PDABE 446
ISN 78173

A.I.D. EVALUATION SUMMARY - PART I

1. BEFORE FILLING OUT THIS FORM, READ THE ATTACHED INSTRUCTIONS.
2. USE LETTER QUALITY TYPE, NOT "DOT MATRIX" TYPE.

IDENTIFICATION DATA

A. Reporting A.I.D. Unit:
Mission or AID/W Office USAID/INDIA
(ES# _____)

B. Was Evaluation Scheduled In Current FY Annual Evaluation Plan?
Yes [X] Slipped [ ] Ad Hoc [ ]
Evaluation Plan Submission Date: FY 90 Q 3

C. Evaluation Timing
Interim [X] Final [ ]
Ex Post [ ] Other [ ]

D. Activity or Activities Evaluated (List the following information for project(s) or program(s) evaluated; if not applicable, list title and date of the evaluation report.)

Project No.	Project /Program Title	First PROAG or Equivalent (FY)	Most Recent PACD (Mo/Yr)	Planned LOP Cost (000)	Amount Obligated to Date (000)
386-0494	Program for the Acceleration of Commercial Energy Research (PACER)	1987	09/96	$20,000	$10,000

ACTIONS

E. Action Decisions Approved By Mission or AID/W Office Director

Action(s) Required	Name of Officer Responsible for Action	Date Action to be Completed
1. Explore the possibility of greater university involvement in the consortium efforts of manufacturers and end users with ICICI and DNES.	TDE	September 30, 1991
2. Take up sustainability and other related issues such as utilization of grant payments with ICICI/ ERDAC to strengthen the concept of consortium research and ensure its continuity even after the PACD.	TDE	December 30, 1991
3. Discuss the modalities to encourage outside specialized assistance in sub-project appraisal with ICICI.	TDE	December 30, 1991
4. Extend the PACD from 6/30/93 to 6/30/96 to give additional processing time to new sub-projects and complete the already approved ones.	TDE / PDPS	July 15, 1991

(Attach extra sheet if necessary)

APPROVALS

F. Date Of Mission Or AID/W Office Review Of Evaluation: (Month) May (Day) 20 (Year) 1991

G. Approvals of Evaluation Summary And Action Decisions:

	Project/Program Officer	Representative of Borrower/Grantee	Evaluation Officer	Mission or AID/W Office Director
Name (Typed)	N.V. Seshadri		B.R. Patil	Walter G. Bollinger
Signature	N.V. Seshadri		B.R. Patil	[signature]
Date	04/21/92		4/14/92	5/7/92

ABSTRACT

H. Evaluation Abstract (Do not exceed the space provided)

1. Project Purpose: The Program for Acceleration of Commercial Energy Research (PACER) was designed to be a catalytic project to bring about operational and organizational models that would have a lasting impact on the way the energy sector operates. Energy technology development, commercialization and research utilization are the core objectives of PACER, the project also seeks to foster creative institution-building and financial innovation in the energy industrial sector.

2. Evaluation Purpose: The present mid-term evaluation was commissioned to provide recommendations on PACER program on the basis of a comprehensive examination of the design, implementation and impacts of the project.

3. Evaluation Methodology: The evaluation was conducted by a four member team. The team interviewed USAID staff, Chairman and several members of Advisory and Peer Review Committees, staff of PACER Secretariat and a large number of present and prospective grantees. It also reviewed documents relating to the program and its subprojects and visited nine of the 12 on-going consortium projects and reviewed their progress.

4. Findings:

i) The concept of PACER is innovative, yet valid and timely in the Indian context. The goal and project design have, however, been difficult to get across to the Indian technological and industrial community.

ii) Transferring expertise from academic research to industry R&D and then into commercial products is a complex, multi-tiered, and little-understood process.

iii) The consortium idea is foreign and the mechanism of the "conditional grant" is novel in India. This has led to a slow start-up of the program.

iv) The program has recently gained considerable momentum, but of the twelve consortium subprojects so far approved, only two have recently completed.

vii) The PACER concept of conditional grants has assumed a promising place in the venture capital market. The concept of paying back only if successful has caught on with many entrepreneurs -- who can thereby avoid the time-consuming red tape of ordinary financial loans.

