PD-ABH-442

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: Worldwide

3. PROJECT NUMBER: 936-5741

4. BUREAU/OFFICE: S&T/EY 15

5. PROJECT TITLE (maximum 40 characters): Energy Technology Innovation

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 09 DD 30 YY 99

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)
A. Initial FY 90 B. Quarter 2 C. Final FY 98

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY 90 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total						
(Grant)	(500)	( )	( )	(20,000)	( )	(20,000)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country						
Other Donor(s)	200			20,000		20,000
TOTALS	700			40,000		40,000

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) PSEE	744	878				5,000		5,000	
(2) ARDN	"	"				15,000		15,000	
(3)									
(4)									
TOTALS						20,000		20,000	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 873 | 877 | 710 | 660

11. SECONDARY PURPOSE CODE

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code	ENV	INTR	TECH	TNG			
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

To introduce innovative and environmentally-sound energy engineering technologies and management techniques which promote sustainable and cost effective operation of electric generation, transmission, and distribution systems in developing countries.

14. SCHEDULED EVALUATIONS
Interim MM 09 YY 92 MM 09 YY 95 Final MM 09 YY 98

15. SOURCE/ORIGIN OF GOODS AND SERVICES
[XX] 000 [ ] 941 [ ] Local [ ] Other (Specify)

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment.)

This is a new project that was not originally proposed in the CP for 1990.

17. APPROVED BY
Signature: James B. Sullivan
Title: Director, Office of Energy
Date Signed: MM 03 DD 28 YY 90

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MM DD YY

Agency for International Development
Washington, D.C. 20523

APRIL 20, 1990

ACTION MEMORANDUM FOR THE ASSISTANT ADMINISTRATOR FOR THE BUREAU FOR SCIENCE AND TECHNOLOGY

FROM: S&T/EN, Jack Vanderryn

SUBJECT: Authorization of the Energy Technology Innovation Project (ETIP) (Project Number 936-5741)

PROBLEM: Your authorization is requested to initiate a new, centrally-funded project, entitled Energy Technology Innovation Project (ETIP - 936-5741), in the amount of $20 million from the Agriculture, Rural Development and Nutrition (103) and Private Sector, Environment,and Energy (106) accounts.

DISCUSSION: The broad goal of the ETIP is to alleviate, in an environmentally acceptable manner, the supply/demand gap in energy sectors of developing countries.

ETIP's objectives are:

- to implement clean energy technologies:
- to assist in the implementation of innovative, energy efficient technologies in the areas of power generation, transmission, and distribution;
- to promote the effective transfer of technology to rehabilitate current systems in the energy/power sector; and
- to improve energy/power sector institutional structure.

In addition to the amount authorized above, an estimated $20,000,000 may be contributed to this project by Missions, Regional Bureaus, other offices of A.I.D., other U. S. government agencies, and international development institutions or lenders. Funding may be provided from the Economic Support Fund (ESF) or the Development Fund for Africa (DFA), as well as the accounts authorized for S&T funding under this project.

The project has been designed to complement and follow on the activities of other A.I.D. energy sector projects, and to promote the integration of these activities with those of ETIP in an efficient and coherent fashion.

PROJECT ISSUES: The 1989 Energy Industry Review Group's report to the A.I.D. Administrator, which followed a previous A.I.D. report to Congress on Power Shortages in Developing Countries, confirmed that substantial electric power shortages exist in over half of

A.I.D.- assisted countries. This situation threatens economic growth and social stability. An additional conclusion was that the U. S. possesses the lead in many clean, efficient energy technologies which are commercially mature and can be effectively transferred to Third World Countries. This transfer will increase the accessibility to reliable energy systems and assist in creating cleaner, more efficient energy sector facilities while providing opportunities for active US private sector participation in energy trade and export markets. The project provides for flexible project activity design and innovative input via A.I.D. Mission and Bureau buy-ins according to the requirements of regional or country circumstances.

Recent Congressional legislation gives A.I.D. authority for direct hires for activities related to global warming. The breadth of ETIP, with projects across the energy/power sector, the requirement for close coordination among A.I.D. Bureaus, Missions and the Office of Energy, and the anticipated level of buy-ins and host country initiatives, supports the decision to fund direct hire staff under ETIP.

SPECIAL INTEREST IN THE PROJECT: This project is responsive to the Congressional mandate provided in the November 1989 House of Representative Report 101-344, and supports the findings reported in the previously mentioned energy reports.

WAIVERS, SPECIAL CLEARANCE, PROVISIONS AND DETERMINATION: No waivers or other special conditions are requested at this time. The project should work to improve the performance of existing energy/power systems, and thus to reduce the emission of greenhouse gases which contribute to global warming. The project is in harmony with the intent of section 534(b)(2) of the FY 1990 Appropriations Act.

It is expected that PASAs and RSSAs may be utilized in the conduct of project activities.

SECTOR COUNCIL REVIEW: The Energy and National Resource Sector Council has reviewed the project paper for this project, and the project was endorsed on March 26, 1990 with no reservations.

CONGRESSIONAL JUSTIFICATION: None required now; an APC has been done.

PROCUREMENT PLAN AND BUDGET: The project will be implemented by two competitively bid contracts, one in FY 90 and one in FY 91. The FY 190 OYB has $500,000 to initiate the project; the project was not originally planned for in the FY 90 CP. A Congressional Notification has been done and submitted to the Program Office on March 7, 1990. Some non-competitive procurements, such as, PASA/RSSAs, IQCs, Purchase Orders, Cooperative Agreements might be used in future years.)

RECOMMENDATION: That you sign the attached project authorization.

Clearances:
S&T/EY, J. Sullivan draft Date: 3/28/90
S&T/EY, A. Sabadell draft Date: 3/28/90
S&T/PO, D. Sheldon draft Date: 4/6/90
GC, S. Tisa phone Date: 4/4/90

Attachments:
Project Data Sheet
Project Authorization
Project Paper

PROJECT AUTHORIZATION

Country/Entity: Worldwide

Name of Project: Energy Technology Innovation Project

Number of Project: 936-5741

1. Pursuant to Section 103 - Agriculture, Rural Development and Nutrition (ARDN) and Section 106 - Private Sector, Environment, and Energy (PSEE) of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Energy Technology Innovation Project involving planned obligations of not to exceed $20 million in grant funds from the ARDN and PSEE accounts, subject to the availability of funds in accordance with A.I.D. OYB/allotment process.

The initial obligation year for the project is FY 1990, the final obligation year is FY 1998, and the PACD is 30 September 1999.

In addition to the amounts authorized above, an estimated $20 million may be contributed to the project by Missions, Regional Bureaus, and other offices of A.I.D. Funding may be provided from the Economic Support Fund (ESF) or the Development Fund for Africa (DFA), as well as the accounts authorized for S&T funding under this project.

2. The project purpose is: To introduce innovative energy engineering technologies and management techniques which promote sustainable and cost effective operation of electric generation, transmission, and distribution systems in developing countries.

The project will promote the use of innovative, clean energy technologies in A.I.D.-assisted countries that are responsive to host country energy and environmental needs, and enhance the trade position of U.S. energy firms. In particular, the ETIP will: (1) introduce new, innovative, and advanced energy technologies that will increase cost-effective power generation and reduce energy waste thereby cutting by 25% the current gap between energy supply and demand in affected LDCs by FY 2000; (2) clean energy policies and regulations will be introduced and/or supported in at least 5 LDCs where fossil-fueled power generation is most intense; (3) at least 5 joint ventures involving U.S. companies will be supported in private sector power generation by FY 2000; (4) at least 100 LDC decisionmakers and 200 power sector engineers will be trained in workshops by FY 2000. To accomplish these activities technical assistance will be provided to missions to introduce new,

innovative engineering services; indigenous resource assessments will be done in various missions; energy system applications and/or market assessments will be done; a variety of workshops and seminars will be held; a number of prefeasibility studies will be funded; and site visits for development and implementation of innovative approaches to technology transfer/training will be conducted.

3. The agreements which may be negotiated and executed by the officer to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority shall be subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate:

a. Source and Origin of Commodities, Nationality of Services. Commodities financed by A.I.D. under the project shall have their source and origin in the "cooperating country" or the United States, except as A.I.D. may otherwise agree in writing. (Each country in which research, training, or technical or other assistance takes place under the project shall be considered a "cooperating country.") Except for ocean shipping, the suppliers of commodities or services shall have the cooperating country or or the United States as their place of nationality, except as A.I.D. may otherwise agree in writing.

Ocean shipping financed by A.I.D. under the project shall, except as A.I.D. may otherwise agree in writing, be financed only on flag vessels of the United States.

Signature: Richard E. Bissell

Richard E. Bissell

Assistant Administrator for Science and Technology

Date: April 25, 1990

Clearances:

S&T/EY, J. Sullivan draft Date 3/28/90
S&T/EN, J. Vanderryn draft Date 4/9/90
S&T/PO, D. Sheldon draft Date 4/6/90
GC, S. Tisa phone Date 4/4/90

PROJECT PAPER

ENERGY TECHNOLOGY INNOVATION PROJECT (ETIP)

PROJECT NUMBER 936-5741

MARCH 1990

OFFICE OF ENERGY
BUREAU FOR SCIENCE AND TECHNOLOGY
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

ENERGY TECHNOLOGY INNOVATION PROJECT

PROJECT PAPER

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ETIP PROJECT PAPER

PART I - EXECUTIVE SUMMARY

A. RECOMMENDATIONS

1. Funding

The A.I.D. Office of Energy (S&T/EY), Bureau for Science and Technology, recommends the authorization of $40.00 million for the Energy Technology Innovation Project (ETIP), #936-5741, with a Project Assistance Completion Date of September 30, 1999. The Office of Energy will contribute $20.00 million in core funding for the ETIP. An additional $20.00 million of buy-ins will be sought from relevant A.I.D. Bureaus, Missions, other U.S. government agencies, other bilateral and multilateral donors, and the private sector. The ETIP funding is planned to be incrementally obligated as follows:

FY	S&T/EY Funding ($Millions)	Mission Buy-Ins ($Millions)
90	0.507	0.200
91	2.164	2.550
92	2.674	3.650
93	2.077	3.250
94	2.129	2.650
95	2.599	2.850
96	2.498	1.950
97	2.462	1.750
98	2.049	1.100
99	0.841	0.000
Total:	$20.00	$19.95

The ETIP will operate primarily through two competitively bid contracts to select two prime contractors: the Technical Assistance Contractor and the Project Identification Fund Contractor. These contractors will head multidisciplinary teams of subcontractors and consultants. The Technical Assistance Contractor will establish a staff of technical experts and administrative personnel located in the Washington, D.C. area. Required expertise will include architect and engineering (A&E) services, economic/financial analysis, market assessments, technology assessments, technical assistance, technology transfer and training, and overall project management. The Project Identification Fund Contractor will issue subcontracts to selected U.S. firms to conduct prefeasibility studies and other project planning services (i.e., resource assessments, definitional missions, and workshops). The Fund Contractor will coordinate the activities of the Fund worldwide including: capitalization of the Fund; periodic solicitations for subproject sponsors ("Fund recipients"); preparation of Fund administrative documents; evaluation of proposals; organization of a Peer Review Committee to review Contractor decisions on Fund awards; and disbursement and accounting of Fund monies. It is anticipated that the Fund will be capitalized with $2.8

million from A.I.D. central core funding and $8.25 million from Mission buy-ins. Additionally, other U.S. government agencies and multilateral donors are expected to contribute an additional $2.7 million (25%) towards activities conducted by the Fund.

2. Waiver Requests and Determinations

The ETIP does not anticipate any requirement for waiver requests or determinations.

B. SUMMARY PROJECT DESCRIPTION

The broad goal of the ETIP is to alleviate, in an environmentally acceptable manner, the supply/demand gap in energy sectors of developing countries. The project purpose is to introduce innovative and environmentally sound energy engineering technologies and management techniques which promote sustainable and cost-effective operation of electric generation, transmission, and distribution in developing countries.

The four main project objectives are as follows:

- Implementation of Clean Energy Technologies
- Innovation in Energy Efficiency and Power Generation, Transmission and Distribution
- Technology Transfer to Rehabilitate Current Systems
- Improvement of Power Sector Institutional Structures

The approach to be taken is:

- responsive to the Congressional mandate provided in the November 1989 House of Representatives' Report 101-344,

- consistent with the March 1988 A.I.D. report that identified the magnitude and impacts of power shortages in developing countries, and

- supportive of recommendations made by the recent Energy Industry Review Group formed by the Administrator of A.I.D. to further review the problem of power shortages.

To satisfy these objectives, the ETIP will fund:

- assessments of indigenous energy resources, market opportunities, and energy system applications.

- engineering services and the introduction of innovative, proven, efficient, and environmentally benign advanced U.S. energy conversion technologies;

- the implementation of energy system control/management techniques;

- technology transfer/training and workshops at management and staff levels;

- o prefeasibility studies to determine the technical, economic, and institutional viability of innovative energy options in country specific applications.

Evaluation criteria to be used in assessing technologies and methodologies for a given country application are:

- o applicability to indigenous energy resources,
- o improvement of existing systems throughout the power sector,
- o minimum impact on the environment, and
- o economic suitability to the specific conditions in the developing country.

ETIP activities will be conducted in Africa, Asia/Near East, and Latin America/Caribbean regions; most likely in the countries of Morocco, Egypt, India, Pakistan, Indonesia, Thailand, Philippines, Costa Rica, Guatemala, and the Dominican Republic. Other countries will be added as needs arise and technical assistance requests are made by US A.I.D. Missions, Regional Bureaus, and developing country governments.

All ETIP activities will have components that focus on creating an institutional framework for sustainable socioeconomic growth and development throughout the broadly defined energy/power sector of LDCs. The ETIP will accomplish its objectives by the completion of the following project elements throughout the 10-year life-of-project:

Project Elements	Estimated Number Total	Estimated Number FY 90-92
Country Indigenous Resource Assessments	20	10
Country Energy System Applications and/or Market Assessments	15	6
Prefeasibility Studies	25	7
Missions for Development and Implementation of Innovative Approaches to Technology Transfer/Training for Power Sector System Implementation and/or Rehabilitation	25	8
Missions for Structuring and Conduct of Management/Operational Assistance Workshops for Institution Upgrade and Development	20	6

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Technical Assistance to Provide New, Innovative Engineering Services to the Energy/Power Sector	25	9
Special Studies	30	7

Completion of these project elements will involve:

- o expanded use of indigenous, less environmentally damaging sources of energy, both fossil and renewable;
- o increasing the efficiency of energy generation, transmission, and distribution systems;
- o integrating environmental criteria into the energy planning process;
- o encouraging efficient, environmentally benign energy conversion.

A typical ETIP task that would, for example, support the objective to implement clean energy technologies in a specific LDC, could be structured as follows:

(1) **A Definitional Mission is conducted** to broadly assess indigenous energy resources and possible system applications for the technology

(2) If warranted, **the Definitional Mission will be followed by a Resource Assessment and a visit(s) by a Technical Assistance Team(s)** to develop conceptual system designs and preliminary implementation procedures and schedules

(3) **Workshops** structured to support necessary institutional development and operational training **could be conducted if required**

(4) **The ETIP Project Identification Fund could finance a prefeasibility study** to:

(a) further quantify the potential for successful implementation of the technology that was anticipated by results from the Definitional Mission and workshop/training activities, and

(b) to refine the system design and implementation procedure and schedule.

(5) If all indications for need and success of the technology are positive at this time, **the country Mission would be encouraged to buy-in to the effort** by funding (and/or securing other donor agency co-funding):

(a) the participation of direct hires in response to the recently enacted

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global warming legislation and/or long-term advisors, and

(b) the purchase of monitoring and/or control hardware, software development and implementation, etc. for application feasibility testing.

The centrally-funded part of this process could typically take 2 years over which ETIP would expend approximately $500,000 to $700,000. The Mission buy-in would most likely be significantly more than this dollar amount (to possibly exceed $1 million) depending on the number of application feasibility projects, the length of the projects, and the monitoring/control hardware/software system costs.

C. SUMMARY FINDINGS

The ETIP is ready to be implemented. The ETIP promises to have a significant impact on the introduction in LDCs of new, innovative U.S. energy technologies which are capable of using alternative fuels, and/or which impose substantially lower environmental impacts than conventional power generation options. It is socially, financially, and economically sound, and administratively and technically feasible.

ETIP PROJECT PAPER

PART II - PROJECT BACKGROUND AND DETAILED DESCRIPTION

A. BACKGROUND

1. Relevant A.I.D.-Funded Technical Assistance Projects

There are three projects with direct relevance to the Energy Technology Innovation Project (ETIP):

- **The Conventional Energy Technical Assistance (CETA) Project** which was started in June 1980 and has a scheduled completion date of September 1990;
- **The Private Sector Energy Development Project (PSED)**, which was recently started and has a project completion date of September 30, 1994; and
- **The Energy Policy Development and Conservation Project (EPDAC)**, a 10-year effort ending in September 1992 that has a number of separate projects of interest, most notably the ongoing Program to Accelerate the Commercialization of Energy Research (PACER), which is a six-year India/U.S. science and technology collaborative program started in 1987.

The main purpose of the CETA Project (936-5724) was to provide developing countries worldwide a range of technical assistance including identification, evaluation, and the development of conventional energy resources, and the utilization of these resources to reduce dependence on oil imports. Types of assistance included resource assessments and surveys; access to the technologies, services, and investment needed to exploit indigenous resources; and provision of in-country technical training required to manage the development of these resources. The term, conventional energy, included all fossil fuel energy forms, as well as geothermal energy resources[1].

The level of funding for the CETA Project was $20.45 million over the 10-year life-of-project. During the first five years of the project, separate field activities were completed by means of Indefinite Quantity Contracts (IQC's) and open bids. Towards the end of the five-year period, a single contractor (Bechtel, National Inc.) was selected to provide on-going technical support and to conduct the majority of the field activities.

However, changing economic realities in the world energy situation, such as reduced oil prices, reordered priorities in the energy sectors of developing countries. With this in mind, A.I.D. Missions have identified anticipated needs for technical services in the energy/power sector principally in the areas of private power development; institutional development; advanced, innovative and environmentally sound technologies and power systems related

[1]Evaluation of the A.I.D. Conventional Energy Technical Assistance (CETA) Project, IDEA, Inc. for A.I.D./S&T/EY, February 1989.

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to conventional sources of energy; and indigenous fuel resource assessment. The CETA Project responded by broadening its scope to address these needs. A significant effort was expended to identify private sector power issues and assess private power activities in a number of developing countries (Jamaica, Jordan, Dominican Republic, Pakistan, Indonesia, etc.). Project Office activities were initiated to investigate rehabilitation of existing power systems and the recovery of indigenous fuel resources. Studies of advanced conversion technologies were supported, e.g. the Indian Integrated Gasification Combined Cycle (IGCC) project and projects using fluidized bed/low grade coal and sugar cane-to-energy technologies. Results of these CETA efforts have focused energy/power sector issues and identified relevant energy related priorities in many developing countries. They provide direction and a sound foundation for the initiation of a complementary project, the Energy Technology Innovation Project (ETIP).

The main purpose of the Private Sector Energy Development (PSED) Project is to accelerate the sustainable economic and social development of A.I.D.-assisted countries by increasing the supply of reliable, affordable energy, particularly electric power, for productive purposes. Additional objectives are to assist in creating a favorable environment for private sector participation in ownership, financing, and operation of energy facilities in selected developing countries, with concentration in the electric power sector[2]. The AID Office of Energy plans a commitment of $9.76 million over the six-year PSED Project period. An additional $5.58 million of buy-ins and matching funds will be sought from relevant A.I.D. Bureaus, Missions, other U.S. government agencies, other bilateral and multilateral donors, and from the private sector.

The PSED Project will consider the following strategy options:

- Private sector participation in generation and distribution of power and development of other energy resources;
- Industrial and commercial cogeneration of power;
- Long-term contracts by the utility for private companies to perform certain functions;
- Investment of private capital in power and other energy facilities;
- Privatization of existing public utilities and other energy operations;
- Participation of private companies in the decentralization of rural electric power systems.

The focus of the PSED Project is narrower than the ETIP scope in that it deals exclusively with the private sector versus the broader total energy sector approach (both public and private) that the ETIP will take using innovative, environmentally benign energy generation technologies. Also, the PSED Project focuses on small power generation whereas the ETIP

[2]Project Paper: Private Sector Energy Development (PSED) Project, A.I.D./S&T, May 1989.

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is primarily interested in development and improvement of utility-scale central power system generation. The ETIP will, however, benefit from PSED Project activities in that the PSED Project will educate government and private sector institutions in small power producer ownership and operation, and the financing of private sector power development, which will most likely be a subset of many of the ETIP initiatives.

The Energy Policy Development and Conservation Project (936-5728) is divided into two sub-projects: the Energy Conservation Services Project (ECSP) and the Energy Policy and Planning Development (EPPD) Project. The ECSP provides technical assistance mainly to end-users in improvements in energy efficiency and the implementation of energy conservation opportunities. Initially the project targeted energy waste in the industrial sector. However, in light of growing concern in developing countries about rapidly increasing power demand, power shortages, poor system reliability, inefficient management, and the shortfall in available capital, A.I.D. began to target energy conservation initiatives for improving efficiency in the power sector. To date, there have been only limited activities under the ECSP in this area, which is a main concern of ETIP initiatives.

The EPPD Project provides technical assistance in seven areas: (1) investment planning under capital constraints, (2) electric utility performance improvement, (3) energy price reform, (4) rural power delivery, (5) environmental management of energy conservation, (6) support to the Multi-Agency Group on Power Sector Innovation (MAGPI), and (7) the Program to Accelerate the Commercialization of Energy Research (PACER).

The purpose of PACER is to foster innovation with the Indian electric power sector, in part through facilitating the establishment of R&D consortia which link the industrial, commercial, R&D, and government sectors. This work focuses on advanced coal combustion technologies, renewable energy systems, electricity technologies, and improved transmission and distribution planning and technologies[3].

The PACER approach is to catalyze the creation and implementation of goal-oriented, market-responsive consortia. These consortia will bring research and industrial institutions as well as end-users from the Indian public and private sectors, together (in some cases) with U.S. companies and institutions. These consortia, established as operating entities to cross-cut across traditionally noninteractive strata of R&D institutions, utilities, and industry, will focus on the development and widespread commercial application of advanced energy technology products and processes. The activities under the PACER are supported by a competitive research awards program and by activities designed to analyze and disseminate information of relevance to commercializing technology innovations.

The PACER initiatives are closely related to the goal and objectives of the ETIP. PACER is to provide beneficial impact to the power sector of India by adding a market-driven focus to science programs. ETIP will take the often broader view of accrual of long-term benefits, an approach that is not always compatible with short-term gains that a market focus tends to promote. Whereas PACER is focused on India, the ETIP focus is worldwide.

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[3]Program Plan: Fiscal Years 1989 and 1990, Report No. 89-08, A.I.D. Office of Energy, June 1989.

2. Legislative Mandate

In March 1988, A.I.D. found and reported to Congress that:

- o substantial electric power shortages exist in over half of A.I.D.-assisted countries, and that
- o these shortages of adequate and reliable supplies of energy/power are directly threatening sustainable social and economic growth.

A.I.D. also acknowledged that assistance to solving power shortages in developing countries was important for the United States for both U.S. development and foreign policy objectives and U.S. trade[4]. In response to this observation, the Administrator of A.I.D. formed an Energy Industry Review Group to further review the situation and suggest steps that could be taken to solve the problem. After the completion of three fact-finding missions and some months of study, the Energy Industry Review Group offered the following among its recommendations[5]:

1. A.I.D. should place a greater emphasis on energy, particularly electric power, and on the transfer of proven U.S. technologies and services. It should make the necessary organizational and budget changes to achieve this objective and seek, if necessary, additional Congressional authority.

