources and innovative application of the latest technologies to increase the efficiency of resource use.

Gearing up for and purchasing cleaner fuels and technologies to improve the efficient use of energy, costs money. Governments generally do not have sufficient funds available to install expensive new energy facilities. Foreign exchange reserves are often severely strained, and with few exceptions much of the technology must be imported. This problem is being addressed by the Office in its efforts to promote energy sector privatization. Private operations often tend to be more efficient than public concerns since profitability depends upon efficient resource use. The private sector is also a likely source of the scarce capital needed to upgrade facilities, and it traditionally has been the fountain of technological innovation.

This has been especially true in the U.S., whose industries lead the world in state-of-the-art energy and environment technologies. The Office of Energy and Infrastructure is therefore in a unique situation to offer its expertise in assessing energy sector needs, brokering policy and financial arrangements that engage the private sector, and bringing together U.S. industry leaders with national leaders and industry officials in search of energy and related environmental solutions in developing countries.

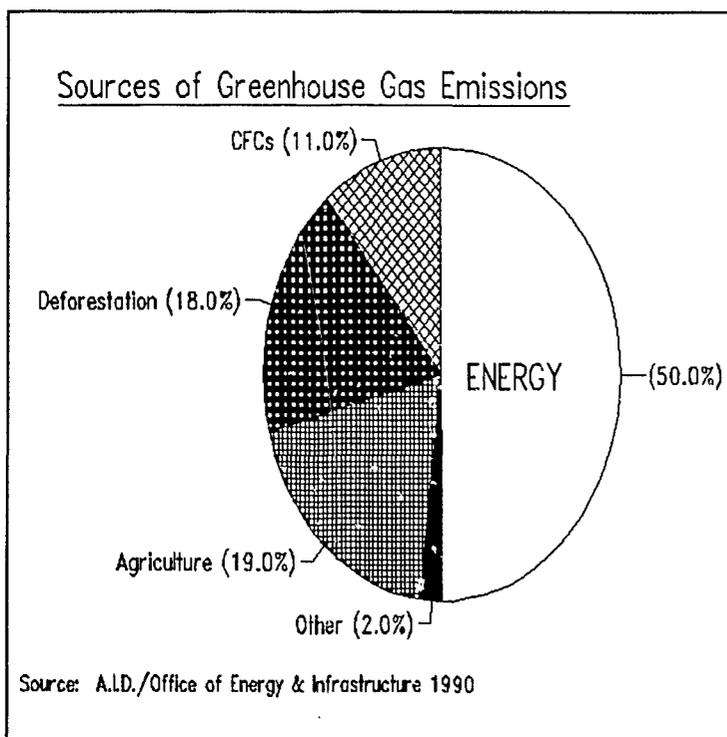


Figure 2 The energy sector is responsible for producing half of all the world's 'greenhouse gas emissions'.

Addressing Urgent Problems

The world's human population is expanding at an average rate of 1.7 percent per annum. While the growth rate is finally beginning to decelerate slightly in some fast growing regions, some areas still approach a staggering 4.0 percent annual growth, and the average for all developing countries (excluding China) is 2.3 percent annually.¹ A healthy economy must grow faster than a nation's human population growth to keep the benefits to the increasingly expectant citizenry from stagnating or declining. Demands on governments to supply basic needs for these populations, including employment, are mounting rapidly. New employment opportunities stem most directly from income generated by successful economic growth.

Economic progress rarely occurs in developing countries without corresponding energy inputs. Versatile forms of energy, such as electricity, provide flexibility and broad economic development options. Expansion of high quality energy resources is critical, therefore, to most A.I.D.-Assisted Countries. Thus, the Office focuses primarily on the power (electricity) sector in its assistance programs.

Recognizing that all economic activity has some associated environmental costs, the Office is challenged to identify and support initiatives that help meet energy requirements in the most environmentally sound manner. While the Office is helping nations shift to, expand and improve electrical energy supplies to enhance economic conditions, energy production is still the leading contributor to CO₂ gas emissions. Similarly, local pollution associated with power generation (NO_x, SO_x, and suspended particulates and related pollution effects) can have a debilitating effect on employee's health, national infrastructure, and the economy.

The way power is generated, is therefore as important a concern of the Office, as is the quantity generated. Technical assistance provided through the Office emphasizes important environmental factors such as the type of energy used to generate power, efficiency of operations, energy management, pollution controls, cleanups, and related policy issues.

¹ WRI 1992. *World Resources 1992-93*. p.246 and Population Reference Bureau, 1992. *The World Population Data Sheet*.

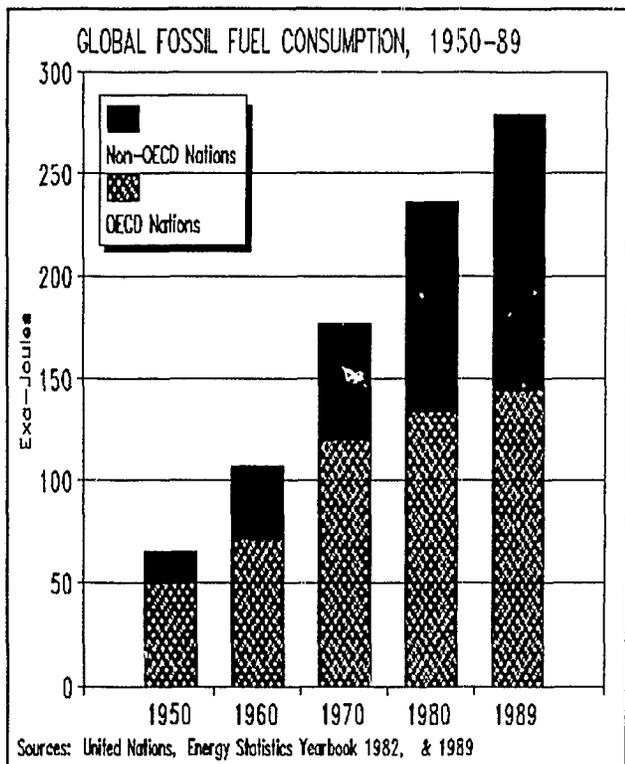


Figure 3.

Current energy conversion capacity in many developing nations and emerging economies is not sufficient to fuel projected economic growth. Power availability must be expanded in many of these countries or economic growth and social development will suffer. While industrialized (OECD) nations currently consume the most energy, the most rapid growth is projected and is already occurring in developing nations (Figures 3 and 4).

While some nations just emerging from near subsistence economies have extreme energy growth rates--a staggering 1,350 percent in Cambodia, more advanced developing countries with large populations present the greatest challenge to energy planners. India, for example, anticipates the most massive energy sector build-up since the post-war U.S. Its 58 percent per annum expansion between 1979-1989 is sobering when the amount of energy consumed is considered. In contrast,

most industrialized nations, have very low energy consumption growth (eg. 3 percent over 10 years in the U.S.) or declining consumption, due to active conservation strategies.²

Failure to invest in appropriate improvements has a recurrent cost as well as implications for future competitiveness. Power shortages in developing countries--often due to overextending existing capacity to meet spiraling demand without corresponding attention to maintenance

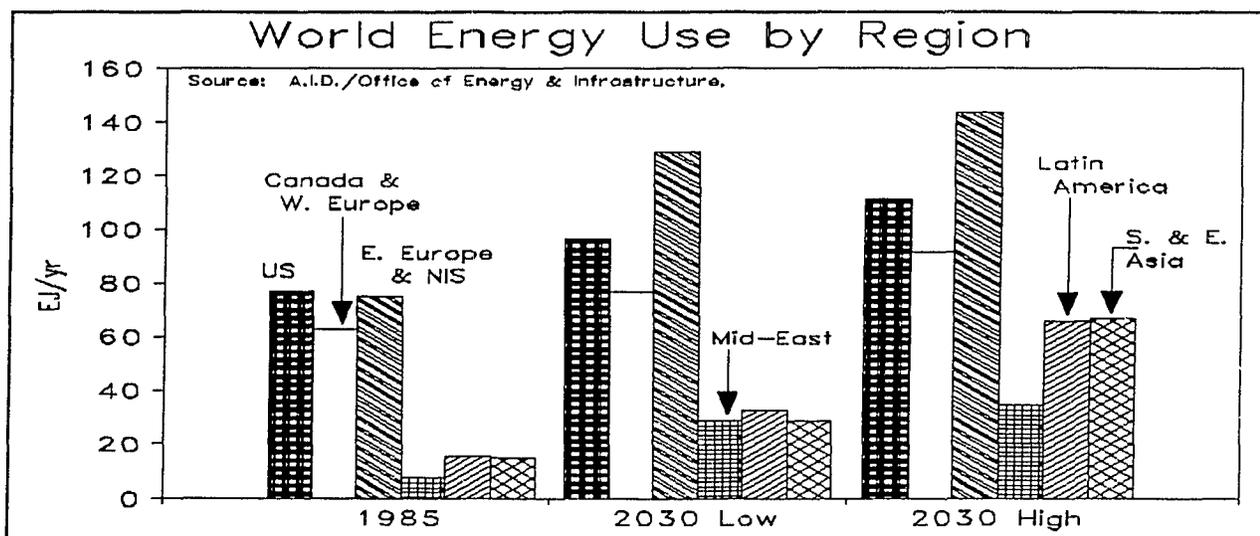


Figure 4.

² WRI 1992. *World Resource 1992-93; A Guide to the Global Environment*, p. 316.

The world's energy shortages are expected to be most acute in India, China, Pakistan, Thailand, Indonesia, Mexico, and Brazil. Only through rapid improvements in the efficiency of resource use, and greater reliance on the private power sector, innovative energy technologies, and renewable energy resources, will these nations be able to afford to meet their energy needs without crippling burdens on their treasuries and the environment.

needs--are responsible for considerable loss in productivity (Table 1). Power outages reduce productivity, thereby raising the average cost of production. The resulting loss of competitive advantage and market share, further reduces the funds available for investing in infrastructure. Makeshift production systems used to provide backup to the grid further exacerbate the problem, since they are generally more costly to both the economy and the environment.

Careful planning and good management can greatly reduce these inefficiencies, improve economic performance, and ease related environmental problems. The race between economic growth and population expansion will

surely continue in spite of financial constraints, and limitations in: infrastructure; institutional capacity; local management capabilities; and technical expertise. All these challenges must be recognized and addressed comprehensively.

Table I

COSTS OF POWER SHORTAGES IN SELECT DEVELOPING COUNTRIES

<u>Country</u>	<u>Sector</u>	<u>Cause of Shortage</u>	<u>Shortage Cost</u>
Brazil	Household	Unplanned outage	\$1.95-3.00/kWh
Chile	Household	Unplanned outage	\$0.53/kWh
"	Industry	Unplanned outage	\$0.25-12.00/kWh
Jamaica	Industry	Unplanned outage	\$1.25/kWh
Pakistan	Industry	Load shedding	\$0.46/kWh
Taiwan	Industry	Unplanned outage	\$1.00/kWh
Tanzania	Industry	Unplanned outage	\$0.70-1.40/kWh

Source: Oak Ridge National Laboratory, *The Impact of Inadequate Electricity Supply in Developing Countries*. January 1988.

In summary, most developing countries face a devastating "triple bind" in the energy sector that seriously constrains their economic and social development. A.I.D.'s Office of Energy and Infrastructure has designed its programs to address the three serious and related problems that create this bind:

- local, regional, and global environmental degradation from energy use;
- inadequate energy policy and institutional frameworks; and
- insufficient capital for investments needed to expand energy capacity.

Affordable Improvements

Expanding a nation's energy production capacity is expensive; but unavoidable in some countries due to the dramatic current and projected increases in power demand. Several alternatives to installing new capacity exist and can help reduce or postpone the need to build new facilities. Effective management of national energy needs usually requires a combination of steps, frequently including: more efficient use of energy and other resources; government policy reform; promoting private sector energy development; applying innovative and improved technologies including renewable energy technologies; and training managers and technicians to

ensure lasting results. The Office of Energy and Infrastructure actively supports all these activities.

Increasing the efficiency of energy use is the easiest and least expensive way for large power facilities to avoid building new power plants and to reduce greenhouse gas and other polluting emissions. Greater energy efficiency helps lower a nation's economic burden due to energy imports. Savings can be gained by improving consumption patterns of the end-users and by better managing and planning power conversion, transmission and distribution on the supply side. These goals can be met in part through policy reform, financial incentives, training and use of private producers.

Developing countries, collectively, will need to invest over \$100 billion/year into their power systems alone over the next two decades, just to maintain moderate growth, if they employ current energy consumption practices.

Renewable energy technologies are an increasingly important component in many nation's energy strategies and provide a major benefit towards reducing environmental impacts. They are especially helpful in reducing the relationship between energy and pollution, since most renewable technologies (wind, solar, hydroelectric, and geothermal) produce no greenhouse gases and little if any pollution. Biogas systems can provide the additional benefit of converting methane gas--a more damaging greenhouse gas than CO₂--into CO₂ and energy.

