PDUOA154

PROJECT PAPER

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH

(386-0494)

March 30, 1987

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: INDIA

3. PROJECT NUMBER: 386-0494

4. BUREAU/OFFICE: ASIA & NEAR EAST BUREAU 03

5. PROJECT TITLE (maximum 40 characters): PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 06 DD 30 YY 93

7. ESTIMATED DATE OF OBLIGATION (Under "B." below, enter 1, 2, 3, or 4): A. Initial FY 87 B. Quarter 4 C. Final FY 91

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

A. FUNDING SOURCE	FIRST FY 87 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	5,000		5,000	20,000		20,000
(Grant)	(5,000)	( )	(5,000)	(20,000)	( )	(20,000)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country		1,250	1,250		12,500	12,500
Other Donor(s)						
TOTALS	5,000	1,250	6,250	20,000	12,500	32,500

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) SD	751	878		-	-	5,000	-	20,000	-
(2)									
(3)									
(4)									
TOTALS				-	-	5,000	-	20,000	-

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 873, 874

11. SECONDARY PURPOSE CODE:

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

A. Code	RGEN						
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

TO DEVELOP, INTRODUCE, AND TEST OPERATIONAL MODES FOR INDIGENOUS TECHNOLOGY INNOVATION AND DEVELOPMENT IN THE INDIAN ENERGY SECTOR.

14. SCHEDULED EVALUATIONS: Interim MM 03 YY 89 — Final MM 06 YY 92

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

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

17. APPROVED BY — Signature: Richard N. Blue — Title: Director (Acting) USAID/India — Date Signed: MM 06 DD 26 YY 87

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

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LIST OF ABBREVIATIONS

ANE	Asia and Near East Bureau
BHEL	Bharat Heavy Electricals Limited
CDSS	Country Development Strategy Statement
CEA	Central Electricity Authority (India)
CEI	Confederation of Engineering Industries (India)
CSIR	Council of Scientific and Industrial Research (India)
DEA	Department of Economic Affairs (Ministry of Finance, India)
DNES	Department of Nonconventional Energy Sources (India)
DOE	U:S: Department of Energy
DOP	Department of Power (India)
EPRI	Electric Power Research Institute (USA)
ERDAC	Energy Research and Development Advisory Committee
GDP	Gross Domestic Product
GNP	Gross National Product
GOI	Government of India
GRI	Gas Research Institute (USA)
HVAC	Heating, Ventilating, and Air Conditioning
IBRD	International Bank for Reconstruction and Development (World Bank)
ICICI	Industrial Credit and Investment Corporation of India
IFC	International Finance Corporation (USA)
IIS	Indian Institute of Science
IIT	Indian Institute of Technology
IQC	Indefinite Quantity Contract
NTPC	National Thermal Power Corporation of India
ORNL	Oak Ridge National Laboratory (USA)
PACER	Program for Acceleration of Commercial Energy Research
PACT	Project for Acceleration of Commercial Technology
PIL	Project Implementation Letter
R&D	Research and Development
S&T/EY	Office of Energy, Science and Technology Bureau (AID/USA)
TVA	Tennessee Valley Authority (TVA)

I. EXECUTIVE SUMMARY

Summary Project Description

The Program for Acceleration of Commercial Energy Research (PACER) is a six year project which will support selected research and technology development proposals while seeking to create an institutional environment for relevant technology innovation in the energy sector. The project will have three interrelated components. The first will provide financial support to consortia organized to undertake specific technology development programs. A consortium will consist of a manufacturer in collaboration with a research institute and/or an end user and will have a significant financial stake in the venture. The second component will support a competitive research awards program in topical areas defined by Component 1. The final component will support the formulation of technology strategies, policy analyses, and information dissemination.

The Department of Non-Conventional Energy Sources (DNES) in the Ministry of Energy will have primary responsibility for implementing the project, with the Industrial Credit and Investment Corporation of India (ICICI) having support responsibility. An Energy Research and Technology Development Advisory Committee (ERDAC) made up of representatives from research institutes, manufacturers, endusers, the finance sector and government will be appointed by DNES to provide policy and procedural guidance for the project and to play an active role in the solicitation, review, and approval of research and technology development proposals.

II. BACKGROUND AND PROJECT RATIONALE

A. Relationship to AID Strategy

In September 1983, AID adopted a ten-year strategy for research and technology development. The strategy reflects a conviction that research and technology development have made and will continue to make far reaching and lasting contributions to broadly based economic and social progress in the developing countries. Energy is targeted in the research and technology development strategy as one of the areas for AID program devel- opment. This is primarily because of the importance of energy to economic development in India and the U.S. comparative advantage in the field of energy research and development.

AID's understanding of the R&D issues has evolved considerably since the 1983 strategy statement. Recognizing the experience of East Asia, the revised strategy advocates that rapidly modernizing societies such as India place an increased emphasis on technology development and innovation. Critical to ensuring the relevancy of a technology development and innovation program is the active involvement of the enterprise sector.

AID, through its R&D portfolio, seeks to take advantage of and perpetuate a trend in India toward a technologically dynamic market economy by supporting projects that (1) accelerate the pace of technology development and innovation by strengthening the link between science and enterprise, (2) create an institutional environment in which technology innovation is fostered, and (3) stimulate public discussion on technology policy issues of national concern.

The first project in the AID portfolio to address these objectives was the Program for the Advancement of Commercial Technology (PACT). PACT is designed to promote Indo-U.S. joint ventures in technology development and, thus, heighten the enterprise sector's interest in building research and technology development programs. It has attracted wide attention in both the U.S. and India. A successful meeting of the Indian and U.S. PACT Councils was held in August 1986 and the implementing organization, the Industrial Credit and Investment Corporation of India, reports that ten high quality proposals have already been submitted. Variations of the PACT model are now being rapidly developed by other Indian financial institutions and supported by public (e.g., IFC and IDBI) and private (e.g. Grindlays Bank) organizations.

The PACER project is the second effort to promote the technology innovation to enterprise link and shares many of the PACT objectives; however, whereas PACT is sectorally crosscutting, PACER is sectorally specific. A third project, currently under development, will further promote the link by increasing the interaction between the science and enterprise communities in a selected city or state.

B. Energy and its Relevance to the Indian Economy

India's gross national product (GNP) of $182 billion is one of the largest in the world. India's Seventh Five Year Development Plan (1985-90) estimates that the annual rate of economic growth must increase from its recent level of 3.5 to 4.0 percent to a new level of 5.0 percent. This is an ambitious growth target.

A serious constraint to economic growth has been the availability, quality, and reliability of delivered energy, with acute shortages of electric power the most pressing problem. During the period 1985-86, India experienced an overall deficit in power supply of 8.6 percent. Many states, however, experienced significantly higher deficits. Haryana had deficits of 29.1 percent; Bihar, 29 percent; Karnataka, 22.6 percent; Orissa, 21 percent; Uttar Pradesh, 15.1 percent; Punjab, 13 percent; and Tamil Nadu 12.7 percent. These seven states represent over one third of the national net value added in manufacturing.

Widespread power shortages have driven industries to install their own captive power stations, usually small diesel generating sets. These units tend to be operationally and economically inefficient, and require increased imports of oil at a time when oil imports are already consuming forty percent of scarce foreign exchange reserves. Despite its high cost to industry and the Indian economy, captive power capacity increased sharply from 2,859 MWe in 1979-80 to 4,190 MWe in 1984-85. The Government of India estimates that captive power will increase another 68 percent to 7,056 MWe by 1990.

The projected capital requirements for expanding power generation, transmission, and distribution systems far exceed the financial resources available. As of April 1, 1985, India had 42,759 MWe of installed electrical generating capacity. The Central Electricity Authority (CEA) estimates that 30,600 MWe of additional capacity is required to keep pace with the demand anticipated during the Seventh Plan. These additions will cost approximately $56 billion; however, the power sector has been allocated only $28 billion, half the amount required. Energy accounts for almost one-third of the Seventh Plan Budget.

The years ahead will undoubtedly strain the capabilities of the energy sector as it strives to meet the needs of the economy. To the extent possible, India will try to meet these requirements from indigenous energy resources. The Seventh Plan responds to the challenge by calling for:

(a) the accelerated exploitation of coal, hydro and nuclear power resources;

(b) the intensification of exploration for oil and gas;

(c) implementation of appropriate policies to assure the efficient utilization of the large gas resources;

(d) the management of energy demand and the creation of incentives for energy conservation and inter-fuel substitution;

(e) the exploitation of renewable energy resources through reforestation, and expanded use of biogas, biomass, wind, and solar energy, to meet in particular the energy needs of rural communities; and

(f) the formulation of a technology policy that balances licensing with indigenous technology development and creates an institutional infrastructure capable of facilitating effective policy implementation.

C. The Potential of Technology Development

The dynamism of the Indian economy is hampered by a gap between energy supply and energy demand. The Government of India intends to narrow the gap by increasing the megawatts of installed electrical capacity; however, as indicated previously, there is a $28 billion budget shortfall between the sums that have been allocated and the sums that are projected as necessary to meet the expected power demand. Therefore, action must be taken to reduce the $28 billion shortfall. The most effective route is through investments in technology adaptation, innovation, and development.

Technology investments hold great promise for existing generation, distribution, and utilization systems. For example, opportunities for technology innovation and development exist for advanced coal beneficiation and conversion systems, including fluidized bed boilers, combined cycle systems, and industrial co-generation. A major positive impact on power delivery would result from an increase in the prevailing 50:1 percent plant capacity factor of thermal power plants to 60 percent or higher. The capacity factor, which is the ratio of actual power generated to the maximum power production capability of a plant, can be increased through improvements in technology as well as in operation and maintenance procedures.

Energy conservation and increased energy efficiency is another area of relevant and immediate importance. According to the report of an Inter Ministerial Working Group on utilization and conservation of energy, there is a conservation potential of 25 percent in the industrial sector. Conservation potential jumps to 30 percent in the agricultural sector. These estimates were made based on existing technologies that had not yet been adapted to Indian conditions or adopted by Indian energy consumers. The potential for energy savings that could be created by the development of new technologies is even greater. For instance, rapid technological advances in electronics are making possible energy savings not foreseen just a few years ago. Microprocessor-based electronic controls can expand significantly the Indian ability to monitor, measure, utilize, and produce energy at higher efficiency rates.

The Government of India fully recognizes the status and potential of technology development in India and is investing considerable sums in the research and development of alternative energy sources that can make decentralized energy systems possible. To manage its alternative energy program, the GOI in 1982 established the Department of Non-Conventional Energy Sources (DNES).

The high priority accorded to DNES and its mission is reflected in GOI budgets. Against an approved Sixth Plan outlay of Rs. 100 crores, the actual expenditure was more than 50 percent higher at Rs.161.7 crores. In the Seventh Plan, the allocation has increased more than five fold to Rs.519 crores.

The focus of DNES sponsored research is to make non-conventional technologies increasingly competitive with conventional technologies by cutting costs and improving operational performance. Some of the areas of nonconventional energy which have already had a visible impact in India include bio-energy (biomass and biogas), solar thermal systems, solar photovoltaic systems, and wind energy conversion. For the Seventh Plan, DNES has identified the following priorities for its research and development program:

- o reducing the cost of family sized biogas plants by 25 percent
- o increasing bio-gas production at low temperatures
- o reducing the cost of solar photovoltaics by developing new materials
- o developing efficient pump systems for windmills
- o developing indigenous wind turbine power generation systems

To achieve its research and technology development objectives, DNES offers incentives and assistance to industries in the public and private sector. Due in part to DNES, in 1984 there were more than 75 manufacturers, largely in the private sector, engaged in the manufacture and development of various renewable energy systems and devices.

III. PROJECT DESCRIPTION

A. Project Goal

To accelerate the development and absorption of new and relevant energy technologies.

B. Project Purpose

To develop, introduce, and test operational models for indigenous technology innovation and development in the Indian energy sector.

C. Project Approach and Objectives

Principal objectives of the project, in support of the overall project goal, are to:

- o increase the quantum of R&D in the enterprise sector;
- o increase collaboration among scientific institutions (including universities), commercial enterprise units, and end-users;
- o increase the responsiveness of the science community to market forces;
- o rationalize and systematize priority setting and resource allocation of public research funds for energy.

- o strengthen the peer review process; and
- o stimulate policy research, public discussion on technology development issues, and advocacy of technology development objectives.

The project approach, presently untried in the Indian context, 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. Established as new operating entities that cut across the traditional and relatively noninteractive strata of R&D institutions, utilities, and industry, these consortia will focus on the development and widespread commercial application of advanced energy technology products and processes. The activities of the consortia will be supported by a competitive research awards program and by activities designed to analyze and disseminate information of relevance to commercializing technology innovations.

D. Project Components

The project is structured around three interactive components:

Component One: Market-Driven Technology Development Consortia

Component Two: Competitive Awards Program for Supporting Research

Component Three: Supporting Analyses and Outreach

In each of these components, proposals will be solicited, reviewed, approved, and, if approved, financed. Proposals, in most instances, will be related to renewable energy. However, as a result of negotiations with DNES and the Department of Power, power-related proposals will also be eligible for project support.

1. Component One: Market-Driven Technology Development Consortia

This component will make AID financial support available to consortia working on specific goal-oriented technology development problems. Eligible consortia will involve manufacturers in collaboration with research organizations and/or end users. Consortia participants could be all Indian or a mix of Indian and American. In order to stretch project resources and to expose as many entities as possible to the consortia concept, no single entity will be permitted to participate in more than two AID-supported consortia.

To ensure the full commitment of each consortium, all profitmaking participants will be required to have a significant financial stake in the venture. The extent of the financial stake will be determined by the level of risk being taken and the financial resources of the consortium but, except in cases specially waived by the AID Director, the AID contribution will not exceed fifty percent of the estimated cost of the venture or $3 million, whichever is lower.

Proposals must show the involvement of a manufacturer with a research organization and/or an end-user, and a significant financial stake by the profit making participants, proposals submitted for approval must also include where feasible a business plan which identifies a lead organization and provides a scheme for interaction among consortium participants, a discussion on how the technology under development will be commercialized, and a description of the total systemin which the technology fits.

Proposals will undergo a technical peer review described in Section IV (Implementation Plan) of this paper. Special consideration will be given to those technologies that can mitigate serious electricity shortages in the country. Such technologies could include the following:

- o advanced products or processes that improve the performance of conventional or non-conventional power generation systems, increase the efficiency of electric end-use equipment, or improve the economics of non conventional energy systems.

- o innovative and advanced systems that need to be demonstrated in a power plant, factory or other operating situation to verify systems performance to important users and thereby accelerate commercial acceptance by those users. Such demonstrations are quite distinct from experiments designed to reduce large technical uncertainties.

Illustrative activities that could be supported under the component include:

- o analysis and design of new or improved systems;

- o fabrication of experimental hardware;

- o laboratory testing of experimental hardware;

- o field testing of prototype hardware (in cooperation with end users);

- o short-term training, including visits to centers in the U.S., for key personnel directly associated with the project.

2. Component Two: Competitive Awards Program for Supporting Research

This component will sponsor a competitive awards program whereby the topical areas eligible for support will be defined by the areas of the proposals accepted in Component One. For instance, if a consortium organizes itself around a problem in fluidized bed combustion, then requests for research and technology development proposals in the area of fluidized bed combustion will be issued. Strong preference will be given to those proposals that directly support the commercialization objectives of the consortia in Component One. However, proposals that do not directly support a Component One consortium can be considered in those instances in which a proposal is deemed to be particularly meritorious.

There are several reasons for requiring Component One to define the activities that will be funded under Component Two. First, following the lead of the consortia in the selection of topic areas increases the chance that the research or technology development undertaken will be market-relevant. Second, by increasing the quantum of research and involving a critical mass of researchers in selected topic areas, the project hopes to increase interaction among interested parties. Finally, the individual institutions and firms supported under Component Two could bring critical technical, market, or financial expertise lacking among the members of the consortium.

Individuals from Indian research organizations, manufacturers, and end users will be eligible for the research awards program. Collaborations among any of the three groups will be eligible but collaborations are not necessary under this component; single entity proposals are expected to be the most common. When the proposal comes from the profit making sector, a reasonable amount of cost-sharing will be expected. When a non-profit making institution is the proposer, the project will be willing to bear the entire cost of the proposal. All proposals will be subjected to a technical peer review described in Section IV (Implementation Plan) of this paper.

Whereas it is expected that proposals in Component One will be at the technology development end of the innovation pipeline, proposals in Component Two will have a broader or longer term focus, with an emphasis on the research end. Typical areas for R&D funding are listed in Table 1.

3. Component Three: Supporting Analyses and Outreach

This component includes three important elements: project strategy formulation, policy analyses, and information dissemination including training and promotional activities. The component is expected to play a key role in broadening our understanding of the innovation/commercialization process for advanced technologies in the Indian energy sector, provide a mechanism to conduct supporting analyses for Components One and Two, and support the essential information dissemination and networking goals and activities of the project.

A good example of the type of activity that will be financed under this component was the recent visit of a team of senior consultants from Hagler, Bailly and Company to study the impediments to and potential for non-utility power generation in India with emphasis on opportunities for private sector investment. The team completed a thorough analysis of the situations in Maharashtra and Gujarat and, at the same time, performed an information dissemination function by discussing with interested Indian policy makers in private meetings and a public seminar the highly regarded Public Utility Regulatory Policies Act enacted in the U.S. to promote the development of non-conventional power generation. Further explanation of the types of activities to be financed are as follows:

a. R&D Strategy Formulation

Activities funded by this subcomponent will provide guidance in setting research priorities, allocating project resources, and preparing project operating plans. The component will help ensure that the project framework is based on sound information and responsive to India's energy needs. It will also finance analyses of unforeseen technical, institutional and other problems which may arise in the course of project implementation.

The studies and analyses will be carried out primarily by Indian contractors, consultants, and organizations such as the Tata Energy Research Institute, the Confederation of Engineering Industries, and the National Productivity Council although American consultants are also eligible. Topics for analysis could be suggested by the GOI, AID, or unsolicited proposals. An illustrative list of the type of activities that could be financed includes:

Market Risk and Financial Analyses

o preliminary market surveys to help determine commercialization prospects;

o identification of the potential market and projected market penetration of new technologies under specific economic, financial, and institutional conditions;

o identification and characterization of the allowable financing mechanisms for research, development, and commercialization of the specific technologies being considered by the consortia;

o assessment of the potential technical, economic, and financial risks associated with development and commercialization of the specific technology options;

o surveys of industry to determine perceived technology needs;

o integrated technical, market, cost, risk, and financial analysis to quantify the cost and timing of commercialization, and to determine the most effective commercialization strategy options;

o development and diffusion of software tools for technical, economic, and financial analysis.

Technology Assessment

Periodic assessments, using well-defined procedures and authoritative sources of information, to define the status of technologies of potential interest and the potential for improvement and reduced technological uncertainty through well-focussed R&D.

b. Policy Analyses

Technology development and utilization are often influenced by government policies that either support or hinder rational decision making: It is important that R&D under this program be consistent with growing Indian interest and government policy trends to liberalize economic activity. To bring to the fore important policy issues that will increasingly dominate the sector, this sub-component will finance policy studies and analyses. Ideas for the studies and analyses could come from the Government of India, AID, or from unsolicited proposals. Following is an illustrative list of topics:

o an assessment of a range of technology policy issues that could impact on R&D priorities (for example, the broad issue of how decreasing oil prices affects the rationale for developing indigenous coal-based or renewable energy systems for power generation);

o an examination of financing options including an assessment of the opportunities and obstacles for third-party financing in the commercialization process;

o an exploration of the issues of ownership and patents, manufacturing rights, licenses, and other market controls;

o an assessment of how policy changes might impact the development of innovative technologies. Examples of such assessments include:

- the effect of relaxation of import barriers;
- the effect of changes in tax laws such as increased deductions for R&D expenditures;
- the ability of utilities to purchase power from private generators;
- incentives for state electricity boards to pursue efficient load management techniques;
- the effect of subsidized prices as a disincentive to implement more efficient energy technologies;

c. Information Dissemination and Training

Workshops, seminars, training and other information dissemination activities that promote the culture of technology development, R&TD collaboration, and commercialization will be sponsored under this subcomponent. Ideas for information dissemination activities could come from the Government of India, AID, or unsolicited proposals. There will also be a need for promotional activities to attract good proposals for Components One and Two. Following is an illustrative list of the types of activities that could be sponsored.

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Project Initiation Workshop

A three-day Project Initiation Workshop will be held to formally kick off the project. The workshop will serve to provide potential Indian and U.S. participants with an overview of the program and the opportunity to make comments and suggestions on the program plan. At this workshop, presentations will be made by individuals who have had active experience with research consortia and the peer review process.

RFP Workshops (Bidders Conferences)

Workshops will be held in major cities in India to announce Requests for Proposals and to describe in detail the nature of the program and requirements for a successful proposal. At these workshops (often referred to as "Bidders' Conferences") potential bidders can request clarification of technical, financing, legal, and other issues.

International Workshops and Symposia

An important aspect of this project will be to promote Indian participation in international workshops. Depending on the progress made by the various consortia in development and commercialization of new technologies, it may be appropriate to sponsor preparation and presentation of professional papers at national and international symposia dealing with issues of energy, development, and technology transfer.