2. A.I.D. should be more active and innovative in helping to promote, market, and finance U.S. energy/power equipment and services that can support sustainable economic growth in developing countries in ways that are environmentally sound.

In November 1989, Congress also supported this view that A.I.D. should increase its efforts in the energy field. Conference Report 101-344 stated that "funding for A.I.D.'s Office of Energy should be targeted at $20 million in fiscal year 1990 ... [to be used for] ... projects within the Office which provide assistance and training for the promotion of end-use energy efficiency and renewable energy ... in 'key' developing countries which contribute significantly to global greenhouse gas emissions, and in which actions to promote energy efficiency, reliance on renewable energy resources, and forest conservation could significantly reduce those emissions." Further, the Conference Report states that the "A.I.D.'s Office of Energy, in cooperation with country missions, should assist countries in developing and implementing energy plans that employ end-use analysis to identify cost effective actions to minimize reliance on fossil fuels."

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[4]Power Shortages in Developing Countries: Magnitude, Impacts,Solutions, and the Role of the Private Sector, Report to Congress A.I.D., March 1988.

[5]Report of the Energy Industry Review Group on Power Shortages in Developing Countries, A.I.D., April 17, 1989.

The Energy Technology Innovation Project (ETIP) is designed to be responsive to these recommendations and the Congressional mandate. The ETIP comprises an energy initiative that supports assessment and system development to employ advanced, innovative power generation, transmission and distribution technologies developed and proven in the United States to efficiently use indigenous energy resources in developing countries and improve existing systems, at savings in foreign exchange, and with a reduction in environmental impact. The ETIP will draw on the considerable experience of the United States with renewable and alternative energy resources, energy efficient hardware, and energy conservation methodologies and equipment that can be transferred to developing countries to reduce the negative environmental impact of power generation while increasing the overall energy capacity required for sustainable socioeconomic development.

In many parts of the developing world, policy decisions continue to be made affecting energy resource use which fail to take into adequate consideration the effects on all segments of society, including women. For example, changes in the power sector often impact cottage industry; both negatively, as with urban schemes to implement municipal solid waste as a feedstock, and positively, as with the introduction of rural village electrification using alternative energy sources. Since women are the primary persons involved with many of these cottage industries, the effect on them is significant.

The lack of awareness of how people use natural indigenous resources, as well as the different gender impacts of policies, technologies, and institutional actions, has often led to poor investments in energy/power sector expansion. Often misunderstanding with regard to end-user customs and sensitivities (both male and female) has significantly reduced the benefits that should accrue from energy conservation methods and the introduction of innovative methodologies for improved system and process control operations throughout the energy/power sectors of developing countries.

As part of the ETIP, policy analyses will be conducted which address some of these issues and, when relevant, specifically with regard to the impact on women. On-the-job training opportunities and attendance at workshops will be available to both men and women on an equal basis.

3. Existing Conventional Energy Assistance Programs

The goal of A.I.D. is a world in which economic growth and development are self-sustaining and the extremes of poverty have been eliminated. A.I.D. has identified six major problems in LDCs that limit the attainment of this goal: inadequate income growth; hunger; health deficiencies, especially infant mortality; illiteracy and lack of education; unmanageable population growth; and environmental and natural resource degradation. Energy is a critical input to any attempt to alleviate these problems[6].

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[6]See Blueprint for Development: The Strategic Plan of the Agency for International Development, U.S. A.I.D., Washington, D.C.

Most of the growing demand for energy in LDCs continues to be met by imported oil. Three-quarters of A.I.D.-assisted countries rely on oil for 50 percent or more of their commercial energy requirements. Existing A.I.D. and other donor assistance programs are structured to reduce the dependence of LDCs on imported oil by providing a wide range of technical assistance to help them exploit indigenous resources and to manage them expeditiously. These programs were in response to the severe impact of the oil crises of the 1970s and the continued high oil prices throughout most of the 1980s. For U.S. agencies, these programs also responded to Congressional mandates such as amendments to Section 106 of the 1979 Foreign Assistance Act which stated in part that "... there is a compelling need for vigorous efforts to improve the available data on the location, scale, and commercial exploitability of potential oil, natural gas, and coal reserves in developing countries ..." and "... assistance for the production of energy from indigenous resources ... would be of direct benefit to the poor in developing countries ...".

Energy resources and energy conversion incur costs - economic, environmental, and social. Until very recently, existing donor agency funded technical assistance programs in the energy/power sector focussed on the "economic" costs of power generation, transmission and distribution, where the definition of "economic" was to reduce the need to use export earnings for energy imports. Pilot projects to test new methods of indigenous energy production were initiated. Exploration for potential oil, natural gas, and coal reserves in LDCs was encouraged. Recent trends in the energy/power sector worldwide indicate a growing awareness of the "true cost" of power generation, i.e. the social and environmental cost as well as the narrowly focussed, traditional, strictly economic least-cost capacity growth approach. Technical assistance programs are being re-structured to include criteria for consideration of global warming and requirements for assessment of external cost factors, i.e. the longer-term impact (air and water quality, employment, toxic wastes, land use, balance-of-trade, and security of energy supplies) of capacity growth on development.

World Bank

The World Bank is a large donor to the energy sector through two mechanisms: (1) the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA) loans, and (2) Joint United Nations Development Program (UNDP)/World Bank Energy Sector Management Assistance Program (ESMAP) program energy assessments, energy-related preinvestment activities, and technical, institutional and policy assistance.

The ESMAP program was started jointly by the World Bank and the UNDP in 1983, as a companion to the Energy Assessment Program which was established in 1980. ESMAP is supported financially and technically by donor countries and bilateral and multilateral organizations. ESMAP is currently carrying out activities in more than 50 countries. Over the years, the largest share of the World Bank's lending has been for projects in the power sector. The World Bank's energy assistance has included[7]:

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[7]Energy in West and Central Africa: Issues, Problems, and Donor Activities, A.I.D. Office of Energy Report Number 88-12B, Prepared by RCG/Hagler, Bailly, Inc., July 1988.

- Country energy assessments
- Power system expansion, efficiency, rehabilitation, and distribution system extension projects (including technical assistance and training)
- Petroleum sector supply, distribution, and management projects
- Forestry projects, including forest conservation and reforestation, training, and technical assistance. Forestry components are often included in agricultural projects
- Household energy strategies and development and distribution of more efficient cookstoves.

Another World Bank energy/power sector effort is the Fossil Fuel Assistance Program which has emphasized aid to countries with known oil, gas, and coal reserves to promote development and production of those reserves. The bulk of funding goes for building pipelines and refineries, assisting in enhanced recovery schemes, and other projects designed to bring into production reserves that were known but were not economical to recover before oil price increases, or reserves whose development has been restricted by other technical, institutional, political or economic constraints.

The ETIP will complement existing World Bank initiatives in the energy area. By conducting prefeasibility studies and other project planning activities (i.e., resource assessments, definitional missions, and workshops), ETIP will identify innovative, economic, and environmentally-clean alternatives for supplying energy/power in LDCs that may not have been otherwise considered by host countries which typically rely on conventional energy options. As a result of the ETIP, host countries will be in a better position to request these new technology options in their loan request packages to donor agencies such as the World Bank. The Bank in turn, having been informed of the prefeasibility study results, will be receptive to favorable consideration of a project involving environmentally-sound alternatives. An additional benefit of the ETIP is the promotion of U.S. technology products/services where they make sense on a technical, economic, and institutional basis. The Bank could assist in cofinancing ETIP activities, as well as in investing in project opportunities identified as a result of this project.

United Nations

The United Nations projects to provide developing countries with assistance in energy exploration and development have been evolving over the last decade. United Nations activities cover a wide range of energy-related topics: study of hydrocarbon potential of the oceans; new concepts, approaches, and technologies for oil and gas exploration; studies of environmental impacts of fossil energy development and production; study of labor-related issues to power sector expansion such as safety, health, and working conditions of petroleum industry workers; studies and pilot demonstrations of small, renewable energy power systems for water supply and health; etc.

The United Nations Industrial Development Organization (UNIDO) has an energy-related technical assistance program that has been steadily increasing. Between 1980 and 1986, UNIDO executed 110 regional and national projects in Africa alone. At the regional level,

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assistance provided includes studies of industrial energy management, training courses and regional cooperation in the exchange of information and research and development findings. Country projects are oriented toward ensuring the supply of energy to industry as well as the establishment of industries to serve the energy sector. Assistance is also provided to help solve the energy problems of rural and small-scale industries. UNIDO's future programs will focus on[8]:

- Measures for improved use of indigenous energy resources, including new and renewable sources of energy
- Possible diversification of energy supplies
- Institutional measures for harmonizing national and regional grids
- Programs for improved energy management and energy conservation in industrial subsectors and processes, and investment programs.

The United Nations has recognized the need for consideration of the environment in these activities. Unfortunately, the United Nations Environment Program, the existing U.N. agency with responsibility for global warming initiatives, has a charter that makes it one of the weaker U.N. bodies. With a minimal budget, it is intended mainly to coordinate the activities of other U.N. organizations.

Similar to the World Bank, many ETIP activities will be complementary to United Nations initiatives. The ETIP offers a means of evaluating new, environmentally-clean technology options, and recommending those that are viable for further project development and implementation. The ETIP structure offers the possibility for cost-sharing with the United Nations Development Program on some projects related to environmental, energy efficiency, or innovative technology issues of energy/power sector development.

European Economic Community

The European Economic Community (EEC) is the sixth largest energy sector donor and energy is the EEC's largest sectoral program. The EEC provides assistance through the European Development Bank and the European Development Fund. Between 1981 and 1985, the European Development Fund provided energy assistance of $207 million European Currency Units (ECU). The EEC's energy assistance is heavily weighted toward projects in the power sector. Most energy assistance has been for capital projects (80 percent), while 7 percent has been for studies and assessments, and 2 percent for technical assistance. The EEC tends to concentrate its energy assistance on energy supply in urban areas, particularly electricity generation. A large number of hydroelectric power generating stations have been built, usually co-financed by the African Development Bank or the World
Bank. There has been little emphasis on meeting rural energy needs which will be addressed by the ETIP.

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[8] Ibid. Energy in West and Central Africa: Issues, Problems, and Donor Activities, Report No. 88-12B, July 1988.

U.S. Government

The U.S. Government does not provide direct financial assistance for oil, gas, or coal exploration in LDCs. The Export-Import Bank provides loans, guarantees and insurance for U.S. exporters of energy equipment. However, most of these initiatives are in countries that are not A.I.D. recipients. The Overseas Private Investment Corporation (OPIC) provides political risk insurance to U.S. investors in oil and gas exploration in LDCs. Political risk is often cited as the most important impediment to investment in oil exploration in LDCs. Political risk will also be a serious issue for ETIP initiatives to promote the use of U.S. goods and services and the involvement of U.S. industry in LDC energy/power sector upgrade and expansion.

The Department of Energy (DOE) has significant, ETIP-relevant energy programs under the Assistant Secretary, Fossil Energy and the Assistant Secretary, Conservation and Renewable Energy. The DOE also has an office at the Assistant Secretary level for Environment, Safety and Health. The DOE programs focus on high risk, high payoff research and development that U.S. industry would not fund. Transfer of the technology for further development and commercialization is left to the private sector.

In 1984, the U.S. Government founded a working group of federal agencies to bring together potential users, decision makers, funding sources, and U.S. industry to ensure that renewable energy technologies are considered for viable applications around the world. The group, the Committee on Renewable Energy Commerce and Trade (CORECT), provides a successful government/industry partnership:

- For U.S. industry - CORECT helps to increase sales and revenues and provides a base for support of further development of a near-term market for current renewable energy technologies;

- For host countries - CORECT links decision makers with an energy alternative that is environmentally acceptable, is conducive to local manufacture, and contributes to economic development, industrial growth, and energy-supply security goals.

CORECT has established an Integrated Electric Utility Program (IEUP) to assist developing countries achieve their electrification objectives; expand the use of U.S. renewable energy technologies where appropriate; strengthen institutional capability to implement renewable energy power projects; and encourage private sector participation[9]. The IEUP will focus on the use of renewable energy technologies for supplying electric power to consumers. Power distribution options will include fully interconnected grids, isolated grids, and dispersed power systems. Supply-side options that will be considered include all sizes of power generators, and all feasible energy sources. Demand-side considerations would include conservation, load leveling, and cogeneration. When the

[9]Draft Implementation Plan, Integrated Electric Utility Program, Committee on Renewable Energy Commerce and Trade, September 29, 1989.

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IEUP investigations indicate that non-renewable energy options should be implemented, then the utility will be directed to other programs specifically designed for those options such as energy end-use efficiency improvements, transmission and distribution loss reductions, or generation efficiency improvements. These programs include the A.I.D. Energy Conservation Program, the A.I.D. Electric Power Utility Efficiency Study, the Energy Efficiency and Strategy Unit of the UNDP/World Bank Energy Sector Management and Assessment Program, and programs supported by the Electric Power Research Institute. The ETIP will certainly be added to this list.

The IEUP is based on the belief that renewable energy power systems offer LDC electric utilities a technically viable, economic, environmentally benign, and reliable means of expanding the energy/power sector. Despite these advantages, very few LDC utilities have implemented projects. Foremost among the reason are:

- Utility planners are not acquainted with the technologies.
- Due to rapid technological improvements there is limited access to up-to-date performance data on renewable energy technologies.
- Utilities are not accustomed to designing, evaluating, implementing, or managing such projects.
- There are no familiar, widely available financing mechanisms for funding such projects or programs.

Funding sources for the IEUP activities have yet to be identified. CORECT has stated that it will actively seek the participation of multilateral donors, development financing institutions (DFIs), public and private power developers, and private investors in implementing IEUP projects. The ETIP, through its provision of project identification funds and planning services, could conduct studies that demonstrate the merits of investing in new, environmentally-sound renewable technologies.

It is fair to assume that the IEUP and the other DOE programs will have significant impact on the design and implementation of ETIP activities. There exists the potential for complementary ETIP/DOE activity and co-funding on specific projects.

4. Innovative Energy Technologies

A number of new technologies for generating electricity are being developed in the United States as alternatives to large-scale, long lead-time conventional powerplants. Of increasing interest are technologies which are capable of using alternative fuels, and/or which impose substantially lower environmental impacts than conventional generating options. Many of these technologies are either fully mature today or will be in the near future (mid-1990s). Among the power generation or conversion technologies that the U.S. is either the world leader or competitive in, and that most likely will be considered by ETIP, are:

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- o Solar Electric Systems (solar thermal and photovoltaic)
- o Wind Electric Systems
- o Geothermal
- o "Clean Coal" Technologies [atmospheric fluidized bed combustors (AFBC) and integrated gasification combined cycle (IGCC) units]
- o Slagging Combustors, and
- o Fuel Cells.

Table II-1 groups these technologies according to size and application. They range in size from units of less than 1 megawatt-electric (MWe) to units of greater than 250 MWe. The technologies are also grouped as those in which the electrical power is available upon utility demand (dispatchable) and those where it is not. Dispatchable applications are further broken down into their functional use - as base, intermediate and peak load applications. Applications where a utility cannot summon electrical power on command are divided into two general categories - intermittent, e.g. wind and direct solar equipment without storage capacity; and "other" technologies, where the utility has no control over the resource, e.g. geothermal, etc.

B. DETAILED PROJECT DESCRIPTION

1. Project Goal

The broad goal of the ETIP is to alleviate, by environmentally acceptable means, the supply/demand gap in energy sectors of developing countries.

2. Project Purpose

The purpose of the ETIP is to introduce innovative and environmentally-sound energy engineering technologies and management techniques which promote sustainable and cost-effective operation of electric generation, transmission, and distribution systems in developing countries.

3. Project Strategy

A.I.D.-assisted countries experience varying degrees of capacity shortfall in their electrical power generation sectors. In the recent past, a narrow focus on the growth of energy capacity to meet an increasing energy demand, when combined with low or subsidized electricity prices, resulted in the installation and operation of systems or technologies that use energy inefficiently or in an environmentally unacceptable manner. Most LDC energy Ministries lack knowledge and expertise on commercially available energy technologies that can be used for electric power generation or to increase efficiency across the broader energy sector. Third World energy Ministries are often "salesmen driven," i.e. they are knowledgeable about off-the-shelf hardware, and in many cases older hardware, that foreign companies wish to sell when their home markets have declined. The tendency for the Ministry is to close their country's energy demand gap by conventional means. A consensus has developed in the scientific, donor, and environmental communities, that energy efficiency improvements represent the most important near-term response for LDCs to

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Table II-1 – Selected Alternative Power Generating Technologies: Typical Sizes and Applications

Installation Size (MW)	Dispatchable Applications (a)			Nondispatchable Applications (b)	
	Base Load (60-70% CF)	Intermediate Load (30-40% CF)	Peaking Load (5-15% CF)	Intermittent (w/o storage)	Others (not utility owned)
Greater than 250 MWe	Coal gasification/ combined cycle ..... Conventional Coal	Coal gasification/ combined cycle	n.a.		
51-250 MWe	Geothermal Atmospheric fluidized-bed combustor ..... Combined-cycle plants	Atmospheric fluidized-bed combustor Solar thermal (w/storage) ..... Combined-cycle plants	Solar thermal (w/storage) ..... Combustion turbine	Solar thermal Wind 	Atmospheric fluidized-bed combustor Solar thermal (w/storage) .....
1-50 MWe	Geothermal Atmospheric fluidized-bed combustor Fuel cells	Fuel cells Solar thermal (w/storage)	Fuel cells Solar thermal (w/storage) ..... Combustion turbine	Solar thermal Wind Photovoltaics	Atmospheric fluidized-bed combustor Solar thermal (w/storage) Geothermal Fuel cells ..... Combustion turbine
Less than 1 MWe				Solar thermal Wind Photovoltaics	Fuel Cells

NOTES: For each unit size and application, new technologies are shown above the dotted line and conventional technologies are shown below the dotted line.
CF = capacity factor and n.a. = not applicable
(a) Dispatchable technologies may not be utility-owned
(b) Note that nondispatchable technologies may serve base, intermediate, or peaking loads.

SOURCE: New Electric Power Technologies: Problems and Prospects for the 1990s, Office of Technology Assessment, OTA-E-246, July 1985

provide an increased supply of energy in a socially and fiscally responsible manner. Further, power sector capacity expansion must include the use of innovative clean power generation technologies in all new power generation units to ensure a minimal effect on the environment.

The ETIP is structured to address these issues. The four main project objectives are as follows:

- Implementation of Clean Energy Technologies
- Innovation in Energy Efficiency and Power Generation, Transmission and Distribution
- Technology Transfer to Rehabilitate Current Systems
- Improvement of Power Sector Institutional Structures

To satisfy these objectives, the ETIP will fund engineering services and the introduction of innovative, proven, efficient, and environmentally benign advanced U.S. energy conversion technologies; the implementation of energy system control and management techniques; technology transfer/training and workshops at management and staff levels; and assessments of indigenous energy resources and energy system applications. The approach to be taken is:

- responsive to the Congressional mandate provided in the November 1989 House of Representatives' Report 101-344,

- consistent with the March 1988 A.I.D. report that identified the magnitude and impacts of power shortages in developing countries, and

- supportive of recommendations made by the recent Energy Industry Review Group formed by the Administrator of A.I.D. to further review the problem of power shortages.

Specific technologies and methodologies will be chosen on a country specific basis for:

- their applicability to indigenous energy resources,

- the improvement of existing systems throughout the power sector,

- minimum impact on the environment, and

- economic suitability to the specific conditions in the developing country.

ETIP activities will be conducted in Africa, Asia/Near East, and Latin America/Caribbean regions; most likely in the countries of Morocco, Egypt, India, Pakistan, Indonesia, Thailand, Philippines, Costa Rica, Guatemala, and the Dominican Republic[10]. Other countries will

[10]Project Concept Paper: Energy Technology Innovation Project (ETIP), 936-5741, December 1989.

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be added as needs arise and technical assistance requests are made by UNSA.I.D. Missions, Regional Bureaus, and developing country governments.

ETIP activities wili initially focus on the power generation, transmission and distribution sectors (in general parastatal utilities) while being sensitive to the impact and implications of development on the broader energy sector, i.e. various other government institutions, industry, and the commercial and residential private sector. As the ETIP expands, and other Office of Energy projects implement their project elements, activities will include elements of the broader energy sector, as well as initiation of, and possible co-funding for, specific subprojects that deal directly with the power-generating part of the private sector. For example, a subproject under the PSED Project may fund a joint venture to develop and implement an integrated gasifier combined-cycle (IGCC) natural gas fired power plant in an LDC. The ETIP could fund a subelement of the effort to ensure that the design will accept a mixed fuel capability for burning indigenous coal or biomass in an environmentally benign manner in the future when gasifier technology is mature and natural gas prices rise.

4. Project Elements

a. Country Indigenous Resource Assessment

An initial component of the ETIP will be the conduct of resource assessments to determine the potential for development and utilization of particular technology options. Resource assessments will be a key determinant in selection of new innovative technology alternatives since an important component of ETIP is to use indigenous resources to the greatest extent possible. In this activity ETIP could: collect, review, compile, and summarize existing geological/geophysical/solar data related to prospects for funding and developing conventional and nonconventional energy resources in a target country; fill-in data gaps that might exist through techniques such as geological maps and satellite images; assist in processing and interpreting collected data; and monitor host country resource evaluation activities.

b. Country Energy System Applications and/or Market Assessment

The ETIP will assist countries in conducting market/application assessments for new technology options. These assessments, which will vary by country, could include; identifying appropriate applications for a given technology by end-use sector in a country; determining technical/market potential by technology/application combination; determining the economic benefits of a technology from a national/local level in terms of energy savings, employment, revenue, etc., identifying the policy, regulatory and institutional barriers to deployment of a given technology option; and developing recommendations for addressing impediments and streamlining technology utilization.

c. Prefeasibility Studies

The ETIP will establish a Project Identification Fund to provide financial assistance in evaluating projects that could potentially involve innovative, environmentally acceptable and clean technologies in the developing world. The Fund would be used to determine the

technical, economic, financial, legal and institutional viability of a proposed subproject opportunity. The Project Identification Fund would be available to firms in the U.S. and developing countries, as well as to host country government agencies. Possible criteria for providing prefeasibility funds could include: the host country's willingness to support the subproject, contribution to environmental concerns, procurement potential, demonstrated availability of funds to conduct detailed feasibility study (as needed) and subproject implementation, demonstrated facilitative role of A.I.D. funds in leading to subproject implementation, conduct of subproject in an A.I.D. assisted country, and the demonstrated soundness/capabilities of Fund applicants.

d. Missions for Development and Implication of Innovative Approaches to Technology Transfer Training

Technology transfer activities are country - specific and industry specific in that they must be tailored to the existing technological circumstances and energy sector needs of a specific country. The size, even the physical characteristics of any country's urban and rural energy markets and the public sector rules which govern energy sector operations, are unique. They will require formal analysis in order to design the marriage of new technologies and their associated training activities to fit the existing country energy setting. Missions to countries to examine and characterize the energy sector, and to determine what new technology is appropriate for transfer will be undertaken. The energy sector parameters will be assessed. Energy sector relations to future development priorities will be determined. Technology "levels" will be analyzed and the physical system attributes will be characterized. Technical institute strengths and resources will be considered. Opportunities for public and private sector participation in technology transfer and training activities will be developed. The result of all of these initiatives will be the emergence of a country's energy sector technological profile and the areas where ETIP activities can provide significant resource strengthening. New technologies will be identified and matched against their potential to determine the probability of success. The profile, and the technology transfer activities identified, will be offered to the host country by A.I.D. as potential energy sector upgrades for the host country to consider.

e. Missions of Management/Operational Assistance Workshops for Institutional Development

With the emergence of a country's energy sector "profile" - a composite of energy resource availability, use patterns, current and projected energy needs reflecting future development growth requirements, and institutional resources - management training and operational assistance opportunities - will become obvious. ETIP proposes to meet these needs through the improvement of the energy management sector. Management's operation of new technologies throughout the energy delivery system will be maximized, ensuring that the use of new technology is in harmony with management capabilities and understanding. Institutions will be strengthened through such activities, enabling them to be rigorous diagnostic and delivery tools for energy sector demands and their ultimate satisfaction. Analytic and implementation workshops and seminars will be designed to meet the country -specific socio-cultural and institutional energy sector needs when these are confronted with new technological realities.

f. Technical Assistance to Provide New, Innovative Engineering Studies

The ETIP provides a range of technical assistance services, primarily to host country power/energy end-users. In particular, technical assistance can be provided on issues pertaining to improvements in energy efficiency; the application of new, innovative technology options to existing/planned power systems; and the deployment of computerized management and control systems.

g. Special Studies

Studies of potential financing assistance programs, rural impact assessments, social costs examinations, or macro-level socioeconomic studies which relate energy availability and use to socioeconomic change, would be undertaken. Studies would allow proactive energy planning, which would strengthen productivity growth trends and ultimately per capita incomes.