COSTS

I. Evaluation Costs

1. Evaluation Team Name	Affiliation	Contract Number OR TDY Person Days	Contract Cost OR TDY Cost (U.S. $)	Source of Funds
Mr. William Ramsay	International Resource Group Ltd.	PDC-0249-I-00-0089-00	$190,000	PD&S
Mr. Arun Banskota	-- do --	- do -	$190,000	-do-
Mr. H. Sharan	Purchase Order	386-0494-0-00-1094	$ 15,000	-do-
Mr. M.K. Sambamurti	Purchase Order	386-0499-0-00-1109	$ 9,596	-do-

2. Mission/Office Professional Staff Person-Days (Estimate) _____

3. Borrower/Grantee Professional Staff Person-Days (Estimate) _____

A.I.D. EVALUATION SUMMARY - PART II

SUMMARY

J. Summary of Evaluation Findings, Conclusions and Recommendations (Try not to exceed the three (3) pages provided)
Address the following items:

- Purpose of evaluation and methodology used
- Purpose of activity(ies) evaluated
- Findings and conclusions (relate to questions)
- Principal recommendations
- Lessons learned

Mission or Office:	Date This Summary Prepared:	Title And Date Of Full Evaluation Report:
USAID/INDIA	March 1992	Program for Acceleration of Commercial Energy Research:Mid-term Evaluation Report (June 1991)

1. Project Purpose: The Program for Acceleration of Commercial Energy Research (PACER), launched in 1987, is charged with making grants from a fund of $20 million to mobilize the expertise of the giant Indian research establishment into helping develop new, promptly marketable energy technologies. PACER forms consortia between energy sector manufacturers and either research establishments or end user industries. It then gives conditional grants, repayable from revenues, in the event of successful commercialization, at 200%. The project is presently scheduled to end in 1993.

PACER was designed to be a catalytic project to bring about operational and organizational models that would have a lasting impact on the way the energy sector operates. Energy technology development, commercialization and research utilization are the core objectives of PACER, the project also seeks to foster creative institution-building and financial innovation in the energy industrial sector.

2. Evaluation Purpose: The present mid-term evaluation was commissioned to provide recommendations on PACER program on the basis of a comprehensive examination of the design, implementation and impacts of the project.

3. Evaluation Methodology: The evaluation was conducted by a four member team between mid-April and mid-May 1991. The team interviewed USAID staff, Chairman and several members of Advisory and Peer Review Committees, staff of PACER Secretariat and a large number of present and prospective grantees. It also reviewed documents relating to the program and its subprojects, covering technical, economic/financial aspects and procedures relating to project solicitation, appraisal, approval and progress monitoring. It visited nine of the 12 on-going consortium projects and reviewed their progress.

4. Findings:

i) The concept of PACER are innovative, yet valid and timely in the Indian context. The goal and project design have, however, been difficult to get across to the Indian technological and industrial community.

ii) Transferring expertise from academic research to industry R&D and then into commercial products is a complex, multi-tiered, and little-understood process.

iii) The consortium idea is a foreign concept to most Indian businessmen.

iv) The mechanism of the "conditional grant" is novel in India. This has led to a slow start-up of the program.

v) Despite the initial handicaps, the dynamic and able staff of the PACER Secretariat, under the guidance of DNES, have managed to get the project off to a slow but promising start -- with a quarter of the funds now committed after three years of operation (out of six budgeted years).

vi) The program has recently gained considerable momentum, but of the twelve consortium subprojects so far approved, only two have recently completed. It is therefore too early to evaluate the success of the commercialization objective.

vii) The PACER concept of conditional grants has assumed a promising place in the venture capital market. The concept of paying back only if successful has caught on with many entrepreneurs -- who can thereby avoid the time-consuming red tape of ordinary financial loans.