Project Newsletter

A project newsletter, issued quarterly, will help all of the various project participants remain in touch with all aspects of the program, provide program visibility within India to government and industry, provide AID with regular updates and information, and generally facilitate the development and expansion of the PACER program network.

Professional Publications

Professional papers that are relevant to the objectives of the project will be encouraged and supported for publication in appropriate journals and magazines. This will extend the reach of the project and underscore the benefits of research and technology development networks.

Training

Training and study tours financed under this project will support the creation of a technology development culture in India. Eligible subject areas will include, but not be limited to, specific technology areas in which project supported consortia are operating, technology commercialization, research and development management, policy and priority-setting, and innovative scientific and technological approaches linked to commercialization.

E. Expected Accomplishments

The principal accomplishment of this project will be the development of a successful model for technology innovation and commercialization in the Indian energy sector. From this experience will come a deeper understanding of the dynamics of the innovation and commercialization in India and how best to facilitate the process. Because the model of goal-oriented R&D consortia as an effective means for development and diffusion of commercially attractive advanced technology in the Indian energy sector has not been tried as proposed in this project, there is no clear guarantee of success. However, the enthusiasm with which the concept has been greeted by officials in the Government of India as well as by Indian public and private electric utilities, industry, and research institutions, suggests that it is a fruitful direction to pursue.

At the completion of the 6-year project the following measurable results are expected:

1. Financed 4-6 market driven technology development consortia (Component One);

2. Completed 10-25 competitive research grants and a series of technical papers and reports dicussing successful commercialization-oriented energy research.(Component Two).

3. Completed a series of authoritative studies on R&D strategies, technology commercialization and innovative policy approaches (Component Three).

4. Completed a series of information dissemination activities that have stimulated public discussion and furthered the promotion of a technology development culture in India (Component Three).

The following non-measurable results are also expected:

1. Fostered market-driven R&D among research institutions, manufacturers, end-users, and government, and demonstrated success in encouraging effective collaborative R&D among these constituencies which are important for India's energy sector development (all Components);

2. Diffused new information and knowledge about the innovation and commercialization process in India, and the role of R&D consortia in this process, within the Indian scientific, technical, commercial, industrial, and academic communities (Component Three).

3. Stimulated public discussion on issues of importance to technology innovation through workshops, seminars, and other forms of information dissemination (Component Three);

4. Provided experience in managing a disciplined proposal solicitation, review, and approval process (Components One and Two);

5. Exposed DNES, on a micro level, to a systematized priority setting and resource allocation process (Components One and Two).

F. The Innovation and Commercialization Process

The commercialization of new technology is a complex and sometimes elusive process involving the interaction of market, technical, economic, financial, regulatory, and institutional issues. It is not sufficient that a new product or process be technically proven and appear to be economically attractive for commercialization to succeed. New technology often has high perceived risks to potential investors, who in turn will require the higher rates of return (relative to normal business risks) commensurate with this level of risk. Potential delays in an expensive project resulting from problems in obtaining regulatory and other institutional approvals may have unacceptable cost implications.

Many U.S. institutions, including the U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI), have been increasingly concerned that the results of extensive and costly energy technology R&D programs are often not effectively coupled to successful commercialization. Yet many technologies continue to move from R&D through prototype and precommercial stages to full commercialization.

Considerable research on the commercialization process suggests that a market-driven perspective on the part of the developers is an essential precondition for successful commercialization. Only after the requirements of the marketplace are established can the market-based specifications be developed for the technology. This establishes a design basis for the technology development and commercialization process. By contrast, DOE and EPRI have often concentrated more on technology development per se than on technologies that reflect in their inherent design and operation the requirements and constraints of the real marketplace.

The commercialization process is depicted in a stylized manner in Figure 1. Conceptually the process begins with an identification of the market, both in terms of its potential size and its specific requirements, from the many actors (utilities, manufacturers, regulatory bodies, investors, etc.) for successful products, processes, or services. Once the required characteristics of the product are defined, the technology itself can be specified. This leads to analysis of projected performance and unit costs (e.g. $/kWe of generating capacity) as a function of time and of market penetration.

With increasing market penetration, the production costs of the technology will decline, reflecting industrial cost learning curve effects and technology improvements. Similarly the economic value of the technology will increase, since as the perceived risks of the technology decline with increased technical confidence, the required rate of return will decline and investors will be able to afford higher unit capital costs.

During the development of a technical and economic assessment of a new technology, the competing options and alternatives must be evaluated. More-over the competing options will not stand still; increased performance, lower capital and operating costs, and longer product life will all challenge the new technology during the commercialization process. All of these factors then impact the design of a successful commercialization strategy and the development of the detailed business plans required to implement the strategy.

Embedded in the overall innovation and commercialization process is a sequence of development steps beginning with laboratory research and bench-scale models, prototype scale-model field tests, pre-commercialization scaleup tests, and introduction of commercial prototypes. Although there are many stages in the hardware development path, the major costs and risks are typically associated with the transition from bench-scale or small field test models to full commercialization, reflecting in part the costs of major physical scaleup.

The PACT project and Component One of the PACER project target resources toward the commercialization end of the development path, whereas Component Two of the PACER project targets resources toward the early and middle-parts of this process. AID intends to evaluate the validity of its targeting judgments. While the relative roles and degrees of investment by government, industry, utilities, and others will vary during the process from innovation to commercial diffusion, successful commercialization may well require all of these actors to participate in the entire process.

Table 1

ILLUSTRATIVE LIST OF PRIORITY R&D AREAS

- Commercially attractive technologies to tap biomass or solar energy:
  - biomass fired power units
  - wind and photovoltaics
  - small scale hydro
  - solar thermal electric power generation
- Coal conversion technologies for low-grade Indian coals
  - fluidized bed combustion;
  - slagging combustion;
  - oil and water coal slurry techniques.
  - coal beneficiation
- Technologies to improve efficiency of major end-use electrical equipment in industry, agriculture and the commercial sector:
  - variable speed drives;
  - motors;
  - lighting;
  - effective agricultural pump-sets.
- Technologies to make better use of available generating capacity:
  - load levelling and load management control systems;
  - energy storage (e.g. off-peak storage of chilled water for air-conditioning);
  - power plant instrumentation, monitoring and advanced diagnostics.
  - cogeneration systems

IV: IMPLEMENTATION PLAN

A: Administrative Structure

The project will be implemented by the Department of Non-conventional Energy Sources (DNES) which falls under the Ministry of Energy. DNES will be guided in the management of the project by an Energy Research and Development Advisory Committee (ERDAC).

The secretary of DNES will be the ex officio chairman of ERDAC. In addition to DNES, the ERDAC will consist of eight members with representation from the finance sector, the industrial establishment, the research community, and energy end users such as a utility. At present, no standing committee involving interaction among these groups exists in the energy sector. Consequently, the ability of the project to pull these groups together and increase interaction among the groups at a high level will in itself be an achievement that will generate considerable benefits. Likely members of the ERDAC include the Industrial Credit and Investment Corporation of India (ICICI), the Central Electricity Authority (CEA), the Tata Energy Research Institute (TERI), the Confederation of Engineering Industries (CEI), a private sector utility such as the Ahmedabad Electric Company, a public sector utility such as the Maharashtra State Electricity Board, and two research organizations, probably the Indian Institutes of Science and one of the Indian Institutes of Technology.

The ERDAC, which will meet on an as needed basis, will have the functional responsibilities described below. These responsiblities will be executed by the committee as a whole or by sub-groups of the committee as deemed appropriate:

- participate in the development of policies and operational procedures for the project addressing, among other things, subproject solicitation, review, and approval mechanisms; financial mechanisms; cost sharing formulas; and monitoring and evaluation procedures;

- participate in the development of annual operating plans and budgets for the project;

- guide and oversee the solicitation process for proposals in Components One and Two of the project;

- manage the peer review process under Components One and Two of the project;

- commission studies, analyses, and assessments to be financed under Component Three of the project;

- sponsor workshops and seminars financed under Component Three of the project.

To handle the day to day implementation chores of the project, a Secretariat will be created. The Secretariat will consist of one mid-level staff person from DNES who will work part time on the project and a full time senior level DNES staff person recruited and financed under the project. ICICI will also be represented on the project Secretariat with the project absorbing the additional ICICI staff cost. The Secretariat offices will be located at DNES with the ICICI representatives commuting from Bombay on a regular basis. The responsibilities of the Secretariat will include:

- ensuring that the policies and operating procedures are respected by the project participants;
- advising potential project participants on the proposal submission, review, and approval process;
- monitoring and reporting on the on-going progress of project financed activities;
- organizing workshop, seminar, and other information dissemination activities;
- undertaking the staff work necessary in preparation for meetings of the ERDAC;
- following up on the recommendations of the ERDAC;
- acting as the liaison for the project with the Department of Economic Affairs.

B. AID Role in the Project

AID responsibility for the project will rest within its Office of Technology Development and Enterprise. The Office currently has one full time professional FSN to manage the energy portfolio. A U.S. consultant will be employed through the project with specific responsibility for the project. The two person energy staff will work with DNES to promote project objectives, monitor project progress, anticipate potential problems, and identify targets of opportunity. In addition to the U.S. consultant's general responsibilities s/he will be expected to maintain and develop contacts in the U.S. and to use these contacts to build bridges between Indian and U.S. scientists active in the energy sector. In implementing the project, the AID energy staff will buy into AID/ Washington projects on an as needed basis.

C. Implementation Mechanisms

1. Solicitation for Proposal

Components One, Two and Three will finance varying types of proposals which will be attracted through formal solicitations. Unsolicited proposals will also be accepted for Components One, Two and Three in instances in which a proposal is judged to be of particular merit.

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Support for unsolicited proposals is important because it permits project administrators to gain experience with the peer approval process (described later) while the lengthy formal solicitation process goes on, and it provides the flexibility to finance worthwhile activities that may fall outside the scope of the formal process. Solicitation procedures for each component are described below.

a. Component One

One of the first activities under the project will be the development of a project strategy by an Indian consulting firm which identifies priority R&D areas for the Indian energy sector. The priority areas will take into consideration Indian energy needs as well as the Indian human and natural resource base.

Once the R&D priority areas have been identified a Request For Proposal (RFP) in the identified priority areas will be prepared by the project Secretariat in coordination with the USAID energy staff and the USAID Contract Officer. The RFP will request a business plan as well as a technical proposal from potential bidders. In addition to a discussion on how the technology under development will be commercialized, business plans will be expected to contain an outline of the responsibilities of respective consortium members in implementing the proposal including the identification of a lead institution, fairly detailed information on the estimated cost of completing the proposed research, and agreed upon provisions for sharing of technology development costs.

The technical proposal will require an in-depth statement of work to be accomplished under the proposal including a description of all "deliverables" (e.g., hardware, test results, reports) to be produced and a timetable for completion. To assist bidders in developing proposals the RFP will contain:

- a description of the project and its objectives;
- an indication of funding available through the program;
- a description of proposal requirements;
- a discussion of proposal format;
- deadlines for proposal submission and estimated date of research awards;
- criteria that will be used to evaluate proposals as well as the weighted value of each criterion;
- a statement of the confidentiality that will be accorded to classified or proprietary data included in a proposal.

Upon finalization of the RFP by the Secretariat, ERDAC will review and approve it and then announce its availability in appropriate publications in India and the U.S. and by direct mailings to potential participants. Preproposal conferences will be sponsored by ERDAC and organized by the project Secretariat in a number of major Indian cities. The purpose of these conferences will be to (1) provide wide exposure to the overall program; (2) explain, in depth, the RFP process, (3) discuss the nature and objectives of the program, and (4) lay the foundation for responses to the RFP. Although it may not be essential, another conference -- a bidders conference -- may be convened after issuance of the RFP to further discuss its contents and answer any potential awardee's questions that may have arisen.

All proposals will be sent to the Secretariat which will present them to ERDAC for the review and approval process described later in this section. It must be recognized that the proposed process is expected to take twelve months at a minimum (see diagram on next page). It could take longer given that the RFP process for soliciting research proposals is novel in the Indian context. However, experience with this process, which is widely employed in several developed countries with successful results, is critical to the institutional development objectives of the project.

b. Component Two

Like component one, component two will finance solicited as well as unsolicited proposals. However, because the bulk of component two financial resources will be tied to the topic area of component one consortia, formal solicitation for component two proposals cannot commence until the consortia under component one have been selected. Once component one consortia have been selected, an RFP process similar to that employed in component one will be initiated to solicit component two research proposals.

c. Component Three

Topics for workshops, seminars, and other information dissemination activities will emanate from AID, the GOI, ERDAC, and unsolicited proposals. For those topics originating with AID, the GOI, or ERDAC, it is expected that informal solicitation of proposals will take place. Under this process, organizations which have a particular expertise in the subject matter of the activity will be contacted by AID or by the project Secretariat to determine their interest and to invite submission of proposals. The organization submitting the soundest proposal within a reasonable price range will be awarded a grant or a contract depending on the nature of the work to be undertaken. Since most of these activities will be undertaken by Indian organizations and are expected to cost less than $10,000, formal competitive procurement is not required by AID rules and regulations. Should U.S. expertise be required, USAID will take advantage of AID's IQC mechanism, existing S&T Bureau contracts, or formal competitive procurement depending on the situation.

THE REQUEST FOR PROPOSAL (RFP) PROCESS

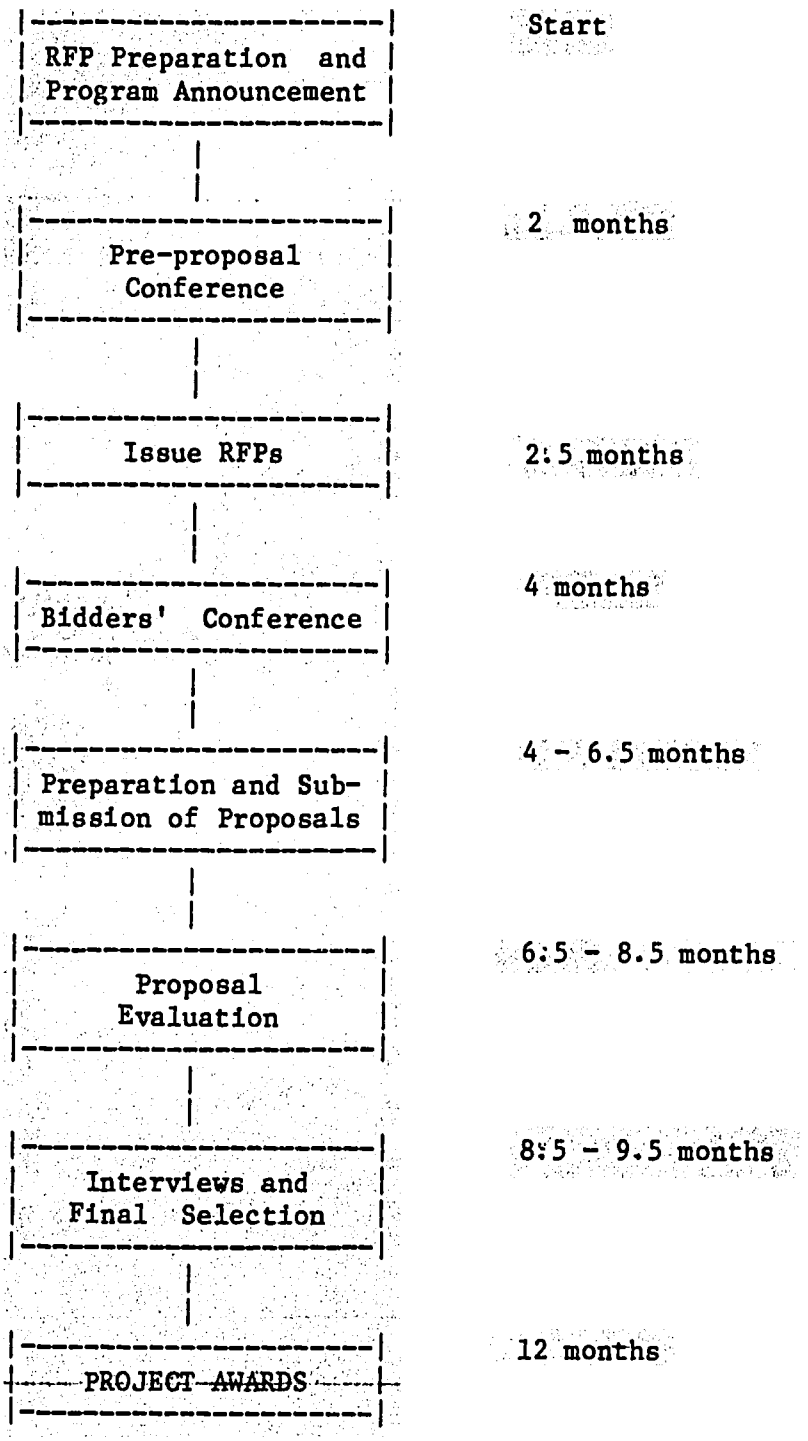

Fig. 1

2. Review and Approval of Proposals

a. Component One

Both solicited and unsolicited proposals received under Component One will undergo a rigorous technical peer review as well as a business plan/financial review. The process will begin with an initial technical screening of proposals by ERDAC members to determine those which show the greatest potential for successful commercialization and which promise to have the greatest impact on the Indian energy supply. Proposals accepted by the ERDAC will receive a more intensive review by a panel and a panel chairman selected by ERDAC. Panel members can be either Indian or American and will be chosen for their expertise in the subject matter at hand and for their willingness to provide a timely and thorough review. Panels will, in most cases, mirror the composition of ERDAC. They will, in general, consist of one representative from each of the following: a research organization, a manufacturing unit, an end user, a financial institution, and the Indian Government.

Panel members will independently review the proposals and provide written comments that will form the basis of a summary of the panel review to be prepared by the panel chairman for ERDAC. For proposals recommended for approval, the summaries will categorize the comments of panel members into suggestions which a consortium may or may not accept and issues which will require a specific response from the consortium. The financial member of the panel will have the special responsibility of commenting on the business plan of the proposal and recommending to ERDAC what the project's commitment of financial resources should be. As mentioned previously, the project contribution will not exceed fifty percent of the estimated cost of the venture or $3 million, whichever is lower, without AID/Director concurrence.

Important to the proposal review and approval process will be the development of effective selection criteria. These criteria, which will be listed and weighted in the RFP, will be drawn up by ERDAC and will be along the lines of the following. Proposals must:

a. involve the development, through R&D, of an innovative product or process which promises tangible benefit to the Indian energy sector;

b. envisage financial exposure and projected returns from commercialization that are commensurate with the risks;

c. involve a manufacturer in collaboration with a research organization and/or and end user;

d. include a private sector member with a financial stake in the consortia;

e. demonstrate that the profit making members of the consortia have a significant financial stake in the implementation of the proposal;

f. identify a product or process which can be commercialized within five years of receipt of project financing;

g. demonstrate the consortia capability to meet the financial and technical demands of the proposal.

After a proposal has been reviewed and either accepted or rejected, ERDAC will so notify the proposers.

b. Component Two

The Component Two review process will be similar to that of the Component One process. ERDAC, after an initial culling of proposals, will forward them for an intensive review to a panel of technical experts and a panel chairman who will be responsible for summarizing the comments of the panel for ERDAC. Because the proposals under Component Two are expected to be more of a research rather than a technology development nature, the composition of a Component Two panel will have a heavier science representation. Illustratively, a Component Two panel will consist of one government official, two scientists, and (if appropriate) one representative from the consortium to which the proposal is related. Selection criteria will be developed by ERDAC and will in all likelihood include the following:

a. the program area to be addressed should be directly relevant to India's critical energy problems and, in fact, closely related to work being conducted by one of the consortia under Component One;

b. if a grantee is a for-profit organization, it will have a significant financial stake in the implementation of the proposal;

c. the proposer will have the technical and, with project support, the financial capability to undertake the research proposed.

A financial review will be undertaken by the AID Contract Officer to ensure that proposed costs are reasonable and within AID's capability to support.

c. Component Three

Component Three proposals will be reviewed technically by the AID energy staff and/or the project Secretariat, depending upon which is initiating the activity. They will be reviewed financially by the AID Contract Officer to ensure that costs are reasonable and within AID's capability to support.

3. Financing Proposals

The terms under which proposals will be financed will be determined by the character of the entity being financed and by the nature of proposal. Following is a component by component explanation of how funds will be transferred to project participants:

a. Component One

Component One will finance technology development consortia consisting of a manufacturer in collaboration with a research organization and/or an end user. Each consortium is required to have one private sector participant. Composition of a consortium can be all Indian or a mix of Indian and American.

In each proposal it will be required that a lead organization be identified by consortium members. It is expected that the lead organization will be that one which is most at risk. The project contribution for each proposal will be transferred to the lead organization from ICICI in the form of a conditional grant. The lead organization will then be responsible for disbursing appropriate amounts of funds to itself and other consortium members through contractual or other acceptable arrangements. The lead organization will assume all liability for the conditional grant.

Terms of conditional grants will vary from proposal to proposal. To determine terms, the following process will be instituted.

Proposals submitted to ERDAC for review will contain a business plan which in addition to identifying the lead organization will indicate the cash and in-kind contribution of each consortium member. Proposals will also suggest the amount of the project contribution, the rate at which resources should flow, and a pay back plan should the product or process under development be successfully commercialized.