Renewable energy systems are ideal technologies to support rural development activities. Their inherent potential for small scale and modularity provide opportunities for applications that benefit rural women, their households and rural industries that are crucial for employment, income generation, and to counter demographic trends towards urban areas. In addition, most renewable systems pose little or no threat to habitat or people's land rights; all significant and prevailing issues of the day.

Renewable energy technologies are, by definition, not finite and therefore more sustainable if properly used and managed. Renewable systems provide energy from indigenous and replenishable sources. They are therefore conducive to energy independence and expansion of power supply beyond the existing grid, where many people in the developing world live and work. Rural productivity and a number of social problems generally benefit from the introduction of even small amounts of electrical power. Renewable energy technologies have recently become (and are continuing to be) more cost competitive than in prior years, making these innovations even more attractive for rural use and for integration into mixed resource energy systems. Larger renewable energy systems, including hydroelectric dams, geothermal, solar and wind farms and biomass conversion all show increasing promise in economic, social and environmental terms relative to conventional energy options.

Private sector energy production through privatization and policy reform offers a variety of environmental and economic benefits. A private owner generally will monitor resource use and operations more thoroughly than the manager of a government-run facility. Vigilant management leads to more efficient operations, higher productivity, and greater profits.

In a competitive market, where power plant operators must report to equity investors, there is no room for wasted resources. In a climate of international and increasingly outspoken local pressure for a cleaner environment, as well as a new realization of the economic costs of pollution, new equipment to abate pollution is in high demand. Public treasuries are ill prepared to make these investments. Private investors have better access to capital, can make quicker, more responsive decisions regarding all aspects of operations, and are inclined to use the latest, most competitive (and usually least polluting) technologies.

I.B. Building Bridges: Working to Engage U.S. Industry and Institutions

U.S. technology and management expertise can help reduce the problems faced by nations around the world and the global problems we cause collectively. It is in our national and global interests to promote the use of these solutions by making them more easily available where they are needed.

The Office aims to serve public and private clients in developing and emerging nations that are faced with energy and environmental management problems. One means to this end is by bringing the U.S. energy and environment industry into dialogue with potential clients and partners in A.I.D.-Assisted Countries (AACs) to discuss interests and needs.

The Office offers a creative range of opportunities for U.S. technical and business leaders in the energy and environment sector to meet with public and private sector counterparts in developing and emerging countries. Trade missions and reverse trade missions, courses, study tours and conferences all provide such opportunities. In addition the Office furnishes ever-expanding information management and dissemination services to guide seekers and providers of products and services to one another. One such information tool is the *Business Focus Series* published by the office to provide timely analyses about the energy and environment sector business climate in selected countries and regions (see box). Cooperative ventures, intended to finance and facilitate technological innovation, provide opportunities for the fusing of ideas from across oceans and the application of local knowledge about markets and business micro-climates abroad. The Office's promotion of new policy and regulations conducive to sector privatization and efficient sector management open new avenues for cooperation between the U.S. and other nations.

The Office of Energy and Infrastructure works closely with other A.I.D. Bureaus, overseas Missions, and with other U.S. government agencies to bring U.S. energy and environment businesses into direct contact with overseas counterparts and prospective clients.

Assessments and pre-feasibility studies, which are co-sponsored by the Office, are one way that desirable innovations such as renewable energy technologies are encouraged. These studies are the first steps required by a business or investment coalition to determine the viability of their plans. Studies assess the appropriateness of various technical options and the financial, environmental and social implications of these choices. With assistance from A.I.D., investment risk is reduced for selected proposals by making an expensive first step more attainable, especially to small investors.

Business Focus Series Reports

- *ASEAN Wastewater Treatment Market Assessment: Opportunities for U.S. Businesses (April 1993)*
- *ASEAN Electric Power Generation Markets: Opportunities for U.S. Companies (September 1992)*
- *Cogeneration in Argentina (December 1992)*
- *Cogeneration in Brazil (December 1992)*
- *Electric Power Generation Markets in India and Pakistan (December 1992)*
- *Energy and Environmental Market Conditions in Mexico (March 1992)*
- *Environmental Market Conditions and Business Opportunities in Key Latin American Countries (October 1992)*
- *Exporting Energy Efficiency Products to Latin America (June 1992)*
- *Private Power Business Opportunities in the Caribbean (April 1992)*
- *Private Power Business Opportunities in Central America (March 1992)*
- *Private Power Business Opportunities in South America (June 1992)*

I.C. Meeting the Concerns of Congress and the White House

The U.S. Congress clearly recognizes the linkage between energy and the environment. The legislators' concerns are expressed in the Foreign Operations, Export Financing and Related Programs Appropriations Act, 1993 (Public Law 102-391), the bill that allocates funds for all A.I.D. activities. The language addressing expenditures on energy (Section 532) is contained under the heading titled *Environment*. Energy efficiency and renewable energy technologies are major concerns of this legislation, which updates similar statements contained in bills passed in 1989 and 1991.

One of the first items discussed in this section is *Sustainable Energy Development*. The bill calls for "least-cost integrated resource plans" that include "analyses of possible end-use energy efficiency measures and nonconventional renewable energy options," in the Agency's scrutiny of U.S. contributions to multi-national development banks (MDBs). Loans and grants made through the MDBs must include plans that "reflect the quantifiable environmental costs of proposed energy developments."

"A substantial portion of loans and grants in the energy, industry, and transportation sections shall be devoted to end-use energy efficiency improvements and nonconventional renewable energy development," the bill continues. It also calls for new staff positions within each organizational unit of the MDBs, to oversee the programming and management of end-use efficiency and renewable energy.

A.I.D. offices often work closely with the MDBs to coordinate assistance and to leverage one another's support for project activities. The Office of Energy and Infrastructure's involvement with the MDBs is discussed in Chapter Two.

Another concern is implementation of the *Global Warming Initiative* mandated by earlier legislation. All A.I.D. missions and bureaus are directed to continue to implement all elements of the initiative. In drawing attention to efforts to "reduce emissions of greenhouse gases,"

(primarily CO₂), "through strategies consistent with continued economic development," Public Law 102-391 explicitly mentions 1. end-use energy efficiency, 2. least-cost energy planning, and 3. renewable energy development. The bill allocates \$55 million for activities in support of the Global Warming Initiative.

The 1993 Foreign Operations Appropriations Bill directs that "not less than \$15 million" of the appropriated Development Assistance Fund shall be made available to support replicable renewable energy projects." In addition, A.I.D. must "initiate at least five significant new activities in renewable energy during fiscal year 1993."

The Congress also explicitly addresses the Montreal Protocol, a global convention, signed by the U.S. which calls for reduction of "substances that deplete the ozone layer." The Office of Energy and Infrastructure, among others, is closely linked to this goal. "Not less than \$15 million" of Development Assistance Funds are allocated for implementing the Protocol through various agencies.

A specific \$10 million allocation is made jointly to three energy and environment programs:

- 1) the Committee on Renewable Energy Commerce and Trade (CORECT), a federal interagency working group;
- 2) the Environmental Technology Export Council; and
- 3) the International Fund for Renewable Energy Efficiency (IFREE).

The Office of Energy and Infrastructure is an active participant in the CORECT working group and a major contributor to IFREE.

In the New Independent States of the former Soviet Union (NIS), language in the bill calls for programs that emphasize "the active participation of local scientific expertise, non-governmental organizations and the public" and should focus on: "environmental monitoring and protection; establishment of appropriate environmental institutions and infrastructure; (and) programs to enhance energy conservation and efficiency." The Office of Energy and Infrastructure has a number of on-going and planned activities in the NIS related to improving efficiency (Chapter Two), training and technology improvement (Chapters Five and Six), revising energy policy and upgrading existing energy sector facilities to improve environmental performance, efficiency and safety (various chapters).

Most concerns of the lawmakers were reinforced by statements published by the President and Vice President during their bid for the White House.³ Specific goals stated by Mr. Clinton and Mr. Gore included, to:

- Increase energy efficiency and conservation;
- Increase natural gas use (relative to other fuel sources);

³ Bill Clinton and Al Gore, 1992. *Putting People First; How We Can All Change America.*

- Expand the use of renewable energy sources;
- Promote a safe, environmentally sound energy policy;
- Reduce pollution and solid waste;
- Use market forces to encourage environmental protection; and
- Exert American leadership for a healthier world.

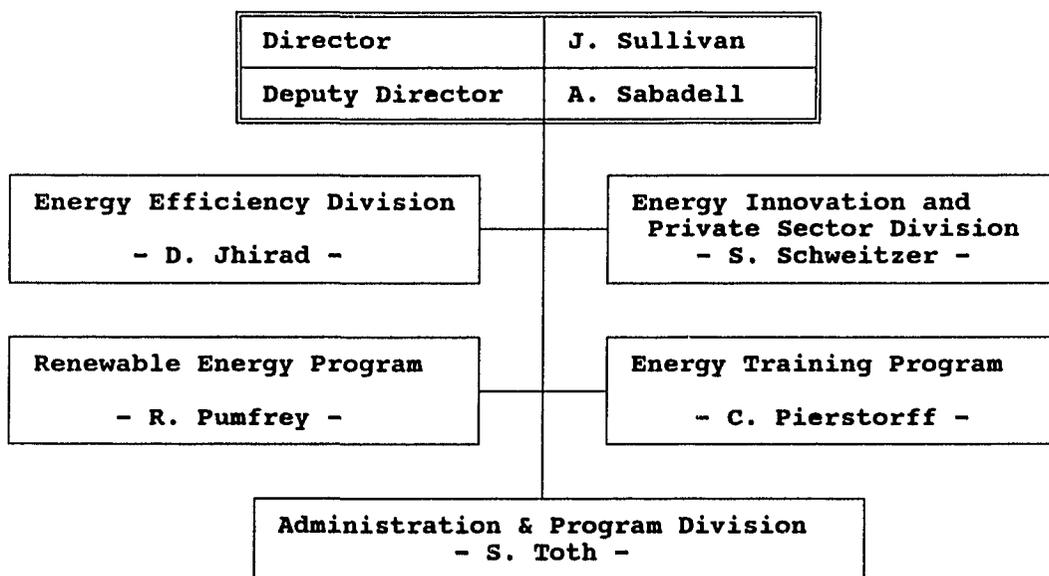
While these comments were made in the context of their domestic agenda, they reflect an approach that is consistent with the concerns of the Congress for international assistance and the nature of technology and expertise targeted for export. The Office of Energy and Infrastructure has been working towards the practical application of these goals and ideals for some time. Using its long-established networks with U.S. energy industry associations, the Office has built innovative trade promotion activities into its training and technical support programs. In recent years, the Office has incorporated environmental industries into its trade activities. Infrastructure-related training and trade activities are now being brought into the process. The consistent support for these initiatives by both the Congress and the White House can only strengthen the Office's and the Agency's ability to meet these challenges successfully.

In the following chapters of this Program Plan, the Office's ongoing and scheduled activities are presented in an easy to read format. Chapters Two and Three present the Office's work in the areas that are of primary mutual concern of the Executive and Legislative branches of U.S. government, energy efficiency and conservation, and renewable energy technologies, respectively. Chapter Four presents the Office's practical efforts to make environmentally-safe energy development a reality by encouraging private sector participation. Chapter Five shows how A.I.D.'s cooperative efforts with other government and private organizations provide opportunities, information and exposure for U.S. industry. Chapter Six portrays the Office of Energy and Infrastructure initiatives that may have the most lasting influence towards a cleaner, more stable and energy efficient world: training and institutional capacity building. The Office's training activities are designed to permeate and support all other Office projects. For the reader's convenience, however, the Office's entire training portfolio is described together in one chapter. Finally, in Chapter Seven, four Office-supported project development funds are described. Three pre-investment funds and a capitalization fund for environmental enterprises help reduce the risks that so often inhibit private investment in the improved and expanded power production systems.

In these six ways: i) improving the efficient use of energy resources; ii) promoting environmentally benign and renewable power production systems; iii) encouraging private power initiatives; iv) priming the pumps of energy sector innovation; v) strengthening institutions with technical training; and vi) stabilizing the investment environment through leveraged funding, the Office of Energy and Infrastructure makes crucial contributions to the energy and environment sectors in A.I.D.-assisted countries. As energy is essential to nearly all economic activity, these contributions are central to the processes of social and economic development at the local and national levels, and bear significantly on fate of the environment shared by us all.

Administratively, the Office of Energy and Infrastructure (R&D/EI) is based in the Agency for International Development's Research and Development Bureau (R&D). The technical offices that make up R&D traditionally function as service centers, primarily in support to the A.I.D. missions. Since its inception in 1978, the Office of Energy and Infrastructure has provided technical information, consultative expertise, and training to and through the missions and bureaus that make up the Agency. Programmatically, it offers these services through Office projects that are organized as shown below.