All ETIP activities will have components that focus on creating an institutional framework for sustainable socioeconomic growth and development throughout the broadly defined energy/power sector of LDCs. The ETIP will accomplish its objectives by the completion of the following centrally-funded project elements throughout the 10-year life-of-project:

Project Elements	Estimated Number Total	Estimated Number FY 90-92
Country Indigenous Resource Assessments	20	10
Country Energy System Applications and/or Market Assessments	15	6
Prefeasibility Studies	25	7
Missions for Development and Implementation of Innovative Approaches to Technology Transfer/Training for Power Sector System Implementation and/or Rehabilitation	25	8
Missions for Structuring and Conduct of Management/Operational Assistance Workshops for Institution Upgrade and Development	20	6

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Technical Assistance to Provide New, Innovative Engineering Services to the Energy/Power Sector	25	9
Special Studies	30	7

The relationship between ETIP's four main objectives and the above project elements is defined in Section 3 below, as well as in Part IV.A, Implementation Plan; Part IV.C, Budget and Schedule; and Annex A, Logical Framework Matrix. Budget estimates to determine the approximate level of activity in each project element are based on the Office of Energy's past experience with similar activities under existing projects.

It is not anticipated that the ETIP will involve activities affecting the physical environment, because the Project will finance only indigenous resource/application assessments, technical assistance, training, information dissemination and prefeasibility studies. However, the construction of actual electric power generation, transmission and distribution facilities, which are out of scope of the ETIP, may have significant impacts on the environment. Therefore, the ETIP will provide appropriate training and technical assistance activities to address environmental concerns.

3. Expected Achievements and Accomplishments

Illustrative accomplishments under some of the four major project objectives are given below. They support two of the A.I.D. Office of Energy goals: (1) to reduce economic instability resulting from the cost of oil imports, and (2) to increase consideration of environmental criteria[11]. Support is broadly provided through:

- expanded use of indigenous energy, both fossil and renewable;
- increasing the efficiency of energy generation, transmission, and distribution systems;
- integrating environmental criteria into the energy planning process;
- encouraging efficient energy conversion;
- promoting the use of less environmentally damaging energy sources and conversion processes when cost-effective.

ETIP tasks will draw on a mix of project elements to satisfy the requirements of a specific activity in a LDC. Each task will most likely select a different set of project elements because of country-specific needs, priorities, and emphasis related to the introduction of a new technology/methodology into the energy/power sector.

[11]A.I.D./S&T Program Plan, Fiscal Years 1989 and 1990, Report No. 89-08, June 1989.

A typical ETIP task that would, for example, support the objective to implement clean energy technologies in a specific LDC, would most likely be structured as follows:

(1) **A Definitional Mission could be conducted** to broadly assess indigenous energy resources and possible system applications for the technology

(2) If warranted, **the Definitional Mission will be followed by a Resource Assessment and a visit(s) by a Technical Assistance Team(s)** to develop conceptual system designs and preliminary implementation procedures and schedules

(3) **Workshops** structured to support necessary institutional development and operational training **could be conducted if required**

(4) **The ETIP Project Identification Fund could finance a prefeasibility study** to:

   (a) further quantify the potential for successful implementation of the technology that was anticipated by results from the Definitional Mission and workshop/training activities, and

   (b) to refine the system design and implementation procedure and schedule.

(5) If all indications for need and success of the technology are positive at this time, **the country Mission would be encouraged to buy-in to the effort** by funding (and/or securing other donor agency co-funding):

   (a) the participation of long-term advisors, and

   (b) the purchase of monitoring and/or control hardware, software development and implementation, etc. for application feasibility testing.

The centrally-funded part of this process could typically take 2 years over which ETIP would expend approximately $500,000 to $700,000. The Mission buy-in would most likely be significantly more than this dollar amount (possibly in excess of $1 million), depending on the number of application feasibility projects, the length of the projects, and the monitoring/control hardware/software system cost. Mission buy-ins could be used to finance long-term studies, long-term staffing assignments, technology pilot projects/demonstrations, and computer software for data analysis.

The following paragraphs describe some typical activities for the four main ETIP objectives, with an estimate of total central funding and expected Mission buy-ins.

Clean Energy Technologies

- **Develop indigenous energy resources such as natural gas and municipal solid wastes for environmentally sound use.** An example of this type of initiative would be the use of gas turbines for the generation of electricity. The traditional use for gas turbines in the U.S. power sector has been for peakload duty at relatively low capacity factors. In some developing countries, like Egypt for example, gas turbines are used for small electric grid application usually near oil fields where the gas is normally flared. Recent U.S. technology developments has increased the design inlet temperatures of gas turbines and thereby increased their reliability and improved their performance. These improvements, coupled with low gas prices and short construction schedules for small gas-fired turbine installations, have caused some utilities to consider the use of gas turbines to provide cheap baseload electricity. This technology can be transferred to developing countries.

  These activities will be supported with estimated central funding of $3 million and Mission buy-in funding of $4 million.

- **Promote advanced technology in developing countries by performing prefeasibility studies in clean coal technologies such as integrated coal gasification combined cycle technology and fluidized bed combustion systems in industrial and electric power generation.** An example of this type of initiative would be the technology transfer of the opportunity for retrofit of the gas turbines described above with coal gasifiers in an integrated combined cycle configuration if and when gas prices increase. A highly integrated gasification and power plant result in a more efficient and cost-effective arrangement compared to currently normally separated units. The implementation of fluidized bed combustor technology offers greater fuel flexibility and enhances the acceptability of a wide range of solid fuels and fuel mixes of varying characteristics, such as the municipal solid waste feedstocks mentioned above.

  These activities will be supported with estimated central funding of $5 million and Mission buy-in funding of $6 million.

- **Conduct prefeasibility studies on well-head geothermal, hydropower, and other alternative non-fossil fuel energy developments in selected developing countries.** These technologies have emerged, or are rapidly emerging, as cost-effective, reliable alternative energy sources for a growing number of applications. Power conversion systems are often transportable or modular, and sized to both resource availability and estimated demand levels at a particular site. Competitive cost-of-electricity rates for modular geothermal units raise the possibility of commercial ventures in LDCs using such units. In Africa, Djibouti, Kenya, Tanzania, and Zambia are currently exploring geothermal resource development for electricity production. These projects will providing "lessons learned" for ETIP prefeasibility studies on alternative fuel developments in the Third World. Hydropower technology has also developed within the United States to the extent that small-scale, cost-effective facilities will enable

presently untapped hydropower resources to be used. These technology advancements support prefeasibility studies under ETIP to address the present potential for technology transfer to LDC settings.

These activities will be supported with estimated central funding of $2 million and Mission buy-in funding of $3 million.

Innovation in Energy Efficiency and Power Generation, Transmission and Distribution

o **Apply innovative, commercially proven technologies, including computer based tools, for energy conversion, environmental protection and energy system management and rehabilitation.** Efforts to reduce the consumption of traditional fossil fuels in the United States since the 1970s have produced a large number of computerized energy management and control techniques, cleaner fuel sources, and more efficient power production processes. The rationale has been to minimize inputs and maximize the use of indigenous fuels to increase energy capacity in environmentally benign ways. As a result of these efforts, the United States has successfully created a technology and knowledge base that is often appropriate to Third World needs. These new technical "tools" are responsive to a variety of power sector characteristics found in A.I.D.-assisted countries to balance the requirements of energy supply and demand which can fluctuate so dramatically throughout the year. ETIP activities in this area will enable LDCs to rehabilitate existing facilities at lower cost while achieving significant improvements in system performance and narrowing the gap between power demand and supply.

These activities will be supported with estimated central funding of $4 million and Mission buy-in funding of $5 million.

Technology Transfer to Rehabilitate Current Systems

o **Foster exposure to U.S. energy equipment manufacturers, engineering firms, utilities, and other firms with knowledge and experience in the technologies of the energy sector and thereby stimulate future trade opportunities.** Five areas where the U.S. energy sector clearly has a competitive advantage over foreign competition include[12]:

- Advanced clean coal and certain other energy resource and conversion technologies; such as wind, solar, and various advanced fuel preparation and combustion methods

- Computer hardware/software management information systems and process control systems

- Financial engineering

[12]A Potential Role for Selected U.S. Energy Technologies in India, A.I.D. Conventional Energy Technical Assistance Project, Bechtel National, Inc., Prepared in 1989.

- Management services for complex energy infrastructure projects

- Power plant rehabilitation and extension of system lifetimes.

These technical areas are directly relevant to the promotion of systems efficiency and environmental safeguards in the development of power sector systems. Power sector organizations in the United States, such as the Electric Power Research Institute (EPRI), could be encouraged to coordinate their research methodologies and share their technical expertise with Third World electrical utilities. This collaboration would facilitate pioneering R&D and commercialization, and ensure high-quality technical management and operation in the successful implementation of energy efficiency studies, environmentally sound technologies, and restructured institutional and policy environments. Innovative approaches to power sector improvements could be implemented within developing countries which were members of this international "EPRI-like" network of electric power utilities. Ultimately the network would have the effect of exposing U.S. technology and firms to international market opportunities thereby introducing advanced U.S. electric power technologies to areas of the world vitally in need of them.

Central funding for these activities is estimated to be $2 million for the life of the project.

Improvement of Power Sector Institutional Structures

o **Increase the efficiency of operation in the energy/power sector through workshops for management personnel and through the streamlining and rehabilitation of institutional organizations in developing countries.** The previously mentioned international electric power sector research institute would facilitate the expansion of more efficient energy/power sector operations among LDCs through technical and management-oriented mechanisms such as workshops, seminars, short-courses, interactive disk instructional methods, videotapes, and "desk top" publications targeted to specific country settings. Culturally appropriate personnel management strategies could be introduced to fit the requirements of LDC utilities. Institutional structures would be examined for opportunities for operational "streamlining" and more responsive leadership structuring.

These activities will be supported by central funding of $2 million and an anticipated $1 million buy-in from Missions over the life of the project.

o **Work with U.S. companies proven in "down stream" involvement with developing countries to design power projects and assist in their implementation involving the private sector.** Many U.S. companies that deal with the energy/power sector have become interested in international trade relatively recently. Competition is intense in many areas. Foreign governments and financial institutions have been more willing that the U.S. government to initiate financial packages for sale of goods and

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services that are attractive to LDCs. The ETIP will support U.S. companies seriously wishing to enter the international markets through project initiatives designed to bring together local host country firms with U.S. counterparts and through initiatives to encourage financial institutions to join in international market development and sales.

These activities will be supported with estimated central funding of $2 million and Mission buy-in funding of $1 million over the life of the project.

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PART III - PROJECT ANALYSIS SUMMARY

A. TECHNICAL ANALYSIS

New technologies for generating electricity that are being developed in the United States as alternatives to large-scale, long lead-time conventional powerplants include: solar electric (solar thermal and photovoltaic); wind; geothermal; atmospheric fluidized bed combustors (AFBC) and integrated gasification combined cycle (IGCC) units (two of the so called "clean coal" technologies); slagging combustors; and fuel cells. These technologies are of increasing interest because they are capable of using alternative fuels, and/or they impose substantially lower environmental impacts than conventional generating options. Many of these technologies are either fully mature today or will be in the near future (mid-1990s). In general they promise the following advantages over conventional power generation technologies:

- Free, secure, widely available and renewable energy source
- No off-site, fuel-related impacts
- No fuel supply infrastructure required
- Wide range of installation sizes with short lead-times
- declining costs
- Relatively small water needs
- Little or no routine emissions
- Siting flexibility.

The parabolic trough is a mature solar electric technology, with commercial units operating, under construction, and planned. Collectively trough systems are generating 134 MW of power in the United States. Important advantages are the technology's commercial experience, resultant low risk, inherent storage capacity, and the relatively wide range of markets other than electricity generation to which it could be applied, e.g industrial process heat applications.

Photovoltaic (PV) and wind electric systems have proven themselves to be viable, cost-effective supplements to traditional sources of energy for a wide range of applications. Wind electric systems can be used for central power generation of electricity. Stand-alone PV and wind electric systems offer reliable and readily available power for remote villages and for other inaccessible locations where a need for dependable power is crucial.

Geothermal energy is one of the most reliable energy sources available. It is also a very large and widespread resource which is making a significant contribution to the production of heat and electricity in the U.S. and has a very promising future to do the same worldwide. Successful extraction of geothermal energy requires both drilling and the application of the geosciences - geology, geophysics, and geochemistry. These technologies are used at every stage of geothermal development - exploration, resource confirmation and characterization, and field management. The U.S. geothermal industry is clearly among the world leaders in all these technologies.

In recent years, the focus of the "clean coal" program in the United States has shifted to the development of new approaches for combustion, the most important of which are the fluidized bed combustion (FBC) and gasification systems. These technologies provide higher conversion efficiencies and inherently lower emission levels that do not require expensive post-combustion pollutant control. The two "clean coal" technologies that have the greatest immediate application to developing countries are Atmospheric Fluidized Bed Combustors (AFBC) and Integrated Gasification Combined Cycle (IGCC) power plants. The AFBC has reached commercial status in the industrial and cogeneration sector on a world-wide basis. More than 70 industrial applications, burning a variety of fuels from cow manure and tree bark to coal and oil shale, are in operation.

A combination of lead time and risk make widespread deployment of the IGCC technology somewhat uncertain in the early to mid-1990s. Because of its modular nature and positive environmental features, the IGCC should have a deployment lead time of no more than 5 to 6 years once design and construction of commercial plants is commonplace. There could emerge an impetus to build these plants in developing countries; motivated by the availability of large quantities of low cost, off-shore gas supply, as there has been in India.

The fuel cell industries in the U.S. and Japan are positioning themselves for substantial commercial deployment of fuel cells in the 1990s. As much as 1200 MWe of fuel cell power plant capacity could be on-line by 1995. High-volume mass production is unlikely to occur until a sizeable market is anticipated.

B. ECONOMIC ANALYSIS

The purpose of economic analysis for the Energy Technology Innovation Project is to determine whether the ETIP will be a worthwhile investment for the affected countries. The analysis estimates whether the outputs from the Project are sufficiently valuable so as to cover the ETIP costs. Economic analysis differs from financial analysis in that it examines the full effects of a project on a country's economy. While financial analysis examines only the explicit monetary costs and benefits of a subproject, economic analysis examines hidden opportunity costs and benefits to the project participants. The general principle of economic analysis is to compare the actual benefits of a project to its actual total costs.

In performing the economic analysis for the Energy Technology Innovation Project, it must be recognized that because the project limits its funding to prefeasibility studies, training, and technical assistance, no specific actual subprojects, e.g. power plants can be analyzed. Additionally, among these funded items, it is not realistic to attempt to quantify the economic benefits of the training sessions, seminars, and technical assistance. Although these items may provide long term benefits there is no way to quantify these. Thus, the economic analysis focuses on illustrative expected economic benefits of the subprojects that may be facilitated by the use of the ETIP Project Identification Fund. In particular, the analysis attempts to quantify the cost of power shortages in developing countries given the general loss of productivity due to the frequent loss of power. Each new kilowatt-hour (kwh) of electricity produced as a result of the ETIP Project Identification Fund serves to

reduce the cost of power shortages in developing countries. Therefore, the economic benefits of the ETIP Project can be calculated by measuring the savings accumulated from increasing the electrical generating capacity in developing countries.

The analysis suggests that the economic returns to the ETIP Project Identification Fund are positive and that the prefeasibility studies are economically viable. The Net Present Value (NPV) for the project is estimated at $766 million dollars, with a corresponding benefit/cost ratio of 1.48. Since each of these economic measures exceeds zero the economic viability of the prefeasibility fund is demonstrated.

C. SOCIAL ANALYSIS

The ETIP can have an important direct or indirect effect on a LDC's social setting because of the universal applicability of energy to human activities. If energy becomes more reliable, more readily available, and arrives cleaner in environmental or in actual terms, the social impact will be significant. Commerce could be extended in urban areas. Education and training of all groups of peoples, from rural and urban school children to illiterate farmers would be a significant result. Rural medical personnel, women and families laboring for water supplies, and for irrigation needs, could all benefit if the energy sector were strengthened. Per capita productivity would increase. The indirect effects would be to slow deforestation trends and reduce environmental pollution resulting from inefficient energy use in homes and industry. A sense of social stability could emerge, a predictability to life that will support planning and development generally.

D. ENVIRONMENTAL ANALYSIS

A narrow focus on the growth of power generation capacity to close the gap between power supply and demand in LDCs has resulted in the implementation of power systems using fossil fuels and other energy-related conversion technologies that use energy inefficiently or in an environmentally unacceptable manner. Often the decision is a short-term economic one. Indigenous resources such as high sulfur coals or crude oil are used to minimize the expenditure of hard currency for fuel import. In many cases, Third World energy Ministries are not knowledgeable about technology advances that can reduce emissions from conventional power plants or that provide alternative power generation, transmission and distribution systems to reduce energy waste and negate the need for capacity growth.

The projected expansion of electric power generating capacity in developing countries will pose serious environmental problems worldwide unless appropriate measures are taken to mitigate such impacts in the planning and implementation stages of development. The construction of these facilities will impact the air, water, ecological, and social resources of the host LDCs. The significance of the impacts will depend on the type of power plant, the type of fuel used, the extent of power plant development and the response of the local environment to various emissions.

The ETIP is an energy development initiative that addresses the implementation in LDCs of energy/power technology, equipment, and services that support sustainable economic growth in ways that are environmentally sound. The ETIP supports assessment and system

development to employ advanced, innovative power generation, transmission, and distribution technologies developed and proven in the U.S. to efficiently use indigenous energy resources in LDCs and improve existing systems. The U.S. continues to be a world leader in scientific and engineering aspects of energy production, conversion, transport and use, as well as in the areas of management, systems analysis, and commercialization. U.S. government expenditures in energy R&D exceed that of any other nation in the world. The U.S. is pre-eminent in essentially all areas of clean and efficient energy development that promise an alternative to large-scale, long lead-time conventional fossil-fired power plants.

E. FINANCIAL ANALYSIS

The purpose of financial analysis for the Energy Technology Innovation Project is to determine the value of the project as a self contained entity. Financial analysis is only concerned with determining whether the directly quantifiable monetary benefits from the project are larger or smaller than the project's costs. The broader analysis of indirect, opportunity, and social costs is undertaken in the economic and social analyses.

Financial analysis for the Energy Technology Innovation Project was conducted for two purposes:

1. To assess the financial returns to A.I.D. resulting from its support in this project.

2. To assess the expected financial returns to the utilities, private firms, donors, and others that will ultimately result from projects and/or technology investments operated as a result of ETIP.

A.I.D. Financial Analysis

As is common in any foreign aid program that seeks to transfer resources to developing countries, the financial returns to A.I.D. for its participation in the Energy Technology Innovation Project are not expected to cover the costs of the program. In terms of project costs, A.I.D. and other donor agencies will provide an estimated $40 million in funding for the ETIP Project. In terms of project revenues, direct financial returns for this investment are very limited; they can only be measured as a result of investments made that can be linked to the prefeasibility studies. For its $40 million investment, A.I.D. and other participating agencies will receive approximately 25 prefeasibility studies, 20 country resource assessments, 15 application/market assessments, 50 definitional missions and/or technical assistance visits, 20 workshops, and 30 special studies.

Project Identification Fund Financial Analysis

Although the direct returns to ETIP are nonexistent, the prefeasibility studies conducted by the project are expected to yield significant investments in innovative, clean energy technologies. A hypothetical assessment of the financial returns of these investments was performed to demonstrate the possible benefits of ETIP. The results of this illustrative example indicate that if the ETIP Project Identification Fund generates 10

projects/investments with a profit (in present value terms) of $6 million each, then the overall value of the ETIP Project would be an estimated $48.95 million. Under the assumptions of the analysis conducted in Annex G each of the 10 projects needs to have a lifetime present value profit of only $1,105,000 to cover the initial costs of the ETIP Fund. Furthermore, in this example, the net profits exceed the full cost of the entire ETIP (as opposed to just the Project Identification Fund) of $40 million.

F. TECHNOLOGY TRANSFER/TRAINING

A major component of the ETIP is its emphasis on sound measures for transferring innovative energy technologies from the United States to the host countries where A.I.D. is present. This implementation of ETIP's strategies will be undertaken via numerous carefully considered mechanisms which are appropriate to the country setting in question. Each country's technology needs and training requirements will be unique, thus requiring the development of individualized implementation plans and mechanisms. ETIP's technology transfer and training strategy consists of two related but separate components: a)innovative technology and equipment integration with the country's existing energy structures, and b) training activities designed to complement existing skills and energy management resources and practices.

The March 1988 report to Congress on "Power Shortages in Developing Countries..." specified "adequate and reliable electricity is essential for continued development of the Third World," the provision of which could be accomplished through conservation strategies, the expansion of existing electricity generating capacity using environmentally sensitive technologies, and stable distribution systems brought about through sound management practices. The United States leads in several areas of energy technology which are relevant to these needs in the Third World. The use of these technologies will a) be beneficial to the countries in question, b) be sensitive to the needs of the global environment,and c)increase the benefits of technology transfer to the Third World.

Specific selected areas of new technology in which the United States maintains a strong competitive position include those mentioned elsewhere in the Project Paper, but, briefly, include several renewable energy technologies, clean coal technologies, slagging combustors and fuel cells, among others. Further, energy management hardware and software are now available from U.S. firms which allow for planned energy conservation strategies to be adopted. Collectively, these will facilitate the rational use and the stabilization of existing and future energy technologies in LDC settings, a prime objective of this project and a priority for almost every Third World country.

The second major component of ETIP's project design is the provision of energy training. This training will be different for each country, as needs dictate and as energy circumstances warrant. Training will allow the effective integration of new technologies and energy management strategies into the prevailing energy setting in each country. It would work to "graft into" existing uses and practices the new technologies and management approaches that will expand, secure, and stabilize present electricity production systems. Training will range widely in format, and will be targeted at senior-level energy planners and administrators, at middle-level engineers and technical personnel, and at others who are

relevant and who can favorably influence energy production, pricing, conservation, distribution and use in the host country. Carefully designed project activities within the ETIP framework, developed in concert with existing energy conditions and future energy development strategies, will integrate these new technologies and their corollary requirements for the potential--if partial--resolution of energy and environmental needs. Some possible initiatives are:

- Studies to define markets for the sale and installation of new U.S. clean energy technologies and services;
- Joint energy sector analyses conducted in concert with existing host-country research institutions to determine areas where ETIP activities will promote efficiency, conservation, and the adaption of new technologies;
- Operations oriented "hands-on" training seminars;
- Comparative or cost-benefit studies which reveal the potential gain of new technologies and their efficient integration and management.