The financial member of ERDAC (ICICI) will be responsible for reviewing the business plan and making recommendations as to the project contribution and terms of pay back. S/He will base these recommendations on the financial resources of the consortium, the degree of risk undertaken, and the potential for profit. Pay back terms will generally follow those established under PACT -

- Pay back will be a negotiated percentage of revenues arising from the commercialization of the product or process;
- Negotiated pay backs will be limited to a maximum of 200 percent of the project contribution;
- If no revenues are earned, no pay back is required.

b. Component Two

Component Two will finance research proposals selected under a competitive awards program. Indian for profit and non-profit entities are eligible to compete. All Component Two assistance will be in the form of a grant; however for profit entities will be required to supplement the grant with a 30-50 percent contribution of their own whereas no matching requirements will be placed on non-profit entities. The source of the grant will depend on the nature of the entity. More specifically -

- Indian public sector and non-profit sector participants will receive finance through DNES.

- Indian private sector will receive finance through ICICI.

American entities on their own are not eligible to compete; however should American participation be requested by one of the awardees either in the original proposal or at a later date, the project can finance the American entity.

c. Component Three

Component Three will finance analyses, studies, and information dissemination. In most instances, funds will be transferred from AID through a contract or grant to the performing organization. In appropriate instances, DNES will award the contract or grant and AID will reimburse DNES.

D. Procurement Plan

1. Overview

This section describes the general procedures by which contractual relationships will be established and grant resources will be distributed, taking into account the varied types of goods and services, the participation of both U.S. and Indian public and private organizations, and the mix of local currency and foreign exchange. The procurement process must be consistent with AID and GOI regulations and procedures, and will provide for:

- o conditional grants to technology development consortia under component one;

- o contracts with or grants to both Indian and U.S. research institutes, national laboratories, industrial R&D units, and consulting firms under components two and three;

- o agreements with U.S. government institutions (TVA, DOE, national laboratories, etc.) and U.S. based technology specialists to assist the ERDAC and the project staff in proposal reviews and technology assessments;

- o goods necessary to the implementation of sub-project activities.

2. Conditional Grants - Component One

There will be two primary modes for identifying activities under this component; competitive solicitations and unsolicited proposals.

Competitive Solicitations:

Project resources will be distributed in accordance with an R&D strategy and associated annual plans approved by the ERDAC. The solicitation process will consist of:

- Preparing Requests for Proposals (RFPs) for technology development and/or demonstrations in specific high priority areas. These RFPs will be distributed to interested parties as determined by some combination of public announcement and contacts with the industry.

- Reviewing proposals received in response to the RFPs by objectively comparing the responses against the selection criteria established for the procurement.

- Negotiating a conditional grant with the selected organizations which clearly indicates:

  - o The scope of work to be performed and all contractual outputs (analysis, experimental data, reports) defined.

  - o Organizational responsibilities including the relationship between team members as defined by subcontracts, joint venture agreements, etc. Special attention will be given to subcontracting or other relationships between U.S. and Indian firms.

  - o Contractual terms including payment procedures, priority rights, default provisions, etc.

- Monitoring the progress of the project and comparing its progress and outputs with that negotiated in the contract. The monitoring process also includes making necessary contract modifications such as time extensions.

Unsolicited Proposals:

It is important that the program maintain a high level of flexibility and can respond to good technical ideas which are not dealt with in the formal plan and, thereby, would not be eligible for support via the competitive solicitation route. This will be done by allowing for the submission of unsolicited proposals and setting aside a modest level of program resources for funding contracts and grants in this category.

The evaluation of such proposals will include applying the same general criteria as used in competitive solicitations plus ensuring that:

- the technology is unique to the proposing organizations (at least within the context of India);

- the technology does not realistically fall within the scope of planned competitive solicitation.

The purpose of these added criteria is to discourage organizations from attempting to circumvent the intent of the competitive process.

If an unsolicited proposal is selected for support, the process of contract of grant negotiation and project monitoring will be the same as for those selected under competitive procurement.

3. Contracts and Grants - Components Two and Three

The primary purpose for contracts or grants in these components will be:

- for supporting research projects which will often be done by Indian R&D organizations in the public and private sector (primarily grants);

- for technical assistance (individuals, national laboratories or consulting firms) to undertake technology assessments, policy analysis, and information dissemination (primarily contracts).

It is important that project staff have flexibility to quickly procure services of local consultant and consulting organizations with a minimum of time consuming contracting mechanisms (RFPs reviews, etc.). To this end, project staff will have the authority to contract for consulting services up to a predetermined maximum amount (initially selected as U.S. $ 10,000 equiv.) without full and open copetition subject to the same need for contract specificity as required in section two above. For larger consulting contracts, the project staff will go through the competitive procurement procedure of section two above.

It is expected that the project staff will need to procure the services of U.S. consulting groups and U.S. government laboratories for assistance in such activities as RFP preparation, technology assessments, and project reviews. Where this is the case, the Secretariat will prepare a scope of work and expected level of effort for discussion with AID. The services will be procured by AID through an appropriate mechanism.

The U.S: national laboratories constitute a unique resource in terms of scientific, engineering, and development capabilities in the area of advanced technology in general and the energy field in particular Just the enormous hardware development and test capabilities of the national labs are a resource that can provide substantial benefits to this program, including significant reduction of development and test time and costs for hardware development programs in India: In addition, the access of the national laboratories to advanced and generally public domain software can also speed the transfer of software and its use (i.e. technology transfer) to the Indian enterprise sector: Finally, in areas where the U.S. has unique and relevant experience (e.g: in the creation of successful policy instruments to stimulate the development and commercialization of new technologies in the power sector or in practical least-cost energy planning) the idea would be to arrange collaborative research and analysis with Indian institutions. The U.S. national laboratories would have to satisfy the test of uniqueness and relevance in the establishment of such joint research and analysis efforts.

E. Implementation Schedule

Action	Responsible party	Target date
Project Agreement signed:	DEA - USAID	05/31/1987
ERDAC appointed.	DNES - USAID	08/03/1987
ERDAC meets to discuss policies and procedures for project:	ERDAC	09/07/1987
Advertisements for senior-level Secretariat member placed in appropriate Indian journals and newspapers:	DNES	06/01/1987
Advertisements for long term U.S: consultant placed in appropriate U.S: journals and newspapers.	USAID	06/01/1987
TDY plan for interim assistance from ST/EY completed.	USAID	06/01/1987
Scope of work for overall energy R&D strategy developed.	Interim Secretariat USAID	06/01/1987
Contractor for R&D strategy selected and contract signed.	Interim Secretariat USAID	08/03/1987

Studies and workshops under component three initiated.	Secretariat - USAID	02/14/1987
Interviews begin for senior level Secretariat Member:	DNES	02/27/1987
Interviews begin for U.S: consultant:	USAID	02/27/1987
Ist year operating plan and budget drafted:	Interim Secretariat USAID-ST/EY	03/13/1987
R&D Strategy completed by contractor.	Contractor	03/13/1987
Proposal solicitation, review and approval process designed.	ERDAC - Interim Secretariat - USAID	03/13/1987
ERDAC meets to review operating plan and budget and to finance statement on project policies and procedures.	ERDAC	03/20/1987
Data collection and monitoring system developed:	Interim Secretariat USAID	04/30/1987
RFPs prepared:	Interim Secretariat - USAID	04/30/1987
Senior level Secretariat member in place.	DNES	04/30/1987
Preproposal conferences initiated.	Secretariat - USAID	06/19/1987
RFPs for component one issued:	Secretariat - USAID	06/30/1987
Proposals for component one received.	Secretariat	09/30/1987
Proposals for component one evaluated and awards made.	ERDAC-Secretariat-USAID	11/30/1987
RFPs for component two prepared.	Secretariat-USAID	12/30/1987

RFPs for component two issued.	Secretariat-USAID	01/15/1988
Proposals for component two received.	Secretariat	04/15/1988
Proposals for component two evaluated and awards made:	ERDAC-Secretariat-USAID	06/15/1988
First project evaluation:	ERDAC	03/31/1989
Second project evaluation:	ERDAC	06/30/1992
PACD		12/31/1992

V: MONITORING AND EVALUATION

A. Monitoring

The primary monitoring concerns during the initial stages of the project will relate to the establishment of the administrative structure to support the project, e.g. the creation of ERDAC and the Project Secretariat, and the ability of the administrative structure to effectively accomplish the tasks assigned to it, e.g: the preparation of RFPs; the preparation and implementation of annual operating plans; the solicitation review, and approval of proposals; and the management of a data monitoring and collection system. Later in the project, monitoring emphasis will be expanded to include sub-project activities supported under Components One, Two and Three.

An operating plan for the project will be completed on an annual basis by the Secretariat with guidance from ERDAC. A data collection and monitoring system will be set up by the Secretariat with USAID assistance to track project performance against the operating plan. From this data collection and monitoring system, the Secretariat will provide semi-annual reports for submission to ERDAC and USAID. The issuance of each report will be followed by an ERDAC meeting to assess project progress and to fine tune operating plans for the next six month period.

Monitoring of sub-project activities in Components One and Two will be aided by semiannual progress reports that will be required of participants. These reports will follow a standard format that will be developed by the Secretariat in coordination with ERDAC. They will identify objectives for the proceeding six months and discuss progress made against objectives that had been made for the preceeding six months. The reports will also contain financial data such as accumulated expenditures, expenditures made over the six month period of the report, and projected expenditures.

Monitoring of sub-project activities will also take place through regular site visits by DNES, ICICI, and USAID, and, when appropriate, CEA staff. Information gathered during these visits will be shared among the implementing agencies and with ERDAC.

B. Evaluation

The project will be subject to mid-term and end-of-term evaluations that will involve AID staff, GOI staff, and outside consultants.

The mid-term evaluation will seek to determine that appropriateness and the effectiveness of the administrative structure set up under the project, the quality of interaction among ERDAC, the Secretariat, and USAID; the quality and appropriateness of the annual operating plan and the ability of project actors to meet the objectives of the operating plan, the ability of the project actors to design and operate an effective data collection and monitoring system; the effectiveness of the peer review process as implemented under the project; the effectiveness and appropriateness of the RFP process in the Indian context; and the ability of project managers to interact effectively with project participants.

The end-of-project evaluation will assess the activities outlined above and will, in addition, seek to determine the quality and relevance of the research that was sponsored; the performance of subprojects in relation to original proposal objectives; the attitudes of project participants in regard to technology development consortia and the likelihood of participants engaging in future technology development consortia; and the impact of the project on helping India to achieve its energy sector goals.

VI: FINANCIAL PLAN

A. Disbursements

Following is a description of the project disbursement plan. The plan is subject to change should it prove to be inappropriate in terms of needs or timeliness. Any changes will be made in consultation with the USAID controller.

1. Anticipated Expenditures

Both foreign exchange and local costs are eligible expenditures under all three components of the project. Anticipated expenditures are as follows:

(1) Component One

- Share of consortium costs for approved proposals (in the form of a conditional grant);

- Payment to Indian and U.S. suppliers of goods or services required for implementation of approved proposals.

(b) Component Two

- All non-recurrent costs for approved proposals from non-profit institutions;
- A share of non-recurrent costs for approved proposals from profit making institutions.

(c) Component Three

- Payment to Indian and U.S. suppliers of services required for studies, policy analyses, information dissemination, and promotional activities sponsored under the project;
- Payment for study tours and training programs sponsored under the project;
- Payment for Indian participation in international work-shops and symposia;
- Payment of honoraria and, in necessary instances, fees for Indian and U.S. reviewers of project proposals under components one and two;
- Payment for production and distribution of project related materials.

(d) Other Costs

- Salaries of Secretariat Staff;
- Project related travel for secretariat, ERDAC, and other eligible travelers;
- Costs associated with project evaluation.

2. Disbursement for Foreign Exchange Costs

a. Component One

Three mechanisms will be available to cover the costs of the goods and services procured from the U.S. The first mechanism will be an AID-issued letter of commitment to a U.S. bank showing ICICI as the beneficiary. The initial letter of commitment will be for $1 million and will be replenished as necessary.

Under the letter of commitment, ICICI will issue letters of credit based on specific authorization from the GOI, Department of Economic Affairs, Controller of Aid Accounts and Audit (CAA&A) for the required amount in favor of U.S. suppliers of goods or services. After the goods are shipped or the services are performed by the U.S. supplier, it can claim payment from the U.S. bank by submitting to the bank the necessary documentation as described in the letter of commitment. The U.S. bank will claim reimbursement for these payments from AID and AID will charge such payment to the grant.

In instances in which the letter of commitment/letter of credit approach is not practical, AID will contract directly for the services or goods to be provided to the technology development consortia. An example of this type of situation would be AID entering into a PASA to acquire the services of a U.S. Government laboratory.

Regarding all other foreign exchange costs, ICICI will submit, to USAID/India, voucher SF-1034 accompanied by a statement showing the details of payments to be made by AID directly to the concerned persons. This voucher will be certified by an authorized official of the GOI.

b. Components Two and Three

In most instances under Component Two and Three, AID will contract directly with the U.S. suppliers of goods or services or it will buy into an existing Science and Technology Bureau contract for goods or services.

3. Disbursement for Local Currency Costs

ICICI and DNES will submit to AID, through the GOI, Department of Economic Affairs, SF-1034, along with a certified statement of expenditures. AID will disburse the appropriate amount to the GOI in accordance with the standard procedure.

B. Estimated Budget

This is a technology development and research project for which exact project inputs and costs of inputs will not be known until proposals have been submitted and approved. Consequently, numbers provided below should be regarded as illustrative.

Category	USAID Contribution	DNES Contribution	ICICI Contribution	Project Participant Contribution	TOTAL
		($000)			
Component One 1/	11,000			11,000	22,000
Component Two 2/	4,000			1,000	5,000
Component Three 3/	2,000				2,000
Long Term U.S. Advisor	1,000				1,000
U.S. Short-term Technical Assistance (outside of Components One Two and Three)	400				400
Project Administration including Secretariat	1,500	300	200		2,000
Project Evaluation	100				100
	20,000	300	200	12,000	32,500

1. Channeled to consortia through ICICI.

2. Channeled to research group through DNES (non profit groups) and ICICI (for profit groups).

3. $1,000,000 of this $2,000,000 will be obligated by USAID outside of the bilateral project agreement.

C. Methods of Implementation and Financing*

Method of Implementation	Method of Financing
Commodities (Host country procurement, procurement by participating U.S. institutions, AID direct procurement)	
Local	Host country reimbursement
U.S.	U.S. bank letter of commitment and AID direct payment
Technical Assistance (Host country contract, AID direct contract)	
Local	Host country reimbursement
U.S.	U.S. bank letter of commitment and AID direct payment
Research Costs (Grants to host country institutions)	
Local	Host country reimbursement
U.S.	U.S. bank letter of commitment and AID direct payment
Studies, Analyses, Information Dissemination, Promotion (AID direct contract)	
Local	AID direct payment and host country reimbursement
U.S.	AID direct payment
Secretariat Costs (Host country contracts)	
Local	Host country reimbursement
U.S.	AID direct payment.

In traditional AID projects, methods of implementation and financing are quantifiable at the project design stage; however, in the instance of this project, information regarding commodities, technical assistance, and other inputs required for the project will not be available until proposals have been received.

D. Audit Provision

The project will be implemented by the Department of Non-Conventional Energy Sources (DNES), Industrial Credit and Investment Corporation of India (ICICI) will assist DNES. The former is a department of the Government of India and the latter a corporation owned by the Government of India. Both are subject to contracting, audit, and payment verification procedures and guidelines prescribed by the Government of India. The bulk of the funds under this project will be disbursed through ICICI which is a well established, professionally staffed and managed lending institution. We do not feel any special needs for audit beyond GOI audit coverage and therefore no funds are being earmarked under the project for that purpose.

VII. PROJECT ANALYSES

A. Economic Analysis

The underlying economic premise of this project is that India is at a stage in its development where acceleration of the pace of indigenous technology development will yield significantly positive benefits to the country. At present, private commercial R&D is less than 1% of turnover compared with rates of 2 - 4% in most developed countries. Corollaries of this relatively low level of R&D are almost total reliance on imported technology for technological adaptation and innovation, and significant under-utilization of both the industrial and the science and technology capabilities of the country.

There is little question that purchase of foreign technology will remain an important resource for technology applications and adaptations. Yet the failure of India to develop broad indigenous capabilities for commercially significant technological innovation exposes the country to technological stagnation during periods when foreign exchange is tight, and over the longer term condemns India to a disadvantage in technological competition for its own domestic and world markets. At the same time, an additional cost is imposed on the economy by the inability to harness the substantial investment in scientific and technological manpower and infrastructure for productive economic ends.

The presence of a large pool of skilled human resources, an increasingly technically sophisticated business community, and rapidly growing markets for technically advanced products indicate that the pre-requisites for successful encouragement of private sector commercial R&D are in place. In the prefeasibility analysis conducted for the PACT project, three interrelated constraints to increased private sector R&D were identified in the areas of information, human resources, and finance:

A central goal of the program is to catalyze a new approach in India -- that of goal-oriented R&D consortia -- for efficient development and commercialization of advanced technology for the power sector. Thus the most significant consequences of this program will lie beyond the immediate returns that may be generated by the consortia stimulated by the program. If, as a consequence of this project, it is widely perceived in India that such goal-oriented R&D consortia are more effective than traditional approaches to development of commercial technology, the consequence could be increased Indian Government support of such ventures and widespread application of the consortia approach. This in turn could result in important increases in the effectiveness of the electric power sector.

If the eventual consequence of a new way of organizing to promote the commercialization and application of R&D resulted in just a one percent increase in efficiency in the installed capacity in India (45,000 MWe), providing additional output equivalent to 450 MWe, the marginal increase in GNP, through increased productivity and wages, could range from several hundred million to a billion dollars annually.

B. Market Analysis

This question was addressed in the Tata Energy Research Institute (TERI) study sponsored by USAID/I on "The Potential of Energy Networks for Goal-Oriented Technology Development in India (see Attachment 4). The study identified the leading candidates for successful energy technology development networks and its major findings are described below.

Manufacturers:

An examination of the Indian energy scene reveals a broad and sophisticated public and private infrastructure devoted to manufacturing, erection and commissioning of large utility sized power systems.

Bharat Heavy Electricals Ltd. (BHEL) is the predominant public sector enterprise in this field; however, there are also about fifty private sector manufacturers of boilers and heavy electrical equipment. The private sector also plays the major role in providing auxilliary equipment and transmission and distribution systems. Major private suppliers include Thermax Ltd., ACC Babcock Wilcox, Indian Agricultural and Engineering Company (IAEC), Texmaco Ltd., Nestler Ltd., NGEF, and Siemens (India). With the possible exception of photovoltaics, the renewables field is virtually dominated by the private sector. Some of the leaders are Jyoti Ltd; Hindustan Brown Boveri, Best & Crompton, Bharat Solar, and Unicorn Ltd.

R&D Institutions:

There are about 15-20 government R&D institutions in India - mainly CSIR laboratories - engaged in energy R&D work. Such R&D is not limited to energy generation, conversion or distribution technology, but covers diverse areas such as control systems, new materials, and data management. Public R&D institutions rarely engage in technology development in association with the enterprise sector, although they have been fairly active in basic energy research. Significantly BHEL, a public sector entity, is responsible for wide ranging R&D activities in the energy arena - possibly more than the entire Indian private sector combined.

Private sector energy R&D is embryonic but growing. Approximately 10-15 private companies emerging from a state of "technology coma" may well be consortia candidates. Informal communications with private sector manufacturers of energy equipment indicate considerable enthusiasm and willingness to participate in the project, and they have proposed several specific areas of energy technology development:

The "User" Community:

An illustrative list of users includes power utilities, industries, commercial establishments, transportation systems, and rural populations. While utilities are largely in the public sector (India has 17 State Electricity Boards (SEBs) and only 3 private utilities), the other organizations mentioned are both public and private. The SEB's are crucial organizations in any consortia aimed at improving power sector efficiency.

The market for technologies developed as a result of this project can be subdivided into two major categories. The first includes the market for a relatively small number of large investment items, such as fluidised bed boilers. The second is the market for mass-produced products and processes such as photovoltaic cells, and batteries. Commercialization strategies will differ depending on which market is being addressed.

C: Institutional Analysis

Indian government energy institutions, except for petroleum and atomic energy, fall under the Central Ministry of Energy, and appropriate state government agencies and State Electricity Boards (SEBs). The most important elements under the Central Ministry of Energy are the Department of Non-Conventional Energy Sources (DNES); the Department of Power (DOP) and its technical arm, the Central Electricity Authority (CEA); and the Department of Coal (DOC).

The Department of Non-Conventional Energy Sources (DNES)

The Department of Non-Conventional Energy Sources (DNES) was established in September 1982 as a department in the Ministry of Energy (MOE). Except for a brief period of about 9 months (Jan '85 - Sept. '85) when it was transferred to the Ministry of Science and Technology, the DNES continues to remain within the MOE as one of its three constituent departments.

The GOI established the Commission on Additional Source of Energy (CASE) in 1981 to take primary responsibility for:

- o formulating policies and programmes for the development of new and renewable sources of energy;
- o co-ordinating and intensifying R&D activities in new and renewable sources of energy;
- o ensuring implementation of GOI policies in regard to all matters concerning new and renewable energy sources.