Office of Energy and Infrastructure Organizational Chart



CHAPTER TWO: ENERGY EFFICIENCY AND CONSERVATION

II. A. Background

As discussed in the introduction, the devastating "triple bind" facing most developing countries, constrains their economic and social development. A.I.D.'s Office of Energy and Infrastructure has designed its energy efficiency programs to address the three serious and related problems of 1) environmental degradation from energy use, 2) inadequate energy policy and institutional frameworks, and 3) insufficient capital for the investments needed to expand energy capacity.

Funding Energy Needs

To maintain even moderate economic growth with current energy consumption patterns, developing countries will need to invest over \$100 billion/year in their power systems alone. Nearly 40 percent of this will need to be in foreign exchange.¹ Governments can not afford such capital outlays. Power sector lending from traditional backers of capital development projects -- the multilateral development banks (such as the World Bank) and commercial banks -- have been cutting their power sector lending.² Other sources of private funding are hesitant to fill in the gap. Failing to make these investments will lead to much greater costs in lost economic production and in paying for costly backup power generation using inefficient and less reliable systems.

Comprehensive energy efficiency programs that focus on both energy supply operations (integrated resource planning) and the energy consumption options (demand-side management) can provide electric power services at typically 20-50 percent the cost of new power plants. These energy conservation services can also improve power supply reliability and quality.

Policy Matters

Energy policy and institutional frameworks in many developing countries are inadequate to meet rapidly growing energy needs. Government bodies and the private sector alike, often lack the technical, financial, and managerial skills needed to capitalize on the diverse opportunities offered by energy efficiency. As a result, existing energy resources are often wasted. Energy prices, particularly for electric power, are often substantially below (30 percent or more) the long-run marginal costs of production, leaving countries with little economic reason to conserve. This eventually results in inadequately financed utilities, major energy shortages, and significant losses to the national economy.

¹ A.I.D./Office of Energy and Infrastructure 1988. *Power Shortages in Developing Countries* (A Report to Congress).

² Total power sector commitments in developing countries declined from a peak of \$14 billion in 1981 to a nearly steady \$7 billion between 1983 and 1987. Most of this decline was due to reduced commitments by commercial lenders.

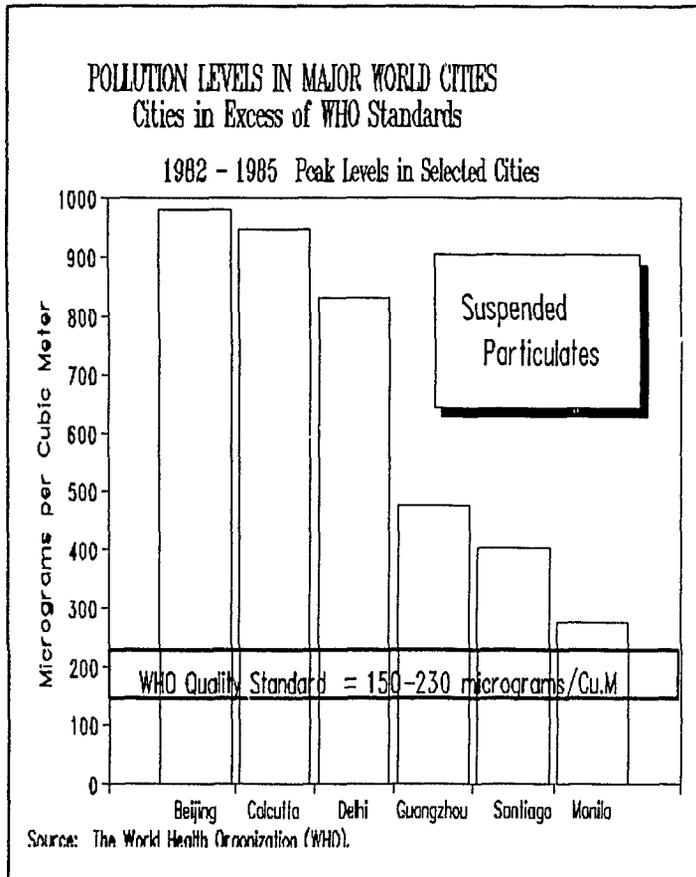


Figure 1

Cleaning Up Our Act

Serious environmental degradation resulting from energy use can be seen already in major urban and industrial centers throughout the developing world (Figures 1). Pollution of this nature is known to have direct negative impacts on the health of local populations. In addition, power plant emissions cause such regional and global problems as acid rain and global warming.

If average annual growth rates in primary energy demand of 5 to 6 percent are sustained, primary energy demand in developing countries would more than double in just 20 years, from 45 million barrels per day of oil equivalent (mbdoe) (27 percent of global consumption) in 1990 to 100 mbdoe (50 percent of world total) by 2010. Such a dramatic expansion in energy use would cause an increase in greenhouse gas emissions, especially CO₂ (Figure 2).

Most scientists agree that a continuing rise in atmospheric CO₂ will effect global temperatures. The resulting disruption to global agricultural systems on which we depend directly and to natural vegetation, which is also critical to our survival would be devastating. Thousands of years of agricultural breeding and evolutionary adaptation could suddenly become virtually irrelevant. Species extinctions would probably be massive, and survival as we now know it would be thoroughly redefined.

Even without assuming global climatic upheaval, the contribution of energy expansion to local pollution levels needs to be addressed. Global warming and industrial pollution are no longer solely problems of industrialized nations. Realizing the urgency of the global warming issue, most nations of the world signed a global convention at the 1992 United Nations Conference on Environment and Development (UNCED) summit in Brazil. This global 'legislation' is intended to reduce greenhouse gas emissions, in spite of the planet's rapidly expanding energy needs.

Congressional Mandate

As discussed in Chapter One, the 1991 Congressional mandate to A.I.D. regarding environmental impacts of power generation and use in developing countries was restated in the Fiscal Year 1993 foreign appropriations act.³ A.I.D.'s response to this mandate emphasizes

³ Public Law 102-391.

improving energy efficiency, promoting least-cost electric utility planning, and encouraging the use of renewable energy and improved technologies. The Office of Energy and Infrastructure is implementing a comprehensive program in energy efficiency to help developing countries resolve these problems. This effort involves cooperating closely with A.I.D. missions and bureaus, other U.S. government agencies, participating governments, U.S. and developing country firms, multi-lateral development banks (MDBs), and bilateral donors. The strategy and expected accomplishments are summarized in the following sections.

II. B. Strategy

The Office of Energy and Infrastructure has created a menu of planned accomplishments to mitigate energy-related greenhouse gas emissions, address sector policy and institutional reform issues, promote private sector involvement, expand U.S. trade and investment, and increase information dissemination through outreach and training. These efforts are organized under an umbrella project called the Energy Efficiency Project (EEP).

All of the Office's energy efficiency improvement activities will emphasize the following three elements:

- building institutional partnerships;
- promoting technology cooperation between U.S. and local firms; and
- leveraging major financing.

Building Institutional Partnerships

A major element of EEP will be the active collaboration with in-country institutions. Experience has shown that local capacity building is critical to sustaining development efforts after donor funding is completed. All EEP activities involving specific countries will have an institutional counterpart to assist in carrying out project objectives. These institutions will strengthen their in-house expertise and develop contacts with U.S. industry and institutions working in the field.

Promoting Technology Cooperation

The growing realization of energy efficiency needs in developing countries create increased export opportunities for U.S. technologies. Imports by developing countries of energy efficiency technology totaled \$4.2 billion in 1990, and are expected to grow by 2 to 3 percent annually.

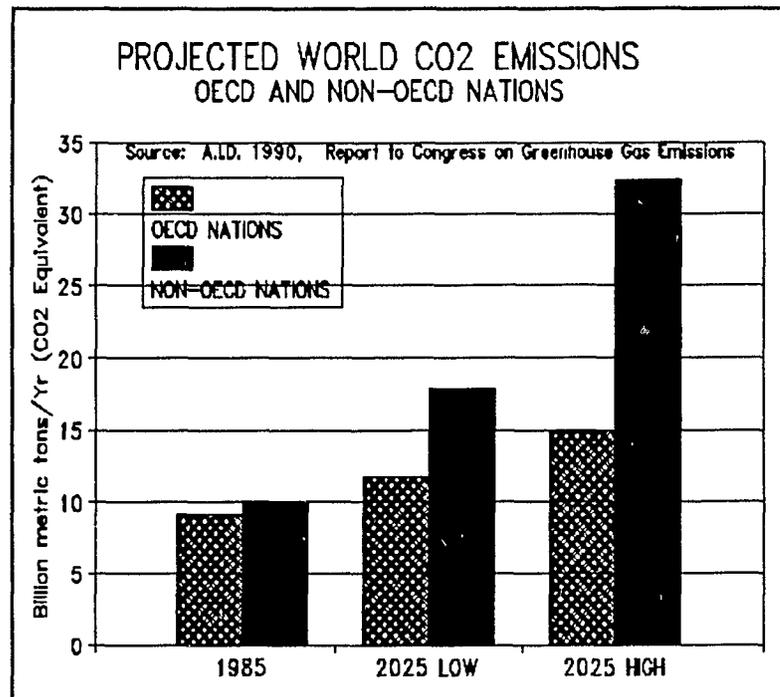


Figure 2 Although developed countries will continue to spew five to ten times more CO₂ per capita, the bulk of worldwide CO₂ emissions into the atmosphere will come from non-OECD nations.

The U.S. market share of these imports was only 10 percent in 1990, however, and is now declining.⁴ Close collaboration between developing countries and U.S. industry can help improve the competitive advantage of American firms and help increase U.S. market share in energy efficiency and environmental technologies and services.

The Office also promotes innovative, market-driven technology cooperation between U.S. and developing country organizations. The Office provides assistance to the Program for the Acceleration of Commercial Energy Research (PACER), a \$20 million collaborative initiative launched by the Government of India and the A.I.D. Mission in 1987. PACER provides funding for innovative research, development, and commercialization for energy efficiency technologies adapted to Indian needs.

Leveraging Major Financing

Many of the Office's energy efficiency activities will engage major funding institutions such as the multilateral development banks (MDBs). The Office will work to leverage financing from the MDBs by providing initial design and start-up efforts that would lead to projects funded by these institutions. It will also serve as a focal point for developing and implementing A.I.D.'s projects for the Global Environment Facility (GEF), and will continue to assist the World Bank in developing and assessing GEF energy projects that address global warming.

The Office will focus its energy efficiency efforts on the following key developing countries: Central America, Congo Basin, India, Indonesia, Mexico, the Philippines, and the NIS. Other countries will be included based on requests from the local Missions or Bureaus.

II. C. Planned Accomplishments

The Office of Energy's specific program and planned accomplishments to promote energy efficiency in developing countries are described according to the following categories:

- Global climate change
- Technology cooperation for energy and environment
 - policy and institutional development
 - private sector encouragement and trade promotion
- Sectoral energy efficiency, environmental improvement, and demand management
- Information and training services

Note that in most cases, specific accomplishments will actually encompass more than a single category. For example, nearly all efforts to improve energy efficiency will reduce greenhouse gas emissions. In these cases, the accomplishment is described in the category that is its major focus.

⁴ U.S. Department of Energy, and A.I.D./Office of Energy and Infrastructure 1991/92. *National Energy Strategy Technical Annex 5*

Global Climate Change

Reducing fossil fuel consumption through improved energy efficiency and fuel substitution is the most economically accessible and politically acceptable means for coping with the threat of global warming. CO₂, the most pervasive greenhouse gas, has increased 25 percent in the atmosphere over the last 150 years.

At the direction of Congress, A.I.D. has launched a *Global Warming Initiative*. Improving energy efficiency is a key component of this initiative. The Office of Energy and Infrastructure has developed a comprehensive program for accelerating energy efficiency projects to address global warming, from a global institution-building effort (the Global Energy Efficiency Initiative) to specific activities in key countries, such as Indonesia, and Mexico. A key to this effort is support for the Global Environment Facility (GEF), which is administered by the World Bank. The GEF will provide financial resources to developing countries to meet their "agreed full incremental costs" of complying with the Framework Convention on Climate Change for greenhouse gas reduction. In particular, a clear and systematic methodology must be developed to estimate these incremental costs.

Planned Accomplishments:

1. Develop, with the GEF, the Program for Incremental Cost Estimation (PRINCE) to help estimate the full incremental costs of complying with the global warming provisions of the Climate Change Convention.
2. Develop computerized techniques and supporting data bases for evaluating the environmental impacts (particularly greenhouse gas emissions) of conventional alternative power generation technologies.
3. Support international energy efficiency activities such as the Global Energy Efficiency Initiative (GEEI), including meetings, workshops and training.
4. Assist in UNCED follow-up activities, including the implementation of at least one Country Study of impacts and mitigation strategies for global warming in cooperation with the IPCC and other U.S. government agencies.
5. Develop, with the World Bank two energy efficiency and environment projects for the operational departments or the Global Environment Facility.