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PART IV - IMPLEMENTATION PLANNING

A. IMPLEMENTATION PLAN

1. Description of Responsibilities of Participants

a. A.I.D. Office of Energy

The ETIP will be administered by a Project Officer in the Office of Energy who will be directly accountable to the Director of the Office of Energy. The Project Officer will provide centralized project supervision and a mechanism for dissemination of project results as needed in the broader policy and programming process. The Office of Energy will coordinate the efforts of the other A.I.D. Bureaus, Missions, multilateral banks, government agencies, and representatives from private industry, in order to achieve the project's objectives in an efficient manner. The Project Officer in the Office of Energy will be responsible for managing the project and ensuring that objectives are met. The Project Officer will also be responsible for management, supervision and oversight of the two new and separate contractors envisioned under the ETIP. These are the Technical Assistance Contractor and the Project Identification Fund Contractor.

b. Technical Assistance Contractor

The Technical Assistance Contractor will be responsible for providing developing countries worldwide with a range of technical assistance services including, identification, evaluation, and development of energy resources, as well as the utilization of these resources through the application of new, innovative, and environmentally sound technology options. The Technical Assistance Contractor will provide day-to-day project management and coordination, and will work in close cooperation with the Project Officer. The requirements placed on the Contractor will be diverse in nature, necessitating the services of specialists in numerous disciplines. These include architect and engineering (A&E) services, economic/financial analysis, market assessments, technology assessments, technical assistance, technology transfer and training, and overall project management. In this regard it is anticipated that the Contractor will utilize a wide variety of individual consulting specialists and subcontractor firms. Selection of such subcontractors will be made by the Contractor with the approval of A.I.D.

The Contractor will maintain a staff of technical experts and administrative personnel, and will have a number of responsibilities:

- Administrative Activities
  - Develop work plans.
  - Conduct arrangements for securing the services of consultants and subcontractors as required.

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- Maintain a Management Information System to track project activities and financial information.

- Report to the cognizant Project Officer for ETIP, who will obtain policy guidance from the ETIP Steering Committee.

- Obtain Project Officer authorizations and technical directives for task activities, as appropriate.

- Assist the Project Officer in coordinating with other relevant activities within the Office of Energy and other A.I.D. bureaus and missions.

- Assist in obtaining mission buy-ins to ETIP.

o Technical Activities

- Organize indigenous resource assessments.

- Organize country energy system application/market assessments.

- Arrange workshops for institutional upgrade and development.

- Organize technical assistance missions to provide new innovative engineering services to the energy/power sector.

- Organize special studies.

- Organize and provide support to the ETIP Steering Committee.

- Assist the Office of Energy, as needed, with prefeasibility studies funded through other projects in the Office of Energy.

Work to be conducted by the Technical Assistance Contractor will be identified through three vehicles: (1) mission requests; (2) sending teams in-country to determine engineering service requirements; and (3) identification of potential project opportunities by the A.I.D. Project Officer who works in close cooperation with other donor agencies.

c. Project Identification Fund Contractor

The Project Identification Fund will be established to provide U.S. private sector firms with financial assistance in conducting subprojects that could potentially involve innovative, environmentally acceptable technologies in the developing world. This Fund provides planning assistance services related to specific subproject opportunities, whereas the Technical Assistance Contract (above) provides more general technical support services.

To obtain financial assistance eligible U.S. firms will apply to the Fund using a standardized application form. Selected awardees will be provided with a subcontract by the Project Identification Fund contractor to perform the work agreed upon in a manner consistent with A.I.D. policies and directives. It is anticipated that the Project Identification Fund may not cover the full costs of prefeasibility studies and other project planning services. Organizations such as the World Bank, other multilateral donors, and U.S. government agencies are expected to contribute an additional 25% of the costs associated with conducting these activities.

The Project Identification Fund Contractor will be responsible for coordinating activities associated with the Fund worldwide. The Contractor will: capitalize the Fund; conduct an periodic solicitations for Fund proposals; evaluate proposals; organize a Peer Review Committee to review Contractor decisions on Fund awards; prepare a "Standard Form Agreement" for Fund recipients which will be developed in consultation with the Office of Procurement and the Office of the General Counsel for execution by the recipient; and manage, distribute, and account for funds provided to the recipients. Additionally, the Contractor may issue solicitations under the Fund for assistance in evaluating a specific project opportunity that may arise in an A.I.D.-assisted country.

The Project Identification Fund Contractor must demonstrate organizational, managerial, and administrative support ability to manage a contract of this magnitude, including expertise in subcontract management, financial analysis, and management information systems/analysis. Additionally, the Contractor will need to have access to the technical skills required to effectively review and evaluate proposals submitted to the Fund. The use of consultants and/or subcontractors is encouraged to ensure access to the diverse disciplinary skills that may be necessary for proposal analyses.

The Project Identification Fund will be modeled after the experience of the Trade and the Development Program. Non-reimbursable funds will be made available to selected subproject recipients through application to the Project Identification Fund Contractor under ETIP. Funds will be disbursed to conduct a range of project planning services related to the development of specific subproject activities. These could include, but are not limited to, definitional studies, technology transfer/training, prefeasibility studies, and technology orientation missions.

The Project Identification Fund Contractor will make periodic announcements in the Commerce Business Daily and other appropriate journals of the availability of funds and a request for applications. The announcement will contain the following:

- Description of the Project Identification Fund and its purpose.
- Priority areas of interest for funding subprojects.
- Proposal selection criteria.
- Proposal evaluation and review procedures.

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- Schedule for submitting applications.

The selection of assistance recipients will be made by judging them against the evaluation criteria, similar to the traditional grant selection review. In this approach Fund applicants are evaluated against one another on a first-come, first-serve basis until the monies are totally committed each year. Evaluation criteria proposed for the Fund include: host country's willingness to support the subproject, contribution to environmental concerns, procurement potential, demonstrated availability of funds to conduct detailed feasibility study (as needed) and subproject implementation, demonstrated facilitative role of A.I.D.funds in leading to subproject implementation, conduct of subproject in A.I.D.-assisted country, and the demonstrated soundness/capabilities of Fund applicant.

d. Other A.I.D. Missions and Bureaus

The expertise and knowledge of the Bureaus and Missions of the current conditions in host countries will be important to the efficient implementation of ETIP activities. The Bureaus and Missions would provide information germane to specific ETIP activities, such as economic, environmental, cultural, and political conditions existing in the host country. Additionally, these organizations are expected to buy into ETIP activities such as prefeasibility studies, resource assessments, application/market assessments, definitional missions, workshops, and special studies. In particular, Bureaus/Mission buy-ins would be used for items such as long-term studies, long-term staffing, technology demonstrations, and software development/implementation. Buy-ins could exceed $1 million per study.

e. Other Appropriate U.S. Agencies, Bilateral Donors and Multilateral Development Banks

Other appropriate U.S. agencies, such as the Overseas Private Investment Corporation (OPIC), the Department of Commerce (DOC), the Export Import Bank (EXIMBANK), and the Department of Energy (DOE) will be invited to participate in this project, either in support of specific ETIP activities, or as members of the Steering Committee.

DOC sponsors trade missions which promote U.S. exports and posts Foreign Commercial Service Officers in A.I.D.-assisted countries. They would be a useful instrument for promoting the ETIP and would be a forum for attracting U.S.firms to invest in the developing countries.

DOE has a fund ($750,000) available for use on energy development in the advanced coal technologies area. DOE also has an experienced technical staff which could assist in the evaluation of subproject proposals.

Since EXIMBANK and OPIC are potential sources of direct loan guarantees or risk insurance for private energy projects, they could play major roles in increasing private participation in the energy sector.

The World Bank, Asian Development Bank, Interamerican Development Bank, African Development Bank, and International Finance Corporation are multilateral financial

institutions that could assist in the cofinancing of prefeasibility studies, follow-on feasibility studies, or resulting energy subprojects. The types of assistance that could be provided by the above organizations include long-term studies, long-term staffing, technology pilot/demonstrations, and computer software. It is estimated that the above organizations will cover up to 25% of the costs associated with conducting prefeasibility studies and other services in A.I.D. countries.

f. In-Country Organizations

Government and state utilities, as well as other government and private sector agencies, will be the direct beneficiaries of technical assistance and project identification activities. Their participation would be sought in activities throughout the life of the project.

g. Private Sector

The ETIP will benefit private industry and energy trade associations through its information dissemination activities and opportunities to provide technical assistance, as well as through its ability to create subprojects through the Project Identification Fund. While the ETIP will not be a funding source beyond the prefeasibility study stage, an objective of the ETIP is to leverage capital for follow-on investment in the energy/power sector of A.I.D. assisted countries.

2. Procurement Plan

a. Number of Procurements

ETIP is expected to involve two new procurement mechanisms: a Technical Assistance Contractor and a Project Identification Fund Contractor. Each of the above procurements are expected to be awarded through the competitive bidding process (however other approaches are under consideration, see below). Through the open bidding process private sector firms, non-profit organizations, academic institutions, and others will be encouraged to submit proposals through the normal contracting channels, in appropriate teaming arrangements. Both contracts will be awarded for a 5-year duration, with mid-project evaluations to be conducted in 1992.

Concerning the Technical Assistance Contract, there is some concern that a possible conflict of interest may arise if this Contractor is able to apply for monies under the Project Identification Fund. The A.I.D. Contracts Office is looking into this matter and will make a decision on whether the Technical Assistance Contractor will be excluded from seeking assistance under the Project Identification Fund.

b. Options on Contracting Arrangements and Procedures

Due to the wide range of activities proposed by ETIP it is anticipated that several contracting mechanisms may need to be employed, in addition to the two new contracts identified above, in order to complete project work in the most efficient and effective manner possible. Contract vehicles to be considered over the course of the contract

include: individually bid contracts, PASAs, RSSAs, cooperative agreements, competitive procurements, Section 8 (a) contracts, non-competitive cooperative agreements, IQCs, and existing A.I.D. contracts. Direct hires are also allowed to address issues related to the recently enacted global warming legislation.

PSSAs and RSSAs in particular may be necessary to secure the unique multidisciplinary skills and expertise of other U.S. government agencies and their national laboratories. In many instances these organizations may offer specialized technical and management capabilities in the energy and environmental field not available from the project contractors; PSSAs and RSSAs enable A.I.D. to access these skills through the ETIP. Furthermore, these organizations may maintain established relationships with key host country counterparts that could enhance the success of particular subprojects. PSSAs and RSSAs will be utilized in instances where it is believed they can enhance the technical performance of a subproject and do so in a more efficient and effective manner than using the two contractors identified above. In the first three years of the ETIP (FY 90-92), A.I.D. is planning to use PASAs and RSSAs with the Environmental Protection Agency and the U.S. Department of Energy (and its national laboratories), to conduct two resource assessments, two definitional missions, and two special studies in target LDCs.

c. Gray Amendment

As part of being responsive to the RFP, all proposing companies will be required to submit subcontracting plans which address how they will have Gray Amendment firms involved in implementation. Such plans must also address the ways in which Historically Black Colleges and Universities (HBCUs) will be used as training facilities.

d. Waivers

At this time no waivers are requested for the ETIP Project. However, during the course of the procurement process, it may be necessary at some point in the future to waive the A.I.D. maximum daily consultant rates since many of the special experts needed to ensure the Project's success must come from the private sector and cannot be obtained at current A.I.D. daily rates.

There are two methods available for compensating specialists at a rate higher than the FS-1 cap rate during the ETIP Project:

- For each individual consultant retained a waiver can be obtained from the Agency Director of the Directorate for Energy and Natural Resources in the Bureau for Science and Technology on a case-by-case basis.

- In new contracts and amendments the contracting firm can attempt to negotiate a higher rate than the government cap for certain classes of experts with certain levels of experience and training. This would be done during initial procurements.

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e. Legal Considerations

With respect to the implementation of the ETIP, two sets of legal considerations must be taken into account, those of the host countries and those of the United States. Legal considerations of host countries will be evaluated on a case-by-case basis. In the United States, the ETIP must take into account the ownership and public accessibility of project identification activities funded, at least partially, with Federal monies.

o The Freedom of Information Act

Under the Freedom of Information Act and Amendments of 1974, all Federally funded information must be available for disclosure to the public. In several situations information can be exempt from the disclosure requirements. As FOIA pertains to the ETIP program, the following exception would apply: trade secrets and commercial or financial information obtained from a person and privileged or confidential information is exempt from disclosure.

Commercial or financial information is considered "confidential" if disclosure of such information is likely to cause substantial harm to the competitive position of the person/firm from whom the information was obtained. This rule also protects the government's ability to obtain necessary information in the future. In several cases of U.S. law, information provided by a private firm or person has been considered exempt from disclosure.

According to the General Counsel's office at A.I.D., all general information found in a prefeasibility study would be available for disclosure. However, specific financial or commercial information of the contractor who conducted the study would not be disclosed.

o Rights and Data Issues

A major component of the ETIP will be to fund prefeasibility studies for energy sector development in A.I.D.-assisted countries. In cases where the U.S. government funds a study, the question arises as to who owns the information in the study's final report. Does the contracted firm own the information in the report because it performed the study? Or does the information belong to the Government because it funded the study? The answer is two-fold. The firm does have access to the information in the study. However, the government has proprietary rights to the information in the study (F.A.R. 52.227-14).

In general, the Government honors the rights in data resulting from private developments, and limits its demands to the form, fit, and function data essential for Government purposes.

In order to carry out their missions and programs, it is necessary for the departments and agencies to acquire or obtain access to many kinds of data produced during or used in the performance of their contracts. Agencies require such data to obtain competition among suppliers; fulfill certain responsibilities for disseminating and publishing the results of their activities; ensure appropriate utilization of the results of research, development, and demonstration activities including the dissemination of technical information to foster subsequent technological developments; and meet other programmatic and statutory requirements.

At the same time, the government recognizes that its contractors may have a legitimate proprietary interest (e.g., a property right or other valid economic interest) in data resulting from private investment. Protection of such data from unauthorized use and disclosure is necessary in order to prevent the compromise of such property right or economic interest, avoid jeopardizing the contractor's commercial position, and preclude impairment of the Government's ability to obtain access to or use of such data. The protection of such data by the Government is also necessary to encourage qualified contractors to participate in Government programs and apply innovative concepts to such programs. In cases where completion of the contract results in an invention, the contractor is normally granted a revocable, nonexclusive, royalty-free license to that invention throughout the world.

B. PARTICIPATING A.I.D. MISSIONS

The first-hand familiarity of A.I.D. Missions and Bureaus with host country circumstances will be valuable and centrally important to the accomplishment of ETIP objectives. Mission understanding of the development priorities of a country, and the obstacles to development, emphasize the Mission's importance in identifying potential opportunities for ETIP activities as well as buying-in to the funding of its objectives, both financially and philosophically.

A.I.D. Missions and Bureaus would offer information relevant to specific ETIP activities as they relate to country energy sector strategies and needs. They will be encouraged to facilitate the ETIP via buy-ins, project implementation opportunities, appropriate contractor or consultant identification and selection, and other activities as follows:

- Advise on pre-feasibility studies;
- Recommend countries needing technical experts;
- Co-sponsor Country Assessments, Conferences, Workshops, Training and Internships, and Study Tours, and
- Collaborate on Special Studies and Regional Energy Consultants.

These are illustrative of the collaboration which is basic to the ETIP design and implementation strategy. Other activities in both of the technology transfer and training components will encourage and require communication and coordination among the Missions and Regional Bureaus and the ETIP contractors.

Prior to the Project Identification Document's preparation, a memorandum was sent to fourteen key participants in A.I.D. missions to elicit their thoughts and perspectives vis-a-vis the ETIP Project's design, its appropriateness for their mission's development program and their country's development priorities. Following on the Conventional Energy Technical Assistance (CETA) Project, and the initiation of the Private Sector Energy Development (PSED) Project, and other A.I.D. energy-related projects, as well as the Report of the Energy Industry Review Group on Power Shortages in Developing Countries, (submitted to Administrator Woods on April 17, 1989), and the Report to Congress entitled "Power Shortages in Developing Countries: Magnitudes, Impacts, Solutions, and the Role of the Private Sector (submitted by A.I.D. in March, 1988), it is important to integrate the ETIP Project with existing A.I.D.-energy related initiatives. Additionally, ETIP should reflect the lessons learned and progress made during the ten-year period in which the CETA Project existed within the energy sector activities of A.I.D. ETIP's proposed structure and philosophical approach would build on these earlier experiences, and advance energy development strategies in LDC countries where the energy setting had evolved during the 1980's. New economic imperatives have arisen in many countries. Different energy supply mixes within these countries have emerged and oil prices have declined relative to earlier periods. Rapid deforestation in many countries, widespread concern about pollution, environmental degradation, and global warming have all altered the way energy fuel sources and energy technologies impact on development objectives in many countries. These changes required Mission input to ETIP's design and potential utility.

The ETIP Project Identification Document elicited varied comments from the fourteen missions and A.I.D. support offices. The missions and offices are as follows:

A. LAC: Costa Rica, Dominican Republic, Guatemala, ROCAP
B. AFR: REDSO/WCA, REDSO/ESA
C. ANE: Egypt, India, Indonesia, Jordan, Morocco, Pakistan, Philippines, and Thailand

Missions and support offices were asked to respond to the following questions:

1. What are your thoughts on the relationship of the ETIP purpose and goals with other ongoing A.I.D. energy projects in your country/region?

2. Does the ETIP respond to the needs of the power sector in your country/region and if so, how?

3. What changes would you suggest to make ETIP more responsive to your needs?

4. Based on the representative tasks described above, what other tasks (energy technologies and/or activities) do you believe are worthwhile for your specific country/region?

5. Do you envision by-ins on any of the tasks described above, and if so, at what level? What other tasks would you be willing to co-fund, and at what level?

Replies were received from Pakistan, Morocco, Jordan, Costa Rica, Egypt, Thailand, Guatemala, and Indonesia. Comments from the missions were strongly favorable and supportive of the ETIP's proposed goals and objectives. One mission commented that ETIP would "support the mission's energy portfolio", and would be helpful in developing indigenous coal resources to environmentally sound use...." Another mission said ETIP matched its present focus and direction, particularly in areas of industrial energy conservation and development of indigenous energy resources. Improved energy efficiency via commercially proven technologies was seen as a strong aspect of the project's design, as were its proposed training activities for A.I.D. officers and host country energy technical and administrative personnel. Still another mission spoke of the ETIP's stimulation of coordinated assistance by United States investors in meeting the energy demands of the future. Several replies mentioned the urgent need for the project. Some missions, particularly the larger missions, felt their energy project portfolios were ambitious at present, and that while useful, ETIP would need integration with existing project activities in order to maximize its potential. One mission reported a very limited involvement in energy sector development at present and therefore would only be able to take advantage of ETIP activities at a later date. Finally, in some countries, the private sector role in energy is limited, which might curtail some project activities.

Thus the prospect of short-and long-term interest, and concomitant buy-ins by the missions, seems guaranteed. It is clear from the responses that ETIP is a timely initiative, which builds on previous successes and which can help reduce the widely projected energy short-falls of the near future in LDCs.

C. BUDGET AND SCHEDULE

The ETIP will have an estimated budget of $40 million. Of this amount, $20 million will be funded by the Office of Energy and $20 million will come in matching funds from A.I.D. Bureau/Mission buy-ins. Additionally, cofinancing is expected from other U.S. government agencies, multilateral donors, and private sector cost-sharing, as well as in-kind country contributions. The project will be conducted over a 10 year period beginning in 1990 and extending to 1999. Funding commitments, with the exception of the Technical Assistance Contractor and the Project Identification Fund Contractor, are to be completed in the ninth year, 1998. The following outputs are expected.

- 20 country indigenous resource assessments.
- 15 country energy system application/market assessments.
- 25 prefeasibility studies.
- 25 missions for development and implementation of innovative approaches to technology transfer/training for power sector system implementation and/or rehabilitation.

- 20 missions for structuring and conduct of management/operational assistance workshops for institution upgrade and development.

- 25 technical assistance missions to provide new, innovative engineering services to the energy/power sector.

- 30 special studies.

Exhibit IV-1 provides a summary of expenditures for the period 1990-1999. Exhibit IV-2 provides detailed budget data for the ETIP over this same period. As indicated in these tables, funds have been provided for direct hires for issues related to global warming as designated by Congressional legislation, as well as for long-term support as depicted under buy-in activities for prefeasibility studies.

D. EVALUATION PLAN

The performance of the two contractors, and the related successfulness of technical assistance and project identification fund activities, will be evaluated during the course of the contract. Formal evaluations of the services provided by the two contractors will be conducted at 3-year intervals over the course of the project. Evaluations are expected in 1992, 1995, and 1998. The evaluation team will have not less than one A.I.D. representative and two external evaluators. These formal evaluations will be funded outside the scope of the contract. The three evaluations will focus on:

- o Appropriateness of project design.
- o Effectiveness of the contracts in achieving project outputs.
- o Adequacy and quality of A.I.D. and contractor resources, including budgets.
- o Adequacy of contractor performance, management, and implementation.
- o Adequacy of A.I.D. management and coordination.
- o Recommendations for modification or extension of contract design, management, implementation, and budget for the time period.
- o Value of the contract to A.I.D.
- o Financial review and audit of the Project Identification Fund.
- o Lessons learned for use in follow-on or subsequent projects.

The final evaluation will occur in the late summer of FY 1998. By completing the evaluation a year before contract termination, A.I.D. will allow sufficient time to begin the contract follow-on process if it is deemed appropriate.

TABLE IV-1
SUMMARY OF EXPENDITURES FOR ETIP PROJECT 1990-1999

	TOTAL ETIP	TOTAL BUYINS	TOTAL EXPEND
1. TECHNICAL ASST. CONTRACTOR			
A. CONTRACT ADMINISTRATION SUBTOTAL	7368	0	7368
B. RESOURCE ASSESSMENTS (1)	400	2600	3000
C. APPLICATION MARKET ASSESS. (2)	100	1200	1300
D. DEFINITIONAL MISSIONS (3)	750	900	1659
E. WORKSHOPS (4)	600	1800	2400
F. SPECIAL STUDIES (5)	600	1200	1800
G. TOTAL	9818	7700	17518
2. PROJECT IDENTIFICATION FUND			
A. FUND ADMINISTRATION	3832	0	3832
B. PREFEASIBILITY STUDIES (7)	2800	8250	11050
C. RESOURCE ASSESSMENTS (1)	0	600	600
D. APPLICATION MARKET ASSESS. (2)	0	200	200
E. DEFINITIONAL MISSIONS (3)	250	350	600
F. WORKSHOPS (4)	150	300	450
G. SPECIAL STUDIES (5)	600	1050	1650
H. TOTAL	7632	10750	18382
3. OTHER EXISTING CONTRACTS/IQCs			
A. RESOURCE ASSESSMENTS (1)	200	200	400
B. APPLICATION MARKET ASSESS. (2)	0	0	0
C. DEFINITIONAL MISSIONS (3)	150	100	250
D. WORKSHOPS (4)	0	150	150
E. SPECIAL STUDIES (5)	0	1050	1050
F. DIRECT HIRES (6)	1600	0	1600
G. TOTAL	1950	1500	3450
4. EVALUATIONS	600	0	600
TOTAL EXPENDITURES	20000	19950	39950

NOTES

(1) Assumes 20 country resource assessments at a cost of $200,0000/assessment.
(2) Assumes 15 application/market assessments at $100,000/assessment.
(3) Assumes 50 definitional missions at $50,000/missions.
(4) Assumes 20 workshops at $150,000/workshop.
(5) Assumes 30 special studies at $150,000/study.
(6) Assumes program funds for direct hire personnel for items related to global warming, per Congressional language.