While the overall responsibility for the formulation of policies and programmes rests with CASE, DNES is charged with the planning, monitoring and financial support of a national integrated R&D programme encompassing a wide range of renewable energy technologies. Co-ordination is ensured between the two bodies since the Secretary of DNES is also the chairman of CASE.

The technologies of interest to DNES are solar, wind, biomass production and conversion, and the development of decentralised energy systems. Other major DNES responsibilities are to:

- o co-ordinate on-going R&D work in new and renewable energy resources;
- o function as the national agency for international cooperation in these energy fields;
- o recommend incentives for commercializing breakthroughs; and
- o function as a data base on all aspects of new and renewable energy sources.

In the four years of its existence, the DNES budget has increased six-fold, from Rs. 19.8 crores in 1982-83 to Rs. 119 crores in 1985-86. (The 7th five year plan has allocated 519 crores.) In 1985-86, the major allocation was for the national bio-gas programme (Rs. 70.7 crores),

followed by solar thermal (Rs. 10.85 crores), wood-stoves (Rs. 10.00 crores), wind energy (Rs. 5.0 crores), and biomass and draught animal power (Rs. 6.75 crores). Rs. 18.0 crores was allocated to geo-thermal energy, hydrogen energy development, magnetohydrodynamics, information/ public education and adminstrative overheads. The R&D component of DNES programmes amounted to Rs. 15 crores in 1985-86 or 12.5% of the total budgetary allocation. Rs. 104 crores was directed towards subsidies, demonstrations, training, publicity and administration. The Rs.15 crores is a significant increase from Rs. 3.8 crores and Rs. 9 crores in 1983-84 and 1984-85 respectively. This trend is expected to continue.

DNES functions through its head office at New Delhi and four regional offices at Chandigarh, Hyderabad, Bhopal and Ahmedabad. Two more regional offices are to be set up in the States of Uttar Pradesh and Assam. DNES has been instrumental in setting up nodal agencies in several state Governments, such as the Gujarat Energy Development Agency, the Uttar Pradesh Energy Development Agency and Punjab Agro-Industries Ltd.

The staff at DNES and its regional offices consist of 173 professional scientific and administrative/secretarial officers. DNES expects to add staff to manage its programs, including AID financed projects.

The Industrial Credit and Investment Corporation of India Ltd. (ICICI)

Beginning with its creation in 1955, ICICI has directed its financial resources to support the development priorities of India. In the early years the priority was rapid industrial development through wider entrepreneurship, and increased output of essential consumption and durable goods and diversified capital goods. Later, ICICI expanded its mandate to assist in the process of balanced regional growth and development of backward areas. In 1984, ICICI's sanctions of direct assistance to projects located in backward areas amounted to 57 percent of its total sanctions.

ICICI has demonstrated a consistent willingness to break new ground in India and has been notably successful in making these new ventures work. In 1977, it became the Indian pioneer in the merchant banking business where it is involved with projects from the time the proposal is formulated to the time the enterprise goes into production and becomes a bankable proposition. In its role of merchant banker, ICICI renders advice on plant capacity, product mix, mobilization of finance, and even marketing of output. Also in 1977, ICICI sponsored the creation of the Housing Development Finance Corporation. In 1984, ICICI became the first term lending institution in India to enter the leasing business.

ICICI has been instrumental in setting up industrial and technical consultancy organizations to guide entrepreneurs through the design, implementation, and management of projects and in supporting various training institutions.

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Because of its well established reputation in program development and financial management, ICICI has been tapped as a source of technical assistance to development banks in Ghana, Sri Lanka, Jamaica and Nepal.

ICICI Ownership and Resources

Ownership shares of ICICI are largely held by public sector corporations, including a number of nationalized commercial banks. Of ICICI's issued share capital of Rs. 270 million ($25.5 million), public institutions hold 79%, foreign shareholders (mainly commercial banks) hold 14% and the remaining 7% is held by some 2,056 private Indian investors.

ICICI is operationally autonomous except in respect of the procedures for appointing auditors. Relations between GOI and ICICI are good and, through its close contact with the business community, ICICI continues to be an important link between the private sector and the Government.

VIII. CONDITIONS AND COVENANTS

Prior to the first disbursement under the grant for subproject financing under Components One and Two of the project, or to issuance by A.I.D. of documentation pursuant to which such disbursement will be made, the Grantee shall, except as A.I.D. may otherwise agree in writing, furnish to A.I.D., in form and substance acceptable to A.I.D., documentation that an Energy Research and Technology Development Advisory Council has been established to provide advice to the Government of India (GOI) Department of Non-Conventional Energy Sources (DNES) in the implementation of the project. The Advisory Council will consist of members from the research community, the manufacturing sector, end user units, a finance institution, and government. The functional responsibilities of the Advisory Council will include:

- participating in the development of policies and procedures to be instituted under the project, addressing, among other things, subproject selection, review, and approval mechanisms; financial mechanisms; cost sharing formulas; and monitoring and evaluation procedures;

- participate in the development of annual operating plans and budgets for the project;

- guide and oversee the solicitation process for proposals in Components One and Two of the project;

- manage the peer review process under Components One and Two of the project;

- commission studies, analyses, and assessments to be financed under Component Three of the project; and

- sponsor workshops and seminars financed under Component Three of the project.

UNITED STATES AGENCY for INTERNATIONAL DEVELOPMENT

NEW DELHI, INDIA

June 25, 1987

ACTION MEMORANDUM

To: Mr. Richard N. Blue - D(A)

From: Peter W. Amato - PRJ(A)

Sibject: Program for Acceleration of Commercial Energy Research (PACER) Project (386-0494)

Problem: To authorize a $20 million grant for the subject project.

Discussion: India's Seventh Five Year Plan (1985-90) aims at an annual growth rate of 5 percent. Given the acute shortages of electric power, the most serious constraint to achieving this ambitious economic growth rate is the availability, quality, and reliability of delivered energy. In order to meet the power needs of the growing economy and achieve the targeted 5% rate of growth, India needs to make a heavy investment in the Energy sector. It is estimated that India must make an investment of $56 billion over the period of the Seventh Plan to keep pace with the anticipated additional demand of 30,600 MWE. But the resources allocated by the GOI for this purpose in the Seventh Five Year Plan are only $28 billion. This represents about 1/3rd of total Seventh Plan budget. This $28 billion budget shortfall must be reduced. One possible means of achieving this is through investments in technology adaptation, innovation and development. USAID proposes, under this project, to develop, introduce, and test operational models for indigenous technology innovation and development in the Indian energy sector.

FAA Section 612 (b): When the USAID/India program was re-established in 1978, it was determined that project financed local costs could be dollar-funded rather than funded from U.S. owned excess rupees. PPC reaffirmed this policy by memorandum on May 7, 1980, with the understanding that all interested agencies would have an opportunity to express their views on the matter at the annual CDSS and ABS reviews. The ABS submission for FY 1988, which included this project, was reviewed and approved by AID/W without objection.

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Therefore, the use of foreign exchange to finance local costs under this project has been approved. In accordance with past practice, your signature on the attached Project Authorization will provide the required FAA Section 612 (b) certification to use foreign exchange to finance local costs under the subject project.

Congressional Notification: A Congressional Notification was cabled to AID/W on May 7, 1987. The CN was forwarded to Congress on June 8, 1987 and will expire on June 23, 1987.

Recommendation: That you sign the attached Project Authorization and the Project Paper Data Sheet and thereby authorize a $20 million grant for the Program for Acceleration of Commercial Energy Research Project.

att: a/s

Clerances: PRJ:SJFreundlich (Concur)
TDE:RKBerry
DPP:CDCrowley
CO(A):NNWahi

PRJ:KCKapoor:trr:6/17/87 (3628C)

PROJECT AUTHORIZATION

INDIA

Program for Acceleration of Commercial Energy Research Project
386-0494

Pursuant to Section 106 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Program for Acceleration of Commercial Energy Research Project for India (the "Cooperating Country") involving planned obligations of not to exceed Twenty Million Dollars ($20,000,000) in grant funds over a six year period from the date of authorization, subject to the availability of funds, in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs.

The Project will finance selected research and technology development proposals, while seeking to create an institutional environment for relevant technology innovation in the Energy Sector. The project will have three interrelated components. The first component will provide financial support to consortia organized to undertake specific technology development programs. Such a consortium will consist of a Manufacturer working in collaboration with a Research Institute and/or an End User. The consortium will be required to have a significant financial stake in the proposed venture. The second component of the project will finance a competitive research awards program in topical areas defined by Component I and the third component will support the formulation of technology strategies, policy analyses and information dissemination.

The Project Agreement, 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, covenants, and/or conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

A. Source and Origin of Goods and Services: Goods and services, except for ocean shipping, 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. Ocean shipping financed by A.I.D. under the Project shall be financed only on flag vessels of the United States and the Cooperating Country, except as A.I.D. may otherwise agree in writing.

B. Conditions Precedent to Disbursement of Funds for Selected Activities:

(1) First Disbursement: Prior to the first disbursement of the Grant, or to the issuance by A.I.D. of documentation pursuant to which such disbursement will be made, the Grantee will, except as A.I.D. may otherwise agree in writing, furnish to A.I.D., in form and substance satisfactory to A.I.D.:

(a) An opinion of counsel acceptable to A.I.D. that this Agreement has been duly authorized and/or ratified by, and executed on behalf of, the Grantee and that it constitutes a valid and legally binding obligation of the Grantee in accordance with all of its terms; and

(b) A statement of the names of the persons holding or acting in the Office of the Grantee as specified in Section 8.2 of the Grant Agreement, and a specimen signature of each such person.

(2) Conditions Precedent to Disbursement for Subproject Financing: Prior to the first disbursement under the Grant for subproject financing under components I and II of the Project, or to issuance by A.I.D. of documentation pursuant to which such disbursement will be made, the Grantee shall, except as A.I.D. may otherwise agree in writing, furnish to A.I.D., in form and substance acceptable to A.I.D., documentation that an Energy Research and Development Advisory Council (Advisory Council) has been established to provide advice to GOI's Department of Non-Conventional Energy Sources (DNES) in the implementation of the Project. The Advisory Council will consist of twelve members chosen by DNES with representation from the Financial Sector, the Industrial Establishment, the Research Community and Energy End-Users, such as power generating companies.

C. Covenants: Except as A.I.D. may otherwise agree in writing, the Grantee will agree to establish and finance under the project an Evaluation Program satisfactory to A.I.D. The Evaluation Program will consist of annual reviews of the various activities under the three Project Components, an in-depth Mid-Term Evaluation and a Final Evaluation at the end of the Project. The Evaluation Program will include:

(a) reviews of progress toward attainment of Project objectives;

(b) the identification and evaluation of problem areas or constraints which may inhibit such attainment;

(c) assessment of how such information may be used to help overcome such problems; and

(d) evaluation of the overall results of the Project as a positive influence on the development of R&D in the Enterprise Sector.

Approved _____

Disapproved: _____

Date: June 26, 1987

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Section 611 (e) Certification
Program for Acceleration of Commercial Energy Research Project
Project No. 386-0494

I, Richard N. Blue, Principal Officer of the Agency for International Development in India, do hereby certify that in my judgment the Government of India has both the financial capacity and resources to carry out, maintain and utilize this project effectively. This judgment is based on the analysis contained in the Project Paper as well as upon the successful maintenance and utilization of projects in India previously financed or assisted by the United States.

Richard N. Blue
Director (Acting)
USAID/India

SD

DISSCUSSION DRAFT

PROJECT PAPER

ENERGY RESEARCH AND ENTERPRISE

(386-0494)

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

OCTOBER 29, 1986

TABLE OF CONTENTS

TABLES

FIGURES

LIST OF ANNEXES

S4

LIST OF ABBREVIATIONS

ANE	Asia and Near East Bureau
BHEL	Bharat Heavy Electricals Limited
CDSS	Country Development Strategy Statement
CEA	Central Electricity Authority (India)
CEI	Confederation of Engineering Industries
CSIR	Council of Scientific and Industrial Research (India)
DEA	Department of Economic Affairs (Ministry of Finance, India)
DNES	Department of Nonconventional Energy Sources (India)
DOE	U.S. Department of Energy
DOP	Department of Power (India)
EPRI	Electric Power Research Institute (USA)
ERDAC	Energy Research and Development Advisory Committee
ERE	Energy Research and Enterprise Project
GDP	Gross Domestic Product
GNP	Gross National Product
GOI	Government of India
GRI	Gas Research Institute (USA)
HVAC	Heating, Ventilating, and Air Conditioning
IBRD	International Bank for Reconstruction and Development (World Bank)
ICICI	Industrial Credit and Investment Corporation of India
IFC	International Finance Corporation
IIS	Indian Institute of Science
IIT	Indian Institute of Technology
IQC	Indefinite Quantity Contract
KWe	Kilowatts Electric
MWe	Megawatts Electric
NTPC	National Thermal Power Corporation of India
ORNL	Oak Ridge National Laboratory (USA)
PACT	Project for Advancement of Commercial Technology
PIL	Project Implementation Letter
R&D	Research and Development
S&T/EY	Office of Energy, Science and Technology Bureau
TVA	Tennessee Valley Authority (TVA)

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I. EXEC

Summary Project Description

Energy Research and Enterprise (ERE) is a six year project which will support selected research and technology development proposals while seeking to create an institutional environment for relevant technology innovation in the energy sector. The project will have three inter-related components. The first will provide financial support to consortia organized to undertake specific technology development programs. A consortium will consist of a manufacturer in collaboration with a research institute and/or an end user and will have a significant financial stake in the venture. The second component will support a competitive research awards program in topical areas defined by Component 1. The final component will support the formulation of technology strategies, policy analyses, and information dissemination.

The Department of Non-Conventional Energy Sources (DNES) in the Ministry of Energy will have primary responsibility for implementing the project. An Energy Research and Technology Development Advisory Committee (ERDAC) made up of representatives from research institutes, manufacturers, end-users, the finance sector and government will be appointed by DNES to provide policy and procedural guidance for the project and to play an active role in the solicitation, review, and approval of research and technology development proposals.

II. BACKGROUND AND PROJECT RATIONALE

A. Relationship to AID Strategy

In September 1983, AID adopted a ten-year strategy for research and technology development. The strategy reflects a conviction that research and technology development have made and will continue to make far reaching and lasting contributions to broadly based economic and social progress in the developing countries. Energy is targeted in the research and technology development strategy as one of the areas for AID program development. This is primarily because of the importance of energy to economic development in India and the U.S. comparative advantage in the field of energy research and development.

AID's understanding of the R&D issues has evolved considerably since the 1983 strategy statement. Recognizing the experience of East Asia, the revised strategy advocates that rapidly modernizing societies such as India place an increased emphasis on technology development and innovation. Critical to ensuring the relevancy of a technology development and innovation program is the active involvement of the enterprise sector.

AID, through its R&D portfolio, seeks to take advantage of and perpetuate a trend in India toward a technologically dynamic market economy by supporting projects that (1) accelerate the pace of technology development and innovation by strengthening the link between science and enterprise, (2) create an institutional environment in which technology innovation is fostered, and (3) stimulate public discussion on technology policy issues of national concern.

The first project in the AID portfolio to address these objectives was the Program for the Advancement of Commercial Technology (PACT). PACT is designed to promote Indo-U.S. joint ventures in technology development and, thus, heighten the enterprise sector's interest in building research and technology development programs. It has attracted wide attention in both the U.S. and India. A successful meeting of the Indian and U.S. PACT Councils was held in August 1986 and the implementing organization, the Industrial Credit and Investment Corporation of India, reports that ten high quality proposals have already been submitted. Variations of the PACT model are now being rapidly developed by other Indian financial institutions and supported by public (e.g., IFC and IBRD) and private (e.g. Grindlays Bank) organizations.

The Energy Research and Enterprise (ERE) project is the second effort to promote the technology innovation to enterprise link and shares many of the PACT objectives; however, whereas PACT is sectorally crosscutting, ERE is sectorally specific. A third project, currently under development, will further promote the link by increasing the interaction between the science and enterprise communities in a selected city or state.

B. Energy and its Relevance to the Indian Economy

India's gross national product (GNP) of $182 billion is one of the largest in the world, but with 750 million people (in 1984) the country's annual per capita income stands at only about US$ 260. To move toward overcoming the pervasive problems of poverty and unemployment, India's Seventh Five Year Development Plan (1985-90) estimates that the annual rate of economic growth must increase from its recent level of 3.5 to 4.0 percent to a new level of 5.0 percent. This is an ambitious growth target. Unlike the Sixth Plan target, it is not based on an unusually low series of predecessor years.

A serious constraint to economic growth has been the availability, quality, and reliability of delivered energy, with acute shortages of electric power the most pressing problem. This is manifested by frequent power cuts, voltage and frequency fluctuations, and frequent load shedding. During the period 1985-86, India experienced an overall deficit in power supply of 8.6 percent. Many states, however, experienced significantly higher deficits. Haryana had deficits of 29.1 percent; Bihar, 29 percent; Karnataka, 22.6 percent; Orissa, 21 percent; Uttar Pradesh, 15.1 percent; Punjab, 13 percent; and Tamil Nadu 12.7 percent: These seven states represent over one third of the national net value added in manufacturing. Their power deficits led to massive industrial cutbacks, the estimated cost of which was a staggering Rs. 5,000 crores (approximately $4 billion).

Widespread power shortages have driven industries to install their own captive power stations, usually small diesel generating sets. These units tend to be operationally and economically inefficient, and require increased imports of oil at a time when oil imports are already consuming forty percent of scarce foreign exchange reserves. Despite its high cost to industry and the Indian economy, captive power capacity increased sharply from 2,859 MWe in 1979-80 to 4,190 MWe in 1984-85. The Government of India estimates that captive power will increase another 68 percent to 7,056 MWe by 1990.

The projected capital requirements for expanding power generation, transmission, and distribution systems far exceed the financial resources available. As of April 1, 1985, India had 42,759 MWe of installed electrical generating capacity. The Central Electricity Authority (CEA) estimates that 30,600 MWe of additional capacity is required to keep pace with the demand anticipated during the Seventh Plan. These additions will cost approximately $56 billion; however, the power sector has been allocated only $28 billion, half the amount required. Yet even at this insufficient funding level, energy accounts for almost one-third of the Seventh Plan Budget.

The years ahead will undoubtedly strain the capabilities of the energy sector as it strives to meet the needs of the economy. To the extent possible, India will try to meet these requirements from indigenous energy resources. The Seventh Plan responds to the challenge by calling for:

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(a) the accelerated exploitation of coal, hydro and nuclear power resources;

(b) the intensification of exploration for oil and gas;

(c) implementation of appropriate policies to assure the efficient utilization of the large gas resources;

(d) the management of energy demand and the creation of incentives for energy conservation and inter-fuel substitution;

(e) the exploitation of renewable energy resources through reforestation, and expanded use of biogas, biomass, wind, and solar energy, to meet in particular the energy needs of rural communities; and

(f) the formulation of a technology policy that balances licensing with indigenous technology development and creates an institutional infrastructure capable of facilitating effective policy implementation.

C. The Potential of Technology Development

The dynamism of the Indian economy is choked by a gap between energy supply and energy demand. The Government of India intends to narrow the gap by increasing the megawatts of installed electrical capacity; however, as indicated previously, there is a $28 billion budget shortfall between the sums that have been allocated and the projected sums that are projected as necessary to meet the expected power demand. Therefore, action must be taken to reduce the $28 billion shortfall. The most effective route is through investments in technology adaptation, innovation, and development.

Technology investments hold great promise for existing generation, distribution, and utilization systems. For example, opportunities for technology innovation and development exist for advanced coal beneficiation and conversion systems, including fluidized bed boilers, combined cycle systems, and industrial co-generation. A major positive impact on power delivery would result from an increase in the disappointing 50.1 percent plant capacity factor of thermal power plants to 60 percent or higher. The capacity factor, which is the ratio of actual power generated to the maximum power production capability of a plant, can be increased through improvements in technology as well as in operation and maintenance procedures.

Energy conservation and increased energy efficiency is another area of relevant and immediate importance. According to the report of an Inter-Ministerial Working Group on utilization and conservation of energy, there is a conservation potential of 25 percent in the industrial sector. Conservation potential jumps to 30 percent in the agricultural sector. These estimates were made based on existing technologies that had not yet been adapted to Indian conditions or adopted by Indian energy consumers. The

potential for energy savings that could be created by the development of new technologies is even greater. For instance, rapid technological advances in electronics are making possible energy savings not foreseen just a few years ago. Microprocessor-based electronic controls can expand significantly the Indian ability to monitor, measure, utilize, and produce energy at higher efficiency rates.

The Government of India fully recognizes the status and potential of technology development in India and is investing considerable sums in the research and development of alternative energy sources that can make decentralized energy systems possible. To manage its alternative energy program, the GOI in 1982 established the Department of Non-Conventional Energy Sources.

The high priority accorded to DNES and its mission is reflected in GOI budgets. Against an approved Sixth Plan outlay of Rs. 100 crores, the actual expenditure was more than 50 percent higher at Rs. 161.7 crores. In the Seventh Plan, the allocation has increased more than five fold to Rs. 519 crores.