5. Recommendations:

i) The project be extended for a further three years to June 30, 1996 to complete ongoing projects and to clear and complete new projects.

ii) A more thorough review of the economic, technological and environmental considerations during the project appraisal stage -- and the hiring of external expertise for this purpose be carried out.

iii) Despite deficiencies in forming true consortia, the consortium concept should be retained.

iv) More careful evaluations of institutions should be made to ensure that the firms having easy access to other sources of financing do not tax limited PACER resources; on the other hand, these evaluations should also take into account the need for sizeable grantee contributions in some types of subprojects.

v) There should be a cap on the maximum amount of funding at $2 million and on the number of projects that any one organization can undertake.

6. Lessons learned: The real test of success for PACER will come when the projects now underway get into the commercialization stage and start making an impact in the Indian energy sector. Since PACER is envisaged to be self-sustaining, the commercialization success of the projects and the payback to the revolving fund is critical to its long-term viability. However, more of the test will be in how and when and how many entities follow the organizational and operational models introduced by PACER.

ATTACHMENTS

K. Attachments (List attachments submitted with this Evaluation Summary; always attach copy of full evaluation report, even if one was submitted earlier; attach studies, surveys, etc., from "on-going" evaluation, if relevant to the evaluation report.)

Copy of the report

COMMENTS

L. Comments By Mission, AID/W Office and Borrower/Grantee On Full Report

1. Evaluation issues are adequately covered and examined.

2. Findings concur with those of AID and GOI officials.

3. The Mission concurs all recommendations except those related to setting priorities, limiting the amount of PACER contribution to $2 million, funding organizations under PACER that have other sources of funding and grant repayment, as they are not practical and feasible at this stage of the project.

June 13, 1991

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH

MIDTERM EVALUATION REPORT

by

Dr. William Ramsay (team leader)

Arun Banskota

M.K. Sambamurti

Dr. H. Sharan

Submitted to

U.S. Agency for International Development

New Delhi, India

4003 Oliver Street
Chevy Chase, Maryland 20815

301/654-0374

13 June 1991

John P. Grant, Chief PDOS/PPE
U. S. Agency for International Development
American Embassy
New Delhi-110021

Dear Mr. Grant:

Enclosed is a finalized copy of the PACER Midterm Evaluation Report. I am also providing IRG with a 3 1/2" diskette containing ASCII files of the report and its annexes.

I have revised the report in response to the mission comments forwarded to me on a marked-up copy of the draft report. All substantive suggestions have been adopted with the following exceptions (references to old page numbers):

> pp. 8, 38: We are no longer recommending that the head of ICICI be on ERDAC -- in part because ICICI is already represented there.
>
> p. 36: We are implicitly advocating the use of socioeconomic feasibility criteria instead of energy sector priorities favoring one energy form or technology over another.
>
> Tables 6-1, 6-3, 7-1: After watching Mr. Seshadri and Mr. Sambamurti slave all one afternoon over dollars and rupees, fluctuating exchange rates, and expenditures made over a number of years, I don't dare try to replace rupees with dollars in these particular tables.

One difficulty that has come up is that I have neither a letter-quality paper copy nor a magnetic copy of tables 6-1, 6-2, 6-3, and 6-5. Dr. Sharan delivered those to you after I left: he said he would also include a diskette with LOTUS files of the tables. I have left blank paginated pages in the text, as marked therein, for the insertion of good copies of these tables.

The draft tables you sent me are O.K. except for the underlines you requested, the extra spaces on Table 6-5, and the rather obscurely abbreviated column headings on Table 6-2. The only non-cosmetic problem is the last, and I have tried to ameliorate that one by explaining the table in the revised text. Assuming you do have the diskette, the column headings should be altered to read: Coal, Oil

and Gas, Power Sector, New and Renewables, Conversion Technologies, Fuel Substitution, Energy Saving, Storage Devices.

Please let me know if you have problems with finding the LOTUS files or with making these few corrections and inserting the letter-quality copies into the enclosed text. I apologize for the inconvenience.

My thanks to you and the rest of the USAID staff for all your help.

Sincerely,

William Ramsay

Encl.