TABLE IV-2 DETAILED EXPENDITURES FOR ETIP PROJECT FY 1990-1999

	1990			1991			1992			1993		
	ETIP	BUYINS	TOTAL	ETIP	BUYINS	TOTAL	ETIP	BUYINS	TOTAL	ETIP	BUYINS	TOTAL
1. TECHNICAL ASST. CONTRACTOR												
A. CONTRACT ADMINISTRATION SUBTOTAL	257	0	257	674	0	674	708	0	708	744	0	744
B. RESOURCE ASSESSMENTS (1)	0	200	200	0	400	400	200	400	600	0	400	400
C. APPLICATION MARKET ASSESS. (2)	0	0	0	100	200	300	0	200	200	0	200	200
D. DEFINITIONAL MISSIONS (3)	50	0	50	100	200	300	50	150	200	50	50	100
E. WORKSHOPS (4)	0	0	0	150	150	300	150	300	450	150	300	450
F. SPECIAL STUDIES (5)	150	0	150	0	150	150	0	300	300	0	150	150
G. TOTAL	457	200	657	1024	1100	2124	1108	1350	2458	944	1100	2044
2. PROJECT IDENTIFICATION FUND												
A. FUND ADMINISTRATION	50	0	50	390	0	390	416	0	416	433	0	433
B. PREFEASIBILITY STUDIES (7)	0	0	0	400	750	1150	400	1500	1900	400	1500	1900
C. RESOURCE ASSESSMENTS (1)	0	0	0	0	200	200	0	200	200	0	200	200
D. APPLICATION MARKET ASSESS. (2)	0	0	0	0	100	100	0	0	0	0	100	100
E. DEFINITIONAL MISSIONS (3)	0	0	0	50	0	50	50	100	150	50	50	100
F. WORKSHOPS (4)	0	0	0	0	0	0	0	0	0	0	150	150
G. SPECIAL STUDIES (5)	0	0	0	0	0	0	0	150	150	0	0	0
H. TOTAL	50	0	50	840	1050	1890	866	1950	2816	883	2000	2883
3. OTHER EXISTING CONTRACTS/IQCs												
A. RESOURCE ASSESSMENTS (1)	0	0	0	0	200	200	200	0	200	0	0	0
B. APPLICATION MARKET ASSESS. (2)	0	0	0	0	0	0	0	0	0	0	0	0
C. DEFINITIONAL MISSIONS (3)	0	0	0	0	50	50	0	50	50	50	0	50
D. WORKSHOPS (4)	0	0	0	0	0	0	0	150	150	0	0	0
E. SPECIAL STUDIES (5)	0	0	0	0	150	150	0	150	150	0	150	150
F. DIRECT HIRES (6)	0	0	0	300	0	300	300	0	300	200	0	200
G. TOTAL	0	0	0	300	400	700	500	350	850	250	150	400
4. EVALUATIONS	0	0	0	0	0	0	200	0	200	0	0	0
TOTAL EXPENDITURES	507	200	707	2164	2550	4714	2674	3650	6324	2077	3250	5327

NOTES

(1) Assumes 20 country resource assessments at a cost of $200,0000/assessment.
(2) Assumes 15 application/market assessments at $100,000/assessment.
(3) Assumes 50 definitional missions at $50,000/missions.
(4) Assumes 20 workshops at $150,000/workshop.
(5) Assumes 30 special studies at $150,000/study.
(6) Assumes program funds for direct hire personnel for items related to global warming, per Congressional language.
(7) Assumes a total of 25 prefeasibility studies. Fourteen prefeasibility studies will be conducted at $200,000/study from centrally-funded ETIP funds. Eleven prefeasibility studies will be conducted at $750,000/study from mission buyins and other sources. It is assumed that the buyin portions of the prefeasibility studies will cover costs not addressed through central ETIP funds, such as pilot projects/demonstrations, and long-term staffing assignments.

	1994			1995			1996			1997		
	ETIP	BUYINS	TOTAL	ETIP	BUYINS	TOTAL	ETIP	BUYINS	TOTAL	ETIP	BUYINS	TOTAL
1. TECHNICAL ASST. CONTRACTOR												
A. CONTRACT ADMINISTRATION SUBTOTAL	781	0	781	820	0	820	860	0	860	903	0	903
B. RESOURCE ASSESSMENTS (1)	0	400	400	0	400	400	200	200	400	0	200	200
C. APPLICATION MARKET ASSESS. (2)	0	200	200	0	200	200	0	200	200	0	0	0
D. DEFINITIONAL MISSIONS (3)	50	50	100	250	200	450	150	150	300	50	50	100
E. WORKSHOPS (4)	0	150	150	150	300	450	0	150	150	0	300	300
F. SPECIAL STUDIES (5)	0	0	0	0	300	300	150	150	300	300	150	450
G. TOTAL	831	800	1631	1220	1400	2620	1360	850	2210	1253	700	1953
2. PROJECT IDENTIFICATION FUND												
A. FUND ADMINISTRATION	448	0	448	479	0	479	488	0	488	509	0	509
B. PREFEASIBILITY STUDIES (7)	400	1500	1900	400	750	1150	400	750	1150	200	750	950
C. RESOURCE ASSESSMENTS (1)	0	0	0	0	0	0	0	0	0	0	0	0
D. APPLICATION MARKET ASSESS. (2)	0	0	0	0	0	0	0	0	0	0	0	0
E. DEFINITIONAL MISSIONS (3)	50	50	100	50	100	150	0	50	50	0	0	0
F. WORKSHOPS (4)	150	0	150	0	150	150	0	0	0	0	0	0
G. SPECIAL STUDIES (5)	150	150	300	0	300	300	0	150	150	300	150	450
H. TOTAL	1198	1700	2898	929	1300	2229	888	950	1838	1009	900	1909
3. OTHER EXISTING CONTRACTS/IQCs												
A. RESOURCE ASSESSMENTS (1)	0	0	0	0	0	0	0	0	0	0	0	0
B. APPLICATION MARKET ASSESS. (2)	0	0	0	0	0	0	0	0	0	0	0	0
C. DEFINITIONAL MISSIONS (3)	0	0	0	50	0	50	50	0	50	0	0	0
D. WORKSHOPS (4)	0	0	0	0	0	0	0	0	0	0	0	0
E. SPECIAL STUDIES (5)	0	150	150	0	150	150	0	150	150	0	150	150
F. DIRECT HIRES (6)	100	0	100	200	0	200	200	0	200	200	0	200
G. TOTAL	100	150	250	250	150	400	250	150	400	200	150	350
4. EVALUATIONS	0	0	0	200	0	200	0	0	0	0	0	0
TOTAL EXPENDITURES	2129	2650	4779	2599	2850	5449	2498	1950	4448	2462	1750	4212

	1998 ETIP	1998 BUYINS	1998 TOTAL	1999 ETIP	1999 BUYINS	1999 TOTAL	TOTAL ETIP	TOTAL BUYINS	TOTAL EXPEND
1. TECHNICAL ASST. CONTRACTOR									
A. CONTRACT ADMINISTRATION SUBTOTAL	949	0	949	672	0	672	7368	0	7368
B. RESOURCE ASSESSMENTS (1)	0	0	0	0	0	0	400	2600	3000
C. APPLICATION MARKET ASSESS. (2)	0	0	0	0	0	0	100	1200	1300
D. DEFINITIONAL MISSIONS (3)	0	50	50	0	0	0	750	900	1650
E. WORKSHOPS (4)	0	150	150	0	0	0	600	1800	2400
F. SPECIAL STUDIES (5)	0	0	0	0	0	0	600	1200	1800
G. TOTAL	949	200	1149	672	0	672	9818	7700	17518
2. PROJECT IDENTIFICATION FUND									
A. FUND ADMINISTRATION	450	0	450	169	0	169	3832	0	3832
B. PREFEASIBILITY STUDIES (7)	200	750	950	0	0	0	2800	8250	11050
C. RESOURCE ASSESSMENTS (1)	0	0	0	0	0	0	0	600	600
D. APPLICATION MARKET ASSESS. (2)	0	0	0	0	0	0	0	200	200
E. DEFINITIONAL MISSIONS (3)	0	0	0	0	0	0	250	350	600
F. WORKSHOPS (4)	0	0	0	0	0	0	150	300	450
G. SPECIAL STUDIES (5)	150	150	300	0	0	0	600	1050	1650
H. TOTAL	800	900	1700	169	0	169	7632	10750	18382
3. OTHER EXISTING CONTRACTS/IQCs									
A. RESOURCE ASSESSMENTS (1)	0	0	0	0	0	0	200	200	400
B. APPLICATION MARKET ASSESS. (2)	0	0	0	0	0	0	0	0	0
C. DEFINITIONAL MISSIONS (3)	0	0	0	0	0	0	150	100	250
D. WORKSHOPS (4)	0	0	0	0	0	0	0	150	150
E. SPECIAL STUDIES (5)	0	0	0	0	0	0	0	1050	1050
F. DIRECT HIRES (6)	100	0	100	0	0	0	1600	0	1600
G. TOTAL	100	0	100	0	0	0	1950	1500	3450
4. EVALUATIONS	200	0	200	0	0	0	600	0	600
TOTAL EXPENDITURES	2049	1100	3149	841	0	841	20000	19950	39950

E. MONITORING PLAN

The A.I.D. Project Officer will have lead responsibility for project monitoring. Accordingly, the Project Officer will conduct regular reviews of the project's progress in achieving specific outputs with effective use of project inputs.

1. Input Monitoring

The A.I.D. Project Officer will monitor: (1) the timely establishment and operation of the Project Identification Fund; (2) the timely provision of technical assistance by the contractor; (3) the timely establishment of the ETIP Steering Committee; (4) the timely provision of inputs by other donors; and (5) the timely provision of A.I.D.. Bureau and Mission contributions to the ETIP.

2. Output Monitoring

The Office of Energy will monitor the number and quality of: country indigenous resource assessments, country energy system application/market assessments, prefeasibility studies, technology transfer and training sessions involving power system implementation/rehabilitation, workshops for institutional upgrade and development, technical assistance missions to provide innovative engineering services in the energy/power sector, and special studies.

3. Monitoring Mechanisms

The Project Officer will acquire data needed to monitor the ETIP from a number of sources. Some of these sources would include:

- Development of workplans from the Technical Assistance Contractor and the Project Identification Fund Contractor to cover the period 1990-1991; workplan revisions will be submitted each year thereafter.
- Weekly meetings with the Project Directors of the Technical Assistance Contract and the Project Identification Fund Contract.
- Monthly/Quarterly reports from the two Contractors.
- Site visits to potential subproject sites.
- Semi-annual meetings with the ETIP Steering Committee.
- As-needed visits to key host countries; these will be conducted in accordance with A.I.D. guidelines.
- Meetings with other donor counterparts.

- Field visits to evaluate the technical and financial claims of potential users of the ETIP Identification Fund. This tool should be used only for spot checks, since monitoring of proposal claims will be the responsibility of the Contractors.

ENERGY TECHNOLOGY INNOVATION PROJECT (ETIP)

PROJECT NUMBER 936-5741

MARCH 1990

ANNEXES

OFFICE OF ENERGY
BUREAU FOR SCIENCE AND TECHNOLOGY
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

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ANNEXES

A. LOGICAL FRAMEWORK MATRIX

B. ADMINISTRATIVE ANALYSIS

C. TECHNICAL ANALYSIS

D. ECONOMIC ANALYSIS

E. SOCIAL ANALYSIS

F. ENVIRONMENTAL ANALYSIS

H. TECHNOLOGY TRANSFER/TRAINING

ANNEX A

LOGICAL FRAMEWORK MATRIX

PROJECT DESIGN SUMMARY – LOGICAL FRAMEWORK

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Goal: To alleviate by environmentally acceptable means the supply/demand gap in energy sectors of developing countries.	Measures of Goal Achievement: 1. Increase in megawatts of power produced and delivered. 2. Increase in efficiency of power generation, transmission, and distribution. 3. Increase in environmental quality. 4. Increase in quality of life, i.e. income, employment, investment, and production.	Verification Through: 1. 3, 6, and 9 year project evaluations. 2. Reports and statistics from relevant host country Ministries. 3. Annual reports on economic indicators. 4. Annual reports on environmental quality. 5. Contractor reports.	Assumptions for Achieving Goal Targets: 1. Developing countries acknowledge power shortages as a problem and recognize that past methods to increase capacity has led to environmental damage. 2. Developing countries acknowledge that power sector institutions need rehabilitation and modernization give policy changes priority, and commit necessary resources to this end.
Project Purpose: To introduce innovative energy engineering technologies and management techniques which promote sustainable and cost effective operation of electric generation, transmission, and distribution systems in developing countries.	End of Project Status: 1. Use of new, innovative, and advanced energy technologies will increase cost-effective power generation and reduce energy waste thereby cutting by 25% the current gap between energy supply and demand in affected LDCs by FY2000. 2. Clean energy policies and regulations will be introduced and/or supported in at least 5 LDCs where fossil-fueled power generation is most intense. 3. At least 5 Joint Ventures involving U.S. companies will be supported in private sector power generation by FY2000. 4. At least 100 LDC decisionmakers and 200 power sector engineers will be trained in workshops by FY2000.	Verification Through: 1. 3, 6, and 9 year project evaluations. 2. Reports and statistics from relevant host country Ministries. 3. Contractor reports.	Assumptions for Achieving Purpose: 1. Sufficient number of A.I.D.-assisted countries and Missions interested in project. 2. Cooperation of host country governmental agencies, research institutions and private sector companies, both industrial and financial.

PROJECT DESIGN SUMMARY – LOGICAL FRAMEWORK

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Inputs: 1. Project Officer and support staff. 2. Technical Assistance Contractor and Project Identification Fund Contractor. 3. Subcontractors and consultants for technical assistance. 4. Cost sharing arrangements for Project Identification Fund initiatives. 5. Mission buy-ins.	Implementation Targets: Clean Energy technol ies: $10M S&T/EY and $13M Buy-Ins Innovation in Energy Processes: $4M S&T/EY and $5M Buy-Ins Technology Transfer/Training: $2M S&T/EY and $0 Buy-Ins Institutional Improvements: $4M S&T/EY and $2M Buy-Ins	Verification Through: 1. 3, 6, and 9 year project evaluations. 2. Reports and statistics from relevant host country Ministries. 3. Contractor reports.	Assumptions for Inputs: 1. A.I.D. commitment of resources, both centrally funded and buy-ins. 2. Availability of appropriate management personnel and contractors. 3. Approval and funding for necessary travel of A.I.D. personnel for project management purposes.
Outputs: Examples of worldwide initiatives for selected LDCs include: 1. Municipal waste-to-energy, geothermal, and wind and solar electric energy resource and application assessments. 2. Definitional Missions to assess the application of clean energy technologies, such as fluidized bed combustors. 3. Project verification studies for clean coal technologies; i. e. integrated gasification combined cycle, fluidized bed combustion, etc. 4. Application assessments, design, and demonstration for computer-based energy technology screening tools and energy management information systems. 5. Support for trade missions and U.S. industry/host country and/or private energy sector initiatives.	Magnitude of Outputs: 1. 20 indigenous resource assessments. 2. 15 energy system applications and/or market assessments. 3. 25 prefeasibility studies. 4. 25 missions for development and implementation of innovative approaches to technology transfer/training. 5. 20 missions for management/operational assistance workshops for institution development. 6. 25 technical assistance missions to provide new, innovative engineering services. 7. 30 special studies.	Verification Through: 1. 3, 6, and 9 year project evaluations. 2. Reports and statistics from relevant host country Ministries. 3. Contractor reports.	Assumptions for Outputs: 1. Cooperation of host country governments, utilities, and private sector industry. 2. Ability to hire qualified staff, consultants, and long-term contractors. 3. Mission interest, cooperation, and buy-ins. 4. Willingness of financial agencies to participate and support U.S./host country local industry joint ventures. 5. Approval and funding for necessary travel of A.I.D. personnel for project management purposes.

ANNEX B

ADMINISTRATIVE ANALYSIS

ANNEX B: ADMINISTRATIVE ANALYSIS

A.I.D. Impact

Careful evaluation and analysis was made during the preparation of the ETIP Project Paper to ensure that proposed project activities would not present an unnecessary administrative burden on A.I.D. Missions, the Bureau for Science and Technology, or the geographic Bureaus.

Implementation of the ETIP, as proposed, will not have any unusual requirements for A.I.D. administrative support capabilities. On the contrary, by allowing for direct hires, the provision of long-term support, and providing a contract mechanism that the Bureaus and Missions can buy into, ETIP should lead to enhanced efficiency and effectiveness on the part of A.I.D. staff and host country counterparts interested in conducting more innovative and environmentally-sound projects in their regions/countries.

The ETIP will be managed by the Office of Energy, which will provide centralized project supervision and a mechanism for dissemination and interpretation of project process. The Project Directors of the Technical Assistance Contract and the Project Identification Fund Contract will report to the A.I.D. Project Officer appointed by the Office of Energy.

The ETIP, as proposed, may affect Mission workloads and may possibly affect staffing requirements. However, this will tend to be minimized since the Contractors and their team members are required to have considerable experience at operating within the A.I.D. administrative system. Project support services on the part of participating Missions are generally expected to be minimal. It is expected that this project can be successfully implemented and managed given present staffing levels within the Office of Energy, however, recent legislation provides the flexibility to allow for direct hires on items pertaining to global warming, and this could be employed in the case of ETIP, as appropriate.

Contract Vehicle Assessment

To implement ETIP, the A.I.D. Office of Energy had originally been interested in utilizing a contract mechanism that would allow for selection of 3-4 competitively bid contractors under a single solicitation. This approach would be similar in nature to an Indefinite Quantity Contract but would involve much larger dollar amounts and longer task durations. Discussions were held with A.I.D. and other organizations to determine if there was any precedence for this approach. In particular, the following contracts were evaluated at the recommendation of the A.I.D. C;ontracts Office:

- Water Supply and Sanitation for Health (A.I.D.)
- Malaria Immunity and Vaccination Research (A.I.D.)
- Health Tech: Technologies for Child Health (A.I.D.)

- Studies on Malaria Antigens (A.I.D.)
- U.S. Department of Energy Blanket Purchase Agreements (D.O.E.)
- Argonne National Laboratory Standby Technical Support in Program and Policy Analysis (A.N.L.)

Based upon a review of materials provided for each of these projects, as well as discussions with the A.I.D. Office of Procurement and relevant A.I.D. contractors, there appears to be no existing contract mechanism that meets the requirements of the Office of Energy. For the most part the above contract vehicles were operated as umbrella contracts that utilized one prime contractor and multiple subcontractors/consultants. In order to meet its requirements, the Office of Energy is considering two new competively bid contracts to obtain the services necessary for ETIP.

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ANNEX C

TECHNICAL ANALYSIS

ANNEX C: TECHNICAL ANALYSIS

A number of new technologies for generating electricity are being developed in the United States as alternatives to large-scale, long lead-time conventional powerplants. Of increasing interest are technologies which are capable of using alternative fuels, and/or which impose substantially lower environmental impacts than conventional generating options. Many of these technologies are either fully mature today or will be in the near future (mid-1990s). Among the power generation or conversion technologies that the U.S. is either the world leader or competitive in, and that most likely will be considered by ETIP, are: solar electric (solar thermal and photovoltaic); wind; geothermal; atmospheric fluidized bed combustors (AFBC) and integrated gasification combined cycle (IGCC) units (two of the so called "clean coal" technologies); slagging combustors; and fuel cells. A brief description of these technologies is presented in this Annex.

Solar Electric

Solar electric technologies promise the following advantages over conventional power generation technologies:

- Free, secure, widely available and renewable energy source;
- No off-site, fuel-related impacts;
- No fuel supply infrastructure required;
- Wide range of installation sizes with short lead-times;
- declining costs;
- Relatively small water needs;
- Little or no routine emissions; and
- Siting flexibility.

Like other power generating technologies, there are some disadvantages. Among them are:

- Intermittent supply of energy;
- Capital intensive;
- Extensive land use;
- Likelihood for remote siting (difficulty of access);
- Exposure of system components to erosion, corrosion, and other environmental/physical factors that could cause system degradation, including vandalism and sabotage.

Solar thermal electric plants convert radiant energy from the sun into thermal energy, a portion of which subsequently is transformed into electrical energy. There are four major conversion systems which, with some achievable combination of reduced costs and risks and improved performance, could be deployed within the 1990s in competition with other conventional technologies. They are central receivers, parabolic troughs, and parabolic dishes. Table C-1 lists advantages and disadvantages of each system.

At present, the parabolic trough is the most mature of the technologies, with commercial units operating, under construction, and planned. Collectively trough systems are generating

Table C–1 – Advantages and Disadvantages of Solar Thermal Electric Systems

Characteristic	Technology			
	Solar troughs	Parabolic dishes (mounted–engine)	Parabolic dishes (remote–engine)	Central Receiver
Demonstrated in U.S. at commercial scale?	yes	yes	yes	no
Privately financed plants now operating	yes	no	yes	no
Nonelectric/repowering/cogeneration market?	yes	no	yes	yes
Overall efficiency	low	high	low	med
Number engines/KWe	low	high	low	low
Degree of modularity	low	high	low	low
Able to use indirect or diffuse sunlight?	no	no	no	no
Thermal storage capability of 1 hour or more?	yes	no	yes	yes
Supplementary fuel required?	yes	no	no	no
Water Requirements	med	low	med	med

Source:

New Electric Power Technologies: Problems and Prospects for the 1990s; Office Of Technology Assessment, OTA-E-246, July 1985

134 MW of power in the United States[1]. Important advantages are the technology's commercial experience, resultant low risk, inherent storage capacity, and the relatively wide range of markets other than electricity generation to which it could be applied, e.g industrial process heat applications.

Central receiver technology is also mature, although no commercial-scale units are now operating in the U.S. Long-lead times and significant expense for first units make it unlikely that large commercial investment will occur in the 1990's without significant U.S. government encouragement. A 10 MWe (net) pilot facility has operated successfully in Southern California since 1982; and a small experimental facility, rated at 0.75 MWe (gross) has been operating in New Mexico. Small central receivers have also been built and operated overseas in demonstration projects.

During the 1980s, both the capital and energy costs of solar thermal systems were reduced by 80 percent. Current system designs generating electricity have an annual efficiency of about 15 percent and a capital cost of about $3000/kW. Long-term electricity generating goals call for system capital cost of $1000/kW and system energy costs of $0.05 per kilowatt-hour. Luz International has installed over 200 MW of power generation using trough technology with plans for an additional 400 MW in the United States by 1998. Today, these systems generate electricity for $0.10 - $0.12 per kilowatt-hour[2].

A large number of photovoltaic (PV) systems have been built in the last ten years. Most of them ranged in size from 10 to 250 kilowatts and were designed and installed as experiments under the U.S. Department of Energy PV research and development program. In recent years, several larger utility systems and many small, stand-alone systems have also been built. The large systems, typically owned and operated by the utility companies, range in size up to 5 MW and are in the U.S., Europe and Japan. The smaller PV systems are usually designed for specific applications, such as water pumping and lighting, and generate less than 10 kilowatts. Thousands of these systems have been installed throughout the world, bringing electricity to Third-World countries, to isolated homes and farms, and to defense installations that are either remote or have a need for mobile power.

PV systems have matured to the point where high reliability has been achieved by all major configurations of modules - fixed flat-plate, tracking flat-plate, and concentrator. They have proven themselves to be viable, cost-effective supplements to traditional sources of energy for a wide range of applications. Privately-funded, stand-alone systems promise to offer reliable and readily available power for miliary applications, for remote villages, and for other inaccessible locations where a need for dependable power is crucial. The cost-of-electricity from PV systems varies greatly depending on systems size and application. In general, costs range from $0.18 per kilowatt-hour for large utility scale systems to $0.28 to $0.32 per kilowatt-hour for small remote, stand-alone systems. However, high efficiency PV

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[1]Solar Thermal Program Summary, Volume I: Overview for Fiscal Year 1988, U.S. Department of Energy, DOE/CH10093-45, February 1989.