The focus of DNES sponsored research is to make non-conventional technologies increasingly competitive with conventional technologies by cutting costs and improving operational performance. Some of the areas of non-conventional energy which have already had a visible impact in India include bio-energy (biomass and biogas), solar thermal systems, solar photovoltaic systems, and wind energy conversion. For the Seventh Plan, DNES has identified the following priorities for its research and development program:

- reducing the cost of family sized biogas plants by 25 percent
- increasing bio-gas production at low temperatures
- reducing the cost of solar photovoltaics by developing new materials
- developing efficient pump systems for windmills
- developing indigenous wind turbine power generation systems

To achieve its research and technology development objectives, DNES offers incentives and assistance to industries in the public and private sector. Due in part to DNES, in 1984 there were more than 75 manufacturers, largely in the private sector, engaged in the manufacture and development of various renewable energy systems and devices.

D. Constraints to Technology Development

The Indian Government has long recognized that technological progress is necessary to enhance industrial and agicultural productivity, reduce production costs, improve the quality of goods and services, and utilize the country's resource endowments most efficiently. Beginning with Nehru,

who had an abiding faith in science, and pronounced that the future belonged to those who cultivated science and befriended scientists, support for science and technology programs has always been forthcoming from the highest levels of government. Yet India's pace of producing useful products from science and technology innovations has not met expectations. The following analysis explores why.

1. Policy Constraints

Early after independence the Government of India initiated the establishment of an extensive physical and human resource infrastructure for science and technology development. A chain of institutes of technology on the model of MIT were created and vast networks of national laboratories were set up. Among the foremost of these networks is the Council for Scientific and Industrial Research. With 42 government supported laboratories, CSIR has a mandate to conduct applied research to develop substitutes for imports from local products.

To complement its network of public supported laboratories, the Government of India has, for some time, provided a variety of fiscal incentives designed to promote in-house R&D within industrial firms, sponsored research in approved laboratories, and the utilization/commercialization of indigenously generated technologies. Sepcifically, the current fiscal regime permits firms with recognized R&D facilities to deduct 100 percent of both current and capital expenditures for R&D from taxable income in the year incurred. A carry-forward provision permits start-up firms to deduct such expenditures incurred up to three years before the commencement of business operations in their first year of operation. In order to support the development and use of the country's science and technology infrastructure, contributions to approved research associations are tax deductible. Furthermore, non-commercial scientific research institutions are exempt from payment of customs duties on imported scientific equipment and spares. Realizing that such incentives addressed only the supply of research, the government approved a tax incentive in 1977 to stimulate demand for and utilization of indigenously generated technology. Specifically, a higher investment allowance of 35 percent (compared to the normal allowance of 25 percent) is offered to users of indigenous technology.

Despite the tremendous investment in scientific infrastructure and a conscious effort to promote science and technology through policy incentives, India's science community has not fulfilled early hopes that it would stimulate the performance of the Indian economy. The most common complaint about commercialization of technology through public research institutes (where over 90 percent of India's R&D expenditures take place) is that they produce little more than bench scale results or prototypes that can work only under controlled laboratory conditions. Moreover, because of the limited interaction that takes place between government laboratories and the commercial sector, many of the products and processes developed are often irrelevant to the demands of the market. Although it is acknowledged that successful industrial innovation is often driven by

the needs and attitudes of users, practices such as extensive testing of machine prototypes on consumer premises under actual working conditions are not prevalent in India. Consequently, when attempting to replicate technologies in a real world manufacturing environment, problems arise such as keeping production costs low enough to to ensure profitable operations and obtaining the required raw materials.

Indian industrial R&D expenditures in 1982/83 amounted to only $300 million, which is slightly higher than the $280 million spent in 1982 by South Korea, a country with an economy 45 percent the size of India, and less than half of Brazil's expenditures in 1979 which exceeded $700 million. Organized in-house research is concentrated in a few subsectors, namely electrical and electronic industries, chemicals, drugs and pharmaceuticals and engineering goods which together accounted for 775 of the 883 recognized R&D units. Even in these subsectors, however, R&D intensity is low.

As a result of the limited investments in technology development, the use of outdated designs and problems of substandard quality and low product reliability are widespread. Even more critical than outdated designs, however, is the use of manufacturing processes that are not conducive to cost reductions and quality improvements.

Technology development in India has not suffered from a lack of scientific talent or from an absence of technology-oriented policies. Indeed, as indicated in the opening paragraphs of this section, the govern- ment has accorded explicit attention since independence to the promotion of science and technology in the country and has used a variety of instru- ments towards this end. The primary drag on technology development has been an industrial policy environment that is not conducive to technolo- gical upgrade. Indian industry has been given little incentive to tap the resources of the public sector laboratories or to make its own R&D in- vestments.

The structure, organization, and conduct of Indian industry has been shaped by a combination of industrial and trade policies motivated originally by the need to conserve scarce investment and foreign exchange resources. Heavy emphasis has been placed on import substitution. This has led to a policy framework characterized by limits on internal competition and high protection from external competition. The absence of both potential and open competition has brought about lax management behavior among Indian industrialists with respect to product costs, quality, and design. Consequently, strong incentives to make technology investments have been lacking.

The technological conduct of Indian industry has also been affected by regulations governing the capacity of manufacturing units. In the late 1970s, the average size of plants in many industries were occasionally between 30 and 50 percent of plant sizes in the U.S. but more often 10 percent or less. By reserving a large number of products to the exclusive production of the small scale sector and, more generally, by restraining

the growth of industrial firms, government policies have made it difficult for industry to reap the economies of scale in technology development. Moreover, the system of capacity licensing discourages the adaptation and development of technologies that would increase productivity because of their potential to push production over licensed limits. Finally, by limiting the entry of new firms and regulating the expansion of incumbents, technologically laggard firms have not only survived but thrived.

Indian policy has been to limit the access of firms to foreign technology believing this would stimulate indigenous technology development. Even the regulations governing the acquisition of disembodied forms (e.g., licenses) of technology which India opted for as the preferred mode of acquisition of foreign technology have been strict and their administration slow and cumbersome. Fairly low ceilings have existed for payments and permitted collaboration periods have been short. Direct foreign investment, which for many developing countries is a major form of technology import, has been strongly discouraged. In the period 1969-82, India approved fresh equity inflows of just $80 million, which was small compared with inflows to Korea ($648 million), Mexico ($7 billion), and Brazil ($14 billion). The net result of regulations affecting the imports of foreign technologies is the existence today of large pockets of Indian industry characterized by gross inefficiencies in the form of outdated techniques and products.

Recognition of the economic costs of the growing technological gaps has led in recent years to a significant liberalization in industrial policy. Recent reforms are directed toward creating a substantial degree of competition in order to effect a reduction in costs and an improvement in quality. While the primary emphasis has been on stimulating internal competition, there has also been some increase in import competition, mainly in the case of capital goods. An increasing number of such goods can now be imported under open general license, and tariffs on several items have been significantly reduced. This should result in substantial upgradation of process technology in the user industries while at the same time providing incentives to domestic manufacturers to upgrade product and process design. In fact, this is already happening in the machine tool industry.

Recent reforms in industrial regulatory policies have also begun to reduce the policy-induced barriers to industrial entry and expansion, increasing to some extent, the degree of competition and fostering an environment in which technology investments are a rational strategy decision. Reforms include delicensing 21 industries in 1985, allowing firms greater flexibility in determining and altering their product mix, and opening up certain sectors previously reserved for the public sector to investments by the private sector.

Although the policies regulating the import of foreign technology still favor suitable domestic substitutes, considerable liberalization is taking place as indicated by the sharp rise in approved collaboration agreements. Foreign joint ventures increased from approximately 550 in

1984 to over 1500 in 1985. A proposal is currently pending whereby all agreements would be routed through a single window and the managing agency would be given a set number of days in which to approve or deny an application.

The immediate impact of the reforms (a complete list of which can be found in Annex 2) has been:

- o to weaken the shields protecting Indian's markets from outside competition and interaction;*
- o to increase manufacturers' rights to the output of their R&D efforts (previously, large manufacturers were often denied licenses and manufacturing rights to technological innovations that they financed; these licenses and rights were instead granted to smaller manufacturers);
- o to ease access to foreign technology (thus, discouraging wasted efforts at reinventing existing technologies and, at the same time, increasing the availability of technological resources which stimulate technology innovation); and
- o to simplify the approval process for foreign collaboration (thus, increasing the opportunities for Indian science and technology units to interact with world-class counterparts).

The reforms, coupled with existing incentives to promote R&D, including an income tax act that allows full deductions for all R&D expenditure, provide the carrot - through increased incentives, and the stick - through increased competition, for India to achieve its technology development potential.

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*In so far as the competetion policies are successful, there will be pressure on the profit margins of many firms. While this should motivate cost-reducing innovations and development of better products, the squeeze on resources could also limit the ability of firms to respond through more substantive and integrated innovation efforts which are more costly and risky. Consequently, there is a recognized need to make funding for technology innovation more easily available. To date, finance operations for technology innovation have been negligible though it is encouraging to note that all three finance institutions (IDBI, ICICI, IFCI), which collectively dominate term lending to industry, are experimenting with or contemplating entry into such activities.

2. Institutional Constraints

In addition to policy constraints, there have been institutional factors hampering the conduct of relevant R&D in India. One of these factors has been the public sector's reluctance to finance research and technology development outside of government laboratories. In contrast to practice in the United States, Japan and West European countries, government funds in India are, by and large, spent in government laboratories, and not even in the laboratories of public enterprises. This, however, is changing. DNES has been one of the first government agencies to recognize the value of sponsoring research in the commercial sector (public and private) and in the universities.

Another institutional constraint is the inability to clearly define research priorities and, consequently, to make valid, well-informed resource allocations. A study of the experience under the Alternative Energy Resources Development project would indicate that proposals tend to move forward on the basis of the bureaucratic strength of a proposal's advocate rather than on a rating of the proposal against identified research priorities.

Finally, Indian science is impeded by a poorly implemented peer review process. Although in some sectors, such as medical research, the peer review process has been used with great success in India, it is in other sectors, for the most part, weak. Most research organizations deal with peer review as an in-house affair and do not seek the expertise of outside, perhaps more qualified and objective reviewers. Moreover, the process is usually activated only for the initial review. Follow up peer reviews are rare. The peer review process in the energy sector is particularly ineffective. This stems from the fact that energy research programs were not considered important until the early 1970s and research review mechanisms are, consequently, not yet fully developed.

E. Project Premises

Science and technology development, grounded in high quality scientific method and results, has over the past three decades been a major source of far reaching and lasting contributions to broadly-based economic and social progress in developing countries. One has only to consider the impact of such accomplishments as the eradication of smallpox, reduction of malaria, and expansion of basic food supply to recognize the veracity of this proposition. Moreover, sustained technological innovation is at the core of the successful transition North American, European, and East Asian countries have made from traditional agricultural to modern industrial societies.

The Government of India understood early on that a strong science and technology program is critical to sustained broadly based economic development and made the rapid expansion of its research capability a major government objective from the beginning of the development planning process in 1950. As a result there are today in India 108 engineering and techno-

logy institutes, 327 polytechnical institutes, and 365 industrial training institutes. Almost 2.5 million Indians have graduate or post graduate degrees in engineering, science, agriculture, and medicine and total annual expenditures on research and technology development have in recent years hovered over the equivalent of the $1 billion mark.

India's investment in research and technology development has contributed to the achievement of a number of notable successes, particularly in adaptation and rapid dissemination of high yielding cereal varieties (HYVs), development of a broad manufacturing base, and establishment of substantial indigenous capacities in space technologies and atomic energy. Nevertheless, the contribution of technological innovation to economic growth could be greatly expanded.

The Energy Research and Enterprise project seeks to increase India's capability to utilize to greater advantage its talented science and technology community. The willingness of USAID and the Government of India to proceed with the project is based on four guiding premises:

The first premise of the project is that science and technology have not had the expected "take off" effect in India because a culture of technology innovation has not taken hold. Indian laboratories, for the most part, support minor adaptation and assimilation of imported technology. Technology innovation that has taken place, regardless of its quality, has often taken place in isolation from the commercial and industrial sector and has, as a result, been irrelevant to the demands of the market place.

The second premise is that the time is ripe to promote technology innovation. The presence of a large pool of skilled human resources, an increasingly sophisticated enterprise community, and rapidly growing markets for more technically advanced products indicate that the requisites for successful encouragement of technology innovation are in place. Recent reforms in the policy and regulatory environment, geared toward increasing India's competitiveness on the world market, are also favorable to technology innovation.

The third premise is that technology innovation requires greater interaction among scientific institutions, commercial enterprises, and end users. This has the mutually beneficial impact of increasing the relevance of science programs by adding a market driven focus; increasing the competitiveness of enterprise by introducing technologies that reduce costs and improve quality; and accelerating the rate of commercialization by preparing the end user market.

The final premise is that, in order for market driven R&D interacions to be successful, the institutional infrastructure to facilitate the process must be in place. Research-sponsoring organizations must be capable of setting research priorities, allocating funds in a manner consistent with those priorities, overseeing a review process that ensures the quality and relevance of sponsored research, and stimulating public awareness and discussion of important R&D issues.

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AID has chosen the energy sector to take advantage of what it sees as an exciting opportunity to facilitate market-driven technology innovation. Energy is a critical factor in the economic growth of any country and, in India, the sector offers tremendous scope for improvement. Moreover, AID has experience and established relationships in the sector through projects in its existing portfolio: Technologies for the Rural Poor, Alternative Energy Resources Development, and Rural Electrification.

F. Models: Market Focused Research and Development Consortia and Government Sponsored Contract Research

The purpose of the project is to develop, introduce and test operational models for indigenous technology innovation and development in the Indian energy sector. In developing these models, the experience of the U.S. Electric Power Research Institute (EPRI) and the U.S. Department of Energy (DOE) was studied. The following is a summary of this experience with an emphasis on the role and significance of consortia as a new way of organizing for high technology development and commercialization in India. (discussed in detail in Annex 3).

The culture of research and technology development in the United States has been created and fostered by two distinct but interrelated approaches: the formation of user supported, market-focused research and development consortia in several critical high-technology areas (the Electric Power Research Institute Model))*; and a system of government sponsored contract research in universities, national laboratores and private industries (the Department of Energy Model).

The Electric Power Research Institute (EPRI) Model

EPRI is a private nonprofit research and development institute based in Palo Alto, California, and is the principal R&D management arm of the U.S. electric utility industry. Founded in 1972 by the electric utility industry in response to congressional proposals to establish a national electric research center, EPRI has grown to a staff of 750 and a current annual budget of $325 million.

The primary aim of EPRI's research and development efforts is to develop new or improved technology and knowledge for electric utility applications and to assist in the commercialization of these technologies. EPRI does not generally conduct research by itself. Virtually all of its research efforts are conducted through collaborative arrangements involving individual electric utilities, manufacturers, consulting companies, universities, and national laboratories. These efforts are for the most part cofunded by EPRI and the participants of the R&D consortia.

*Other research consortia in the United States include the Semiconductor Research Cooperative, the Council for Chemical Research, the Center for Advanced Television Studies, and the Micro-electronics and Computer Technology Corporation.

The experience of EPRI and other catalysts of research consortia has shown that the resultant product of a consortium is more cost effective and technically attractive than otherwise would have been the case. Moreover, involving end-users in the research process prepared the market and quickens the pace of commercialization when the product become available.

Until recently, joint R&D ventures by private companies were difficult to establish in United States, due to their ambiguous status under anti-trust laws. Recognizing the value of scientific collaboration, the U.S. congress passed legislation in 1984 which shelters R&D joint ventures from action under the anti-trust laws if the participating companies have significant market shares in the particular area in which R&D is to be carried out.

The Deparment of Energy (DOE) Model

The model for government sponsorship of research in university and industry laboratories was established by Vannevar Bush, an Advisor to President Franklin Roosevelt, and Director of the Office of Scientific Research and Development (OSRD) during World War II. The plan put forward by Bush in "Science, the Endless Frontier" has won fame as the blueprint for the institutions that now exist within the U.S. government, specifically the granting agencies that support scientific research.

The U.S. Department of Energy (DOE) follows this plan, and supports basic and applied research through competitive and non-competitive contracts to an array of private and public institutions. DOE generally funds long-term research in national laboratories, universities and private industries, with an annual budget of approximately $2.5 billion, a budget that is considerably larger than that of the Electric Power Research Institute.

Many R&D projects have multiple sponsors, with EPRI or DOE or both providing part of the funds with the remainder provided by utilities or other organizations. Viewed broadly, DOE's R&D activities focus more on fundamental and longer-range problems, while EPRI places a much stronger emphasis on the commercialization process in the near and medium-term.

The Japanese Experience

The particular success of Japan in gaining major and often leading positions in key industries over the past 15 years reflects the success of that country's establishment of goal-oriented market-focused R&D consortia. Japan's Ministry of International Trade and Industry (MITI) has organized and underwritten large, vertically and horizontally integrated multicompany consortia in key industries. These include the steel, automotive, microelectronics, and machine tool industries. In these consortia, a group of companies band together, sometimes in collaboration with university and government research institutions, and focus on a specific development and commercialization goal. This eliminates duplication of effort, promotes standardization, and provides financial resources far beyond the capabilities of all but the largest corporations.

Relevance to the ERE Project

The project components are discussed in the section that follows. Component One supports the sponsorship of market-driven consortia, and draws its inspiration from the EPRI model. Components Two and Three follow the model of government sponsored contract research and therefore engage directly with the issue of how government resource allocation and R&D priority setting mechanisms are established.

III. PROJECT DESCRIPTION

A. Project Goal

To accelerate the development and absorption of new and relevant energy technologies.

B. Project Purpose

To develop, introduce, and test operational models for indigenous technology innovation and development in the Indian energy sector.

C. Project Approach and Objectives

Principal objectives of the project, in support of the overall project goal, are to:

- o increase the quantum of R&D in the enterprise sector;
- o increase collaboration among scientific institutions (including universities), commercial enterprise units, and end-users;
- o increase the responsiveness of the science community to market forces;
- o rationalize and systematize priority setting and resource allocation of public research funds for energy.
- o strengthen the peer review process; and
- o stimulate policy research, public discussion on technology development issues, and advocacy of technology development objectives.

The project approach, presently untried in the Indian context, 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. Established as new operating entities that cut across the traditional and relatively noninteractive strata of R&D institutions, utilities, and industry, these consortia will focus on the development and widespread commercial applica-

tion of advanced energy technology products and processes. The activities of the consortia will be supported by a competitive research awards program and by activities designed to analyze and disseminate information of relevance to commercializing technology innovations.

D. Project Components

The project is structured around three interactive components:

Component One: Market-Driven Technology Development Consortia

Component Two: Competitive Awards Program for Supporting Research

Component Three: Supporting Analyses and Outreach

In each of these components, proposals will be solicited, reviewed, approved, and, if approved, financed. Proposals, in most instances, will be related to renewable energy. However, as a result of negotiations with DNES and the Department of Power, power-related proposals will also be eligible for project support.

Component One: Market-Driven Technology Development Consortia

This component will make AID financial support available to consortia working on specific goal-oriented technology development problems. Eligible consortia will involve manufacturers in collaboration with research organizations and/or end users. Consortia participants could be all Indian or a mix of Indian and American. In order to stretch project resources and to expose as many entities as possible to the consortia concept, no single entity will be permitted to participate in more than two AID-supported consortia.

To ensure the full commitment of each consortium, all profitmaking participants will be required to have a significant financial stake in the venture. The extent of the financial stake will be determined by the level of risk being taken and the financial resources of the consortium but, except in cases specially waived by the AID Director, the AID contribution will not exceed fifty percent of the estimated cost of the venture or $3 million, whichever is lower.

Proposals must show the involvement of a manufacturer with a research organization and/or an end-user, and a significant financial stake by the profit making participants, proposals submitted for approval must also include where feasible a business plan which identifies a lead organization and provides a scheme for interaction among consortium participants, a discussion on how the technology under development will be commercialized, and a description of the total systemin which the technology fits.

Proposals will undergo a technical peer review described in Section IV (Implementation Plan) of this paper. Special consideration will be given to those technologies that can mitigate serious electricity shortages in the country. Such technologies could include the following:

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- o advanced products or processes that improve the performance of conventional or non-conventional power generation systems, increase the efficiency of electric end-use equipment, or improve the economics of non conventional energy systems.

- o innovative and advanced systems that need to be demonstrated in a power plant, factory or other operating situation to verify systems performance to important users and thereby accelerate commercial acceptance by those users. Such demonstrations are quite distinct from experiments designed to reduce large technical uncertainties.

Illustrative activities that could be supported under the component include:

- o analysis and design of new or improved systems;

- o fabrication of experimental hardware;

- o laboratory testing of experimental hardware;

- o field testing of prototype hardware (in cooperation with end users);

- o short-term training, including visits to centers in the U.S., for key personnel directly associated with the project.

Component Two: Competitive Awards Program for Supporting Research

The second component of the project will sponsor a competitive awards program whereby the topical areas eligible for support will be defined by the areas of the proposals accepted in Component One. For instance, if a consortium organizes itself around a problem in fluidized bed combustion, then requests for research and technology development proposals in the area of fluidized bed combustion will be issued. Strong preference will be given to those proposals that directly support the commercialization objectives of the consortia in Component One. However, proposals that do not directly support a Component One consortium can be considered in those instances in which a proposal is deemed to be particularly meritorious.