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ACRONYMS

AID	Agency for International Development
BHEL	Bharat Heavy Electricals Limited
CEA	Central Electricity Authority
CEI	Confederation of Engineering Industries
CSIR	Council of Scientific and Industrial Research
DNES	Department of Non-Conventional Energy Sources
ERDA	Electrical Research & Development Association
ERDAC	Energy Research and Development Advisory Committee
GOI	Government of India
ICICI	Industrial Credit & Investment Corporation of India
IGIDR	Indira Gandhi Institute of Development Research
IIT	Indian Institute of Technology
IREDA	Indian Renewable Energy Development Agency
IRG	International Resources Group
PACER	Program for Acceleration of Commercial Energy Research
PACT	Program for the Advancement of Commercial Technology
PP	Project Paper
PRC	Peer Review Committee
PS	PACER Secretariat
RFP	Request for Proposal
SPIC	Southern Petrochemical Industries Corporation
USAID	U.S. Agency for International Development

EXECUTIVE SUMMARY

The Program for Acceleration of Commercial Energy Research (PACER), launched in 1987, is charged with making grants from a fund of $20 million to mobilize the expertise of the giant Indian research establishment into helping develop new, promptly marketable energy technologies. PACER forms consortia between energy sector manufacturers and either research establishments or end user industries. It then gives conditional grants, repayable from revenues, in the event of successful commercialization, at 200%. The project is presently scheduled to end in 1993.

The present mid-term evaluation was commissioned to provide recommendations on PACER program on the basis of a comprehensive examination of the design, implementation and impacts of the project.

Purpose of the Project:

PACER was designed to be a catalytic project to bring about operational and organizational models that would have a lasting impact on the way the energy sector operates. Energy technology development, commercialization, and research utilization are the core objectives of PACER, the project also seeks to foster creative institution-building and financial innovation in the energy industrial sector.

Methodology:

The evaluation was conducted by a four member team between mid-April and mid-May 1991. The team interviewed USAID staff, Chairman and several members of ERDAC/PRC, staff of PACER Secretariat and a large number of present and prospective grantees. It also reviewed documents relating to the program and its subprojects, covering technical, economic/financial aspects and procedures relating to project solicitation, appraisal, approval and progress monitoring. It visited nine of the 12 on-going consortium projects and reviewed their progress.

Major Findings and Recommendations:

The concepts of PACER are innovative, yet valid and timely in the Indian context. The goal and project design have, however, been difficult to get across to the Indian technological and industrial community. First, transferring expertise from academic research to industry R&D and then into commercial products is a complex, multi-tiered, and little-understood process. Second, the consortium idea is a foreign concept to most Indian businessmen. Third, the mechanism of the "conditional grant" is novel in India. This has led to a slow start-up of the program. Despite the initial handicaps, the dynamic and able staff of the PACER Secretariat, under the guidance of DNES, have managed to get the project off to a slow

but promising start -- with a quarter of the funds now committed after three years of operation (out of six budgeted years). The program has recently gained considerable momentum, but of the twelve consortium subprojects so far approved, only two have recently been completed. It is therefore too early to evaluate the success of the commercialization objective.

Because of the long lead time required in many of the projects, the Evaluation Team has recommended that the project be extended for a further three years to June 30, 1996 to complete ongoing projects and to clear and complete new projects. The Team has recommended a more thorough review of the economic, technological and environmental considerations during the project appraisal stage -- and the hiring of external expertise for this purpose.

Despite deficiencies in forming true consortia, PACER has had notable successes in bringing organizations together, especially manufacturers and end-users, and the consortium concept should be retained.

The PACER concept of conditional grants has assumed a promising place in the venture capital market. The concept of paying back only if successful has caught on with many entrepreneurs -- who can thereby avoid the time-consuming red tape of ordinary financial loans.

More careful evaluations of institutions should be made to ensure that the firms having easy access to other sources of financing do not tax limited PACER resources; on the other hand, these evaluations should also take into account the need for sizeable grantee contributions in some types of subprojects. A cap on the maximum amount of funding at $2 million and on the number of projects that any one organization can undertake alone have been recommended.