[2]Ibid. Solar Thermal Program Summary, Volume I: Overview for Fiscal Year 1988.

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systems and new manufacturing techniques promise large cost reduction within a few years[3]. However, two U.S. utility companies have proposed large manufacturing facilities (up to 5 MW annually), in cooperation with PV companies. These facilities, using new amorphous silicon technology, are expected to generate electricity at about $0.12 per kilowatt-hour by the early 1990s.

The strongest markets for PV systems today are in consumer products and remote power applications. There are, however, major utility projects to investigate large-scale, grid-connected central power station generation of electricity with PV systems. ARCO Solar and Southern California Edison began to operate two 500 kW PV array fields in 1982; The Pacific Gas and Electric Company is operating a 6.5 MW PV power plant at Carissa Plains, CA; in 1984, the DOE and the Sacramento Municipal Utility District co-funded a 2 MW PV power plant that has been successfully operated since then to produce grid-connected electricity at approximately $0.28 per kilowatt-hour. Finally, a new effort led by the Pacific Gas and Electric Company and partially funded by DOE, is providing hands-on field experience with PV power plants to several different utilities. The Photovoltaics for Utility-Scale Applications (PVUSA) project has constructed four 20 kW arrays by different U.S. manufacturers for initial testing. Following these tests, large-scale deployment (200 to 400 kW arrays) will test innovative technologies in a utility framework at different locations in the United States[4].

Foreign competition for sales of PV systems is intense. However, the total value of PV module shipments by the U.S. manufacturers in 1988 was $59.1 million, up 32 percent from the $45 million figure for 1987 and up 55 percent over the $38 million total for 1986. Exports in 1988 represented more than 55 percent of all shipments, underscoring the importance of foreign sales for the U.S. PV industry. These increases occurred while the number of U.S. companies that manufacture and sell PV modules declined from 17 in 1987 to 14 in 1988[5].

Wind Energy Systems

The generation of electricity from wind turbines matured throughout the 1980s to the point where there is now a current U.S. capacity of approximately 1500 MWe generated by over 16,000 commercially available wind turbines with an average power output of 100 to 150 kilowatts peak. Wind turbines can now be installed for about $1,000 per kWe. Operating availability of over 90 percent is common. Installed costs should be as low as $600 per kWe

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[3]Comparative Assessment of PV and Wind for Non-Utility Power Generation, J. Siegel and Associates for U.S. Export Council for Renewable Energy, September 15, 1988.

[4]Photovolatic Energy Program Summary, Volume I: Overview for Fiscal Year 1988, U.S. Department of Energy, DOE/CH10093-40, January 1989.

[5]Photovoltaic Insider's Report, Vol. IX, No. 1, January 1990.

by 1990-1995[6].

As with PV systems, foreign competition is strong. U.S. turbine manufacturing companies have declined since 1985, when the renewable energy tax credits expired, to only one manufacturer of large-scale turbines (over 50 kWe) and about 5 manufacturers of small-scale turbines (less than 25 kWe). These companies have only recently begun to take a serious interest in the international marketplace. Denmark dominates the world export market for large-scale turbines, as they have targeted foreign sales from the beginning (as a result of the large California wind farm market in the early 1980s) and they have a cost-competitive, reliable product with attractive, government supported financing. During 1987, two Japanese firms were developing wind turbines for utility use. They are both operating turbines in California wind farms. While neither has yet emerged from the development cycle, these initiatives show that the companies have a serious interest in entering the utility-scale competition. In the U.S., wind generated electric power as an option for future capacity growth, is gaining more interest from utility companies. Pacific Gas and Electric Company, a pioneer in the integration of wind farms with existing grid distribution systems in California, is developing a new advanced 300 kW wind turbine in conjunction with the Electric Power Research Institute and the only U.S. manufacturer of large wind turbines, U.S. Windpower. The cost-of-electricity from this generation of wind turbine installed in wind farm sizes is about $0.07 - $0.09 per kilowatt-hour, competitive with fossil fueled power units virtually anywhere in the world[7].

Smaller U.S. wind turbines, in the 1 to 20 kilowatt range, have been marketed internationally with more success. Potential markets include hybrid wind/PV and wind/diesel installations at remote locations and for small isolated grid electric generation, where modularity permits the addition of rather small increments of generating capacity on an as needed basis to minimize capital expenditure. U.S. companies that manufacture instrumentation systems for wind resource monitoring and turbine performance measurements are competing very well in foreign markets due to their technical excellence.

Geothermal Energy

Geothermal energy - the heat of the earth - is one of the most reliable energy sources available. It is also a very large and widespread resource which is making a significant contribution to the production of heat and electricity in the U.S. and has a very promising future to do the same worldwide. The resource is divided into four categories of geothermal energy as shown in Table C-2. All categories are potentially capable of electric power generation if sufficient heat at a high enough temperature (greater than about 150 degrees centigrade) can be obtained for economic operation of a power plant.

Successful extraction of geothermal energy requires both drilling and the application of the

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[6] A Potential Role for U.S. Energy Technologies in India, Conventional Energy Technical Assistance Project, Bechtel National, Inc. for the U.S. Agency for International Development, 1988.

[7] Wind Energy Weekly, Vol. 9, #387, American Wind Energy Association, February 12, 1990.

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Table C–2
Characteristics of Four Categories of Geothermal Resources and Methods of Extraction

Type of Reservoir	Form of Energy	Typical Depth (feet)	Temperature Range (F)	Method of Energy Extraction
Hydrothermal	Hot water and/or steam	Several hundred to 14,000	90–>680	Conventional oil and gas rotary drilling equipment modified to withstand heat, hard rock, and corrosive geothermal environment.
Geopressured	Moderately hot water under high pressure containing dissolved methane	10,000–20,000	212–>400	High pressure oil and gas rotary drilling equipment and gas liquid separators to extract methane from the produced brines.
Hot Dry Rock	Relatively water–free hot rock	8,000–20,000	Highly variable	Closed–loop circulation of water through man–made fractures in hot impermeable rock between two directionally drilled wells.
Magma	Molten or partially molten rock	10,000–33,000	1650–2200	Experimental drilling system that will chill, solidify, and fracture magma through which a working fluid will be circulated for direct contact heat transfer.

Source: Geothermal Energy Program Summary, Vol. 1, FY 88 Overview, DOE/CH10093-47, March 1989

geosciences - geology, geophysics, and geochemistry. These technologies are used at every stage of geothermal development - exploration, resource confirmation and characterization, and field management. There are three distinct energy conversion technologies used for generating electricity with geothermal resources based on the characteristics of the resource (vapor or liquid form, temperature and chemistry) - conventional turbine generators, flash steam, and binary cycle. Currently, binary cycle technology is marginally economic for commercial applications, although a government/industry 45 MWe plant has been tested in the U.S. The U.S. geothermal industry is clearly among the world leaders in all these technologies and their relationship to all facets of geothermal development.

The most mature geothermal resource is hydrothermal. Nearly 2000 MWe of natural steam generated capacity are on-line at The Geysers in California; the largest geothermal power plant in the world. By the end of 1989, some 45 hot water plants were in operation in six states with a total capacity of nearly 780 MWe. While the U.S. is clearly in the forefront in new geothermal energy research, the other geothermal resource technologies under test in the U.S. are not currently commercially cost-effective. The hot dry rock concept has been proven on a modest scale with a small, shallow reservoir which produced up to 5 megawatts-thermal (MWt). Tests are underway on deeper, hotter wells to develop technologies for more economical systems. The scientific feasibility of extracting energy from molten rock (magma) has been proven by DOE experiments in Hawaii. However, the scientific and engineering technology to locate subsurface magma chambers and to extract energy from them has yet to be developed and tested. Long-term production tests have shown that geopressured reservoirs will produce useful energy, but reservoir drive mechanisms and techniques for locating and evaluating them are not fully understood.

Pacific Gas and Electric Company (PG&E), operator of The Geysers, has stated that geothermal is second only to hydropower as the cheapest source of energy in the PG&E system. The DOE Geothermal Program objectives are to reduce the life-cycle cost of producing electricity with hydrothermal fluids to $0.03 - $0.10 per kilowatt-hour by 1992. This compares with a cost range for hydrothermal electricity of $0.04 - $0.18 per kilowatt-hour as of 1986. Improvements in the other geothermal conversion technologies are planned to achieve a production cost of $0.06 - $0.10 per kilowatt-hour for geopressured by 1995, $0.05 - $0.08 for hot dry rock by 1997, and $0.10 - $0.20 for magma by the year 2000[8].

"Clean Coal" Technologies

The precise definition of the term, "clean coal" technologies is unclear, but it is generally taken to mean the development of techniques other than combustion in the now conventional pulverized coal (PC) boiler -- such as fluidized bed combustion, or gasification, and the development of new emission control technologies beyond the now conventional Electrostatic Precipitator for particulate control and wet-limestone based flue gas desulfurization (FGD) systems for sulfur (SOx) control. Efforts to find improved emission

[8]Geothermal Energy Program Summary, Volume I: Overview for Fuscal Year 1988, U.S. Department of Energy, DOE/CH10093-47, March 1989.

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controls for conventional combustion technology have proven to be difficult and expensive, and will likely prove to be ultimately unsatisfactory. In recent years, therefore, the focus of the "clean coal" program in the United States has shifted to the development of new approaches for combustion, the most important of which are the fluidized bed combustion (FBC) and gasification systems.

These technologies provide inherently lower emission levels that do not require expensive post-combustion pollutant control, and which are also inherently more efficient. In general, demonstrations in the U.S. show that they are cost competitive with conventional PC boilers fitted with FDG systems, but have the additional benefit of lower NOx emissions. However, they may not be competitive with conventional boilers that do not require FDG systems (since FDG systems add approximately 15 percent to capital cost) for SOx control. One major advantage of both FBD and gasification systems is that they appear much better suited for coals of very low calorific content (and high ash content typical of places like India). Experience in India has shown that when the costs of low availability are taken into account, PC plants that receive very high ash coals also incur substantial economic penalties as a consequence of high outage rates. Consequently, when actual availability factors are taken into account, the cost difference between these new technologies and conventional PC plants per kilowatt-hour of output becomes much smaller. In fact, per kilowatt-hour costs for atmospheric FBC systems is less than for a PC system with FDG or a PC system with a 15 percent lower availability, a very realistic number in light of availability rates in India, for example, of 45-55 percent. The two "clean coal" technologies that have the greatest immediate application to developing countries, i.e. Atmospheric Fluidized Bed Combustors (AFBC) and Integrated Gasification Combined Cycle power plants., are briefly discussed below.

Atmospheric and Pressurized Fluidized Bed Combustors

Fluidized Bed Combustion (FBC) technologies offer advantages of more conventional types of combustors, such as stoker-fired or pulverized coal-fired boilers. The FBC can be designed to operate at atmospheric pressure (an AFBC) or at pressures typically in the range of 6 to 16 atmospheres (a PFBC). The AFBC is a less complex technology with greater fuel flexibility than the PFBC, although the PFBC has lower emissions, is more thermally efficient and the compactness of components makes it more modular. The AFBC can be used in utility, industrial, commercial and residential applications, either as a new system or a retrofit. The PFBC will most likely be used as a power producer in the utility and large industrial cogeneration sectors when it becomes commercially available.

The AFBC has reached commercial status in the industrial and cogeneration sector on a world-wide basis. More than 70 industrial applications burning a variety of fuels from cow manure and tree bark to coal and oil shale are in operation. Several large industrial and small utility units are operating in the U.S. The most significant include:

o	Colorado-Ute Electric Association	110 Mwe (retrofit)
o	Scott Paper, Chester, PA	650,000 lb/hr steam
o	Northern States Power	125 MWe (retrofit)
o	Montana Dakota Utilities	75 MWe (retrofit)

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o Tennessee Valley Authority 160 Mwe (repowering)

Experience with the operation of AFBC units indicates that the manufacturing risk for units smaller than 100 MWe is minimal, careful specification and design review make the risk for units up to 200 MWe acceptable, and single-combustor boilers above 200 MWe most likely will require considerable design studies and/or test programs before confidence in equipment manufacture can be assured[9].

The PFBC is a very promising technology that is currently in the demonstration phase with three utility projects that are expected to start operation by the end of 1990[10]:

- The American Electric Power Co. retrofit to an existing 70 MWe unit in Ohio.
- The Stockholm Energi Production AB two PFBC modules, with combustors and gas turbines, and a single steam turbine in Sweden (135 MWe and more than 225 MWt).
- The Empreessa Nacional de Electricidad S.A. (ENDESA) of Spain 63 MWe PFBC firing black lignite and using dolomite as a sorbent.

Essentially all the large U.S. boiler manufacturers offer AFBC designs for industrial and utility applications. Most systems operate on a range of coal, slurries, petroleum coke, biomass, wastes, and other low-grade fuels. Considering the availability of low-quality fuels in many developing countries, the pressure to comply with stringent environmental regulations, and the need for additional power generation, AFBC technology is an attractive option for these countries. The similarities of AFBC technology to pulverized coal technology make introduction of AFBC in developing countries relatively easy. However, international competition is very high, particularly from the Europeans lead by Ahlstrom (Finnish) and Lurgi (West Germany). There is also some competition from ASEA (Sweden), the Japanese and the Chinese. The Chinese have over 2000 fluidized bed installations throughout China and are now pursuing overseas marketing of their designs.

Integrated Gasification Combined Cycle

An integrated gasification combined cycle (IGCC) power plant centers around two elements; a gasification plant which converts a fuel into a combustible gas, and a combined-cycle power plant in which the gas fuels a combustion turbine generator to produce electricity and whose hot exhaust gases are used to generate steam which drives a steam turbine to also generate electricity. The primary attractions of the IGCC are fuel efficiency and low sulphur dioxide, carbon monoxide, nitrogen oxide, and particulate emissions. The low emissions make the process attractive for the use of low-quality coal if gas prices increase and coal gasification cost decreases in the future. Another advantage of the IGCC is "phased construction", i.e. some parts of the plant may be installed and operated before

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[9]Ibid. A Potential Role for U.S. Energy Technologies in India, CETA Project, USAID, 1988.

[10]The Current State of Atmospheric Fluidized-Bed Combustion Technology, Prepared by the Fluidized-Bed Combustion Program of the Electric Power Research Institute for the World Bank, March 1989.

the complete plant is finished (for example, the gas turbine/generator sets may be installed before the gasifiers and operated off of natural gas), which is a financial plus for the implementation of the technology. In addition, the technology requires less land and water than conventional scrubber-equipped, pulverized coal boiler power plants. Solid wastes are less voluminous and easier to handle than scrubber-equipped and AFBC systems[11].

In the U.S., utility companies have been cautious toward the implementation of the IGCC technology. Gas turbine/combined cycle (GTCC) is being used more extensively as gas turbine technology has improved in recent years to increase performance and as the price of natural gas has declined. U.S. utilities are considering the use of GTCC units for cheap base load electricity and not just for peaking power plants. As the use of this technology grows, the cost of implementation will become competitive with other competing power options. The gas turbine and combined cycle industry and worldwide marketing efforts are lead by the U.S., the Europeans, and the Japanese. The Japanese are marketing and building General Electric and Westinghouse (the leaders of a total of 7 firms active in the U.S.) technology gas turbines under license. The most active European firms are Kraftwork Union (German), Brown Boveri (Swiss) and ASES (Sweden). The largest combined-cycle power plant in the world is a 2000 MW multitrain unit being built in Japan. There is no question that international competition for sales in developing countries will be intense with cost and financing being the major factors for success.

Coal gasification is a process which converts solid coal into a synthetic gas composed mainly of carbon monoxide and hydrogen. A gas cleaning step is required to remove sulfur compounds and particulate to meet environmental requirements. Intensive efforts to develop viable gasification processes during the 1970s and 1980s were stopped when oil and gas prices dropped. Electric utilities in the U.S. are now committing to gas-fired combined cycle plants with the intention of conversion to IGCC later by adding a gasification unit when prices rise again. Currently there are six major U.S. technology suppliers and five large architecture and engineering firms involved with development of gasification processes.

Several gasification processes are under development including two in the U.S. with commercial plants using the Texaco (Coolwater, 1000 tons per day) and the Dow (Plaquemine, 2400 tons per day) processes. These plants are the largest in the world and illustrate the U.S. lead in this technology. Foreign competition is primarily from the West Germans (Lurgi, Winkler), British (British Gas), and the Dutch (Dutch Shell). Foreign gasification pilot plants and demonstration facilities are also being built including two large plants in Europe using the High Temperature Winkler (900 tons per day, West Germany, 1985) and British Gas/Lurgi (600 tons per day, 1986) processes. Currently, the primary constraint to the application of gasification and IGCC plants is economics, particularly when cost comparisons are made with competing fuels such as natural gas. However, cost estimates vary considerably. For example, based on the Texaco gasification process, the U.S. Electric Power Research Institute estimates a power plant cost of $1630 per kilowatt for a 500 Megawatt IGCC, while the cost for a conventional power plant of the same

[11]New Electric Power Technologies: Problems and Prospects for the 1990s, Washington, D.C., U.S. Congress,Office of Technology Assessment, OTA-E-246, July 1985.

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capacity is estimated to be $1360 per kilowatt of output power.

A combination of lead time and risk make widespread deployment of the IGCC technology somewhat uncertain in the early to mid-1990s. Because of its modular nature and positive environmental features, the IGCC should have a deployment lead time of no more than 5 to 6 years once design and construction of commercial plants is commonplace. There could emerge an impetus to build these plants in developing countries which is motivated by the availability of large quantities of low cost, off-shore gas supply, as there has been in India[12].

Slagging Combustors

Slagging combustor technology is an outgrowth of U.S. rocket engine research and efforts to develop coal-fueled magnetohydrodynamics (MHD) power plants. The primary impetus in the U.S. was originally the need to retrofit oil- and gas-fired boilers to coal-firing. More recently, interest has been on retrofit applications of existing coal-fired cyclone burners to reduce emissions. Recent systems involve combustion of coal in the presence of limestone to achieve both full combustion and excellent particulate and sulfur oxide/nitrogen oxide emission control in three versions; an air-cooled systems, a water-cooled systems, and a system with refractory insulation to minimize water tube damage.

Slagging combustor technology is still in the developmental stage and commercial installations have not been built. Pilot plant testing is underway and power plant demonstration projects are expected in the near future. Once retrofit applications have demonstrated the advantages of this technology, boiler designs incorporating slagging combustors will most likely be developed for new installations. Reductions in oil and gas prices and U.S. government funding will probably delay significantly the introduction of this technology by the U.S. industry. Optimistic estimates for commercial readiness are at least five years from now with the possibility of this stretching to 10 to 15 years if competitive fuel prices and government funding for development remain low and early performance goals are not met.

U.S. companies involved with slagging combustor technology development include TRW, AVCO, CoalTech, and Rockwell (coupled with TransAlta of Canada). Technology development is mainly in the U.S. at this time, with concentration on a domestic market. Specific costs and benefits are difficult to quantify as additional research and development is necessary to define commercial units[13].

Fuel Cells

A fuel cell produces electricity by an electrochemical reaction between hydrogen, supplied by a hydrocarbon fuel and oxygen. Neither combustion nor moving parts are necessary for the conversion process. Fuel cell power plants are expected to generate electrical power

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[12]Ibid. A Potential Role for U.S. Energy Technologies in India, CETA Project, USAID, 1988.

[13]Ibid. A Potential Role for U.S. Energy Technology in India, CETA Project, USAID, 1988.

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very efficiently and with minimal environmental impact in units of a wide variety of sizes ranging from small cogeneration units to central power stations. They can be installed in locations where available space and water are minimal. Among other advantages are:

- o responsiveness to changes in desired output,
- o short construction lead-time,
- o easily recoverable waste heat,
- o fuel flexibility,
- o off-site manufacturing, and
- o ability to operate unattended.

Most of the commercial demonstration plants that are crucial to the development of the fuel cell only began operation in the late 1980s. In 1985, a 4.5 MWe demonstration plant was operating successfully in Japan and thirty-eight 40-kWe demonstration units were operating in the U.S.

The future level of deployment of fuel cell technology depends heavily on the success of these demonstration units. Current evidence suggests that the early-1990s could see the first production of fuel cells on a commercial scale. As much as 1200 MWe of fuel cell power plant capacity could be on-line by 1995. High-volume mass production is unlikely to occur until a sizeable market is anticipated, and a sizeable market will not occur until there is sufficient confidence in production and operating cost from data supplied by the demonstration units.

The fuel cell industries in the U.S. and Japan are positioning themselves for substantial commercial deployment of fuel cells in the 1990s. The potential market in the U.S. is large; an EPRI study suggests that fuel cells could provide as much as 65,000 MWe of generating capacity by 2005. At predicted future cost and performance levels, extensive markets for both central station and dispersed applications could develop. In Japan, deployment could be quite rapid if fostered by government incentives. Japanese fuel cell manufacturers have a close working relationship with the country's electric power companies which will ease difficulties with a commercial transition. Over the next 10 years, a well-coordinated effort in Japan could put them in a position comparable with or perhaps superior to their U.S. counterparts without a significant increase in U.S. development efforts.

ANNEX D

ECONOMIC ANALYSIS

ANNEX D: PROJECT ECONOMIC ANALYSIS

Introduction

The purpose of economic analysis for the Energy Technology Innovation Project is to determine whether the project will be a worthwhile investment for the affected countries. The analysis estimates whether the outputs from the project are sufficiently valuable so as to cover the project costs. Economic analysis differs from financial analysis in that it examines the full effects of a project on a country's economy. While financial analysis examines only the explicit monetary costs and benefits of a project, economic analysis examines hidden opportunity costs and benefits to the project's participants. The general principle of economic analysis is to compare the actual benefits of a project to its actual total costs.

In performing the economic analysis for the Energy Technology Innovation Project, it must be recognized that because the project limits its funding to prefeasibility studies, training, and technical assistance, no specific actual projects can be analyzed. Additionally, among these funded items, it is not realistic to attempt to quantify the economic benefits of the training sessions, seminars, and technical assistance. Although these items may provide long term benefits there is no way to quantify these benefits beforehand. Thus the economic analysis focuses on the expected economic benefits of the prefeasibility studies funded under the Project Identification Fund.

As was done in the financial analysis (Annex G), the economic analysis uses estimates of the number of successful projects resulting from the prefeasibility studies to gauge the economic viability of the Project Identification Fund. The following analysis first discusses the broad economic and social benefits expected to result from prefeasibility fund initiatives. These benefits are then quantified in an economic investment analysis.

Project Outputs and Benefits.

o Projects Outputs

One of the major anticipated long-term outputs of the ETIP is additional electricity in developing countries. Furthermore, through the ETIP, this electricity will be provided through new, efficient, and environmentally clean energy technologies. In the financial analysis, it was estimated that of an expected 100 proposals for prefeasibility study funding under A.I.D.'s Energy Technology Innovation Project, about 25 proposals (25 percent) would be granted funding.

Additionally, from these 25 prefeasibility studies, it is hypothesized for purposes of this analysis that the project will eventually act as a catalyst for an investment of some $500 million of local/donor capital for new generating capacity or major rehabilitation in 10 or more plants ranging from 20 to 200 MW, with a total capacity of 500 MW. The electricity generated will provide many additional benefits to developing countries.

o Benefits of Electric Power

As discussed in the body of the text, the major impetus for the Energy Technology Innovation Project is the excess and rapidly growing demand for electric power in developing countries. The combination of high growth rates in industrial output, inefficient utility management policies, and inadequate pricing policies in many of these countries has caused the demand for electric services to rise more rapidly than supply. Many developing countries now face power shortages of over 10 percent of their generation capability (Exhibit D-1).