Technology Cooperation for Energy and Environment

The United States manufactures and exports some of the world's most efficient technologies, and competes in world markets to sell these technologies. The energy-efficient and environmental technologies in which the U.S. has leadership include combined cycle power plants, computer-based control systems, heat exchangers, lighting equipment, windows, refrigerators, electric motors, variable-speed drives, refrigeration and air-conditioning equipment, hazardous waste disposal, precipitators and scrubbers, waste water treatment, automotive emission controls, landfill gas utilization, and bioremediation. Further, energy service companies (ESCOs) have emerged in the U.S. ESCOs can provide similar services abroad and can transfer know-how through joint ventures.

The Office of Energy and Infrastructure cooperates with U.S. industry, other U.S. government agencies (e.g., DOE, EPA, TDA) and the multilateral development banks (MDBs) to design initiatives to increase the use of U.S. energy-efficient and environmental technologies in developing country markets. The Office is currently: identifying promising technologies; targeting key countries in which to conduct detailed market assessments; forming and providing assistance to industry working groups of U.S. manufacturers to identify and develop specific market opportunities; and assisting in project preparation at the pre-investment level.

These activities are being extended to cover ozone-depleting substances, industrial waste minimization, and power plant emission controls since these markets require application of the latest technologies and similar analytical approaches.

Planned Accomplishments

6. Conduct three country-specific market assessments and development activities for promising U.S. energy-efficient and environmental control technologies (Thailand).
7. Carry out two workshops, or exhibitions to promote exports of energy-efficient technologies and services by U.S. manufacturers and Energy Service Companies (ESCOs) (Mexico).
8. Convene seminars to explore joint private U.S./developing country ventures in technology cooperation.
9. Support the Asia Environmental Partnership in developing a strategy for targeting energy-related environmental opportunities for U.S. firms.
10. Define a policy framework and financial incentive package for private investment in power supply and demand (India) (in cooperation with PSED and ETP).
11. Provide one Resident Environment Advisor and one Resident Energy Advisor to USAID/Mexico.
12. Explore a 'Sustainable Cities' initiative, together with U.S. private sector, to develop integrated energy and environment programs for developing country 'megacities'.

Sectoral Energy Efficiency, Environmental Improvement and Demand Management

Power Sector

Many A.I.D.-assisted countries must improve the use of current and new capacity by reducing system losses 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. Transmission and distribution losses commonly 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 A.I.D.-assisted countries, the Office of Energy and Infrastructure uses three approaches:

- increasing the efficiency of power generation, transmission, and distribution
- improving management of the power load
- enhancing end-use efficiency.

Planned Accomplishments:

13. Develop a cooperative process with international lenders and developing country public and private sectors to identify, design, and implement major demand-side management/integrated resource planning and rural power programs.
14. Assist in the implementation of the EMCAT power sector program, including power and industrial sector efficiency, multilateral and local development bank loan design, and pre-investment feasibility studies (India).
15. Implement four load management and demand-side management programs (Mexico, Sri Lanka, Thailand, and Chile).

Industry Sector

Industry is a major energy efficiency target because it typically accounts for 30 to 50 percent of total commercial energy consumption in many countries. The industrial sector is also one of the main contributors of serious long-term pollution threats to human health and sustainable economic development. Technically-proven, cost-effective energy efficiency techniques and processes can save developing countries an estimated 10 to 30 percent of industrial sector energy consumption, while lowering industrial pollutant emissions significantly.

The Office will improve the policy and investment climate for private-sector activities, and enhance private sector capabilities to design, finance, and implement energy efficiency projects. The Office will continue to emphasize strengthening the linkage between energy efficiency and industrial pollution abatement, promoting private sector investment in efficiency, and building local institutional capabilities to implement energy efficiency programs on a long-term, large-scale basis.

Planned Accomplishments:

16. Cooperate with USAID/ASEAN, in implementing the Environmental Improvement Project (EIP) to assist industry in cost-saving approaches to reduce environmental emissions.
17. Develop and start implementation of a comprehensive industrial energy efficiency program (Mexico).
18. Develop an initiative to produce CFC-free Energy Efficient Refrigeration (India).

Transport Sector

Energy consumption for transportation represents over 40 percent of total oil consumption in many A.I.D.-assisted countries.⁵ Even small improvements in efficiency can produce large savings on oil import bills, freeing resources for more productive uses. Transportation efficiency has received much attention in industrialized countries, and with significant results, but the subject has received little attention from developing countries. Scant information exists on the effectiveness of various approaches to efficiency in the transportation sector of developing countries. With a small budget, this program must concentrate on cooperating with multilateral organizations such as the World Bank to leverage infrastructure development programs and on low-cost/high-payback measures.

Planned Accomplishments:

19. Convene a workshop, together with the U.S. private sector, to evaluate the potential for U.S. low-polluting options for urban transportation in developing countries.

Buildings Sector

Much of the growth in electricity demand in the developing world's largest cities is driven by the demand for air conditioning and lighting in commercial and residential buildings. The buildings sector is the fastest growing consumer of electricity in developing countries, with demand increasing by up to 20 percent per year. In most of these cities, there is a shortage of electricity to meet current and future demand, and of investment capital for additional capacity.

The most serious obstacles to improving energy efficiency in the buildings sector are the lack of: buildings energy-use data; awareness of energy efficiency benefits in buildings; knowledge about energy-efficient building design; ample energy-efficient technologies; strong financial incentives for energy-efficient design and construction; and building codes and standards that ensure energy efficiency. This program will provide developing country planners, architects, and building owners and operators with tools to remedy these shortcomings.

Planned Accomplishments:

20. Develop an innovative building-sector energy efficiency financing program, including utility DSM, ESCOs, tariff design, shared savings, etc. with a donor lender and/or the GEF.

⁵ Levine, Mark D. et al. 1991. *Energy Efficiency, Developing Nations, and Eastern Europe*.

Information and Training Services

Information and training play a major supportive role in Office projects and are crucial to ensuring that energy and environmental improvements are sustained when the project is completed and the funding is ended. The Office will focus on developing networks of power sector engineers and planners and of energy-efficient equipment and service providers. Members will include persons from key developing countries and counterparts in the U.S., including utilities and manufacturers. Actual training and study tour activities will be coordinated by the Office's Environmental Training Project (ETP), which serves all other projects in the Office with training support.

Planned Accomplishments:

21. Develop and initiate an energy efficiency information/outreach strategy, to include worldwide information dissemination, global energy efficiency program tracking, and U.S. energy-efficiency and environmental technology database components.
22. Develop and disseminate an energy end-use efficiency technology menu.
23. Develop a series of demand-side management, load research, and integrated resource planning promotion, training, and implementation materials for developing countries and conduct a DSM conference to disseminate results worldwide.
24. Develop a training program for energy-efficient building design, technologies, auditing, and operating practices.
25. Host an IRP training workshop for the IDB.
26. Develop and support a network of utility planners/engineers and equipment/service providers in developing countries and the U.S. (Mexico, India, and Indonesia).

CHAPTER THREE: RENEWABLE ENERGY FOR SUSTAINABLE DEVELOPMENT

III. A. Background

Renewable energy resources (wind, solar, hydroelectric, biomass, and geothermal) are playing an increasingly important role in providing the energy needed for development. The Office of Energy and Infrastructure has funded programs in renewable energy since the Office's inception in 1978, and in very recent years interest, demand, commercial viability, and the Office's budgetary commitments all have risen steadily.

In approving the A.I.D. budget for Fiscal Year 1993, the U.S. Congress emphasized its support for renewable energy by requiring the Agency to effectively triple its expenditures on related activities. As the fiscal year begins, the Office is being asked by various Agency Missions and regional bureaus for advice and assistance in satisfying that mandate.

The increased use of renewable energy technologies in industrialized countries and in A.I.D.-Assisted Countries (AACs) is in response to both economic and environmental stimuli. These technologies are technically proven, commercially available, and economically competitive in more and more applications each year. And in general they provide energy at significantly less environmental impact than power generated from fossil fuels.⁶

Technical advances and production-related economies of scale are continually increasing the economic competitiveness of renewable energy technologies both as contributors to centrally managed electricity grids and for off-grid applications. Hydroelectric and geothermal energy systems, for instance, have long been competitive for grid connection. Within the past two years, so-called "wind farms" have become much more attractive, and photovoltaics are now viewed as economic for very specific end-of-line applications.

Powering Rural Development

In rural areas beyond the central grids (where the majority of developing country citizens live), relatively small quantities of reliable electricity, thermal energy, and mechanical power can transform the quality of life by providing energy for water pumping and purification, irrigation, lighting, communication, refrigeration, and small-scale industry. Decentralized and stand-alone renewable energy systems can supply many of the power and energy needs of rural populations at lower economic cost than either grid extension or diesel power.

⁶ Due to the large social and environmental impacts, and high cost of large scale hydroelectric projects, the Office limits its assistance to small-scale hydroelectric proposals and requires environmental impact assessments.

Being indigenous, renewable energy resources supply power independent of world market conditions for petroleum and thereby provide a measure of energy independence for countries, communities, and individuals.

Their modularity, based on their frequently small size, also permits incremental investments in power supply to respond to growth in local demand, thereby maximizing scarce capital resources.

These two characteristics also make renewable energy technologies a popular choice for many private companies who wish to become independent power producers, selling electricity to the grid.

Constraints

Despite the inherent advantages of renewables, various factors constrain their potential to increase world power supply significantly in the near future.

First, those who would purchase or finance renewable energy systems -- including government officials, utilities, businesses, individuals, and international and local financing institutions -- are often unaware of the evolving competitiveness of renewable energy technologies.

Renewable energy technologies are significantly less harmful to the environment than conventional fossil-fueled systems. Using renewable energy resources rather than fossil fuels dramatically reduces the emissions that contribute to local air pollution, acid rain, and the potential threat of global warming.

A second factor is that although the renewable fuels themselves are generally "free" (solar and wind, for example), and the costs of running the systems over the lifetime of the equipment can be lower than competing technologies, the initial capital investment is often higher than for competing technologies. The use of agricultural residues as a fuel is an exception on both counts: the material is not entirely free, but the appropriate technologies are usually competitively priced or even cheaper than conventional power supply options.

A third constraint is that developing countries often subsidize conventional fossil fuels and electricity as a social "service." By hiding the real cost, they inadvertently stifle the incentive on the part of customers to invest in alternatives. And finally, AACs often lack local financing and infrastructure for sales, installation, and repair for individuals, communities, and small enterprises to purchase stand-alone renewable systems.

III. B. Strategy

III. B. Strategy

The purpose of the Office's renewable energy program is to promote market-based applications of renewable energy technologies. A plurality of the program budget is devoted to assisting with site-specific project development in AACs, but the Office recognizes that complementary activities help to fertilize the field. To overcome the constraints summarized in the previous section, the Office has designed a strategy that concentrates on three general areas: site-specific project development; strategic assessments and planning assistance; and market development, which includes several subcategories.

The Office of Energy and Infrastructure has two multi-year programs intended to meet the strategic objectives and promote economic uses of renewable energy:

- The Renewable Energy Applications and Training (REAT) project; and
- The Biomass Energy Systems and Technology (BEST) project.

The REAT project has a mandate to work with all renewable energy resources (solar, wind, small hydro, geothermal, and biomass). But in the late 1970s the Office perceived especially competitive and significant opportunities for particular kinds of biomass fuel (that is, sustained-yield crops and crop residues, especially as they can be used in cogeneration) and decided to instigate a program dedicated exclusively to this category, and the current incarnation is the BEST project.

The Office believes that its most useful role in renewable energy is to identify opportunities for commercially available technologies to promote sustainable development in the market context. The pre-condition of commercial viability and the fact that the Office does not have a budget sufficient to assist with actual project financing mean that collaboration with two categories of external groups -- U.S. industry and the multilateral development banks (MDBs) -- is often critical. Office interaction with U.S. industry is directly contractual. The single biggest mechanism for implementing the REAT project is an agreement with the U.S. Export Council for Renewable Energy, a consortium of trade associations. This agreement gives A.I.D. access to almost all relevant industry and facilitates efficient two-way support.

The Office has several modes for interacting with the MDBs. A formal agreement with the World Bank allows A.I.D. to provide pre-financing assessments that leverage significant investments. Other MDBs are dealt with less formally but with the same goal.

Additional perspectives are important for program implementation, and the Office also has agreements with the Winrock International Institute for Agriculture Research and Development (a consolidation of several Rockefeller-related organizations), and the Environmental Enterprises Assistance Fund (a non-profit venture capital fund).

Finally, the Office actively represents A.I.D. on the Congressionally mandated Committee on Renewable Energy Commerce and Trade (CORECT). CORECT is an inter-agency working group chaired by the Department of Energy and including the Department of Commerce, the

Export-Import Bank, the Overseas Private Investment Corporation, the Trade and Development Agency, and others. The agencies cooperate with each other and with U.S. industry in sponsoring workshops and trade missions and play institution-specific and complementary roles in applying U.S. capabilities to the needs for sustainable development in AACs.