Conclusions:

The real test of success for PACER will come when the projects now underway get into the commercialization stage and start making an impact in the Indian energy sector. Since PACER is envisaged to be self-sustaining, the commercialization success of the projects and the payback to the revolving fund is critical to its long-term viability. However, more of the test will be in how and when and how many entities follow the organizational and operational models introduced by PACER.

PART ONE: MIDTERM EVALUATION, PROJECT BACKGROUND AND STATUS

1.0 MIDTERM EVALUATION

A scheduled midterm evaluation of the PACER project was carried out during April-May 1991.

1.1 Scope of Work

The purpose of the mid-term evaluation was to provide recommendations on the Program for Acceleration of Commercial Energy Research (PACER) on the basis of a comprehensive look at the design, implementation, and impacts of the project. General questions addressed involved suitability of project design, success in implementation, progress and outlook for current prcjects, needs for adjustments, and general recommendations for guiding the the future course of the project.

The detailed scope of work is given in Annex 1-A.

1.2 Team

The Team was composed of Dr. William Ramsay, Team Leader; Mr. Arun Banskota; Mr. M. K. Sambamurti; Dr. Hari Sharan. Dr. Ramsay and Mr. Banskota were contracted through International Resources Group, Ltd., a Washington-based consulting firm.

Dr. Ramsay is an energy consultant, formerly Senior Staff Scientist at the National Academy of Sciences, Washington and earlier, Senior Fellow at the Center for Strategic and International Studies, Georgetown University. Mr. Banskota is an energy economist and financial analyst at International Resources Group. Mr. Sambamurti is an energy consultant and was formerly Chairman of the Central Electricity Authority and ex-officio Secretary to the Government of India and earlier, Director of Energy at the Department of Power. Dr. Sharan is president of Dasag, an energy engineering company in Switzerland, and former Director of Engineering at Bharat Heavy Electricals, Ltd.

1.3 Evaluation Methodology

More than eighty documents, including project documents, records of the PACER project, and documents generated by PACER grantees were examined.

Fifty-seven interviews were carried out with relevant officials of the United States and India, PACER staff and members of its two review committee, grantees, and independent scientists, engineers, and businessmen.

Site visits were made to nine out of 12 subprojects and briefings attended on two out of eight research projects.

Details of documents reviewed and persons visited are given in Annex 1-B.

2. PACER BACKGROUND

2.1 Summary Description

The Program for Acceleration of Commercial Energy Research (PACER) is a six-year project (1987-1993) funded at a level of $20 million. Its main thrust is to partially fund, through conditional grants, the operations of consortia of Indian engineering/manufacturing firms and research institutions and/or end-users to develop new or newly-indigenous products in the energy sector that show near-term commercial promise.

2.2 Rationale

The Project falls generally under the 1983 AID ten-year strategy for research and technology development. It focuses on accelerating the pace of technology development by strengthening the connections between science and enterprise. It derives explicit inspiration from a preceding project, PACT (Program for the Advancement of Commercial Technology), which promoted U.S.-Indian consortia for technology development.

2.3 Components

The PACER program consists of three components:

2.3.1 Component One, the principal program activity, is the thrust to commercialize new energy technology -- mentioned above -- involving conditional cost-sharing grants to consortia.

2.3.2 Component Two is a program of unconditional grants for research projects in support of Component One subproject grants.

2.3.3 Component Three is a program of unconditional grants for policy studies, other research, informational dissemination and other activities relevant to the project.

2.4 Chronology

The PACER agreement was signed in August, 1987, with operations starting about the middle of 1988.

3. OBJECTIVES: GOALS AND SUB-GOALS

Energy technology development, the commercialization of that development, and the increased utilization of Indian research capabilities are the three main goals of PACER. To achieve these goals, somewhat novel techniques are being employed: industrial institutions (consortia) that are unfamiliar in the local context, and financial innovations (conditional grants). The effective use of these techniques have become "sub-goals" or project objectives in themselves. The validity of the PACER approach must then be measured in terms of both achievement of the three main goals and the successful deployment of the two new techniques -- these goals and sub-goals are called here "objectives":

3.1 Energy Technology Development

Various estimates have shown the significant impact of the energy supply shortfall in India: studies have estimated this to be equivalent to 1.5% of lost Gross Domestic Product (GDP). PACER's objective in developing new and improved energy technologies is thus an essential part of a national strategy to narrow the supply-demand gap.