There are several reasons for requiring Component One to define the activities that will be funded under Component Two. First, following the lead of the consortia in the selection of topic areas increases the chance that the research or technology development undertaken will be market-relevant. Second, by increasing the quantum of research and involving a critical mass of researchers in selected topic areas, the project hopes to increase interaction among interested parties. Finally, the individual institutions and firms supported under Component Two could bring critical technical, market, or financial expertise lacking among the members of the consortium.

Individuals from Indian research organizations, manufacturers, and end users will be eligible for the research awards program. Collaborations among any of the three groups will be eligible but collaborations are not necessary under this component; single entity proposals are expected to be the most common. When the proposal comes from the profit making sector, a reasonable amount of cost-sharing will be expected. When a non-profit making institution is the proposer, the project will be willing to bear the entire cost of the proposal. All proposals will be subjected to a technical peer review described in Section IV (Implementation Plan) of this paper.

Whereas it is expected that proposals in Component One will be at the technology development end of the innovation pipeline, proposals in Component Two will have a broader or longer term focus, with an emphasis on the research end. Typical areas for R&D funding are listed in Table 1 which can be found on page 21.

Component Three: Supporting Analyses and Outreach

This component includes three important elements: project strategy formulation, policy analyses, and information dissemination (which also includes training and promotional activities). The component is expected to play a key role in broadening our understanding of the innovation/commercialization process for advanced technologies in the Indian energy sector, provide a mechanism to conduct supporting analyses for Components One and Two, and support the essential information dissemination and networking goals and activities of the project.

A good example of the type of activity that will be financed under this component was the recent visit of a team of senior consultants from Hagler, Bailly and Company to study the impediments to and potential for non-utility power generation in India with emphasis on opportunities for private sector investment. The team completed a thorough analysis of the situations in Maharashtra and Gujarat and, at the same time, performed an information dissemination function by discussing with interested Indian policy makers in private meetings and a public seminar the highly regarded Public Utility Regulatory Policies Act enacted in the U.S. to promote the development of non-conventional power generation. Further explanation of the types of activities to be financed are as follows:

R&D Strategy Formulation

Activities funded by this subcomponent will provide guidance in setting research priorities, allocating project resources, and preparing project operating plans. The component will help ensure that the project framework is based on sound information and responsive to India's energy needs. It will also finance analyses of unforeseen technical, institutional and other problems which may arise in the course of project implementation.

The studies and analyses will be carried out primarily by Indian contractors, consultants, and organizations such as the Tata Energy Research

Institute, the Confederation of Engineering Industries, and the National Productivity Council although American consultants are also eligible. Topics for analysis could be suggested by the GOI, AID, or unsolicited proposals. An illustrative list of the type of activities that could be financed includes:

Market Risk and Financial Analyses

o preliminary market surveys to help determine commercialization prospects;

o identification of the potential market and projected market penetration of new technologies under specific economic, financial, and institutional conditions;

o identification and characterization of the allowable financing mechanisms for research, development, and commercialization of the specific technologies being considered by the consortia;

o assessment of the potential technical, economic, and financial risks associated with development and commercialization of the specific technology options;

o surveys of industry to determine perceived technology needs;

o integrated technical, market, cost, risk, and financial analysis to quantify the cost and timing of commercialization, and to determine the most effective commercialization strategy options;

o development and diffusion of software tools for technical, economic, and financial analysis.

Technology Assessment

Periodic assessments, using well-defined procedures and authoritative sources of information, to define the status of technologies of potential interest and the potential for improvement and reduced technological uncertainty through well-focussed R&D;

Policy Analyses

Technology development and utilization are often influenced by government policies that either support or hinder rational decision making. It is important that R&D under this program be consistent with growing Indian interest and government policy trends to liberalize economic activity. To bring to the fore important policy issues that will increasingly dominate the sector, this sub-component will finance policy studies and analyses. Ideas for the studies and analyses could come from the Government of India, AID, or unsolicited proposals. Following is an illustrative list of topics:

o an assessment of a range of technology policy issues that could impact on R&D priorities (for example, the broad issue of how decreasing oil prices affects the rationale for developing indigenous coal-based or renewable energy systems for power generation);

o an examination of financing options including an assessment of the opportunities and obstacles for third-party financing in the commercialization process;

o an exploration of the issues of ownership and patents, manufacturing rights, licenses, and other market controls;

o an assessment of how policy changes might impact the development of innovative technologies. Examples of such assessments include:

- the effect of relaxation of import barriers;

- the effect of changes in tax laws such as increased deductions for R&D expenditures;

- the ability of utilities to purchase power from private generators;

- incentives for state electricity boards to pursue efficient load management techniques;

- the effect of subsidized prices as a disincentive to implement more efficient energy technologies;

Information Dissemination and Training

Workshops, seminars, training and other information dissemination activities that promote the culture of technology development, R&TD collaboration, and commercialization will be sponsored under this subcomponent. Ideas for information dissemination activities could come from the Government of India, AID, or unsolicited proposals. There will also be a need for promotional activities to attract good proposals for Components One and Two. Following is an illustrative list of the types of activities that could be sponsored.

Project Initiation Workshop

A three-day Project Initiation Workshop will be held to formally kick off the project. The workshop will serve to provide potential Indian and U.S. participants with an overview of the program and the opportunity to make comments and suggestions on the program plan. At this workshop, presentations will be made by individuals who have had active experience with research consortia and the peer review process. The workshop will also introduce the AID project staff to the Indian R&D, industrial, and utility communities.

RFP Workshops (Bidders Conferences)

Workshops will be held in major cities in India to announce Requests for Proposals and to describe in detail the nature of the program and requirements for a successful proposal. At these workshops (often referred to as "Bidders' Conferences") potential bidders can request clarification of technical, financing, legal, and other issues.

International Workshops and Symposia

An important aspect of this project will be to promote Indian participation in international workshops. Depending on the progress made by the various consortia in development and commercialization of new technologies, it may be appropriate to sponsor preparation and presentation of professional papers at national and international symposia dealing with issues of energy, development, and technology transfer.

Project Newsletter

A project newsletter, issued quarterly, could help all of the various project participants remain in touch with all aspects of the program, would provide program visibility within India to government and industry, would provide AID with regular updates and information, and generally facilitate the development and expansion of the ERE program network.

Professional Publications

Professional papers that are relevant to the objectives of the project will be encouraged and supported for publication in appropriate journals and magazines. This will extend the reach of the project and underscore the benefits of research and technology development networks.

Training

Training and study tours financed under this project will support the creation of a technology development culture in India. Eligible subject areas will include, but not be limited to, specific technology areas in which project supported consortia are operating, technology commercialization, research and development management, policy and priority-setting, and innovative scientific and technological approaches linked to commercialization.

Table 1

ILLUSTRATIVE LIST OF PRIORITY R&D AREAS

- o Commercially attractive technologies to tap biomass or solar energy:
  - biomass fired power units
  - wind and photovoltaics
  - small scale hydro
  - solar thermal electric power generation
- o Coal conversion technologies for low-grade Indian coals
  - fluidized bed combustion;
  - slagging combustion;
  - oil and water coal slurry techniques.
  - coal beneficiation
- o Technologies to improve efficiency of major end-use electrical equipment in industry, agriculture and the commercial sector:
  - variable speed drives;
  - motors;
  - lighting;
  - effective agricultural pump-sets.
- o Technologies to make better use of available generating capacity:
  - load levelling and load management control systems;
  - energy storage (e.g. off-peak storage of chilled water for air conditioning);
  - power plant instrumentation, monitoring and advanced diagnostics.
  - cogeneration systems

E. Expected Accomplishments

The principal accomplishment of this project will be the development a successful model for technology innovation and commercialization in th Indian energy sector. From this experience will come a deeper understan ing of the dynamics of the innovation and commercialization in India and how best to facilitate the process. Because the model of goal-oriented I consortia as an effective means for development and diffusion of commercially attractive advanced technology in the Indian energy sector has no been tried as proposed in this project, there is no clear guarantee of success. However, the enthusiasm with which the concept has been greete by officials in the Government of India as well as by Indian public and private electric utilities, industry, and research institutions, suggest that it is a fruitful direction to pursue.

At the completion of the 6-year project the following measurable results are expected:

1. Financed 4-6 market driven technology development consortia (Component One);

2. Completed 10-25 competitive research grants and a series of technical papers and reports dicussing successful commercialization-oriented energy research.(Component Two).

3. Completed a series of authoritative studies on R&D strategies, tec nology commercialization and innovative policy approaches (Compone Three).

4. Completed a series of information dissemination activities that ha stimulated public discussion and furthered the promotion of a tech nology development culture in India (Component Three).

The following immeasurable results will also have occurred:

1. Fostered market-driven R&D among research institutions, manufacturers, end-users, and government, and demonstrated success in encouraging effective collaborative R&D among these constituencies which are important for India's energy sector development (all Components);

2. Diffused new information and knowledge about the innovation and commercialization process in India, and the role of R&D consortia in this process, within the Indian scientific, technical, commercial, industrial, and academic communities (Component Three).

3. Stimulated public discussion on issues of importance to technology innovation through workshops, seminars, and other forms of information dissemination (Component Three);

4. Provided experience in managing a disciplined proposal solicitation, review, and approval process (Components One and Two);

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5. Exposed DNES, on a micro level, to a systematized priority setting and resource allocation process (Components One and Two).

F. The Innovation and Commercialization Process

The commercialization of new technology is a complex and sometimes elusive process involving the interaction of market, technical, economic, financial, regulatory, and institutional issues. It is not sufficient that a new product or process be technically proven and appear to be economically attractive for commercialization to succeed. New technology often has high perceived risks to potential investors, who in turn will require the higher rates of return (relative to normal business risks) commensurate with this level of risk. Potential delays in an expensive project resulting from problems in obtaining regulatory and other institutional approvals may have unacceptable cost implications.

Many U.S. institutions, including the U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI), have been increasingly concerned that the results of extensive and costly energy technology R&D programs are often not effectively coupled to successful commercialization. Yet many technologies continue to move from R&D through prototype and precommercial stages to full commercialization.

Considerable research on the commercialization process suggests that a market-driven perspective on the part of the developers is an essential precondition for successful commercialization. Only after the requirements of the marketplace are established can the market-based specifications be developed for the technology. This establishes a design basis for the technology development and commercialization process. By contrast, DOE and EPRI have often concentrated more on technology development per se than on technologies that reflect in their inherent design and operation the requirements and constraints of the real marketplace.

The commercialization process is depicted in a stylized manner in Figure 1. Conceptually the process begins with an identification of the market, both in terms of its potential size and its specific requirements, from the many actors (utilities, manufacturers, regulatory bodies, investors, etc.) for successful products, processes, or services. Once the required characteristics of the product are defined, the technology itself can be specified. This leads to analysis of projected performance and unit costs (e.g. $/kWe of generating capacity) as a function of time and of market penetration.

With increasing market penetration, the production costs of the technology will decline, reflecting industrial cost learning curve effects and technology improvements. Similarly the economic value of the technology will increase, since as the perceived risks of the technology decline with increased technical confidence, the required rate of return will decline and investors will be able to afford higher unit capital costs.

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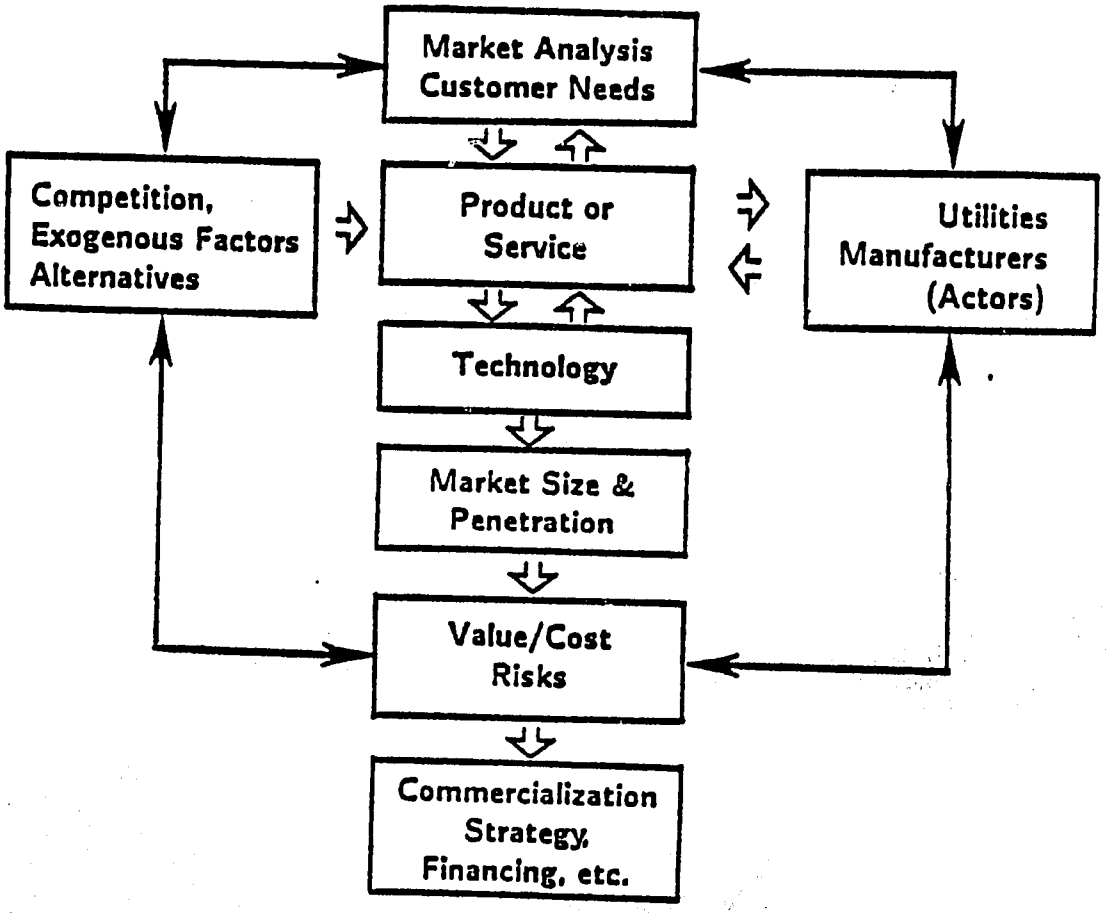
During the development of a technical and economic assessment of a new technology, the competing options and alternatives must be evaluated. Moreover the competing options will not stand still; increased performance, lower capital and operating costs, and longer product life will all challenge the new technology during the commercialization process. All of these factors then impact the design of a successful commercialization strategy and the development of the detailed business plans required to implement the strategy.

Embedded in the overall innovation and commercialization process is a sequence of development steps beginning with laboratory research and bench-scale models, prototype scale-model field tests, precommercialization scaleup tests, and introduction of commercial prototypes. Although there are many stages in the hardware development path, the major costs and risks are typically associated with the transition from bench-scale or small field test models to full commercialization, reflecting in part the costs of major physical scaleup.

The PACT project and Component One of the ERE project target resources toward the commercialization end of the development path, whereas Component Two of the ERE project targets resources toward the early and middle-parts of this process. At some point, AID intends to evaluate the validity of its targeting judgments. While the relative roles and degrees of investment by government, industry, utilities, and others will vary during the process from innovation to commercial diffusion, successful commercialization may well require all of these actors to participate in the entire process.

Figure 1

REPRESENTATION OF THE TECHNOLOGY TRANSFER AND COMMERCIALIZATION PROCESS



IV. IMPLEMENTATION PLAN

A. Administrative Structure

The project will be implemented by the Department of Non-conventional Energy Sources (DNES) which falls under the Ministry of Energy. DNES will be guided in the management of the project by an Energy Research and Development Advisory Committee (ERDAC).

The secretary of DNES will be the ex officio chairman of ERDAC. In addition to DNES, the ERDAC will consist of eight members with representation from the finance sector, the industrial establishment, the research community, and energy end users such as a utility. At present, no standing committee involving interaction among these groups exists in the energy sector. Consequently, the ability of the project to pull these groups together and increase interaction among the groups at a high level will in itself be an achievement that will generate considerable benefits. Likely members of the ERDAC include the Industrial Credit and Investment Corporation of India (ICICI), the Central Electricity Authority (CEA), the Tata Energy Research Institute (TERI), the Confederation of Engineering Industries (CEI), a private sector utility such as the Ahmedabad Electric Company, a public sector utility such as the Maharashtra State Electricity Board, and two research organizations, probably the Indian Institutes of Science and one of the Indian Institutes of Technology.

The ERDAC, which will meet on an as needed basis, will have the functional responsibilities described below. These responsiblities will be executed by the committee as a whole or by sub-groups of the committee as deemed appropriate.

- participate in the development of policies and operational procedures for the project addressing, among other things, subproject solicitation, review, and approval mechanisms; financial mechanisms; cost sharing formulas; and monitoring and evaluation procedures;

- participate in the development of annual operating plans and budgets for the project;

- guide and oversee the solicitation process for proposals in Components One and Two of the project;

- manage the peer review process under Components One and Two of the project;

- commission studies, analyses, and assessments to be financed under Component Three of the project;

- sponsor workshops and seminars financed under Component Three of the project.

To handle the day to day implementation chores of the project, a Secretariat will be created. The Secretariat will consist of one mid-level staff person from DNES who will work part time on the project and a full time senior level DNES staff person recruited and financed under the project. ICICI will also be represented on the project Secretariat with the project absorbing the additional ICICI staff cost. The Secretariat offices will be located at DNES with the ICICI representatives commuting from Bombay on a regular basis. The responsibilities of the Secretariat will include:

- ensuring that the policies and operating procedures are respected by the project participants;
- advising potential project participants on the proposal submission, review, and approval process;
- monitoring and reporting on the on-going progress of project financed activities;
- organizing workshop, seminar, and other information dissemination activities;
- undertaking the staff work necessary in preparation for meetings of the ERDAC;
- following up on the recommendations of the ERDAC;
- acting as the liaison for the project with the Department of Economic Affairs.

B. USAID Management of the Project

AID responsibility for the project will rest in the Office of Technology Development and Enterprise. The Office currently has one full time professional FSN to manage the energy portfolio. A U.S. consultant will be employed through the project with specific responsibility for the project. The two person energy staff will work with DNES to promote project objectives, monitor project progress, anticipate potential problems, and identify targets of opportunity. In addition to the U.S. consultant's general responsibilities s/he will be expected to maintain and develop contacts in the U.S. and to use these contacts to build bridges between Indian and U.S. scientists active in the energy sector. In implementing the project, the USAID energy staff will buy into AID/ Washington projects on an as needed basis.

C. Implementation Mechanisms

1. Solicitation for Proposals

Components One, Two and Three will finance varying types of proposals which will be attracted through formal solicitations. Unsolicited

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proposals will also be accepted for Components One, Two and Three in instances in which a proposal is judged to be of particular merit. Support for unsolicited proposals is important because it permits project administrators to gain experience with the peer approval process (described later) while the lengthy formal solicitation process goes on, and it provides the flexibility to finance worthwhile activities that may fall outside the scope of the formal process. Solicitation procedures for each component are described below.

a. Component One

One of the first activities under the project will be the development of a project strategy by an Indian consulting firm which identifies priority R&D areas for the Indian energy sector. The priority areas will take into consideration Indian energy needs as well as the Indian human and natural resource base.

Once the R&D priority areas have been identified a Request For Proposal (RFP) in the identified priority areas will be prepared by the project Secretariat in coordination with the USAID energy staff and the USAID Contract Officer. The RFP will request a business plan as well as a technical proposal from potential bidders. In addition to a discussion on how the technology under development will be commercialized, business plans will be expected to contain an outline of the responsibilities of respective consortium members in implementing the proposal including the identification of a lead institution, fairly detailed information on the estimated cost of completing the proposed research, and agreed upon provisions for sharing of technology development costs.

The technical proposal will require an in-depth statement of work to be accomplished under the proposal including a description of all "deliverables" (e.g., hardware, test results, reports) to be produced and a timetable for completion. To assist bidders in developing proposals the RFP will contain:

- a description of the project and its objectives;
- an indication of funding available through the program;
- a description of proposal requirements;
- a discussion of proposal format;
- deadlines for proposal submission and estimated date of research awards;
- criteria that will be used to evaluate proposals as well as the weighted value of each criterion;
- a statement of the confidentiality that will be accorded to classified or proprietary data included in a proposal.

Upon finalization of the RFP by the Secretariat, ERDAC will review and approve it and then announce its availability in appropriate publications in India and the U.S. and by direct mailings to potential participants. Preproposal conferences will be sponsored by ERDAC and organized by the project Secretariat in a number of major Indian cities. The purpose of these conferences will be to (1) provide wide exposure to the overall program; (2) explain, in depth, the RFP process, (3) discuss the nature and objectives of the program, and (4) lay the foundation for responses to the RFP. Although it may not be essential, another conference — a bidders conference — may be convened after issuance of the RFP to further discuss its contents and answer any potential awardee's questions that may have arisen.