The principal components of the Office strategy and the sub-categories of planned accomplishments are described below. The description starts with site-specific project development, that is the most important facet of the program.

III. C. Planned Accomplishments

Site-Specific Project Development and Implementation

The single most important objective of the REAT and BEST projects is to catalyze specific commercial renewable energy projects in A.I.D.-assisted countries. These real-world commercial demonstrations (in contrast to simple technical demonstrations) are intended to kick-start larger and sustainable markets.

The Office shares the costs of *pre-investment studies* for projects that have significant potential for commercial success and that can leverage the financing necessary for their development. Three pre-feasibility/feasibility study funds and one equity/debt fund receive financial contributions from the REAT project for renewable energy project support. The three pre-investment funds are the: i) International Fund for Renewable Energy and Energy Efficiency (IFREE); ii) Renewable Energy Project Support fund (REPS); and iii) Energy Project Development Fund (EPDF). REAT also supports the Environmental Enterprise Assistance Fund (EEAF), a non-profit, loan and equity project investment fund. The REPS fund also receives support from the BEST project. Chapter Seven contains further details about these funds.

The Office has supported the establishment of in-country Renewable Energy Project Support Offices (REPSOs), located in key countries and administered by local professionals. The Office has already established REPSOs in Costa Rica (which may be expanded to serve Central America) and in Indonesia. Additional countries are being considered. The purpose of the REPSOs is to provide for more intensive assistance for the development of renewable energy in the selected countries, including overseeing REPS fund applications and disbursements. As with the REPS fund, this is a joint activity of the REAT and BEST projects.

Leveraging investments by the MDBs, as stated earlier, is one of the preferred approaches of the Office. In Costa Rica in 1991 and 1992, the Office collaborated with the national utility, the World Bank's Global Environment Facility, and the Inter-American Development Bank and provided the funding for a pre-feasibility study of a wind farm. The wind turbines are proposed to be located at a site considered among the best in the world, and the project is expected to be the first commercial wind farm in Latin America.

The BEST project occasionally also reviews and funds unsolicited proposals for pre-investment studies of biomass projects outside of the REPSO network, and can perform similar studies at the special request of USAID Missions. USAID/Argentina, for example, has requested assistance in promoting efficient cogeneration in the sawmill industry in that country.

In 1990, REAT collaborated with A.I.D.'s Bureau for Private Enterprise to initiate support for EEAF, which receives a significant portion of its core support from REAT. EEAF has also garnered foundation support, has established local affiliates in Costa Rica and Indonesia, and has made initial investments in collaboration with private companies.

REAT Planned Accomplishments:

- REAT 1. Provide support through US/ECRE to IFREE for at least ten pre-feasibility studies.
- " 2. Provide support through US/ECRE for at least three in-country REPSOs (Central America, Indonesia and the Philippines) and six affiliated pre-investment studies.
- " 3. Provide support through the Office's Energy Project Development Fund for at least three feasibility studies.
- " 4. Provide continued support to the EEAF and local affiliates in at least three countries (Costa Rica, Indonesia, and a third to be determined), leading to at least six additional commercial investments.

BEST Planned Accomplishments:

- BEST 1. Provide support for biomass activities in at least three key countries through the REPSOs, sharing the costs of at least five pre-investment studies (Central America, Indonesia, and the Philippines).
- " 2. Provide support for at least two additional pre-investment studies for biomass-based power generation, outside of the REPSO network.

Market Development

Decision makers in developing countries need up-to-date, reliable data on the cost and performance of renewable energy technologies in various applications. The Office is working both with the U.S. renewable energy industry and with experienced users of renewable energy technologies in the AACs to provide this information. A combination of publications and media productions addresses the role of renewables in development and spreads information. Workshops, conferences, trade missions, and reverse trade missions (in which developing country nationals come to the U.S. to "kick the tires" of operating commercial facilities) establish dialogues among developing world users, and between U.S. industry, and counterparts in the public and private sectors of those A.I.D.-Assisted Countries.

Periodic publications and international networks are useful information exchange tools. The REAT project feeds information into established periodicals and will attempt to formalize some networks including those in AACs during 1993. The BEST project provides information on developing world experiences to a U.S.-based biomass journal, works with the Biomass Users Network (BUN, a private developing-country organization) on preparing and disseminating case studies. In 1993 BEST will formalize an international network of persons interested in cogeneration using sugarcane residues.

Beginning with FY 91 funds, the REAT project initiated support for an innovative information exchange program, utilizing a low-orbit satellite, called VITASAT, organized by Volunteers in Technical Assistance (VITA). Using low-cost computer-based ground stations, VITASAT provides a link between projects in developing countries and centers of expertise in the U.S., including renewable energy projects. Through VITASAT, a U.S. firm will be able to monitor and control the first installation of small hybrid generation facilities (combination diesel-renewable energy) in remote island villages in Indonesia.

Publications and workshops receive regular support. The REAT project recently funded the preparation and wide dissemination of videos on wind energy and on rural electrification with photovoltaics. The BEST project will prepare a video on biomass in 1993. Printed materials on such technologies are periodically updated and distributed. One example is the BEST project's *Bioenergy Systems Reports*, which publicize program results and educate the policy and financial community on biomass energy investment options. REAT supports an annual symposium for AAC decision-makers organized by the American Wind Energy Association.

In 1992, BEST initiated an exchange program between U.S. and AAC utilities aimed at increasing the understanding of all participants regarding the technical and economic aspects of integrating renewable energy sources into existing utility systems. Such technical cooperation will serve to reduce the perceived risks inherent to innovative undertakings.

The Office plans to increase its support for its renewable energy training courses in 1993 and 1994. Trainers come from private industry and selected non-profit or publicly funded centers. In 1993 EEAF will present the first in-country course (in Indonesia) on entrepreneurial skills for small entrepreneurs interested in environmentally proactive goods and services. A local business school will run the course.

In order for U.S. capabilities to be brought to bear appropriately in AACs, current information on the developing countries -- energy use profiles, institutional information, and local energy-related costs and prices -- must be available for U.S. industry. The Office will increase its funding for such data collection in 1993.

BEST has selectively funded applied research, in recent years, that was intended to innovatively adapt existing technologies so as to fundamentally affect energy markets for agricultural residues in AACs. Two successes stand out. First, the project pioneered the development of advanced biomass gasification systems to fuel gas turbines. This will permit highly efficient generation of electric power at an acceptable cost in developing countries. In 1992, the Global Environment Facility (GEF) approved a project in Brazil that will serve as the first commercial demonstration. The second example is the nurturing of support from national utilities, multilateral financial institutions, and the sugar industry for year-round power generation and electricity sales based on the combined use of field and process residues from sugar cane.

In 1993 and 1994, the Office expects to support a form of biomass market development. Due to global climate change concerns, industrialized countries have recently begun looking for low-cost ways to reduce or offset CO₂ emissions resulting from burning fossil fuels. One evolving approach is for U.S. utilities to invest in tropical reforestation or similar action that would sequester carbon, to balance their carbon emissions in the U.S. A potential hurdle is that the

carbon sequestering effect of these projects may be difficult to verify. The BEST project has begun to consider how to monitor such projects in a scientifically defensible way, so as to enable parties to validate their anticipated benefits objectively.

REAT Planned Accomplishments:

- REAT 5. Prepare printed materials or videos that provide technical and economic information to developing countries, as well as to USAID Missions.
- " 6. Provide support for selected workshops, conferences, and trade missions that will bring together U.S. industry, development professionals, and developing country decision-makers.
- " 7. Provide continued support for the VITASAT low-orbit satellite program as a means of information exchange for renewable energy projects located in remote areas (Indonesia).
- " 8. Develop a database of developing-country energy sector characteristics and trade and investment information.
- " 9. In collaboration with the BEST project, initiate a newsletter aimed at developing countries and U.S. industry.
- " 10. Cooperate with U.S. industry and other federal agencies in establishing a Renewable Energy Training Institute.
- " 11. Conduct at least one training workshop in an AAC for environmental entrepreneurs (Indonesia).

BEST Planned Accomplishments:

- BEST 3. In collaboration with the REAT project, initiate a newsletter aimed at developing countries and U.S. industry.
- " 4. Establish and support a network of developing country decision makers to exchange information on cogeneration from sugarcane residues.
- " 5. Prepare a video on biomass energy and distribute worldwide.
- " 6. Publish two Bioenergy System Reports, one on wood energy in the context of sustainable forest management and a second on intensive silviculture energy plantations.
- " 7. Support the Biomass Users Network in funding and disseminating case studies of commercial biomass projects.

- " 8. Develop a standard methodology for monitoring and validating the performance of carbon sequestration projects involving closed-loop biomass energy systems.

Strategic Assessments, Planning Assistance, and Program Design

Generic technical and financial information about technologies, or even specific information about how technologies have fared in selected locations, is not always sufficient for decision-makers in countries where such technologies are new. Two additional categories of information can be critical in order to stimulate action in both the public and private sector:

- (1) What are the contributions that particular renewable energy resources can make in a given country?
- (2) How can technologies using those resources be integrated into the plans of the power sub-sector in a specific country (this include a number of institutional issues)?

The Office expects that in 1993 several USAID Missions will request assistance in answering such questions so that those Missions can design their own programs in renewable energy. The Office is prepared to use all the mechanisms at its disposal to provide such assistance.

An excellent example of what A.I.D. can do to leverage major activities, and which includes issues in both the categories of question raised above, is occurring in Indonesia. The World Bank is planning a \$500 million loan for rural electrification in that country, and both the Bank and the Indonesians would like to include decentralized renewable energy technologies among the options pursued in bringing electricity services to people on the many islands of eastern Indonesia. The program designers need information about available resources -- especially biomass, wind, and small hydro (solar insolation is more easily established and already used on a pilot basis) and the local costs for exploiting those resources. They also need information about the institutional mechanisms that can be used to deliver electricity -- sales and leases of generation technologies for households versus villages, mini-grids, the use of cooperatives, etc. The Office of Energy and Infrastructure (through both the REAT and BEST projects) is supporting analysis of these issues, as is the U.S. Department of Energy.

As more and more countries have begun opening up their power sub-sectors to private sector participation in generation, the potential contribution of biomass residues is often an early question. In order to catalyze activity, the BEST project can perform a nation-wide assessment that demonstrates how significant the contribution of crop residues can be. The specific industries examined have most often been sugarcane production, rice production, and the wood products industry. The BEST project has also provided assistance to local utilities in examining institutional options for those industries' access to the national grid. In 1992 the project investigated these questions with regard to the sugar industry in two of India's states.

In 1992 the BEST project also initiated a program of exchanges between U.S. and AAC utilities. During the past dozen years some U.S. utilities have begun to purchase large amounts of electricity from private sector generators who use renewable resources, with biomass being the most significant category. Those utilities have had to deal with a myriad of institutional issues that AAC utilities also face.

REAT Planned Accomplishments:

- REAT 12. Provide assistance to USAID Missions in designing renewable energy programs.
- " 13. Support the World Bank in incorporating renewable energy technologies into energy sector loans in selected countries (Indonesia, Mexico).
- " 14. Support U.S. industry in working with energy ministries, utilities, and the private sector in selected countries or regions for the purpose of developing renewable energy strategies (Central America).

BEST Planned Accomplishments:

- BEST 9. Conduct an assessment of the contributions that the sugar industry could make to the national power systems in at least two countries based on cogeneration using crop residues (Mexico, Honduras).
- " 10. Facilitate exchanges between U.S. and AAC utilities on important issues regarding decentralized electricity generation using renewable energy.

CHAPTER FOUR: PRIVATE SECTOR PARTICIPATION IN THE ELECTRIC POWER SECTOR

IV.A. Background

Electric power sectors in developing countries have traditionally been structured under the direct supervision of governments, and financed by budgetary resources or sovereign borrowing. However in recent years several factors have forced governments to reassess traditional electric power development strategies. These factors include:

- severe budgetary crises;
- the reduced sovereign borrowing capacity of many developing countries;
- the increasingly rapid shift towards privatization;
- efficient operation and maintenance to be gained through the private sector;
- the need for environmentally sound power development; and
- the need to compete effectively in the global marketplace.

The lack of sufficient power has become a growing obstacle to achieving sustained economic growth.

A key element in A.I.D.'s ultimate goal of a world in which environmental improvement, economic growth and, development are self-sustaining is to improve the electric power sector of developing countries.

Electric power development is a highly capital-intensive activity. The lack of public investment funds in developing countries, frequently combined with general inefficiencies of government-owned or controlled utilities are largely responsible for the electric power deficiencies that are so common in the developing world. Recently, serious financial and operating problems of government owned or controlled utilities have become evident, such as the lack of cost-based pricing, over-staffing and nepotism, cost overruns, political interference, inadequate environmental protection, and poor operation and maintenance practices. These, together with the debt problems of many developing countries, make financing their rapidly growing power needs over the next decade extremely challenging.