3.2 Commercialization

Most of the basic research being conducted in India occurs in R&D organizations not directly concerned with commercial technology development. In contrast, there are numerous manufacturing firms and users that are capable of conducting appropriate R&D leading to new commercial energy products. Without normal access to government R&D funds, these firms may lack the funding to engage in such R&D. Thus, a PACER objective is to assist in development of energy technologies for commercialization.

3.3 Research utilization- Energy Sector

The considerable sums expended on science and technology in India over the past decades have developed a formidable scientific infrastructure. PACER is attempting to support policy initiatives in India in recent years to foster the increasing application of this research capability to technological development in industry.

3.4 Industrial Institution-Building

The PACER consortium approach has been designed to provide models of collaboration in technology commercialization as well as to increase the likelihood of success. The PACER consortia -- composed of a manufacturer together with a research organization and/or an end-user -- represent a new kind of institution in the industry.

3.5 Financial Innovation

PACER provides financing in the form of conditional grants: if a project fails to commercialize, the grantee would not have to repay anything; if it succeeds, it would pay 200% of the amount borrowed. Ideally, this form of financing will serve to keep the program viable beyond its present project life through repayments from the grantees after USAID funding ends.

4. PROJECT ORGANIZATION

The PACER Project Grant Agreement is between Industrial Credit and Investment Corporation of India Ltd. (ICICI) and the United States of America acting through the Agency for International Development (USAID). The Department of Non-Conventional Energy Sources (DNES) of Government of India coordinates the project and guides and oversees its implementation. While the responsibility of soliciting subprojects and processing them for approval is vested in ICICI, the approval of major subprojects and activities under PACER is

the responsibility of the Energy Research and Development Advisory Committee (ERDAC) constituted by DNES with the Secretary of DNES as its ex-officio Chairman. The responsibility for monitoring subprojects and disbursing grants is that of ICICI.

The PACER project seeks to make use of the expertise available in ICICI, DNES, and other GOI ministries and departments and institutions involved in energy R&D through a three-tier administrative system, with ERDAC as the apex body. The other two tiers are the Peer Review Committee (PRC) constituted by ERDAC to serve as its technical arm and the PACER Secretariat working staff in the ICICI.

4.1 The United States Agency for International Development (USAID)

USAID's responsibility for the project is to work with DNES to progress and monitor the project through its staff in the USAID Office of Technology Development and Enterprise. This staff also functions as a bridge between Indian and U.S. energy scientists and technologists.

4.2 Department of Non-Conventional Energy Sources (DNES)

DNES forms part of the Ministry of Energy and is responsible for development of non-conventional energy sources. DNES coordinates the project and provides guidance to the Secretariat.

4.3 Energy Research and Development Advisory Committee (ERDAC)

ERDAC is a high-level committee in charge of general overseeing of the project and of approving major subprojects and other significant actions. Its responsibilities include approval of policies and operational procedures for the project: subproject solicitations; review and approval mechanisms; financial mechanisms; cost sharing formulas; monitoring and evaluation procedures; approval of the annual operating plans and budgets; review of the progress of subprojects; commissioning studies and analyses; and sponsoring workshops and seminars.

ERDAC was originally envisaged having a role in pre-screening proposals going to the Secretariat.

The Secretary of DNES is the ex-officio chairman of ERDAC. ERDAC was authorized to consist of 10-12 members with representation from ICICI, industrial establishments, the research community and electric utilities. Institutions from which members may be drawn include the Central Electricity Authority (CEA), Tata Energy Research Institute (TERI), Confederation of Engineering Industries (CEI), public and private power utilities and research institutions such as Indian Institute of Science and Indian Institute of Technology (IIT).