All proposals will be sent to the Secretariat which, will present them to ERDAC for the review and approval process described later in this section. It must be recognized that the proposed process is expected to take twelve months at a minimum (see diagram on next page). It could take longer given that the RFP process for soliciting research proposals is novel in the Indian context. However, experience with this process, which is widely employed in several developed countries with successful results, is critical to the institutional development objectives of the project.

b. Component Two

Like component one, component two will finance solicited as well as unsolicited proposals. However, because the bulk of component two financial resources will be tied to the topic area of component one consortia, formal solicitation for component two proposals cannot commence until the consortia under component one have been selected. Once component one consortia have been selected, an RFP process similar to that employed in component one will be initiated to solicit component two research proposals.

c. Component Three

Topics for workshops, seminars, and other information dissemination activities will emanate from AID, the GOI, ERDAC, and unsolicited proposals. For those topics originating with AID, the GOI, or ERDAC, it is expected that informal solicitation of proposals will take place. Under this process, organizations which have a particular expertise in the subject matter of the activity will be contacted by AID or by the project Secretariat to determine their interest and to invite submission of proposals. The organization submitting the soundest proposal within a reasonable price range will be awarded a grant or a contract depending on the nature of the work to be undertaken. Since most of these activities will be undertaken by Indian organizations and are expected to cost less than $10,000, formal competitive procurement is not required by AID rules and regulations. Should U.S. expertise be required, USAID will take advantage of AID's IQC mechanism, existing S&T Bureau contracts, or formal competitive procurement depending on the situation.

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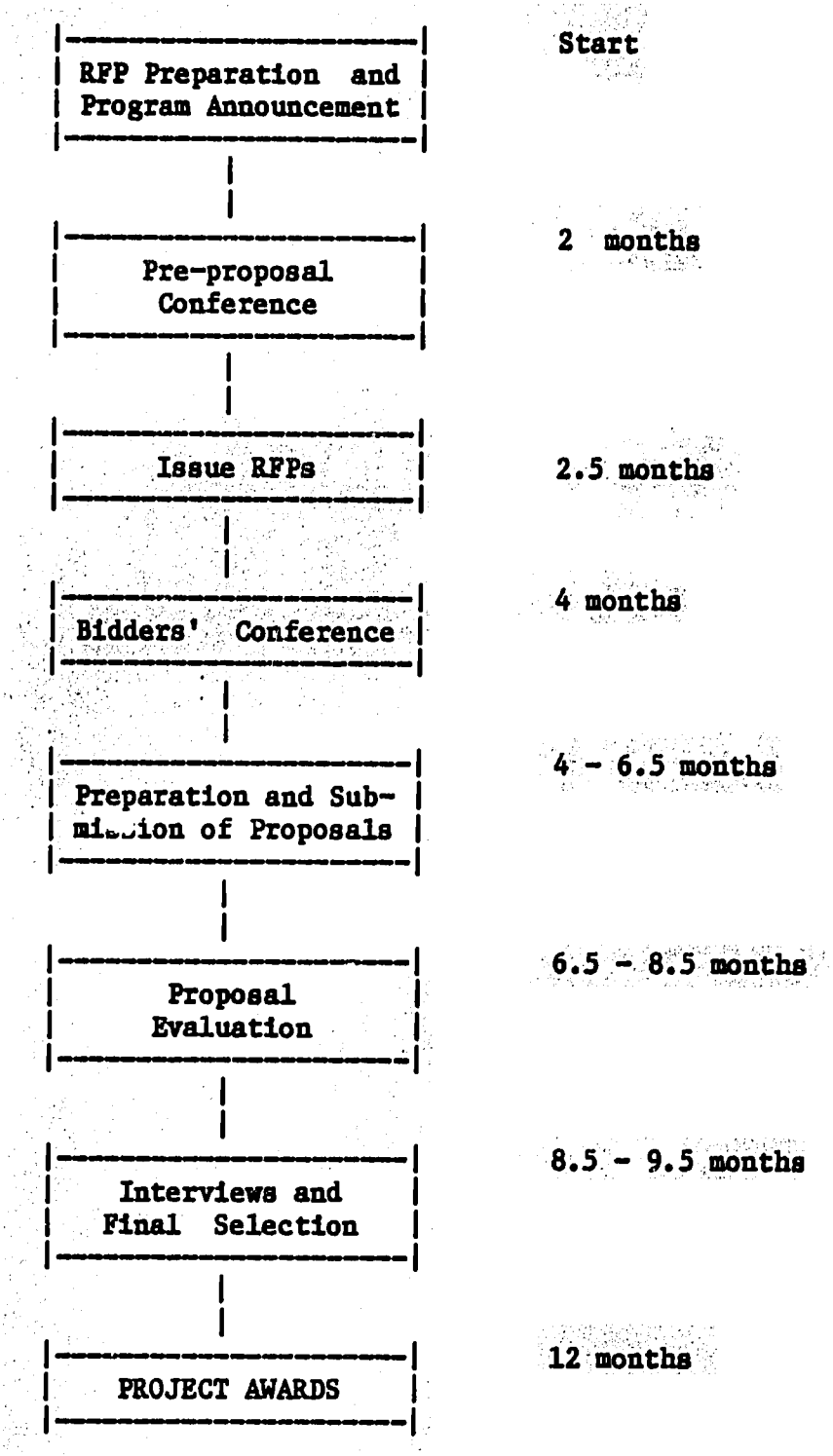
THE REQUEST FOR PROPOSAL (RFP) PROCESS



2. Review and Approval of Proposals

a. Component One

Both solicited and unsolicited proposals received under Component One will undergo a rigorous technical peer review as well as a business plan/financial review. The process will begin with an initial technical screening of proposals by ERDAC members to determine those which show the greatest potential for successful commercialization and which promise to have the greatest impact on the Indian energy supply. Proposals accepted by the ERDAC will receive a more intensive review by a panel and a panel chairman selected by ERDAC. Panel members can be either Indian or American and will be chosen for their expertise in the subject matter at hand and for their willingness to provide a timely and thorough review. Panels will, in most cases, mirror the composition of ERDAC. They will, in general, consist of one representative from each of the following: a research organization, a manufacturing unit, an end user, a financial institution, and the Indian Government.

Panel members will independently review the proposals and provide written comments that will form the basis of a summary of the panel review to be prepared by the panel chairman for ERDAC. For proposals recommended for approval, the summaries will categorize the comments of panel members into suggestions which a consortium may or may not accept and issues which will require a specific response from the consortium. The financial member of the panel will have the special responsibility of commenting on the business plan of the proposal and recommending to ERDAC what the project's commitment of financial resources should be. As mentioned previously, the project contribution will not exceed fifty percent of the estimated cost of the venture or $3 million, whichever is lower, without the approval of the AID Director.

Important to the proposal review and approval process will be the development of effective selection criteria. These criteria, which will be listed and weighted in the RFP, will be drawn up by ERDAC and will be along the lines of the following. Proposals must:

a. involve the development, through R&D, of an innovative product or process which promises tangible benefit to the Indian energy sector;

b. envisage financial exposure and projected returns from commercialization that are commensurate with the risks;

c. involve a manufacturer in collaboration with a research orgnization and/or and end user;

d. include a private sector member with a financial stake in the consortia;

e. demonstrate that the profit making members of the consortia have a significant financial stake in the implementation of the proposal;

f. identify a product or process which can be commercialized within five years of receipt of project financing;

g. demonstrate the consortia capability to meet the financial and technical demands of the proposal.

After a proposal has been reviewed and either accepted or rejected, ERDAC will so notify the proposers.

b. Component Two

The Component Two review process will be similar to that of the Component One process. ERDAC, after an initial culling of proposals, will forward them for an intensive review to a panel of technical experts and a panel chairman who will be responsible for summarizing the comments of the panel for ERDAC. Because the proposals under Component Two are expected to be more of a research rather than a technology development nature, the composition of a Component Two panel will have a heavier science representation. Illustratively, a Component Two panel will consist of one government official, two scientists, and (if appropriate) one representative from the consortium to which the proposal is related. Selection criteria will be developed by ERDAC and will in all likelihood include the following:

a. the program area to be addressed should be directly relevant to India's critical energy problems and, in fact, closely related to work being conducted by one of the consortia under Component One;

b. if a grantee is a for-profit organization, it will have a significant financial stake in the implementation of the proposal;

c. the proposer will have the technical and, with project support, the financial capability to undertake the research proposed.

A financial review will be undertaken by the AID Contract Officer to ensure that proposed costs are reasonable and within AID's capability to support.

c. Component Three

Component Three proposals will be reviewed technically by the AID energy staff and/or the project Secretariat, depending upon which is initiating the activity. They will be reviewed financially by the AID Contract Officer to ensure that costs are reasonable and within AID's capability to support.

3. Financing Proposals

The terms under which proposals will be financed will be determined by the character of the entity being financed and by the nature of proposal. Following is a component by component explanation of how funds will be transferred to project participants.

a. Component One

Component One will finance technology development consortia consisting of a manufacturer in collaboration with a research organization and/or an end user. Each consortium is required to have one private sector participant. Composition of a consortium can be all Indian or a mix of Indian and American.

In each proposal it will be required that a lead organization be identified by consortium members. It is expected that the lead organization will be that one which is most at risk. The project contribution for each proposal will be transferred to the lead organization from ICICI in the form of a conditional grant. The lead organization will then be responsible for disbursing appropriate amounts of funds to itself and other consortium members through contractual or other acceptable arrangements. The lead organization will assume all liability for the conditional grant.

Terms of conditional grants will vary from proposal to proposal. To determine terms, the following process will be instituted.

Proposals submitted to ERDAC for review will contain a business plan which in addition to identifying the lead organization will indicate the cash and in-kind contribution of each consortium member. Proposals will also suggest the amount of the project contribution, the rate at which resources should flow, and a pay back plan should the product or process under development be successfully commercialized.

The financial member of ERDAC (ICICI) will be responsible for reviewing the business plan and making recommendations as to the project contribution and terms of pay back. S/He will base these recommendations on the financial resources of the consortium, the degree of risk undertaken, and the potential for profit. Except in cases waived by the AID Director, the project contribution will not exceed fifty percent of the estimated cost of the proposal or $3 million, whichever is lower. Pay back terms will generally follow those established under PACT -

- Pay back will be a negotiated percentage of revenues arising from the commercialization of the product or process;

- Negotiated pay backs will be limited to a maximum of 200 percent of the project contribution;

- If no revenues are earned, no pay back is required.

b. Component Two

Component Two will finance research proposals selected under a competitive awards program. Indian for profit and non-profit entities are eligible to compete. All Component Two assistance will be in the form of a grant; however for profit entities will be required to supplement the grant with a 30-50 percent contribution of their own whereas no matching requirements will be placed on non-profit entities. The source of the grant will depend on the nature of the entity. More specifically -

- Indian public sector and non-profit sector participants will receive finance through DNES.

- Indian private sector will receive finance through ICICI.

American entities on their own are not eligible to compete; however should American participation be requested by one of the awardees either in the original proposal or at a later date, the project can finance the American entity.

c. Component Three

Component Three will finance analyses, studies, and information dissemination. In most instances, funds will be transferred from AID through a contract or grant to the performing organization. In appropriate instances, DNES will award the contract or grant and AID will reimburse DNES.

D. Procurement Plan

1. Overview

This section describes the general procedures by which contractual relationships will be established and grant resources will be distributed, taking into account the varied types of goods and services, the participation of both U.S. and Indian public and private organizations, and the mix of local currency and foreign exchange. The procurement process must be consistent with AID and GOI regulations and procedures, and will provide for:

o conditional grants to technology development consortia under component one.

o contracts with or grants to both Indian and U.S. research institutes, national laboratories, industrial R&D units, and consulting firms under components two and three.

o agreements with U.S. government institutions (TVA, DOE, national laboratories, etc.) and U.S. based technology specialists to assist the ERDAC and the project staff in proposal reviews and technology assessments.

o goods necessary to the implementation of sub-project activities.

2. Conditional Grants - Component One

There will be two primary modes for identifying activities under this component; competitive solicitations and unsolicited proposals.

Competitive Solicitations:

Project resources will be distributed in accordance with an R&D strategy and associated annual plans approved by the ERDAC. The solicitation process will consist of:

- Preparing Requests for Proposals (RFPs) for technology development and/or demonstrations in specific high priority areas. These RFPs will be distributed to interested parties as determined by some combination of public announcement and contacts with the industry.

- Reviewing proposals received in response to the RFPs by objectively comparing the responses against the selection criteria established for the procurement.

- Negotiating a conditional grant with the selected organizations which clearly indicates:

  o The scope of work to be performed and all contractual outputs (analysis, experimental data, reports) defined.

  o Organizational responsibilities including the relationship between team members as defined by subcontracts, joint venture agreements, etc. Special attention will be given to subcontracting or other relationships between U.S. and Indian firms.

  o Contractual terms including payment procedures, priority rights, default provisions, etc.

- Monitoring the progress of the project and comparing its progress and outputs with that negotiated in the contract. The monitoring process also includes making necessary contract modifications such as time extensions.

Unsolicited Proposals:

It is important that the program maintain a high level of flexibility and can respond to good technical ideas which are not dealt with in the formal plan and, thereby, would not be eligible for support via the competitive solicitation route. This will be done by allowing for the submission of unsolicited proposals and setting aside a modest level of program resources for funding contracts and grants in this category.

The evaluation of such proposals will include applying the same general criteria as used in competitive solicitations plus ensuring that:

- the technology is unique to the proposing organizations (at least within the context of India);

- the technology does not realistically fall within the scope of planned competitive solicitation.

The purpose of these added criteria is to discourage organizations from attempting to circumvent the intent of the competitive process.

If an unsolicited proposal is selected for support, the process of contract of grant negotiation and project monitoring will be the same as for those selected under competitive procurement.

3. Contracts and Grants - Components Two and Three

The primary purpose for contracts or grants in these components will be:

- for supporting research projects which will often be done by Indian R&D organizations in the public and private sector (primarily grants);

- for technical assistance (individuals, national laboratories or consulting firms) to undertake technology assessments, policy analysis, and information dissemination (primarily contracts and PASAs).

It is important that project staff have flexibility to quickly procure services of local consultant and consulting organizations with a minimum of time consuming contracting mechanisms (RFPs reviews, etc.). To this end, project staff will have the authority to contract for consulting services up to a predetermined maximum amount (initially selected as U.S. $ 10,000 equiv.) without full and open copetition subject to the same need for contract specificity as required in section two above. For larger consulting contracts, the project staff will go through the competitive procurement procedure of section two above.

It is expected that the project staff will need to procure the services of U.S. consulting groups and U.S. government laboratories for assistance in such activities as RFP preparation, technology assessments, and project reviews. Where this is the case, the Secretariat will prepare a scope of work and expected level of effort for discussion with AID. The services will be procured by AID through an appropriate mechanism which could include purchase orders, the central energy IQCs, 'buy-ins' to long-term central contracts or existing contractual relations (PASAs) between AID/Washington and other U.S. government organizations.

The U.S. national laboratories constitute a unique resource in terms of scientific, engineering, and development capabilities in the area of advanced technology in general and the energy field in particular. Just the enormous hardware development and test capabilities of the national labs are a resource that can provide substantial benefits to this program, including significant reduction of development and test time and costs for hardware development programs in India. In addition, the access of the national laboratories to advanced and generally public domain software can also speed the transfer of software and its use (i.e. technology transfer) to the Indian enterprise sector. Finally, in areas where the U.S. has unique and relevant experience (e.g. in the creation of successful policy instruments to stimulate the development and commercialization of new technologies in the power sector or in practical least-cost energy planning) the idea would be to arrange collaborative research and analysis with Indian institutions. The U.S. national laboratories would have to satisfy the test of uniqueness and relevance in the establishment of such joint research and analysis efforts.

E. Implementation Schedule

Action	Responsible party	Target date
Project Agreement signed.	DEA - USAID	12/31/1986
ERDAC appointed.	DNES - USAID	02/14/1987
ERDAC meets to discuss policies and procedures for project.	ERDAC	03/20/1987
Advertisements for senior-level Secretariat member placed in appropriate Indian journals and newspapers.	DNES	01/15/1987
Advertisements for long term U.S. consultant placed in appropriate U.S. journals and newspapers.	USAID-ANE/TR	01/15/1987
TDY plan for interim assistance from ST/EY completed.	ST/EY	01/15/1987
Scope of work for overall R&D strategy developed.	Interim Secretariat USAID-ST/EY	01/15/1987
Contractor for R&D strategy selected and contract signed.	Interim Secretariat USAID	02/14/1987

Studies and workshops under component three initiated.	Secretariat - USAID	02/14/1987
Interviews begin for senior level Secretariat Member.	DNES	02/27/1987
Interviews begin for U.S. consultant.	USAID	02/27/1987
Ist year operating plan and budget drafted.	Interim Secretariat USAID-ST/EY	03/13/1987
R&D Strategy completed by contractor.	Contractor	03/13/1987
Proposal solicitation, review and approval process designed.	ERDAC - Interim Secretariat - USAID	03/13/1987
ERDAC meets to review operating plan and budget and to finance statement on project policies and procedures.	ERDAC	03/20/1987
Data collection and monitoring system developed.	Interim Secretariat USAID	04/30/1987
RFPs prepared.	Interim Secretariat - USAID	04/30/1987
Senior level Secretariat member in place.	DNES	04/30/1987
U.S. consultant in place.	USAID	04/30/1987
Preproposal conferences initiated.	Secretariat - USAID	06/19/1987
RFPs for component one issued.	Secretariat - USAID	06/30/1987
Proposals for component one received.	Secretariat	09/30/1987
Proposals for component one evaluated and awards made.	ERDAC-Secretariat-USAID	11/30/1987
RFPs for component two prepared.	Secretariat-USAID	12/30/1987

RFPs for component two issued.	Secretariat-USAID	01/15/1988
Proposals for component two received.	Secretariat	04/15/1988
Proposals for component two evaluated and awards made.	ERDAC-Secretariat-USAID	06/15/1988
First project evaluation.	ERDAC	03/31/1989
Second project evaluation.	ERDAC	12/31/1989
PACD		

V. MONITORING AND EVALUATION

A. Monitoring

The two person USAID energy staff, consisting of an FSN project officer and U.S. contractor to be employed through the project will have primary monitoring responsibility for the project within AID. They will be assisted in the task as necessary by a financial analyst, an engineer, and an economist from the USAID's Project Development and Program Offices.

An operating plan for the project will be completed on an annual basis by the Secretariat with guidance from ERDAC. A data collection and monitoring system will be set up by the Secretariat with AID assistance to track project performance against the operating plan. From this data collection and monitoring system, the Secretariat will provide semi-annual reports for submission to ERDAC and USAID. The issuance of each report will be followed by an ERDAC meeting to assess project progress and to fine tune operating plans for the next six month period.

The primary monitoring concerns during the initial stages of the project will relate to the establishment of the administrative structure to support the project, e.g. the creation of ERDAC and the Project Secretariat, and the ability of the administrative structure to effectively accomplish the tasks assigned to it, e.g. the preparation of RFPs; the preparation and implementation of annual operating plans; the solicitation review, and approval of proposals; and the management of a data monitoring and collection system. Later in the project, monitoring emphasis will be expanded to include sub-project activities supported under Components One, Two and Three.

Monitoring of sub-project activities in Components One and Two will be aided by semi-annual progress reports that will be required of participants. These reports will follow a standard format that will be developed by the Secretariat in coordination with ERDAC. They will identify objectives for the proceeding six months and discuss progress made against ob-

jectives that had been made for the preceeding six months. The reports will also contain financial data such as accumulated expenditures, expenditures made over the six month period of the report, and projected expenditures.

Monitoring of sub-project activities will also take place through regular site visits by DNES, ICICI, and USAID, and, when appropriate, CEA staff. Information gathered during these visits will be shared among the implementing agencies and with ERDAC.

B. Evaluation

The project will be subject to mid-term and end-of-term evaluations that will involve AID staff, GOI staff, and outside consultants.

The mid-term evaluation will seek to determine that appropriateness and the effectiveness of the administrative structure set up under the project, the quality of interaction among ERDAC, the Secretariat, and USAID; the quality and appropriateness of the annual operating plan and the ability of project actors to meet the objectives of the operating plan, the ability of the project actors to design and operate an effective data collection and monitoring system; the effectiveness of the peer review process as implemented under the project; the effectivenss and appropriateness of the RFP process in the Indian context; and the ability of project managers to interact effectively with project participants.

The end-of-project evaluation will assess the activities outlined above and will, in addition, seek to determine the quality and relevance of the research that was sponsored; the performance of subprojects in relation to original proposal objectives; the attitudes of project participants in regard to technology development consortia and the likelihood of participants engaging in future technology development consortia; and the impact of the project on helping India to achieve its energy sector goals.

VI. FINANCIAL PLAN

A. Disbursements

Following is a description of the project disbursement plan. The plan is subject to change should it prove to be inappropriate in terms of needs or timeliness. Any changes will be made in consultation with the USAID controller.

1. Anticipated Expenditures

Both foreign exchange and local costs are eligible expenditures under all three components of the project. Anticipated expenditures are as follows:

(1) Component One

- Share of consortium costs for approved proposals (in the form of a conditional grant);
- Payment to Indian and U.S. suppliers of goods or services required for implementation of approved proposals.