As many countries address this problem they have turned increasingly to the private sector for assistance. The experience of U.S. electric power developers, honed by a competitive private market, is a valuable resource for developing countries. In addition, the short-term generating capacity requirements provide an opportunity for U.S. developers and suppliers to use their

experience to capture a large segment of a new, capital intensive market. It has been estimated that between now and the year 2000 the power equipment market **alone** represents a potential opportunity of \$1,200-1,300 billion. Facility ownership, finance, operations, maintenance and environmental protection represent additional opportunities for U.S. suppliers.

IV.B. Strategy

Providing Overseas Support

Although the burgeoning demand for electric power in the developing world offers significant business opportunities for U.S. private power developers, few private projects have actually been built. The principal impediment to project development has not been a lack of interest by U.S. project developers. On the contrary, many prospective developers actively seek to develop and implement private power projects in AACs. A significant constraint to private sector partnerships in AACs continues to be the level of technical skill and experience with the contractual requirements of international financial institutions and the needs of private power developers on the part of host-government officials. As a result, these officials are often unable or unwilling to negotiate project proposals from U.S. developers. This delays and inhibits the development and implementation of projects and results in excessive development costs, and few project development successes for private power developers.

The Office aims to bolster AAC decision makers' project assessment skills and knowledge of the private power landscape, so as to enhance the ability of these officials to analyze and evaluate proposals from private power developers. In addition, the Office offers technical guidance to these countries on proposal formulation, contract development, policy reform, regulatory design, and institutional development -- the essential building blocks necessary to foster successful private power development.

With these building blocks in place, governments of AACs will be better able to make astute and prudent decisions concerning private power development. Improved decision making will help assisted countries to maximize their benefits from negotiated partnerships, while preserving the financial and market incentives that provide private power developers with a fair return on their investment.

Educational Activities

All training, internships, and study tours are coordinated by the Office's Energy Training Project. These activities are described further in Chapter Six.

Study tours to the U.S. familiarize developing country officials with the strategies and techniques of private sector energy development while establishing a dialogue with U.S. industry counterparts. The Office recruits industry executives and other specialists who are in a position to play a significant role in implementing viable private enterprise projects and activities to participate as study tour hosts. A valuable complement to study tours in the U.S. is the exposure of developing country officials to experiences in other developing countries with similar characteristics which have overcome similar difficulties.

Training and internships are conducted to build institutional capacity, the local skills base, and to promote greater understanding of private sector energy development. Programs employ an interdisciplinary effort encompassing policy, institutional, legal, financial, economic, environmental and technical instruments. The Office has identified and developed four critical points which will serve as central training modules:

- Private Sector Electric Power Policy and Institutional Issues
- Strategies and Techniques for Project Finance
- Creating, Attracting, and Developing Private Investment Opportunities
- Environmental Protection/Enhancement.

Serving U.S. Industry

In industrialized countries, qualitative information about the developing world is scarce. There is great need to foster understanding and awareness of the operative trends in developing countries among business leaders. Firms in the U.S. and other industrialized nations are quickly becoming aware of the commercial opportunities opening to them overseas as a result of global development of the private energy sector. Most firms do not know where or how to begin working in international markets however.

To improve this situation, the Office conducts **seminars** and **disseminates information** on business opportunities to U.S. suppliers, contractors, operators, investors, and financiers through a variety of channels. The Office also organizes and conducts **workshops** designed to address the practical aspects of electric power project development and privatization in developing countries. These workshops aim to assist U.S. firms seeking to become involved in developing country electric power ventures. Some of the issues covered in these forums are policy and institutional issues, deal structuring, financial architecture, security packages, risk identification and allocation, and environmental protection.

Risk reduction is another major feature of the strategy. This is accomplished by co-financing preinvestment studies. The "Private Sector window" of the Office's **Energy Project Development Fund** (see Chapter Seven) complements the work of other bilateral and multilateral institutions and private organizations. The Feasibility Study Fund shares with private sector companies the cost of pre-feasibility and feasibility studies and other development activities for qualified electric power projects. Awareness about the fund is promoted throughout the electric power community to identify and foster qualified projects development efforts. Projects funding is based on the technical and commercial merits of the proposed project, its environmental sensitivity, and its probability for successful implementation.

The Office also gathers information for its **Private Power Database** which contains information on private electric power activities in developing countries. In addition, this resource includes information on project opportunities, pertinent laws and regulations for selected countries, and listings of U.S. vendors of power and cogeneration technologies. Information is available to the public upon request.

The quarterly newsletter, **Private Power Reporter** (PPR), is instrumental in keeping the public-at-large, and the electric power community in particular, informed on the status of privatization and

private sector involvement in the developing countries. The PPR has a circulation of over 4000, approximately 40% of which are mailed to developing country governments and private sector subscribers.

Finally, the Office of Energy and Infrastructure coordinates its activities with A.I.D. Missions and regional bureaus, and other U.S. government agencies including the Overseas Private Investment Corporation (OPIC), the Export-Import Bank, the Departments of Energy and Commerce, and the Trade and Development Agency (TDA). In addition, the Office works closely with other bilateral donors, multilateral development banks, and the private sector.

IV.C. Planned Accomplishments

Assist in Defining and Implementing Private Enterprise Involvement

The Office of Energy and Infrastructure lends assistance to governments, utilities, and A.I.D. Missions and bureaus in defining and implementing private enterprise involvement in the electric power sector through country assessments, workshops, conferences, technical assistance, study tours, and training.

Planned Accomplishments:

1. Provide AAC governments with technical assistance to induce policy reform, institutional development, and infrastructure enhancement and to facilitate the development of private electric power (Dominican Republic, India, Panama, Indonesia, Russia, Armenia, Ukraine, and Kazakhstan);
2. Conduct country assessments to determine the particular legal, economic, institutional, and political conditions that will impact on private enterprise involvement in the electric power sector (Panama, India, Russia, and the Dominican Republic);
3. Organize and conduct conferences or workshops on private electric power (Argentina, Uruguay, Russia, and a regional workshop in the Middle East);
4. Conduct study tours in the U.S. for energy and finance officials from developing and emerging countries (Colombia, India, Thailand, Russia, the Ukraine, and Kazakhstan);
5. Develop and conduct, in cooperation with the Energy Training Program, a training program for senior and mid-level management from developing and emerging countries (Russia, the Ukraine, Indonesia, India, and the Philippines).

Provide Resources to Foster Project Development Efforts Relating to Private Electric Power

Part of the Office of Energy and Infrastructure's assistance to developing country governments and utilities is the identification of projects and activities suitable for private enterprise involvement. Once these opportunities are identified they must be defined and structured in such a way that the developing country's interests are protected. At the same time, the project must remain attractive to the U.S. and host country's private sector concerns about viable implementation, operation and profitability.

Planned Accomplishments:

6. Promote and administer the Energy Project Development Fund to attract qualified U.S. companies that are capable of developing environmentally sound infrastructural projects.
7. Organize and conduct four (4) workshops, (two in the U.S. and two abroad) directed at U.S. electric power developers, investors, and financiers on the practical aspects and opportunities associated with project development and privatization in developing countries.

Information Gathering and Dissemination

The Office maintains the Private Power Database to include information on private electric power activities in developing countries, project opportunities, pertinent laws and regulations for selected countries, and listings of U.S. vendors of power and cogeneration technologies. This information is disseminated through the quarterly newsletter, Private Power Reporter.

Planned Accomplishments:

8. Further develop and maintain an enhanced Private Power Data Base focused on private electric power and environmental enhancement opportunities for U.S. developers and suppliers;
9. Develop a program brochure and a monthly information package which will inform A.I.D. Missions and Bureaus of the private electric power, infrastructure and environmental protection activities of the Office;
10. Edit, publish and expand the circulation of the *Private Power Reporter*, and develop a "Tool Box" feature where project developers, financiers, suppliers and others might locate the information resources necessary to the development of projects and the formation of project groups.

CHAPTER FIVE: CREATIVE SOLUTIONS THROUGH INNOVATIVE ENERGY TECHNOLOGY

V. A. Background

As stated throughout this document, currently accessible energy supplies and facilities in developing countries, operating under present management regimes and growth trends, will be hard pressed to meet the electric energy needs of industry and the population in coming years. The main constraints to improving the situation are insufficient investment capital, poor maintenance and management of existing facilities, inappropriate policy frameworks and a diminishing ability of the environment to absorb the impacts of an expanding energy sector under the burden of available energy technologies. The likely scenario in many A.I.D.-Assisted Countries is further economic and environmental decline, unless decisive action is taken.

We have seen that the solution must rely on increasing energy supplies tempered by reduced energy demand through improved efficiency of supply, distribution, and consumption patterns. Success requires a combined approach involving policy reform, intense capitalization through cooperative financing and privatization, and perhaps most significantly, the application of new environmentally benign and energy efficient technologies.

Frequently exacerbating the energy dilemma of many developing countries is their reliance on imported energy, particularly oil. Energy imports, especially oil, are vulnerable to supply interruptions, unstable prices, and competing uses of limited hard currency.

Development of indigenous energy resources offers a cost-effective way to reduce the adverse economic growth consequences of excessive dependence on imported energy.

A variety of energy types benefit from the application of innovative technology. The Office of Energy and Infrastructure promotes the improvement of energy resources such as biomass, oil shale, low grade coal, and solid waste products, among others. Many of these were not considered productive or cost-effective enough to be developed until recent technical advances made them viable alternatives. The latter energy resources can result in conversion of environmental problems into energy assets.

Energy sector problems in the New Independent States (NIS) are generally similar in nature (though not in scale) to the developing countries in which A.I.D. has traditionally worked. Energy

shortages and severe environmental degradation are prevalent in all NIS republics. Russian oil production, a key hard currency source, is declining precipitously. Natural gas production is static. In some Republics, such as Ukraine, Armenia, and Kyrgyzstan, severe oil shortages are occurring due to Russia's declining oil production, and hard currency payment demands. Currently, A.I.D. is providing technical energy sector cooperation in six former Soviet states: Russia, Ukraine, Belarus, Kazakhstan, Kyrgyzstan, and Armenia.

Because of the comparatively high energy production and consumption levels achieved by the former Soviet Union, the magnitude of energy sector problems (particularly the extent of environmental degradation) is significantly greater than in most current A.I.D.-Assisted Countries.

In response to the oil price shocks during the 1970s, the 1980s have seen the emergence of a number of new energy production, conversion, transmission, and distribution technologies that are more cost effective, more efficient, and less damaging to the environment than previous technologies. Industrialized countries are applying these innovative and cleaner energy technologies to sustain economic growth and to protect the environment. These new technologies, either directly or with modifications to suit local conditions, can be equally beneficial for developing countries and the New Independent States. In addition to being cost-effective and more environmentally sound, innovative energy technologies offer many developing countries opportunities to use previously undeveloped indigenous fossil fuel and renewable energy resources and to expand current fossil fuel utilization without additional environmental degradation.

V. B. Strategy

Cost-effective solutions to energy supply problems, import dependency, and environmental degradation in A.I.D.-Assisted Countries requires bold action. The Office of Energy and Infrastructure has planned to pursue the following goals.

- Increased application of innovative energy technologies that are both more efficient and environmentally benign than conventional energy technologies.
- Increased application of environmental clean-up technologies at existing energy production and consumption facilities.
- Improved performance from existing energy facilities.
- Improved management of both parastatal and private energy utilities.

To effectively transfer innovative, cleaner energy technologies to A.I.D.-assisted countries, the Office created the Energy Technology Innovation Project (ETIP). This project, working in cooperation with other Office projects and A.I.D. Missions: performs **country assessments** on the economic potential for energy technologies; promotes **in-country demonstrations** of appropriate, commercial, cleaner energy technologies; hosts **workshops** and **seminars** on selected technologies; and, plans and manages **trade and reverse trade missions**.

A critical component in successful mitigation of pollution from energy production and consumption facilities is the collection of better information about emission levels and the economics of controlling this pollution. In most developing countries and the NIS, emission level estimates are usually extrapolated from industrialized country data. Generally, these estimates are not suitable for decision-making and regulating industry in A.I.D.-assisted countries. To plan more efficient energy use and undertake more rigorous pollution control programs, A.I.D.-assisted countries need to improve existing data collecting and analyzing systems.

In many AACs, it is more cost-effective and requires less capital to improve the efficiency, availability, and useful life of existing energy facilities than to build new structures. Since the performance of energy facilities in many AACs is poor relative to their potential, there is ample opportunity to improve performance of existing facilities by providing better monitoring and analysis. The resulting refinements will improve managers' abilities to operate the facilities more efficiently and with less pollution output.

The Office's programs for improving energy efficiency and power availability provide support in a number of technical areas, including:

- rehabilitation of energy facilities;
- cogeneration;
- advanced power cycle repowering;
- efficiency improvement through state-of-the-art instrumentation and control applications;
- application of plant component condition diagnostics; and
- fuel quality improvements.