4.4 Peer Review Committee (PRC)

PRC is appointed by ERDAC and functions as a link between the PACER Secretariat and ERDAC. The PACER agreement had envisaged two PRCs, one for dealing with consortium projects

(Component I) and the other for dealing with Research projects (Component II): in practice, only one PRC has been constituted. Its responsibilities are to carry out a detailed technical and financial review of subprojects proposed for inclusion in the PACER -- based on appraisal reports prepared by the PACER Secretariat -- and make a recommendation on them to ERDAC. PRC had been delegated powers to approve subprojects costing Rs. 4 million and below. The Advisor, DNES, who is member-secretary of ERDAC, functions as Chairman of the PRC. The members of PRC are drawn from ICICI, National Productivity Council, IIT Bombay, National Council of Power Utilities, Indian Renewable Energy Development Agency and PACER Secretariat. Presently, all the members of PRC except two are also members of ERDAC.

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

ICICI is the implementing agency for the project and the home of the PACER Secretariat -- which comprises the staff and management of the day-to-day operations of the project.

4.5.1 ICICI Background

ICICI is a financial institution involved in assistance for the creation and expansion of industrial enterprises, encouraging the participation of private capital in the industrial sector and helping development of capital markets.

ICICI is also involved in other development activities, including promotion of technology development, training institutes, entrepreneurships and consultancy organizations. It

has a separate Technology Division responsible for development activities under a Deputy General Manager, who reports directly to the Deputy Managing Director/Chairman and Managing Director.

ICICI also administers the Program for Advancement of Commercial Technology (PACT) under a grant agreement signed between Government of India and USA to provide USAID funds for promotion and advancement of Indo-U.S. joint ventures in research and development.

4.5.2 PACER Secretariat

The PACER Secretariat in the Technology Division of ICICI is the administrative unit responsible for execution of the project. Its cost is met in part out of grant funds. It works in close cooperation with the Department of Advisor in DNES.

The PACER Secretariat receives proposals, evaluates them, and submits promising proposals to PRC for discussion and approval or disapproval. The Secretariat also reworks proposals as instructed by the PRC.

The PACER Secretariat has a staff strength of four professionals. The head of the group at the Assistant General Manager level is an economist with a doctorate in finance, and a former professor in a Bombay college. His supporting staff represents expertise in mechanical and chemical engineering and business management.

5. HOW PACER WORKS

PACER follows standard solicitation methods, together with its own prescribed review process.

5.1 Project Solicitation Methods

PACER project solicitation methods envisage unsolicited proposals and Request for Proposals (RFP's).

5.1.1 Unsolicited Proposals

Unsolicited proposals have been initially regarded as a straightforward method of initial project implementation. All subprojects in the three Components have so far been implemented through unsolicited proposals.

5.1.2 RFP Program

The Secretariat has determined that some areas of interest have not been addressed in unsolicited proposals. The PRC has therefore recently approved guidelines for the introduction of RFPs. At present, the PACER Secretariat is in the process of formulating draft RFPs on ethanol from cellulose and on solar process heating.

5.2 Project Review Procedures

Project review involves a detailed appraisal by the Secretariat, a review or series of reviews by the PRC, and a final review by ERDAC. The agreement envisaged a comprehensive

procedure for review of subprojects and their approval by ERDAC.

5.2.1 PACER Secretariat

The main responsibility for evaluating the proposals and preparing detailed appraisal memos is assumed by the PACER Secretariat. In order to facilitate such appraisals, it has devised forms for submission of proposals for both consortium and Research Projects. It has also devised a format for appraisal report which lists all essential aspects to be reviewed in the appraisal to ensure their conformity with the PACER requirements. These include:

- background and capabilities of the proposers
- statement of problem the technology is expected to solve
- technical features of the proposal
- implementation plan
- cost of project
- financing plan
- business plan for marketing the product
- strategic analysis in terms of business attractiveness and company strength factors
- recommendations

The Secretariat works closely with the proposers in the preparation and revision of the appraisal reports.

Procedures in practice take on the flavor of ICICI's established role as a development bank. While the PACER Secretariat has the acknowledged capability to take care of financial and institutional aspects of the proposals, it continues to regard itself as requiring guidance regarding technical and technological aspects of energy matters from the PRC.