(b) Component Two

- All non-recurrent costs for approved proposals from non-profit institutions;
- A share of non-recurrent costs for approved proposals from profit making institutions.

(c) Component Three

- Payment to Indian and U.S. suppliers of services required for studies, policy analyses, information dissemination, and promotional activities sponsored under the project;
- Payment for study tours and training programs sponsored under the project;
- Payment for Indian participation in international workshops and symposia;
- Payment of honoraria and, in necessary instances, fees for Indian and U.S. reviewers of project proposals under components one and two;
- Payment for production and distribution of project related materials.

(d) Other Costs

- Salaries of Secretariat Staff;
- Project related travel for secretariat, ERDAC, and other eligible travelers;
- Costs associated with project evaluation.

2. Disbursement for Foreign Exchange Costs

a. Component One

Three mechanisms will be available to cover the costs of the goods and services procured from the U.S. The first mechanism will be an AID. issued letter of commitment to a U.S. bank showing ICICI as the bene-

ficiary. The initial letter of commitment will be for $1 million and will be replenished as necessary. Under the letter of commitment, ICICI will issue letters of credit based on specific authorization from the GOI, Department of Economic Affairs, Controller of Aid Accounts and Audit (CAA&A) for the required amount in favor of U.S. suppliers of goods or services. After the goods are shipped or the services are performed by the U.S. supplier, it can claim payment from the U.S. bank by submitting to the bank the necessary documentation as described in the letter of commitment. The U.S. bank will claim reimbursement for these payments from AID and AID will charge such payment to the grant.

Although bank letters of commitment (l/com.) are not among the preferred methods of disbursement, we believe the multiplicity of beneficiaries seems to outweigh all other considerations. It is administratively more desirable to have one bank l/com.than a number of direct l/com. for relatinvely small amounts.

In instances in which the letter of commitment/letter of credit approach is not practical, AID will contract directly for the services or goods to be provided to the technology development consortia. An example of this type of situation would be AID entering into a PASA to acquire the services of a U.S. Government laboratory.

Regarding all other foreign exchange costs, ICICI will submit, to USAID/India, voucher SF-1034 accompanied by a statement showing the details of payments to be made by AID directly to the concerned persons. This voucher will be certified by an authorized official of the GOI.

b. Components Two and Three

In most instances under Component Two and Three, AID will contract directly with the U.S. suppliers of goods or services or it will buy into an existing science and technology bureau contract for goods or services.

3. Disbursement for Local Currency Costs

ICICI and DNES will submit to AID, through the GOI, Department of Economic Affairs, SF-1034, along with a certified statement of expenditures. AID will disburse the appropriate amount to the GOI in accordance with the standard procedure.

B. Estimated Budget

This is a technology development and research project for which exact project inputs and costs of inputs will not be known until proposals have been submitted and approved. Consequently, except for the breakdown between funds available for power proposals and funds available for renewable proposals, numbers provided below should be regarded as illustrative.

Category	USAID Contribution	DNES Contribution	ICICI Contribution	Project Participant Contribution	TOTAL
		($000)			
Component One 1/	11,000			11,000	22,000
Component Two 2/	4,000			1,000	5,000
Component Three 3/	2,000				2,000
Long Term U.S. Advisor	1,000				1,000
U.S. Short-term Technical Assistance (outside of Components One Two and Three)	400				400
Project Administration including Secretariat	1,500	300	200		2,000
Project Evaluation	100				100
	20,000	300	200	12,000	32,500

1. Channeled to consortia through ICICI.

2. Channeled to research group through DNES and ICICI.

3. $1,000,000 of this $2,000,000 will be obligated by USAID outside of the bilateral project agreement.

C. Methods of Implementation and Financing*

Method of Implementation	Method of Financing
Commodities (Host country procurement, by procurement by participating U.S. institutions, AID direct procurement)	
Local	Host country reimbirsement
U.S.	U.S. bank letter of commitment and AID direct payment
Technical Assistance (Host country contract, AID direct contract)	
Local	Host country reimbirsement
U.S.	U.S. bank letter of commitment and AID direct payment
Research Costs (Grants to host country institutions)	
Local	Host country reimbirsement
U.S.	U.S. bank letter of commitment and AID direct payment
Studies, Analyses, Information Dissemination, Promotion (AID direct contract)	
Local	AID direct payment and host country reimbursement
U.S.	AID direct payment
Secretariat Costs (Host country contracts)	
Local	Host country reimbirsement
U.S.	AID direct payment.

*In traditional AID projects, methods of implementation and financing are quantifiable at the project design stage; however, in the instance of this project, information regarding commodities, technical assistance, and other inputs required for the project will not be available until proposals have been received.

D. Audit Provision

The project will be implemented by the Department of Non-Conventional Energy Sources (DNES) and the Industrial Credit and Investment Corporation of India (ICICI). The former is a department of the Government of India and the latter a corporation owned by the Government of India. Both are subject to contracting, audit, and payment verification procedures and guidelines prescribed by the Government of India. As stated in USAID's initial submission of "Mission Financing Policy and Procedures as of December 31, 1984," USAID has reasonable assurance, based on USAID's thirty odd years experience, that the GOI and its departments have the necessary financial and management capability to implement projects. Although we have not had any recent reviews made specifically of DNES or ICICI's payment verification systems and practices, we are generally satisfied with their capability to implement projects. In fact, both DNES and ICICI have been involved in the implementation of other AID projects and we have had no occasion to doubt their administrative audit, and financial management capabilities. The bulk of the funds under this project will be disbursed through ICICI which is a well established, professionally staffed and managed lending institution. We do not feel any special needs for audit beyond GOI audit coverage and therefore no funds are being earmarked under the project for that purpose.

VII. PROJECT ANALYSES

A. Economic Analysis

The underlying economic premise of this project is that India is at a stage in its development where acceleration of the pace of indigenous technology development will yield significantly positive benefits to the country. At present, private commercial R&D is less than 1% of turnover compared with rates of 2 - 4% in most developed countries. Corollaries of this relatively low level of R&D are almost total reliance on imported technology for technological adaptation and innovation, and significant under-utilization of both the industrial and the science and technology capabilities of the country.

There is little question that purchase of foreign technology will remain an important resource for technology applications and adaptations. Yet the failure of India to develop broad indigenous capabilities for commercially significant technological innovation exposes the country to technological stagnation during periods when foreign exchange is tight, and over the longer term condemns India to a disadvantage in technological competition for its own domestic and world markets. At the same time, an additional cost is imposed on the economy by the inability to harness the substantial investment in scientific and technological manpower and infrastructure for productive economic ends.

The presence of a large pool of skilled human resources, an increasingly technically sophisticated business community, and rapidly growing markets for technically advanced products indicate that the pre-requisites

for successful encouragement of private sector commercial R&D are in place. In the prefeasibility analysis conducted for the PACT project, three interrelated constraints to increased private sector R&D were identified in the areas of information, human resources, and finance. In addition, policy and regulatory constraints have also inhibited investment in industrial and commercial R&D. The recently initiated actions of the Government of India toward liberalizing the economy are very encouraging in this regard.

It is difficult to measure the potential benefits of this project, in part because they are expected to extend well beyond the life of the project and to non-energy sectors of the Indian economy. The benefits of investments in successful goal-oriented R&D consortia are uncertain and difficult to quantiy. However, for the energy sector alone, it is anticipated that the direct results of the program to foster science/industry/utility links will include increased reliability of the electric power supply system, increased supply of electricity, and improvements in the conversion efficiency of thermal power plants.

A central goal of the program is to catalyze a new approach in India — that of goal-oriented R&D consortia — for efficient development and commercialization of advanced technology for the power sector. Thus the most significant consequences of this program will lie beyond the immediate returns that may be generated by the consortia stimulated by the program. If, as a consequence of this project, it is widely perceived in India that such goal-oriented R&D consortia are more effective than traditional approaches to development of commercial technology, the consequence could be increased Indian Government support of such ventures and widespread application of the consortia approach. This in turn could result in important increases in the effectiveness of the electric power sector.

If the eventual consequence of a new way of organizing to promote the commercialization and application of R&D resulted in just a one percent increase in efficiency in the installed capacity in India (45,000 MWe), providing additional output equivalent to 450 MWe, the marginal increase in GNP, through increased productivity and wages, could range from several hundred million to a billion dollars annually.

B. Market Analysis

This question was addressed in the Tata Energy Research Institute (TERI) study sponsored by USAID/I on "The Potential of Energy Networks for Goal-Oriented Technology Development in India (see Attachment 4). The study identified the leading candidates for successful energy technology development networks and its major findings are described below.

Manufacturers:

An examination of the Indian energy scene reveals a broad and sophisticated public and private infrastructure devoted to manufacturing, erection and commissioning of large utility sized power systems.

Bharat Heavy Electricals Ltd. (BHEL) is the redominant public sector enterprise in this field; however, there are also about fifty private sector manufacturers of boilers and heavy electrical equipment. The private sector also plays the major role in providing auxilliary equipment and transmission and distribution systems. Major private suppliers include Thermax Ltd., ACC Babcock Wilcox, Indian Agricultural and Engineering Company (IAEC), Texmaco Ltd., Nestler Ltd., NGEF, and Siemens (India). With the possible exception of photovoltaics, the renewables field is virtually dominated by the private sector. Some of the leaders are Jyoti Ltd; Hindustan Brown Boveri, Best & Crompton, Bharat Solar, and Unicorn Ltd.

R&D Insititions:

There are about 15-20 government R&D institutions in India - mainly CSIR laboratories - engaged in energy R&D work. Such R&D is not limited to energy generation, conversion or distribution technology, but covers diverse areas such as control systems, new materials, and data management. Public R&D institutions rarely engage in technology development in association with the enterprise sector, although they have been fairly active in basic energy research. Significantly BHEL, a public sector entity, is responsible for wide ranging R&D activities in the energy arena - possibly more than the entire Indian private sector combined.

Private sector energy R&D is embryonic but growing. Approximately 10-15 private companies emerging from a state of "technology coma" may well be consortia candidates. Informal communications with private sector manufacturers of energy equipment indicate considerable enthusiasm and willingness to participate in the project, and they have proposed several specific areas of energy technology development.

The "User" Community:

An illustrative list of users includes power utilities, industries, commercial establishments, transportation systems, and rural populations. While utilities are largely in the public sector (India has 17 State Electricity Boards (SEB's) and only 3 private utilities), the other organizations mentioned are both public and private. The SEB's are crucial organizations in any consortia aimed at improving power sector efficiency.

The market for technologies developed as a result of this project can be subdivided into two major categories. The first includes the market for a relatively small number of large investment items, such as fluidised bed boilers. The second is the market for mass-produced products and processes such as photovoltaic cells, and batteries. Commercialization strategies will differ depending on which market is being addressed.

C. Institutional Analysis

Indian government energy institutions, except for petroleum and atomic energy, fall under the Central Ministry of Energy, and appropriate state

government agencies and State Electricity Boards (SEB's). The most important elements under the Central Ministry of Energy are the Department of Power (DOP) and its technical arm, the Central Electricity Authority (CEA); the Department of Non Conventional Energy Sources (DNES); and the Department of Coal (DOC).

The Department of Non-Conventional Energy Sources (DNES)

The Department of Non-Conventional Energy Sources (DNES) was established in September 1982 as a department in the Ministry of Energy (MOE). Except for a brief period of about 9 months (Jan '85 - Sept. '85) when it was transferred to the Ministry of Science and Technology, the DNES continues to remain within the MOE as one of its three constituent departments.

The GOI established the Commission on Additional Source of Energy (CASE) in 1981 to take primary responsibility for:

- o formulating policies and programmes for the development of new and renewable sources of energy;
- o co-ordinating and intensifying R&D activities in new and renewable sources of energy;
- o ensuring implementation of GOI policies in regard to all matters concerning new and renewable energy sources.

While the overall responsibility for the formulation of policies and programmes rests with CASE, DNES is charged with the planning, monitoring and financial support of a national integrated R&D programme encompassing a wide range of renewable energy technologies. Co-ordination is ensured between the two bodies since the Secretary of DNES is also the chairman of CASE.

The technologies of interest to DNES are solar, wind, biomass production and conversion, and the development of decentralised energy systems. Other major DNES responsibilities are to:

- o co-ordinate on-going R&D work in new and renewable energy resources;
- o function as the national agency for international cooperation in these energy fields;
- o recommend incentives for commercializing breakthroughs; and
- o function as a data base on all aspects of new and renewable energy sources.

In the four years of its existence, the DNES budget has increased six-fold, from Rs. 19.8 crores in 1982-83 to Rs. 119 crores in 1985-86. (The 7th five year plan has allocated 519 crores.) In 1985-86, the major allocation was for the national bio-gas programme (Rs. 70.7 crores), followed by solar thermal (Rs. 10.85 crores), wood-stoves (Rs. 10.00 crores), wind energy (Rs. 5.0 crores), and biomass and draught animal power (Rs. 6.75 crores). Rs. 18.0 crores was allocated to geo-thermal energy, hydrogen energy development, magnetohydrodynamics, information/ public education and adminstrative overheads. The R&D component of DNES programmes amounted to Rs. 15 crores in 1985-86 or 12.5% of the total budgetary allocation. Rs. 104 crores was directed towards subsidies, demonstrations, training, publicity and administration. The Rs.15 crores is a significant increase from Rs. 3.8 crores and Rs. 9 crores in 1983-84 and 1984-85 respectively. This trend is expected to continue.

DNES functions through its head office at New Delhi and four regional offices at Chandigarh, Hyderabad, Bhopal and Ahmedabad. Two more regional offices are to be set up in the States of Uttar Pradesh and Assam. DNES has been instrumental in setting up nodal agencies in several state Governments, such as the Gujarat Energy Development Agency, the Uttar Pradesh Energy Development Agency and Punjab Agro-Industries Ltd.

The staff at DNES and its regional offices consist of 173 professional scientific and administrative/secretarial officers. DNES expects to add staff to manage its programs, including AID financed projects. Based on current and projected staff levels, AID is reasonably assured of effective management and administration in project implementation.

The Industrial Credit and Investment Corporation of India Ltd. (ICICI)

Beginning with its creation in 1955, ICICI has directed its financial resources to support the development priorities of India. In the early years the priority was rapid industrial development through wider entrepreneurship, and increased output of essential consumption and durable goods and diversified capital goods. Later, ICICI expanded its mandate to assist in the process of balanced regional growth and development of backward areas. In 1984, ICICI's sanctions of direct assistance to projects located in backward areas amounted to 57 percent of its total sanctions.

ICICI has demonstrated a consistent willingness to break new ground in India and has been notably successful in making these new ventures work. In 1977, it became the Indian pioneer in the merchant banking business where it is involved with projects from the time the proposal is formulated to the time the enterprise goes into production and becomes a bankable proposition. In its role of merchant banker, ICICI renders advice on plant capacity, product mix, mobilization of finance, and even marketing of output. Also in 1977, ICICI sponsored the creation of the Housing Development Finance Corporation. In 1984, ICICI became the first term lending institution in India to enter the leasing business.

ICICI has been instrumental in setting up industrial and technical consultancy organizations to guide entrepreneurs through the design, implementation, and management of projects and in supporting various training institutions.

Because of its well established reputation in program development and financial management, ICICI has been tapped as a source of technical assistance to development banks in Ghana, Sri Lanka, Jamaica and Nepal.

ICICI Ownership and Resources

Ownership shares of ICICI are largely held by public sector corporations, including a number of nationalized commercial banks. Of ICICI's issued share capital of Rs. 270 million ($25.5 million), public institutions hold 79%, foreign shareholders (mainly commercial banks) hold 14% and the remaining 7% is held by some 2,056 private Indian investors.

ICICI is operationally autonomous except in respect of the procedures for appointing auditors. Relations between GOI and ICICI are good and, through its close contact with the business community, ICICI continues to be an important link between the private sector and the Government.

D. Environmental Analysis

Pursuant to Sections 216.2(c) (2) (ii) and 216.2(c) (2) (x) Regulation 16, an environmental analysis will not be required in conjunction with the ERE project design. ERE will support controlled experimentation for the purpose of accelerating the pace and quality of technology development in India.

VIII. CONDITIONS AND COVENANTS

Prior to the first disbursement under the grant for subproject financing under Components One and Two of the project, or to issuance by A.I.D. of documentation pursuant to which such disbursement will be made, the Grantee shall, except as A.I.D. may otherwise agree in writing, furnish to A.I.D., in form and substance acceptable to A.I.D., documentation that an Energy Research and Technology Development Advisory Council has been established to provide advice to the Government of India (GOI) Department of Non-Conventional Energy Sources (DNES) in the implementation of the project. The Advisory Council will consist of members from the research community, the manufacturing sector, end user units, a finance institution, and government. The functional responsibilities of the Advisory Council will include:

- participating in the development of policies and procedures to be instituted under the project, addressing, among other things, subproject selection, review, and approval mechanisms; financial mechanisms; cost sharing formulas; and monitoring and evaluation procedures.

- participate in the development of annual operating plans and budgets for the project;

- guide and oversee the solicitation process for proposals in Components One and Two of the project;

- manage the peer review process under Components One and Two of the project;

- commission studies, analyses, and assessments to be financed under Component Three of the project; and

- sponsor workshops and seminars financed under Component Three of the project.

ANNEXES

ANNEX I

LOGICAL FRAME WORK

ANNEX - I

ENERGY RESEARCH AND ENTERPRISE
LOGICAL FRAMEWORK

	Verifiable Indicators	Important Assumptions
Sector Goal: To accelerate the absorption of new and relevant energy technologies.	An increased number of new processes and products for domestic and export markets.	Within the existing policy frameworkan accelerated pace of technology development is feasible. India has the human and capital resource base to sustain a technology innovation oriented economy.
Project Purpose: To develop introduce and test operational models for indigenous technology innovation and development in hte Indian energy sector.	Proposals from technology development consortia have been solicited, reviewed, and financed. Proposals received under the competitive awards program have been solicited, reviewed, and financed. An Energy Research and Technology Development Advisory Committee is organized and fucntioning. Several collaborating among research institutions, manufacturers, end users, and government will have occurred. The Department of Non-Conventional Energy Sources and ICICI will have increased experience in managing a disciplined proposal solicitation, review, and approval process geared to technology innovation. Public discussion will have been stimulated on issues of importance to technology innovation through workshops, seminars, and other forms of information dissemination.	Sustained technology innovation is critical to Indian economic growth. India has the human and capital resources to develop a capacity for technology innovation. The existing policy framework has the incentives necessary to promote technology innovation. Technology innovation requires greater interaction among scientific institutions, commercial enterprises, and end users. For market driven R&TD interactions to be successful, the institutional infrastructure to facilitate the process must be in place.

	Verifiable Indicators	Important Assumptions
Inputs: Finance to support: (a) consortia organized to undertake market driven technology development. (b) A research awards program. (c) R&TD strategy formulation, policy analyses, and information dissemination activities.	Proposals from technology development consortia have been solicited, reviewed, and approved. Proposals received under research awards program have been solicited, reviewed, and approved. An R&TD strategy has been formulated. Policy analyses have been undertaken. Seminars, workshops and other information dissemination activities have been sponsored.	The Department of Non-Conventional Energy Sources and the Industrial Credit and Investment Corporation of India (ICICI) can coorddinate with other members of the Advisory Committee to solicit, review, and approve suitable proposals and to promote project activities. Enterprises will be willing to collaborate with research institutions and/or end users.
Outputs: Financed 4-6 market driven technology development consortia. Completed 10-25 competitive research awards. Completed several authoritative studies on R&D strategies, technology commercialization and innovative policy approaches. Diffused new information and knowledge about the innovation and commercialization process in India. Demonstrated success in fostering market-driven R&D among research institutions, manufacturers and government. Provided experience to DNES and ICICI in managing a disciplined proposal solicitation, review, and approval process.	Consortia in place and collaborating on approved technology development proposals. Competitive research awards have been made and research is taking place. Energy Research and Technology Development Advisory Committee Council is organized and functioning. Project R&TD strategy has been set and resource allocations made. Workshops and seminars have been completed. Policy analyses have been completed.	Department of Non-Conventional Energy Sources can coordinate with ICICI and other members or the Advisory Committee to solicit, review, and approve suitable proposals and to promote project activities. Enterprises will be willing to collaborate with research institutions and/or end users.

	Verifiable Indicators	Important Assumptions
Exposed DNES on a micro level, to a systematized priority setting and resource allocation process. Stimulated public discussion on issues of importance to technology innovation.		

ANNEX II

GOVERNMENT OF INDIA POLICY STATMENTS
1985 - 86

ANNEX III

GOAL-ORIENTED RESEARCH AND DEVELOPMENT CONSORTIA AS A FORCE FOR DEVELOPMENT

By

David J. Jhirad and Dr. Jerome M. Weingart

ANNEX IV

STUDY ON THE POTENTIAL OF ENERGY NETWORKS FOR GOAL-ORIENTED TECHNOLOGY DEVELOPMENT IN INDIA

(PART II)

By

Tata Energy Research Institute
New Delhi, India

ANNEX V

ENERGY RESEARCH AND ENTERPRISE PROJECT
(386-0496)

PID REVIEW AND PP GUIDANCE CABLE
(STATE 226530)