Spotlight on Innovative Technologies

In response to public concern and legislation regarding energy sector impacts to the environment, U.S. utilities have developed a number of innovative technologies to reduce polluting emissions. These approaches have included:

- Upgrading fuel prior to combustion;
- Cleaner, more efficient combustion techniques; and
- Scrubbing pollution from effluent gas.

With pressure growing in A.I.D.-Assisted Countries to protect the environment, and rising costs and demand associated with energy resources, the technologies developed over the past two decades in the U.S. are now needed in developing and emerging countries.

Technologies receiving significant attention these days include:

Integrated Gasification Combined Cycle (IGCC) - Due to improved electricity conversion efficiency (45-50%) compared to coal fired plants with scrubbers (30%), this gas and steam power generating system is cost competitive with conventional coal technologies according to a feasibility study conducted in India with Office support.

Fluidized Bed Combustion - Coal and low grade (previously unusable) fuels, such as oil shale, can be burned more cleanly and efficiently at lower temperatures in combination with limestone (to reduce SO₂ emissions) in a hot bed, fluidized by upflowing air.

Flue Gas Cleanup - A number of existing and evolving processes can reduce SO₂ and NO_x emissions by chemically reacting these pollutants into easily handled, less toxic, and often useful compounds. SO₂ can be reduced by as much as 90% with high reduction of NO_x as well. Resulting marketable products help lower operating costs and improve overall efficiency.

The Office provides A.I.D.-assisted countries with technical assistance for specifying and setting up computer based information systems, demonstrating information management applications, and transferring management systems and analytical techniques developed in industrialized countries.

V. C. Planned Accomplishments

Through a combined approach incorporating technical assistance, training, and introduction of innovative technologies -- including both, modern equipment and management techniques -- the Office plans to upgrade the target countries' abilities to meet energy and related environmental challenges.

Specifically, efforts are aimed towards:

- increasing the use of cleaner energy production technologies;
- reducing environmental impact as a result of energy production through development of better information resources and more efficient operation of facilities; and
- improving 'availability' (full operation) of existing power production facilities.

Innovative Applications of Cleaner Energy Technology

Many innovative and environmentally improved energy technologies have been developed primarily for use in new energy facilities such as power plants, industrial heat plants, central heat and cooling plants, and oil refineries. These technologies are also attractive for repowering and expanding existing power plants and the replacement or expansion of existing energy, processing, transmission, and distribution facilities. The latter application is a frequent strategy in developing countries because of the substantial capital savings.

Planned Accomplishments:

1. Initiate 'clean' coal technology demonstrations (Thailand and Kazakhstan);
2. Initiate prefeasibility assessments of proposals to upgrade low-rank coal (Indonesia or Kyrgyzstan);
3. Provide technical support for Integrated Gasification and Combined Cycle (IGCC) demonstration (India); and
4. Conduct oil and gas fuel production assessments in the NIS (Russia and Kazakhstan).

The Office of Energy and Infrastructure strengthens management and operations capabilities by working directly with energy and environmental personnel to demonstrate sound management techniques.

Technology Applications to Enhance the Environment

Recognizing the need for comprehensive and accurate information about hazardous emissions, the Office will lead a multilateral initiative to provide developing countries with the data and funding required to implement national-scope monitoring systems. To address the need for better understanding of the economics associated with controlling emissions, projects will be undertaken that quantify the potential reduction of emissions and the costs of installing improved technologies that can bring about emission improvements. The primary technologies in this category are 'clean' coal technology and increased use of natural gas energy systems. These efforts will be applied in specific A.I.D.-assisted countries that are key contributors to greenhouse gas emissions. Clean coal technology and natural gas are the main supply side options available to most countries for reducing emissions from electricity generation that contribute to global warming and acid rain. Where local resources are adequate, geothermal technology will also be considered.

Planned Accomplishments:

5. Undertake technology transfer activities in the NIS to improve natural gas distribution and storage (Armenia, Kazakhstan, and Russia); and
6. Plan and install an atmospheric emissions monitoring system using multilateral financing mechanisms. Assess technology options for reducing global warming emissions (Thailand).

Power Efficiency and Availability Improvement

The Office develops and supports projects that involve rehabilitation of energy facilities, cogeneration, advanced power cycle repowering, efficiency improvement through state-of-the-art instrumentation and control applications, plant component diagnostics, and improvements in fuel quality.

Planned Accomplishments:

7. Demonstrate power plant performance enhancement in ASEAN countries (Philippines, Indonesia, and Thailand).

Energy Management and Operations Improvement

The Office strives to strengthen management and operations by working directly with energy and environmental professionals to demonstrate sound energy management and operations techniques. This includes development of the planning organization and tools to tap international financial markets and obtain finance from multilateral lenders.

Planned Accomplishments:

8. Provide energy planning support to selected Republics (Kazakhstan and Kyrgyzstan); and
9. Assist power loan and management support (Armenia).

Feasibility Studies Fund

Complementing the Office's direct funding of energy technology innovation activities is "public sector window" of the Energy Project Development Fund (EPDF). Public sector projects employing any of the following technologies may be eligible for partial pre-investment study funding through this mechanism.

- Advanced electric power generation
- Advanced energy transmission and distribution
- Energy related environmental control technologies
- Clean coal technologies
- Energy conversion

The reader is referred to Chapter Seven for details about this fund.

Planned Accomplishments:

10. Provide funds for three (3) feasibility or prefeasibility studies by public sector energy concerns to determine the viability of proposed energy development projects.

CHAPTER SIX: TRAINING ENERGY MANAGERS, POLICY MAKERS AND TECHNICIANS WORLDWIDE

VI. A. Background

Capacity building is key to attaining durable improvements to a country's energy and environment situation. Personnel advancement through training is central to nearly all institutional development activities. Helping a nation to buy new technology, modify policies, and upgrade or build new facilities is only cost effective and viable if technicians and leaders possess the skills to:

- manage and maintain energy resources efficiently;
- make the best policy and technology decisions;
- conserve energy resources, protect the environment and people's health; and
- effectively operate private energy enterprises and related institutions.

The energy and environment problems of AACs -- anticipated power shortfalls, limited energy resource options in some regions, pollution and climate threats caused by energy production, financial challenges arising from growing energy needs, and the management and policy deficiencies inherent in existing institutions -- have been thoroughly covered in earlier chapters. For each of these issues and each of the Office's prescriptive initiatives, there is a complimentary role for training programs, to ensure viable local capacity to support these activities. The Office of Energy and Infrastructure's training programs are designed to impart the types of skills listed above to AAC professionals in conjunction with each of the projects and activities described in Chapters Two through Five.

Specifically, the Office sponsors customized formal classroom training, hands-on learning opportunities, internships and professional study tours. Each of these vehicles provides interaction between participants and U.S. industry. Usually, two or more modes of training are combined to enhance cost-effectiveness and to encourage broader exposure to the U.S private sector, its management style and available technologies.

The United States has much to offer developing countries in assisting them to make difficult energy policy and management decisions. U.S. engineers, planners, economists, and managers have accrued a substantial knowledge base appropriate to these decisions. Sharing this knowledge leads to new ties between the U.S. private sector and the energy

The combination of U.S. leadership in technology and resource management, and the new relationships developed through A.I.D.'s training programs, can create a significant competitive advantage for U.S. exports in the global market.

planners, policy makers, and technicians in AACs. This interchange opens doors for future trade opportunities.

In their efforts to institute greater energy efficiency and other energy sector improvements, some nations are beginning to transfer public electric utilities and other energy enterprises into private hands. Not surprisingly, they are turning to the United States for the consultative services, technical training, and modern equipment that will ensure the success of their ventures into private enterprise.

Recognizing the potential contribution they can make in the developing country energy sector, a broad cross-section of U.S. energy companies are beginning to explore opportunities for technology and management cooperation in the developing country energy sector for the first time. To the detriment of both the developing countries and the U.S. energy sector, however, a lack of information on potential markets coupled with the high cost and risk of marketing in developing countries has prevented U.S. companies from aggressively seeking new opportunities in the emerging developing country market.

VI. B. Strategy

The most pressing need of the developing nations is for technically skilled personnel in all phases of energy exploration, production, operations, maintenance, distribution, and management, especially as they apply new technologies to address environmental and energy conservation goals. In other words, a systematic Human Resource Development strategy is needed, that combines technical and managerial skills in the energy sector with skills in environmental management and protection.

With this in mind, the Office's training strategy is two-pronged, relying on:

- 1) formal courses and internships targeted to particular technical, managerial and policy training needs; and
- 2) informal study tours organized to bring AAC decision-makers in contact with appropriate U.S. manufacturers, energy utilities and service providers.

Although there is overlap in the types of lessons gained through each approach, basically, the first avenue is targeted towards the transfer of knowledge about technique -- be it management, plant operations and maintenance, environmental protection or design engineering -- while the second thrust is aimed at increasing awareness of available technologies and services on the market and of U.S. 'style' of operating in the energy sector.

An important subsidiary benefit of these training programs is the establishment of close working relationships between the AAC professionals and their training institutions. These ties have often led to business opportunities for the American organizations that provided the training. Alumni often have successfully advocated the purchase of their trainer's equipment or services upon returning to their home countries.

An additional benefit of the Office's training programs, that is often overlooked, is their impact on women and citizens of countries in which the Office of Energy and Infrastructure is otherwise not very active. Women are generally not well represented in the upper echelons of industry and government. The Office's training courses are one way for the Office to reach across gender barriers and build bridges with nations that do not have any other Office presence.

VI. B. 1) Formal Training Programs

The Office of Energy and Infrastructure has developed a formal training strategy with the objective of promoting energy efficiency, protecting the environment while conducting energy operations, encouraging the efficient use of renewable-energy sources; and support efforts toward privatization and free-market operation within energy industries.

The five key approaches used to obtain these objectives are:

- Scheduled, U.S.-Based Training Courses
- In-Country Workshops on Management Training Programs (MTPs)
- Internships
- Training Needs Assessments
- Cooperative Activities within the Office and with other government agencies

Scheduled, U.S.-Based Courses

A main element of this portion of the Office's training activities are short-term, U.S.-based training courses for practicing professionals in energy efficiency, environmental protection, renewable energy, privatization, and related topics. The expectation is that the new skills will be incorporated into long-term institutional capability.

Complementing the major components of all other Office of Energy and Infrastructure programs, these courses are offered by U.S. training cooperators including electric utilities, national laboratories, and private-sector engineering and consulting firms.

VI. B. 2) Study Tours - New Opportunities for U.S. Industry

The Office of Energy and Infrastructure has developed the Energy Study Tour Program, in cooperation with the United States Energy Association, to provide a mechanism to cooperate with industry and facilitate communication between U.S. and developing country officials. The primary purpose of the program is to broaden the technical and managerial abilities of senior-level professionals involved in energy planning, production and utilization in developing countries through exposure to advanced U.S. technology and management practices. The Office encourages top U.S. industry executives and technicians to contribute time from their schedules during study tours, since the businesses also benefit directly from the new international contacts.

Study tours may be technical in nature, such as a two week visit to study the application of a specific electric power generation technology, or may be policy-oriented and focus on regulatory, pricing, environmental or financing issues. During the past fiscal year the Energy Study Tour Program has conducted study tours for energy officials from: Argentina, Brazil,

Paraguay, Colombia, Mexico, El Salvador, Egypt, Pakistan, India, Philippines, Indonesia, Ghana, Zimbabwe, Kazakhstan and Kyrgyzstan.

VI. C. Planned Accomplishments

To meet the needs of energy sector planners, policy-makers, managers, and technicians, the Office has planned eight formal courses under its Core Energy Training Program, three more courses under its Management Training Program, and a number of Study Tours and Conferences for Fiscal Years 1993 and 1994. The Office will also take on the administrative management of courses conducted by the U.S. Telecommunications Training Institute (USTTI). These activities are described below.

Core Energy Training Program

The Office has planned seven formal core courses to be conducted in the U.S. during Fiscal Year 1993. Collectively, these courses will involve 200 participants from a wide range of countries. Courses will address several topics consistent with the Office's other programs, including: **Energy Efficiency and Conservation, Energy and Environment, Renewable Energy, Human Resource Development and Management, Economic and Financial Evaluation, and Power Plant Operation and Maintenance.**

Planned Accomplishments:

1. Conduct a **Demand-Side Management/Integrated Resource Planning** course for utility and government engineers, planners, analysts and managers involved in energy conservation/efficiency programs.
2. Conduct a **Stationary Source Air Pollution Monitoring** course for regulatory and company technical personnel, including practical internships on point source monitoring.
3. Conduct a course on **Regional Air Quality Monitoring** for regulatory and company technical personnel, examining the regulatory environment and required infrastructure, including a practical internship.
4. Conduct a **Solar Electricity (Photovoltaic) Technologies** course providing hands-on training in all aspects of photovoltaic (PV) design and use, including technical, economic, and other practical information for individuals with responsibility in this area.
5. Conduct an eight-week long Energy Sector **Human Resource Development** course targeting, among others, women professionals in management positions.
6. Conduct a course on **Economic and Financial Evaluation of Energy Projects** that responds to requests from USAID Missions and supports Office of Energy and Infrastructure project needs, such as that of the Office's Private Sector Energy Development activities (see Chapter Four).