Exhibit D-1
POWER GENERATION SHORTAGES

Country (at peak)	Shortage, Demand minus Supply
Dominican Republic	over 15 percent
Sierra Leone	10 percent
India	10 percent
Pakistan	over 25 percent

As a result of such power shortages, local industry must face periods of load shedding, use private and comparatively expensive diesel generators, and adjust production with night shifts and other methods. Thus there is a strong relationship between electric power generation and the economic development of a country-- and a high cost to power shortages. The ETIP Project Identification Fund would benefit countries by encouraging the implementation of reliable, energy efficient hardware that would reduce the cost of these power shortages and load shedding.

In addition to problems faced by industry in countries where electricity must be rationed by load shedding, much of the population of these countries remains without electric power. As Exhibit D-2 shows for a selection of countries where data are available, the complete lack of electrical services is particularly acute in rural areas:

Exhibit D-2
PERCENT OF POPULATION WITHOUT ELECTRICAL SERVICE

Country	Total	Rural
Costa Rica	25%	55%
El Salvador	60%	89%
Guatemala	75%	93%
Honduras	70%	95%
Egypt	54%	81%
Pakistan	69%	85%
Philippines	72%	93%
Sudan	74%	NA

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For residents of these and other countries who live without electric power, the benefits of electricity are many. Not only would electric power replace candles, gas generators, and batteries for these residents, but major economic benefits would be forthcoming in the areas of health care, education, agriculture, and industry. Economic multiplier effects would further increase these benefits.

o Relationship Between Economic Growth and Electricity Use

Over time, there is a strong correlation between the economic growth rate in a country and its use of electricity. Electricity has a large role in a country's development process, (although cause and effect relationships are hard to establish). From 1970 to 1980, Gross Domestic Product (GDP) in developing countries grew at about 3.5-5.5 percent per year, while total energy consumption use grew by 5.9 percent and consumption of modern energy forms, i.e. electricity, grew about 7 percent annually.

Economic growth in many developing countries is constrained by shortages of electric power, as mentioned above. With each 1 percent increase in GDP corresponding to a 1 to 2 percent increase in energy use and electricity use, power shortages can be a major impediment to economic growth. (The use of modern energy forms tend to grow faster than GDP as more productive uses for energy replace unproductive ones. Electric stoves may replace wood stoves, for example). While it is unrealistic to attempt to measure the effect that the ETIP will have on overall GDP growth rates in developing countries, past evidence suggests that any additional electricity generated as a result of the project will lead to additional economic growth.

Quantifying the Economic Benefits

The ETIP will provide a variety of technical analyses and project planning services that are not directly quantifiable in an economic analysis. Thus for purposes of this evaluation an assessment will be made of the possible projects that will stem for the A.I.D. Project Identification Fund. This Fund will be used to finance prefeasibility studies for potential developing country utility, private sector, and other end-user projects evaluating the use of innovative, cost-effective, and environmentally clean technologies. At this time however, no specific projects or countries can be examined to determine ETIP's economic benefits. this type of analysis, however, will be conducted as part of the selection process for potential projects to receive funding. Hypothetical estimates of the economic benefits of the ETIP Project Identification Fund are provided through the illustrative example presented below.

o Economic Cost of Power Shortages

In this example, an analysis is provided for the development of a clean coal power plant that will be built in a developing country as a result of the favorable findings from an A.I.D. prefeasibility study and related follow-on analyses. The major requirement necessary to estimate the economic returns to building an electric power generation plant in a developing country is an estimate of the opportunity cost of the power shortages, load shedding, and total lack of electricity mentioned above. While few studies have attempted to estimate the incremental benefits in health care, education, agriculture, and other areas, extensive work has been done to estimate the cost of load shedding and power shortages.

This work focuses on the efficiencies gained with electric power when compared to the use of candles and expensive gas generators, and the general loss of production in an economy. Exhibit D-3 presents estimates of the cost of power shortages in selected developing countries. Note in particular that the range of the estimates is well above the average price of a kilowatt-hour (kWh) of power generated with electricity (about 8 to 12 cents). The estimates of the cost of power shortages from Exhibit D-3 are the key to assessing the economic benefits of the ETIP Project Identification Fund. Every additional kilowatt-hour of electricity produced as a result of the ETIP initiatives will save industries and households the cost of a shortage. (Note that in Exhibit D-3, the range of estimates is from $0.06-$6.00/kWh. For the analysis that follows, an estimate of $0.50/kWh or $500/MWh is used for the cost of a power shortage. This is conservative in that it is at the low range of the estimates from Exhibit D-3 note that the cost values in Exhibit D-3 are in 1978 dollars).

o Discount Analysis of ETIP Project Identification Fund Benefits

In order to determine the economic benefits of the ETIP Project Identification Fund, a discounted cash flow analysis was performed. The economic benefits of the Fund are found not in the prefeasibility studies per se, but in the successful projects resulting from these studies.

The steps and assumptions behind the analysis are as follows. First, we assume that plants with a total capacity of 500 MW are constructed. Next, using a plant factor (utilization) of 40% and multiplying by 24 hrs/day and 365 days/year, we estimate the total generated electricity per year at 1,752,000 MWh. We then assume that only half of this new generation is used for shortages and that losses from generation to distribution are 15%. Finally, each MWh of newly distributed electricity is valued at $500/MWh (from Exhibit D-3). This produces an estimate of the economic benefits per year -- which can then be projected out over the life of the project and discounted back to arrive at a net present value.

o Results

Exhibit D-4 presents an analysis of the economic benefits that can be attributed to the successful plants resulting from the prefeasibility studies. (Note that this analysis does not attempt to quantify benefits from improvements in health care, education, and other social areas.) As the chart indicates the economic Net Present Value (NPV) for the ETIP Project Identification Fund under this scenario is estimated at $766 million dollars, and the corresponding benefit/cost ratio is 1.48. The positive nature of these figures (i.e., greater than zero), demonstrates that the Project Identification Fund is economically viable.

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Costs of Power Shortages in Selected Developing Countries (1978 US$)

Country	Sector(s)	Type of Shortfall	Cost of Shortage
Bangladesh	All	Unplanned outages	1.00$/kWh
Brazil	Households	Unplanned outages	1.95-3.00$/kWh
Chile	Households	Unplanned outages	0.53$/kWh
	Industry	Unplanned outages	Range: 0.25-12.00 $/kWh Central Tendency 1.50-6.00 $/kWh
Costa Rica	Households	Unplanned outages	--
Egypt	Industry	Unplanned	0.40 $/kWh
India	Industry	Controlled load shedding	Annual cost ranges from 1 to 3% of GDP (1.5 to 3 billion dolars annually)
Jamaica	Industry	Unplanned outages	1.25 $/kWh
Pakistan	Industry	Controlled load shedding	Range: 0.26-1.77 Average: 0.46 $/kWh
		Unplanned outages	Range: 0.36-2.54 Average: 0.81 $/kWh
		Controlled and Uncontrolled load shedding	$350 million in 1984-85
Paraguay	Residential		--
Taiwan	Industry		0.06-2.16$/kWh
Tanzania	Households		0.50 $/kWh
	Industry		0.70-1.40 $/kWh
	Commercial		1.00 $/kWh
	All sectors		0.70-1.10 $/kWh

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

Exhibit D-4

ETIP PROJECT IDENTIFICATION FUND DISCOUNTED CASH FLOW ANALYSIS

YEAR	ECONOMIC BENEFITS ($MILLIONS)	PROJ. ID. FUND ($MILLIONS)	NET COST BENEFITS ($MILLIONS)	NET DISC. BENEFITS ($MILLIONS)
0	0	(11)	(11)	(11)
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	509	0	509	206
9	530	0	530	191
10	551	0	551	177
11	573	0	573	165
12	596	0	596	153
13	620	0	620	142
14	645	0	645	132
15	670	0	670	122
16	697	0	697	114
17	725	0	725	106
18	754	0	754	98
19	784	0	784	91
20	816	0	816	85
21	848	0	848	79
22	882	0	882	73
23	918	0	918	68
24	954	0	954	63
25	992	0	992	58
26	1032	0	1032	54
27	1073	0	1073	50
28	1116	0	1116	47
29	1161	0	1161	43
30	1208	0	1208	40

($ in millions)

NET BENEFITS:		2357
NET COSTS:		(1591)
	Prefeas. Studies	(11)
	Capital Costs	(250)
	O&M	(380)
	Fuel	(950)
	Net Costs	(1591)
NET PRESENT VALUE:		766
BENEFIT/COST RATIO:		1.48

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Notes:

1) Only 50% of the costs are presented in the analysis since this portion addresses load shedding.
2) The estimate for the cost of unserved energy is conservative, in that it is at the low end of the range of estimates in Exhibit D-3.
3) No benefits are received until year eight, when plants are expected to come on line.
4) The estimate for the percent of power going to areas of shortage and load shedding is also conservative. Unless electricity demand abruptly stops growing, 100 percent of the generated electricity will be needed.
5) The estimate for plant factor is conservative and assumes a mix between baseload and peaking or hydro.
6) The estimated percent of power lost from generation to distribution is at the high end of most estimates.
7) The analysis assumed a 4% escalation rate and a 12% discount rate.

ANNEX E

SOCIAL ANALYSIS

ANNEX E: SOCIAL ANALYSIS

It is now recognized that along with food, water and shelter, energy in all its forms is a universal component of every nation's development characteristics, or "profile", and indeed every person's daily activities. As such this means the effective expansion of environmentally sound, reliable energy through intelligent conservation measures, the adoption of relevant new technologies, and sound management principles is to be encouraged.

The ETIP project can have a significant, positive direct and indirect impact on the populations of participating LDC countries, because the expansion of energy availability through innovation to broader portions of the population can improve the daily lives and productivity of the people involved. The ETIP project addresses energy sector opportunities sufficiently diverse for rural and urban energy use settings. It is impossible to quantify but not difficult to envision the breadth of social impact the project can have.

For example, innovative energy analyses which promote load management techniques will enable new users to have access to more reliable supplies of electricity. These measures which are instituted successfully will allow existing electrical equipment such as refrigerators and other medical equipment to perform more reliably and thus prevent vaccine spoilage through an interruption of the "cold chain". Better regulated electricity supplies will prevent brown-out damage to other electrical equipment as well, thus increasing their useful life with lower repair costs.

Additionally, innovative energy technologies can expand the availability of electricity for educational applications such as lighting for night school classes, educational radio or television program reception, science education, and other routine school energy needs. Some innovative technologies, employed in rural areas where grid power is not available, may enable schools and clinics to use electricity for the first time on a regular basis, without the dependence on imported fuels which are transported at considerable expense and irregular intervals to rural settings.

Environmentally benign energy technologies, such as those which provide electricity from the various renewable energy sources, or clean coal technologies, or those technologies which encourage electricity demand balancing while reducing pollution per unit of output, work to reduce the pollution from traditional fuel sources. While difficult to measure, the impact of such pollution on the quality of life in many urban areas of LDCs is becoming increasingly apparent. For example, coal-fired electricity plants in India, Pakistan, and Eastern European countries, among others, are visibly reducing the environmental air quality and increasing respiratory-related illnesses among urban residents. The application of clean-coal technologies and improved control mechanisms, employed after appropriate feasibility studies, could be expected to greatly improve these situations.

Importantly, the A.I.D. report to Congress entitled Power Shortages in developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector, presented in March, 1988, cites many of the reasons suggested here for the expansion of electricity availability in LDCs. The report concludes its list of benefits with the realization that

cleaner, more reliable, more efficient and economical electricity production will increase economic productivity in two ways:reducing "downtime", and making more products available to secondary producers.

Such measures will also heighten the sense of stability present in daily life that is essential for popular support of governments. Public confidence and satisfaction are increased with the supply of predictable and reliable power supplies.

Similar sentiments are included in The Report of the Energy Industry Review Group on Power Shortages in Developing Countries, submitted to Administrator Alan Woods in April, 1989. This group concluded that A.I.D. should "place a greater emphasis on energy, particularly electric power, and on the transfer of proven U.S. technologies and services." Further, in urging A.I.D. to take a more active role within the United States in energy and power issues, it suggested A.I.D. be "active and innovative in helping to promote, market, and finance U.S. energy/power equipment services that can support sustainable economic growth in developing countries in ways that are environmentally sound...[within] a long-term perspective. Sustained economic growth has obvious social benefits for all sectors of the society.

Furthermore, the growth and stabilization of the energy/power sector through increased efficiencies and technological and management improvements should serve to expand employment opportunities. Employment in the energy sector should similarly grow and diversify as innovations occur. Productivity should rise, with a corresponding increase in individual income and in the country's gross national product.

Finally, innovative electricity/power technologies which heighten efficiency and improve the reliability of power delivery systems in ways which reduce pollution are more responsive to issues of domestic and global social costs.

ANNEX F

ENVIRONMENTAL ANALYSIS

ANNEX F: ENVIRONMENTAL ANALYSIS

The goal of the A.I.D. Energy Technology Innovation Project (ETIP) is to reduce the gap between energy supply and demand in lesser developed countries (LDCs) in an environmentally acceptable and cost-effective manner. In November 1989, the Congress of the United States supported an environmental emphasis on new energy development with legislation which it interpreted in Conference Report 101-344 as funding "projects in 'key' developing countries which contribute significantly to global greenhouse gas emissions, and in which actions to promote energy efficiency, reliance on renewable energy resources, and forest conservation could significantly reduce those emissions." Further the Conference Report states that A.I.D. should "... assist countries in developing and implementing energy plans ... to minimize reliance on fossil fuels." This concern has also been voiced by other worldwide government agencies, bilateral donors, and multilateral development banks. More and more, approval of power development projects and loans for their financing are being tied to careful analysis of long-term environmental impact to provide the needed increased supply of energy in a socially and fiscally responsible manner.

The need for "socially and fiscally responsible" power generation must also consider A.I.D.'s 10-year strategy adopted in 1983 to initiate programs that satisfy a critical need for economic and social growth in the developing nations of the world. Projects to alleviate these two related needs, i.e. power generation and economic and social growth, often exacerbate the clash between the cost and implications of technology versus social progress.

The developed nations of the world have enjoyed a pattern of increased energy consumption as they grew and overconsumption as they mature. Natural resources were abundant and were used without thought of their finite nature. The United States was, and continues to be, the prime example of this naive indulgence. One American consumes as much energy as approximately 2 Germans or Austrians, 3 Swiss or Japanese, or 6 Yugoslavs. The discrepancy quickly widens if LDCs are considered. One American consumes as much energy as 16 Chinese, 19 Malaysians, 53 Indians or Indonesians, 109 Sri Lankans, 438 Malians, or 1072 Nepalese. Across a range of LDCs, this is an average of approximately 24 times as much energy per capita as the LDCs.

In itself, this could be considered not to be a serious problem. Through agencies such as A.I.D., the developed nations of the world could systematically help LDCs to increase their energy supply until they too enjoyed the benefits of a consumption level equal to that of the developed world. An increased standard of living and social progress would benefit all. A closer look at the underlying foundation for this level of energy consumption, however, clearly indicates that the extent of the "non-problem" depends on two critical assumptions, (1) that there is an unlimited source of energy, and (2) that the source of energy is environmentally benign. The "greenhouse effect" which is resulting in a global warming trend is caused in large part by carbon dioxide emissions from fossil-fired power plants. Once again, the developed nations of the world are the prime contributors to this problem. The United States and the Soviet Union are the worst offenders both in total emissions and per capita emissions. Total emissions are the result of size, i.e., China is the third largest polluter, but its per capita emissions are low. Per capita emissions are a better measure

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of the technology being used. It is interesting to note that the Eastern European countries are chief offenders in this measure. While LDCs do not significantly contribute to carbon dioxide emissions now, development of their power generating capacity without concern for the environment will follow a similar pattern to that of the Eastern European countries.

Clearly with the energy sources that have been exploited throughout history, the above assumption of an unlimited and environmentally benign energy supply is not valid. Coal surpassed wood as the main energy source in developed countries in the 1850s, oil and natural gas took over in the 1950s, and only after severe oil crises in the 1970s have alternative and renewable sources of energy even been considered for the generation of power. Many LDCs are essentially in the 1850s with regard to energy supply, and the most "developed" LDCs are just entering the 1950s. There is a strong indication that (1) as the world's population grows and total energy demand increases (even at a zero per capita rate of increase - essentially a stagnant standard of living), and (2) LDCs strive to reach a level of energy consumption that provides a standard of living at even a 1950s level in developed countries, the scarcity of the world's energy resources will result in exploitation by developed countries at the expense of LDC.

In 1970, in response to growing concerns about energy crises and the environment, the U.S. Congress began a massive effort to address the pollution damage that had been accumulating over the previous decades. In short order, legislators passed the National Environmental Protection Act (NEPA) and created the Environmental Protection Agency (EPA) to administer it. These two events are the cornerstone of what is undoubtedly the world's most vigorous pollution control effort, a model for other nations of the world to follow. However, nearly 20 years later, the apparent progress made toward restoring the quality of the world's environment is woefully small and centered in only a few selected areas.

The areas where some progress has been made may indicate what works and what does not. Every success on this rather short list of significant environmental quality improvements reflects the same remedial action: Production of the pollutant has been stopped. For example, DDT and PCB levels have dropped, mercury is much less prevalent, and lead levels are lower. Use of all these pollutants has been banned by law. The lesson appears to be plain: Pollution prevention works; pollution control does not. Only where production technology has been changed to eliminate the pollutant has the environment been substantially improved. Where it remains unchanged, where attempts are made to trap the pollutant after it has been produced, environmental improvement is modest or nil. It appears that when a pollutant is attacked at the point of origin, it can be eliminated. Once it is produced, it may be too late[1].

A narrow focus on the growth of power generation capacity to close the gap between power supply and demand in LDCs has resulted in the implementation of power systems using fossil fuels and other energy-related conversion technologies that use energy inefficiently or in an environmentally unacceptable manner. Often the decision is a short-term economic

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[1]Why Environmentalism has Failed, Barry Commoner, Greenpeace, September-October 1989.

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one. Indigenous resources such as high sulfur coals or crude oil are used to minimize the expenditure of hard currency for fuel import. In many cases, Third World energy Ministries are not knowledgeable about technology advances that can reduce emissions from conventional power plants or that provide alternative power generation, transmission and distribution systems to reduce energy waste and negate the need for capacity growth.

The ETIP is an energy development initiative that addresses the implementation in LDCs of energy/power technology, equipment, and services that support sustainable economic growth in ways that are environmentally sound. The ETIP supports assessment and system development to employ advanced, innovative power generation, transmission, and distribution technologies developed and proven in the U.S. to efficiently use indigenous energy resources in LDCs and improve existing systems. The U.S. continues to be a world leader in scientific and engineering aspects of energy production, conversion, transport and use, as well as in the areas of management, systems analysis, and commercialization. U.S. government expenditures in energy R&D exceed that of any other nation in the world. The U.S. is pre-eminent in essentially all areas of clean and efficient energy development that promise an alternative to large-scale, long lead-time conventional fossil-fired power plants. Among the power generation or conversion technologies that the U.S. is either the world leader or competitive in, that most likely will be considered by ETIP, are:

- Solar Electric Systems (solar thermal and photovoltaic)
- Wind Electric Systems
- Geothermal
- "Clean Coal" Technologies [atmospheric fluidized bed combustors (AFBC) and integrated gasification combined cycle (IGCC) units]
- Slagging Combustors, and
- Fuel Cells.

Environmental aspects of power system development in general, and of some of these technologies in particular, are discussed below.

FLUIDIZED BED COMBUSTORS

The environmental issues of concern with fluidized bed combustors (FBC) are similar to those associated with conventional power plants. The most significant issues arising from FBC technology are the control of stack emissions of SO_2, NOx, and particulates and the disposal of solid waste (including material discharged from the bed and fly ash from the particulate control system)[2].

Atmospheric Emissions

The rate of SO_x emissions from a limestone-fed FBC boiler is expected to be comparable to that of a conventional coal-fired power plant with an SO_2 scrubber. The rate of NO_x

[2]Energy Technologies and the Environment, U.S. Department of Energy, National Technical Information Service #DE89-003779, October 1988, pages 45-65.

emissions is expected to be somewhat less than that resulting from conventional coal-fired combustion. Particulate emissions from FBCs, however, are of more concern. Particulate emissions are estimated to be comparable in quantity to those from conventional combustion per unit of feed energy fired, but their size distribution, composition, and difficulty of capture make them potentially more hazardous. Volatile trace metals and hydrocarbons preferentially condense on smaller particles, which could increase the health hazard from them. Furthermore, FBC fly ash is formed at relatively low temperatures and does not fuse like conventional fly ash. For this reason, it can release components (e.g. metals and hydrocarbons) more easily than conventional fly ash.

Because of lower operating temperatures and incomplete combustion, FBC is expected to have a higher hydrocarbon emission rate than that for conventional combustion. Although little information is available on the health effects of hydrocarbons from FBC, one study found that the levels were less than the minimum acute toxicity effluent values for air. Other research has demonstrated, however, that the hydrocarbons have appreciable mutagenic activity in microbial bioassays. The findings did indicate that hydrocarbon activity from atmospheric FBC is lower than that from pressurized FBC or conventional combustion.

Solid Waste

As with FBC emissions, little information is available on the potential impact of solid waste from FBC. However, the mass of the solid waste produced by a FBC plant achieving 90 percent sulfur capture can be two to four times that produced by a conventional boiler without flue gas desulfurization (FGD). The mass of solid waste from an FBC plant may be only 30 percent greater than the mass of dry solids from a pulverized-coal boiler with FDG and high-efficiency fly-ash removal. A major consideration is the amount of land required for the disposal of waste solids from an advanced technology coal-burning power plant, whether the technology used to control SO_2 emissions is FBC or FGD.

Environmental Controls

FBC is viewed as a viable method for controlling SO_x and NO_x emissions during combustion, but the particulate matter normally entrained in FBC flue gas poses special environmental and operational problems requiring both conventional and innovative control methods. The large amount of solid waste that results from using non-regenerable sulfur sorbents to control stack emissions from high-sulfur fuel requires new disposal and reuse options, or innovative alternatives for capturing the sulfur.

The technologies proposed for controlling particulate emissions from atmospheric FBC are conventional. Control methods used in pressurized FBC, however, are still in the development stage, and information regarding their efficiencies and operating problems is limited.

- Emissions Control

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Sulfur is absorbed in fluidized beds by natural ash alkalis and added limestone or dolomite. Limestone is typically used as a sorbent in atmospheric FBC. Dolomites that contain calcium and magnesium carbonates are used in pressurized FBCs. Nitrogen oxides emission are inherently controlled by the low combustion temperatures used in FBC. In general, these emissions are less for pressurized FBC than for atmospheric FBC.

The primary control device used for removing particulate matter from FBC combustion gases is the mechanical cyclone. A cyclone used centrifugal force generated by a whirling gas-solids mixture to separate the solids from the gas stream. Unburned carbon, ash, and bed material removed by the cyclone are either reinjected into the main bed or disposed of as a solid waste. The cleaned gas is sent to a secondary collector - a baghouse for atmospheric FBC and a granular or ceramic filter for pressurized FBC - for further particulate removal. Particles can be collected from atmospheric FBC systems by state-of-the-art techniques and devices used with conventional boilers, but the high pressure and temperature of the combustion gas stream leaving a pressurized FBC require more rugged and effective devices. Several promising technologies are being pursued, but non have yet been fully developed.

o Solid Waste Control

Three options are available to manage the stream of dry, solid waste that results from coal-fired FBC boilers. It may be discarded by sea dumping, mine filling, or land spreading and filling; it may be sold for a limited number of uses; or it may be processed to separate the ash from the sorbent component, which can be regenerated and reused. Each of these options has difficulties and uncertainties. Additional research is needed to establish better, more economical methods for using spent bed material, regenerating spent sorbent to recycle it and recover sulfur, and controlling leaching from landfills.