7. Conduct an updated version of the previously successful course, **Power Plant Operation and Maintenance**, to support the Office's Energy Technology Innovation (ETIP) project activities (see Chapter Five).

Management Training Program (MTP)

The Office has developed a series of one to two week, in-country workshops for senior-level decision-makers, managers, and planners. The objectives of the MTP are to support the Office's policy goals, increase the opportunity to reach out to alumni by providing additional training and access to U.S. technology, and to conduct training needs assessments. The Office also hopes that the involvement of high level managers and policy-makers in MTP sessions will help popularize its core training programs among the supervisors of prospective future participants.

Two or three MTP workshops series will be implemented during FY 1993. Each series will be held in three to four different countries, training a total of approximately 200 participants. Special emphasis will be put on Private Sector Energy Development, Energy Technology Innovation, Renewable Energy Application and Training, and Energy Efficiency. Participating industries will be expected to provide in-kind contributions towards conducting these workshops.

Planned Accomplishments:

8. Conduct a **Demand-Side Management/Integrated Resource Planning Workshop** aimed at policy-makers associated with the DSM/IRP course being offered (see Accomplishment #1.)
9. Conduct a workshop entitled, **Renewable Energy for Electric Power: Technology Options** in cooperation with the U.S./Export Council for Renewable Energy, either in country or on a regional basis, involving the Office's BEST and REAT projects (See Chapter Three).
10. Conduct a workshop on **Environmental Management**, drawing on experts in the field and held regionally or in-country, depending upon interest in AACs.

New Independent States - Energy Commodity Exchange Training Program

The Office is working with the New York Mercantile Exchange (NYMEX) to conduct a six-week training program for a total of 40-50 mid- to senior level commodities exchange officials and managers from the NIS. The program includes two weeks of in-country training on basic market economics, and four weeks in the U.S. on commodity exchanges and futures markets for oil and gas.

Planned Accomplishments:

11. Develop and conduct a six-week Energy Commodity Exchange Training course to be held in two phases in both the U.S. and the NIS.

Internships

At Mission request, the Office arranges working internships for energy professionals, generally in highly specialized fields, with corporations, universities, governmental agencies, consulting firms, and other enterprises with the requisite expertise.

Training Needs Assessments

The Office will integrate training needs assessments (TNAs) into staff members' overseas trips to aid in the planning of future training activities. The first compilation of these surveys will be made within FY 1993 so that the results can be incorporated into the program design for FY 1994. The Office will also conduct TNAs during the second week of the MTP in-country workshops, thereby obtaining input from MTP participants, who are generally senior representatives of their organizations.

Cooperative Activities with Office of Energy and Infrastructure Contractors and Government Agencies

The Office will work with other U.S. government agencies, A.I.D. contractors, and U.S. industry in developing programs to respond to AAC training needs, to further the objectives of the Office and to enable participants to develop contacts with U.S. industry.

Study Tour Program

The Study Tour Program is conducted through a Cooperative Agreement with the U.S. Energy Association. This collaboration enhances the Office's access to U.S. industry as partners in training foreign policy-makers and industry leaders, and exposing them to the U.S. approach to private and public sector energy management and regulation, environmental protection, conservation, and technology development. The training activities developed for FY 1993 include an emphasis on **Energy Efficiency, Innovative Technology, Private Sector Participation, Utility Management, Environmental Technologies, and the Oil and Gas Industries.**

The **Training Course Follow-up Study Tours** will also be conducted to complement the training provided to participants of the formal core courses and for some Management Training Program participants. The itineraries and foci of these tours are tailored to these courses.

Planned Accomplishments:

12. Conduct an Energy Efficiency Study Tour and Conference -- for participants from Egypt, Pakistan, Colombia, and Peru.
13. Conduct the *POWERGEN '93* Study Tour -- including participants from the Philippines, Ghana, and Poland.
14. Conduct the International Electric Utility Forum and Study Tour for participants from the Philippines, Indonesia, Thailand, Colombia, and Argentina.
15. Organize the Environmental Technology Transfer and Policy Report, Conference and Study Tour for participants from the Philippines, Malaysia, Thailand, and India.
16. Set up and administrate the International Energy Agency's (IEA) Use of Clean Coal in Asia Conference focussing on participants from the Philippines, Indonesia, Thailand, Malaysia, and India.

17. Sponsor participants to the Edison Electric Institute Annual Convention and *U.S. Power Technology Symposium Study Tour* from the Philippines, Indonesia, Mexico, Colombia, El Salvador, Guatemala, Ghana, Zimbabwe.
18. Support a Single Country Visits from Latin America for a Gas Industry tour -- Mexico, Argentina.
19. Support a Single Country Visit from Asia for an Oil Industry tour -- Indonesia, Philippines.
20. Single Country Energy Industry Orientation Visits from Egypt and Morocco.
21. Conduct Follow-up Study Tours to three Core Training courses as determined.
22. Conduct a Multinational Oil Refinery Study Tour.
23. Conduct a Multinational Gas Efficiency Study Tour.
24. Develop and Distribute a Training and Study Tour Newsletter.

The United States Telecommunications Training Institute (USTTI)

In Fiscal Year 1993, the Energy Training Program will assume the administrative management of the ongoing United States Telecommunications Training Institute. Since April 1983, the USTTI, a non-profit corporation and private sector-dominated joint venture with the U.S. Government, has offered a diverse curriculum of free telecommunications and broadcast training programs for qualified men and women who manage the communications infrastructure of the developing world. In 1993, the USTTI will feature a 74-course curriculum in topics such as privatization concepts for both telephone and broadcasting, spectrum management, telephone network management, broadcast studio design, satellite communications, and regulatory structures. U.S. firms that are involved in the training program contribute their share by hosting course participants.

During its decade-long tenure, USTTI has conducted communications training services to more than 3,000 professionals in 135 countries worldwide. Its repertoire of programs included 380 diverse courses during this period. Since beginning its cooperative agreement with the Office, USTTI has trained 24 Office-funded communications professionals from 16 countries. Funding from the Office takes the form of travel and per diem expenses for each participant. Cooperating U.S. federal agencies (Department of Commerce, U.S. Information Agency, the TDA, and others) contribute course materials and provide international outreach and additional services to prospective and accepted candidates.

Planned Accomplishments:

25. Oversee the United States Telecommunications Training Institute's implementation of a training program to approximately 100 participants during this fiscal year.

CHAPTER SEVEN: FUNDING INNOVATION FOR ENERGY PROJECT DEVELOPMENT

Pre-Investment and Equity Funds

To alleviate the energy and environmental problems facing developing countries, the Office of Energy and Infrastructure provides partial financial support for sustainable, environmentally acceptable energy projects. Emphasizing energy efficiency, renewable energy and environmentally sound technologies and practices, the Office has established project support funds available to private U.S. and developing country companies to cost-share prefeasibility and feasibility studies, and to partially finance acceptable projects.

The high cost and risk of developing projects in A.I.D.-assisted countries (AACs) raises barriers to the adoption of innovative and environmentally benign energy technologies. Resistance to innovative approaches by developing country officials and by international financial institutions handicaps efforts to introduce energy efficient technologies, renewable energy projects, and environmentally beneficial energy production facilities. Also, the uncertain economic and policy terrain of developing countries has discouraged many U.S. private sector firms from seeking overseas opportunities for their advanced technologies and practices. This is especially true in the energy sector, because of the high capital costs required for engineering, construction and equipment.

To overcome these barriers and encourage the U.S. private sector to be a partner in international development, the Office of Energy and Infrastructure subsidizes four project support funds -- three provide assistance for prefeasibility and feasibility studies and one provides equity or debt financing for renewable energy projects. The funds include:

Prefeasibility/Feasibility Study Funding

- Energy Project Development Fund
- International Fund for Renewable Energy and Energy Efficiency
- Renewable Energy Pre-Investment Support Fund

Equity and Debt Funding

- Environmental Enterprises Assistance Fund

By limiting the financial contribution of the Office of Energy and Infrastructure, these funds require project sponsors to share the costs of studies or other project activities. In some cases, the project sponsors must fully repay the contribution made by the Office of Energy and Infrastructure to the U.S. government when the project goes to financial closing.

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The Energy Project Development Fund (EPDF)

The *Energy Project Development Fund*, cost-shares prefeasibility and feasibility studies for projects leading to the development and application of efficient, commercially proven and environmentally sound energy technologies. EPDF supports both private and publicly-owned projects, contributing up to 50 percent of the study costs.

The types of projects EPDF supports include energy efficiency improvements, advanced electric power generation technologies, 'clean coal' projects, environmental control technologies, environmentally prudent private power plants, energy sector privatization, and sound energy conversion techniques.

Funds are available to U.S. companies that propose projects in A.I.D.-assisted countries with the support of the host country governments and the USAID Missions. The applicants must demonstrate that the projects have a high probability of being implemented. The Office of Energy and Infrastructure contribution can reach \$200,000 or more.

The International Fund for Renewable Energy and Energy Efficiency (IFREE)

The *International Fund for Renewable Energy and Energy Efficiency* provides cost-shared contingent loans of up to \$50,000 for prefeasibility studies of biomass, geothermal, small hydropower, solar or wind energy projects as well as energy efficiency and natural gas project initiatives. Projects must be commercially viable and replicable. IFREE requires that potential funding for the subsequent full feasibility study be identified, a capable in-country participant must exist, and the project must utilize predominantly U.S. equipment.

IFREE was conceived by the U.S. Export Council for Renewable Energy, a consortium of renewable energy and energy efficiency trade associations. It derives from the concern about global climate change, thus the emphasis on renewable energy and natural gas systems; each of which are relatively benign to the environment compared with conventional energy systems.

IFREE is jointly funded by A.I.D.'s Office of Energy and Infrastructure, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Rockefeller Foundation.

The Renewable Energy Pre-Investment Support Fund (REPS)

The *Renewable Energy Pre-Investment Support Fund* offers financial assistance to private companies to support feasibility and prefeasibility studies for renewable energy projects in developing countries. The REPS Fund is operated collaboratively under the Renewable Energy Applications and Training (REAT) and Biomass Energy Systems and Technology (BEST) projects. REAT seeks to catalyze investments in sustainable and replicable renewable energy projects in the developing world. BEST focuses more specifically on promoting electric power generation and the production of fuels from waste biomass associated with agricultural and forest products industries.

The REPS Fund supports prefeasibility or feasibility studies to private developers for projects using commercially-proven biomass, geothermal, small hydro, solar, and wind energy technologies. Both local developers and U.S. developers that include a local company as a principal collaborator are eligible to apply. The expected average contribution is \$50,000.

In certain focus countries, the Office has established Renewable Energy Project Support Offices (REPSOs) to provide a variety of support services to project developers. REPSOs may periodically conduct in-country solicitations for proposals from private developers, both locally and in the U.S. Solicited proposals will be evaluated and grants awarded on a competitive basis. Unsolicited proposals for projects in these countries will be directed to the solicitation process. Currently, A.I.D. has established REPSO's in Costa Rica and Indonesia. Several others are in the planning stages (see Chapter Three for further discussion).

Environmental Enterprises Assistance Fund (EEAF)

Unlike the above three pre-investment funds, the *Environmental Enterprises Assistance Fund* provides capital to support environmentally benign projects and development-oriented companies in developing countries. EEAF's purpose is to catalyze small-scale renewable energy and environmental companies by providing loans and equity capital for environmentally attractive projects that are commercially viable, but require financing to move ahead.

EEAF will provide financial support for projects under \$2 million in renewable energy systems, energy efficient, energy-conversion technologies, and environmentally responsible management of organic waste. Proposals submitted to EEAF will be evaluated on their financial viability as well as their environmental, economic, and social impact. Direct loans are made at concessional rates, but equity investments are expected to provide higher returns than conventional financing arrangements.

EEAF is a nonprofit corporation that was established in 1990 with the help of A.I.D., Winrock International, and the Rockefeller Foundation. The expected average loan will rise during the year to range between \$200,000 to \$400,000.

For more information about these funds, contact:

Energy Project Development Fund

Price Waterhouse, Fund Administrator
1801 K Street, NW, Washington, DC 20006

Tel (202) 296-0800
Fax (202) 296-2785

International Fund for Renewable Energy and Energy Efficiency

777 N. Capitol Street, NE, Suite 805, Washington, DC 20002

Tel (202) 962-3393
Fax (202) 962-3396

Renewable Energy Pre-Investment Support (REPS) Fund

Renewable Energy and the Environment Program, Winrock International
1611 N. Kent Street, Suite 600, Arlington, VA 22209-2134

Tel (703) 525-9430
Fax (703) 243-1175

Environmental Enterprises Assistance Fund

1611 N. Kent Street, Suite 202, Arlington, VA 22209

Tel (703) 522-5928
Fax (703) 522-6450

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