Environmental Constraints

Environmental factors related to particulate emissions and solid waste disposal or use may retard the widespread adoption of FBC. Particle size distribution and composition have yet to be adequately characterized, and disposal practices for FBC wastes will have to take into account the potential environmental impacts relating to leachate salinity, alkalinity, and heat release. A lack of disposal sites may also constrain FBC use. Commercial use of wastes may be developed, but the existence of adequate markets for the predicted large volume is questionable.

Except for particulate emissions, the environmental constraints of FBC are generally shared by conventional boiler furnaces. The widespread use of FBC may well have to wait until the relatively more efficient but more complicated pressurized FBC technology is mature. Four demonstration plants that are now in operation should provide information within the next five to ten years that will enable utilities to make rational choices among the three FBC technologies and conventional boilers with flue gas desulfurization.

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COMBINED-CYCLE POWER PLANTS

Combined-cycle technology refers to the combined use of hot combustion gas turbines and steam turbines to generate electricity. This process can significantly raise the overall thermal efficiency of power plants beyond that of typical conventional fossil-fueled plants using either turbine alone. This technology also is generally believed to result in less environmental impact for fossil-fueled power plants.

Several types of combined-cycle systems have been designed (at least conceptually) for various fuels. Units burning natural gas or oil have been operated in the electric utility sector, and several designs using coal have been proposed. The coal designs typically include a coal gasification facility or a coal-burning, fluidized bed combustor. The combined cycle permits an efficient application of gasification technology.

The combined-cycle technology offers several advantages to utility power generation, including improved thermal efficiency, reduced requirements for scarce materials (such as water), and elimination of the calcium-based sludge produced when coal is burned in a conventional plant equipped with a flue-gas desulfurization system using wet limestone. Another advantage is that plants can be designed modularly. For example, a modular integrated gasification combined cycle (IGCC) unit would have multiple gasifiers and combustion turbines combined with a single steam turbine. This improves plant availability and load growth requirements can be more closely matched than is often feasible with other technologies. Modularity also helps to minimize the capital cost in the time between the beginning of construction and the initial production of power, as the combustion turbines could be producing electricity while construction of the remainder of the plant is being completed[3].

Environmental Issues

The environmental emissions and control technologies used in a combined-cycle power plant will depend on the combustion technology and the fuel type. The following discussion deals with the environmental impact of coal-based power plants associated with the combined-cycle technology, since they are likely to have the greatest impact. The discussion also centers on pressurized fluidized bed combustors (PFBC) and integrated coal gasification combined cycle (IGCC) plants, as they represent the most probable coal-based applications in the electric utility sector.

- Solid Waste from Coal-Based Plants

  In current designs, solid wastes from combined-cycle power plants are produced in two areas: the coal consumption region, e.g. the fluidized-bed or gasification area,

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[3]Ibid. Energy Technologies and the Environment, U.S. DOE, NTIS #DE89-003779, October 1988, pgs 117-128.

and the gas-stream particulate collection region. In PFBC designs, the solid waste collected from the combustor is called spent bed material and consists principally of partially sulfated limestone or dolomite. This material can represent as much as 85 to 95 percent of the total solid waste stream. The solid waste taken from the gas stream includes coal ash and char as well as fine particles of the sulfated sorbent. The quantity of solid waste generated in a PFBC plant would depend on several factors, including the composition of the coal, the heat rate of the plant, the required emissions levels of sulfur dioxide and particulates, and the calcium-to-sulfur ratio used for sulfur dioxide control.

The solid waste from the gasification portion of an IGCC plant would be a slag consisting of coal ash, unreacted coal, and limestone that has been added to promote slag formation. The material removed in the hot-gas cleanup system includes some fine, unburned coal particles but not any sorbent used for SO_2 control, as would be the case in a PFBC plant. Less solid waste would be produced in an IGCC plant than in a PFBC plant.

o Emissions from Coal-Based Plants

Gaseous emission from combined-cycle power plants would include SO_2 and NOx along with trace concentrations of substances such as ammonia, arsenic, fluorides, mercury, and beryllium. The level of these emissions could be controlled to within the acceptable standards through the use of commercially available systems or practices. Other trace emissions would be reduced in the gas cleanup systems or would be at levels low enough to be of no concern.

o Emissions from Gas- or Oil-Fired Plants

Gaseous emissions from gas- or oil-fired combined cycle power plants would be much lower than those from uncontrolled coal-fired plants. With natural gas-fired units, the fuel is subjected to hydrogen sulfide removal and therefore it does not contain any significant amount of sulfur, resulting in very low SO_2 emissions. The lack of ash in either natural gas or oil would produce a particle-free turbine exhaust gas. Emission of NO_2 from gas- and oil-fired plants would vary with the fuel composition and the design and operation of the facility.

Environmental Controls

o Atmospheric Emissions

During the gasification process in an IGCC plant, sulfur in the coal would be converted to H_2S along with some carbonyl sulfide (COS). These gases would be carried out of the gasification chamber along with the fuel gas and would have to be removed before the gas could be released to the atmosphere.

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The first step is to cool the gas in a convective heat exchanger. Next the gas would be scrubbed with condensate from the power cycle. This will remove fine particles from the fuel gas and minimize the oils and tars that are produced by some gasification technologies. Removal of ammonia is done by saturating the fuel gas with water vapor and then condensing the vapor.

o Wastewater Control

The wastewater streams in PFBC and IGCC designs are generally treated similarly, although the size of the streams and the level of contamination differ. Five major wastewater streams are expected: water from the major process areas, cooling tower blowdown, runoff from coal piles and coal handling areas, runoff from process areas, and sanitary wastewater. Each stream must be treated to some extent before the water can be discharged.

o Solid Wastes

The quantity of solid waste produced in PFBC or IGCC plants would be less that that produced by an equivalent pulverized coal-fired plant with a wet limestone FGD system. The solid waste handling systems for these technologies are comparatively simple and reflect the fact that these wastes are generally expected to be nonhazardous under current regulatory definitions.

COAL GASIFICATION TECHNOLOGIES

Coal gasification facilities produce a variety of gaseous, liquid, and solid streams that may contain toxic or otherwise harmful components. Although several of the larger effluent streams are unique to coal gasification plants, many are similar to those from other industrial sources, such as coal-fired power plants.[4]

Environmental Issues

For example, most large coal gasification plants will have facilities to prepare, store, and handle coal; collect coal pile and stormwater runoff; treat wastewater; generate steam; and handle ash and solid waste. These units are likely to be major sources of atmospheric emissions, liquid effluents, and solid wastes. The characteristics of these effluents and the potential environmental problems associated with them are identical to those from conventional power plants. Pollution control technologies for these streams are well known.

However, some high-volume streams unique to coal gasification are potential sources of environmental contamination. All coal gasifiers discharge an ash or slag containing most of the trace elements present in the coal and produce a raw gas containing a high concentration of carbon monoxide, as well as lesser amounts of other toxic species such as

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[4] Ibid. Energy Technologies and the Environment, U.S. Department of Energy, NTIS #DE89-003779, October 1988, pages 67-78.

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H_2S, carbonyl sulfide, ammonia, hydrogen cyanide, and trace elements volatilized in the gasification process. Specific areas of concern include (1) atmospheric emissions from the coal lockhopper vents, gas cleanup and sulfur recovery system, fuel combustion, and cooling towers; (2) fugitive odors, vapors, and aerosols from various sources; (3) aqueous discharges from wastewater treatment and other systems; and (4) solid waste disposal and the potential contamination of groundwater supplies with hazardous trace elements.

Environmental Control

All modern coal gasification plants will have at least four process-specific environmental control systems for gasifier effluent cleanup, wastewater treatment, sulfur removal and recovery, and solid waste handling and disposal. The complexity of these systems will vary with the gasifier design, nature of the end product, and specific environmental strategies used. The overall strategy in most cases will be based on two precepts: (1) to avoid the production of problem streams and resulting use of end-of-pipe controls and (2) to integrate the environmental control system as fully as possible.

The purpose of the gasifier effluent control system is to minimize the release of odors, particulates, hydrocarbons, and other undesirable atmospheric emissions. The purpose of the process wastewater treatment system is to recover usable or salable products and to reduce the concentrations of all organic and inorganic contaminants to levels that permit reuse or acceptable discharge to the environment. The system may have to include a gravity separation step that removes oil and tar, a solvent extraction system that strips dissolved organics, an ammonia recovery system that strips acid gases, and biological treatment that reduces residual organic contamination.

The purpose of the sulfur removal system is to remove sulfur from the process gas, recover CO_2 and elemental sulfur for sale or disposal, and limit sulfur dioxide emissions to the permitted level. The primary purpose of the solid waste control system at a large coal gasification plant is to collect the ash or slag from multiple gasifiers, to handle and treat the ash (and other plant wastes), and transport it to a long-term storage or disposal site, and to control all environmental contaminants during the process.

Although the outlook for coal gasification is promising, several environmental issues remain. Acid gas cleanup techniques need further refinement to make them more reliable and less costly. The environmental fate of trace metals, both in process emissions and residue leachates, needs further study. The long-term effects of occupational exposure to coal tars is not known. If these by-products of coal gasification are found to present a hazard to workers or the environment, control strategies need to be developed.

FUEL CELL TECHNOLOGY

In general, fuel cell power plants are considered to be environmentally benign. Limited information is available on any possible concerns. The information below is for multikilowatt and larger phosphoric acid cells, since that technology is closest to commercialization. The environmental impacts of the other fuel cell types (alkaline, solid

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polymer electrolyte, molten carbonate, and solid oxide) are likely to be similar[5].

Environmental Issues

Air-Pollutant Emissions

Fuel cell power plants emit very low levels of nitrogen oxides (NO_2), sulfur dioxide (SO_2), particulates, and smoke. The reason is that they burn relatively clean fuels (e.g. natural gas and naphtha) and operate at a low temperature that limits the formulation of thermally produced NO_x. The principal source of air pollutant emissions is the combustion process that provides the thermal requirements of the reformer in the fuel processing section of the cell. In general about 80 percent of the reformed fuel (primarily hydrogen and residual fuel) entering the fuel cell stack is consumed by the fuel cells while the rest is combusted in the reformer burner. Under normal operating conditions, the burner fuel is converted almost completely to carbon dioxide and water vapor.

The integration of coal gasifiers with phosphoric acid fuel cell systems results in efficient power plants with emissions that are 150 to 230 times lower (SO_2 and NO_x respectively) than a conventional power plant using the same amount of coal. The integrated plant would also produce by-products of coal fines and dust and tars and oils. If these by-products are sold for their fuel value, the net thermal efficiency of the integrated plant would be about 36 percent.

Liquid Effluents

One of the principal differences between a phosphoric acid fuel cell power plant and a conventional steam-electric generator is the water supply and discharge characteristics. In general, the fuel cell system is self-sufficient in terms of its water requirement. The electrochemical reactions within the fuel cell stack produce enough water to compensate for steam consumption in the reformer and for water vapor loss via the plant exhaust stream. This by-product water is recovered, cleaned, and returned to the fuel cell for cooling and fuel processing needs.

A second wastewater stream for the fuel cell system is blowdown. This stream requires some pretreatment before discharge. A third stream is released from the turbocompressor's intercooler. No environmental impacts are expected from this water supply. Finally, there is flush water from the demineralizer and cleaning system. Depending on the source of the water supply, this flush water may need some type of treatment.

In general, wastewater issues are of less concern than air pollutant emissions and solid waste disposal. The reasons are because (1) the quantity of wastewater produced and discharged is extremely small and (2) the concentrations of the contaminants can be reduced by relatively mild treatments.

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[5]Ibid. Energy Technologies and the Environment, U.S. Department of Energy, NTIS #DE89-003779, October 1988, pages 217-237.

Solid Wastes

The biggest source of solid waste in a fuel cell is in the fuel processing section, which uses zinc oxide reaction beds to remove sulfur from the raw fuel feed. These beds require disposal at sanitary landfills. The quantity of reaction bed waste is a function of the sulfur content of the fuel, but in general, it will be much less than the solid waste generated by comparable coal-fired power plants. Also, because of the low hazard potential of this waste, proper disposal should not present any significant or unusual problems.

The second solid waste source is flushing of the fuel processor section with nitrogen. This residual waste stream, which consists of hydrocarbons, including some aromatics, is produced in extremely small quantities. The small amount of solid wastes generated by fuel cell power plants makes them an attractive energy-generating option for many applications.

Other Environmental Considerations

Four other environmental considerations associated with the construction and operation of fuel cell power plants involve aesthetics, exhaust height, public safety concerns, and the possibility of electromagnetic interference. Fuel cell power plants have a low profile, which can be landscaped to enhance its appearance. However, the low profile allows exhaust emissions to be released closer to the ground than conventional power plants. Under certain climatic conditions, this can cause a problem.

Another concern is public safety. The extent of any risk to the public will be higher for fuel cell power plants due to their dispersed nature relative to conventional steam electric systems. Possible consequences are shock waves and projectiles from explosions, asphyxiation, smoke poisoning, and CO poisoning from fires. The fuel cells plastic components could also produce a variety of toxic gases in a fire.

Electronic noise is produced by fuel cells which can cause electromagnetic interference (EMI) in radios, television sets, and other communication devices. Prior to commercialization, a fuel cell power plant must conform with all FCC or equivalent regulations.

Environmental Controls

Little, if any environmental control equipment will be necessary for fuel cell power plants since the residuals from them are very low. In general, no air pollutant emissions control equipment is necessary for natural gas- and naphtha-fired cell systems, including the fuel processing sections. Liquid effluents are also not a significant concern since the amounts generated are very small. The only solid waste that may require some control is the zinc sulfide produced by the fuel processing section. Here again, the quantities are generally quite small. If a coal-based fuel cell system is used, equipment will be required to control particulate, SO_2, and NO_x emissions as well as liquid effluent and solid waste disposal. Since the fuel processing section would contain a coal gasification unit, the techniques and equipment required to control those residuals would be similar to those for any other coal

gasification unit.

PHOTOVOLTAIC AND WIND ENERGY SYSTEMS

Health and environmental issues related to photovoltaic (PV) energy systems arise at several stages: (1) extracting, processing, and refining raw materials; (2) fabricating, installing, operating and maintaining PV devices; and (3) decommissioning spent PV devices. Most of the attention has been focused on the second stage, since potential chemical and physical hazards of PV systems are greatest for these activities. The most significant hazards are associated with large central-station installations, no significant effects are expected from small, decentralized installations which are the most likely type for the developing world in the next 5 to 10 years[6].

For large installations of multi-megawatt scale, large areas of land will be required (approximately 3 square kilometers per 100 megawatts of output power). Water may be required to clean panels and herbicides may be used to control plant growth around the PV arrays. If significant battery storage is required, environmental hazards associated with the maintenance and disposal of batteries will be evident for the PV installation.

The most significant environmental hazards for PV systems are associated with the fabrication of the cells and the manufacture of the PV modules themselves, and not with the installation and operation of the PV power plant. Specific emission standards and controls for materials and pollutants are similar to those applied to the semiconductor manufacturing industry as a whole. Operating and maintenance hazards and risk to the public are similar to, but generally less than, those associated with any large power generation facility. Since transport and storage of fuel is not required, many of the hazards and sources of pollution for fossil-fired power plants are not evident at PV facilities.

The use of wind energy systems is an environmentally benign power generation activity. The environmental effects of wind energy may comprise the use of land for the installations of the turbines, infringements of the landscape by a multitude of wind turbines (as in wind farms), the noise produced by the wind turbines, and interference with radio or television reception[7].

The occupation of land is thought to be a very minor effect, because the land below the wind turbine is still useful for many productive activities such as cattle grazing. Infringements of the landscape are an important aesthetic cost in many cases, but they are not strictly an environmental hazard in the sense used for this analysis. In many cases, conventional power plants are considered by many people to be an infringement on the landscape also.

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[6]Ibid. Energy Technologies and the Environment, U.S. Department of Energy, NTIS #DE89-003779, October 1988, pages 367-381.

[7]Social Costs of Energy Consumption, Olav Hohmeyer, Commission of the European Communities, 1989, page 56-58.

The disturbance of electromagnetic waves by metal rotors is at present a minor problem as most of the commercially available turbines use fiberglass blades. This could become a serious problem requiring directional antennas, if future wind turbines use metal blades. Because of cost and fatigue strength issues, this is not likely. The only real quantifiable environmental effect of the installation of wind turbines on a scale equivalent to large utility central power generation facilities is noise. Since wind turbines are sited in areas where the wind resource is high, people normally do not live close by because of constant high winds. The experience has been that noise problems to neighboring populations is small.

ANNEX H

TECHNOLOGY TRANSFER/TRAINING

ANNEX H. TECHNOLOGY TRANSFER/TRAINING

Specific activities to implement the technology transfer and training objectives of the ETIP project will be determined by the energy/power sector needs and opportunities of each country's energy setting. Nonetheless it is useful to describe the types of technology transfer mechanisms which will be most appropriate for ETIP project objectives to be achieved. Further, the prospective training opportunities which ETIP will present are considered in this annex as well.

The country settings in which AID operates are obviously diverse, differing in numerous important ways which affect respective energy sectors. Size of country, economic resources, human resources, infrastructure characteristics, national policies and regulations vis-a-vis public and private sector power roles are some of the more obvious influences on domestic power circumstances. This suggests that project activities, both in terms of the nature of technological innovations that can be transferred and the types of training opportunities which are needed, will vary accordingly.

The concept of technology transfer is several decades old, and yet there are few precise notions about what it constitutes that a consensus of people agrees on. For the purpose of this project paper, technology transfer is defined as the following:

a. The conscious process of moving a technological innovation from its source or place of origination, through development, testing and evaluation stages, to its place of applications;

b. The technology transfer process is now understood to be different for every technology and technology setting;

c. A government's role in promoting technology transfer can take various forms, be they passive, semi-passive (or semi-active), or active;

d. The roles government and the private sector take in removing barriers to new technology help determine the success of the transfer process and the spread of the technology's adoption;

e. Opponents to new technologies always exist, in the form of institutions, private sector commercial interest, laws patenting and licensing regulations, cultural practices, etc. The objective upon recognizing this is to overcome the apposition in such a way as to integrate opponents with the new process, share the success or "credits" of the new technology with them, and demonstrate how the new technology or proces is more beneficial to the majority of society than existing practices. This facilitates the adoption and implementation of the new technology.

The ETIP will transfer hardware and software technology, information about new technologies, and otherwise distribute or disseminate awarene bout energy-related

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technologies to appropriate audiences or markets within the user communities. Decision-makers and energy planners will be included in the process, as will utility engineers, economists, and perhaps environmental planners. The scheme of a typical technology, transfer system is a flow of activities that include New Technical Concepts, Funding Support (with financial Analysis), Laboratory Development, Field Testing Demonstration, and Feasibility Demonstration with economic Analysis and Test Results. These Test Results then support activities to investigate and identify Institutional, Cultural, Regulatory, and Environbmental Barriers which will lead to an Implementation Strategy for Commercialization.

This simplified technology delivery system displays the generic issues or impediments which most new technology must confront in any setting. It can be refined for any application, but as a process, such as the transfer of a clean coal technology developed in the United States, it constitutes a technological improvement over existing approaches or methods of producing - in this example - electric power.

Many mechanisms are available to facilitate the transfer of technology. Government's role as suggested earlier can be passive, semi-passive/active, or active, depending on the role the government assumes in national economic life. The roles adopted by the public and private sectors determine the mechanisms selected and ultimately the speed of "transfer", or information dissemination within a country.

Aside from those institutional and regulatory forces that bear on a technology's adoption, there are other issues which affect the rapid adoption of a new technology, such as:

- capital availability
- patent and licensing issues
- environmental constraints
- cost issues
- social impact issues
- political influences
- policy environments
- human technical resource availability

The mechanism chosen should be determined by the size and nature of the market for the new energy technology. Thus the adoption of a computerized load shedding strategy at government-owned power plants will require a different introduction to a country's technology base than would adoption of new electricity billing procedures. The initiation of new renewable energy technologies would demand still another technology transfer plan, if it is to be successful.

A list of technology transfer mechanisms which will merit consideration by contractors and A.I.D. Missions and Bureaus under the ETIP would include the following:

1. Pre-investment initiatives: The consideration of economic and financial circumstances or opportunities that a new energy/power technology presents.

2. Joint technology development initiatives: these would take new technical approaches to energy development, conservation, distribution, pricing and other considerations and encourage their joint development and refinement by relevant U.S. energy technology interests and host country research and development institutions. These might be located at university laboratories, government-sponsored research institutions, or at government-private sector joint venture locations. This joint technology development activity would promote a quicker, better "fit" between the technology and the environment to which it is being introduced.

3. An organization which is an international electricity power research and development institute, with pooled international technical resources and perhaps regionally - specific technical orientations, could be called upon by missions, support offices and A.I.D. regional bureaus to develop solutions to electric power problems. This international organization could be "bought into" by the ETIP, for specific power technology management or power development requirements.

4. An organization much like the U.S. Congress' Office of Technology Assessment (OTA) could be created at an international level to consider new electric power technologies for their suitability in various regions of the developing world. Thus, this "IOTA" might examine all the factors relevant to the widespread adoption of portable geothermal power facilities in geothermally - promising zones such as the Rift Valley in Eastern Africa, or it could explore the potential of new methods to rehabilitate existing traditionally - funded urban power plants. Findings and results would be disseminated to all relevant country settings.

5. ETIP activities could include the collaboration of governments, industry and trade groups for the development of energy information and technology exchanges in ways which were not promotional of any one technology, at the expense or arbitrary exclusion of other technologies. This collaboration could be quite effective in quickly diffusing new technologies and technical approaches into appropriate energy market settings.

6. Initiatives could be undertaken with other national, regional or international research or development agencies such as the OECD's International Energy Agency.

7. ETIP activities should include direct coordination with host country power sector organizations in order to develop an understanding of energy problems to propose new technical solutions, and to properly develop field tests of the technology.

8. Technology transfer projects would conceivably include projects at the

feasibility/pilot/demonstration/pre-commercialization stage. The evaluation of the technology in the host country, along with any modifications that might result from the technology pilot testing, would serve as a valuable means of expanding awareness of the technology and its potential for application.

9. Another mechanism might be the conduct of environmental impact assessments of existing power generation facilities, and their comparison to newer "clean" energy technologies which are more responsive to environmental concerns and the social costs associated with any energy technology.

10. Alternative management information systems, and importantly, management strategies could be prepared which heighten control, increase reliability and enhance systems efficiency at lower costs.

11. The ETIP would propose innovative approaches to power sector planning, sector analysis, and decision-making structures within government and the private sector which impact on national or regional-level energy production and policy.

These representative examples of technology transfer mechanisms which are appropriate within the structure of the ETIP project. They are illustrative of the great numbers of innovative strategies that can be devised to move creative new technology from the laboratory test bench to full utilization. The key elements in all of them are coordination, integration with existing conditions, and the need to be innovative in the pairing of technology with potential applications.

Distinct from technology transfer mechanisms are training activities. Training focuses on the teaching of new technologies, analytic methods, evaluative procedures, and implementation planning so as to strengthen the institutions and their performance within the power sector of a country in question. To accomplish this task the ETIP project will seek to undertake a broad array of workshops, seminars, short courses, conferences and other formal and informal information dissemination techniques. The training sessions would include coursework appropriate to the needs of decision appropriate power sector personnel. Senior administrators, other decisionmakers, and operational levels personnel could be introduced to novel technologies and management information systems. The ETIP is the awareness that operational staff engineers and their equivalents in the power sector may be as useful in integrating a new technology or approach within a country's power system. Personnel attached to rural or isolated grid systems would be included among those considered for training, for the potential adoption of new technologies and management practices may be as useful in promoting growth and development of the nation's power sector as urban-based personnel might be. Thus the types of training and training methodologies will be varied according to the country's energy and power sector circumstances and the most appropriate means to disseminate information about a new technology to the most appropriate personnel.

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