5.2.2 Peer Review Committee

The PRC carries out its detailed review of proposals mainly in its meetings on the basis of appraisal notes prepared by the PACER Secretariat -- which form the agenda notes for the meetings. The proposers are called to the PRC meetings for presentation of their proposals and to clarify aspects where PRC members may have doubts or reservations. PRC may accept the proposals and recommend them for approval or ask the proposers to modify them if they can be brought in conformity with PACER requirements. The PRC has also been delegated the power of approval of subprojects costing Rs. 40 lakhs or less.

5.2.3 ERDAC

The role of ERDAC in subproject proposal review, as it has evolved, is mainly confined to considering the recommendations of PRC in respect of each proposal during its meetings. Although ERDAC project pre-screening was not anticipated in the agreement, some members of ERDAC, especially those serving also on the PRC, do become involved in detailed review of proposals.

6. CURRENT PROJECTS

Two hundred forty-three inquiries about financial assistance have been received so far by the Secretariat. Only a small number of these inquiries have represented projects relevant to PACER objectives and resources, with demonstrated capability by the potential grantee.

6.1 Consortia Projects

Twelve projects have been approved so far, of which six have actually started up. Of those six, two are classified as completed, while four are under way.

Brief characteristics of current projects are summarized in Table 6-1. More detailed information is given in Annex 6-A.

Table 6-2 shows the relationships of the current projects to fuel sectors and energy objectives: many have relationships to a number of sectors and objectives. The first three columns show that one project is related to coal utilization, three to oil and gas, eight to the power sector, and four new and renewable sources of energy. The last three columns show that four projects are related to conversion technologies, four to fuel substitution, nine to energy saving, and one to energy storage.

TABLE 6-1
PACER CONSORTIUM PROJECTS.

GRANTEE	PROJECT BEING FUNDED	TOTAL COST	PACER SHARE	DISBUR--SEMENT
		(Rupees, Lakh)		
1. Engineers India, Delhi Hindustan Zinc	Energy Conservation in milling.	96	38	-
2. Thermax, Pune	Regenerative burner	16	8	7.5
3. Nagadi, Madras	Combustion control	8	4	3.78
4. SPIC, Madras	Fuel cell stacks(1-5kW)	210	100	55
5. Ankur, Baroda	Bio-gasifier power gen.	29	14.5	6.5
6. Fluidtherm, Madras	Fluidised bed furnace	82	41	17
7. Mecon, Ranchi Bokaro Steel, Bokaro	Wasteheat / desicant cooling system	11	5.5	-
8. Lotus, Bangalore	Cogen plant with phased out aero engine	14	7	3.6
9. FRP, Baroda	FRP blades for wind gen	32	16	-
10. Patson, Baroda	Amorphous core transformer	48	24	-
11. Plumac, Hyderabad	Deep cycling battery	53	20	-
12. BHEL, Tiruchi	Fluidised bed gasifier in a Demo IGCC plant	1200	550	-
TOTAL		1799	828	93.38
TOTAL, million $ (at exchange rates on the day of sanction)		10.293	4.723	

TABLE 6-2
FUEL AND ENERGY SECTOR OBJECTIVES

GRANTEE	FUEL SECTOR			ENERGY OBJECTIVES				
	COAL	OIL+ GAS	POWER SECTOR	NEW & RENEW-ABLES	CONVER-SION TECH. NOLOGIES	FUEL SUBST. ITUTION	ENERGY SAVING	STORAGE DEVICES
1. EIL/Hindustan Zinc Energy Conservation			X				X	
2. Thermax, Pune Regenerative burner		X					X	
3. Nagadi, Madras Combustion control		X					X	
4. SPIC, Madras Fuel cell stacks			X	X	X	X	X	
5. Ankur, Baroda Bio-gasifier gen.			X	X	X	X		
6. Fluidtherm, Madras Fluid.bed furnace		X	X				X	
7. Mecon/Bokaro Steel WH-based cooling system							X	
8. Lotus, Bangalore Cogen plant with phased-out aero engines			X		X			
9. FRP, Baroda FRP blades-wind gen.				X		X		
10. Patson, Baroda Amorphous transform.			X				X	
11. Plumac, Hyderabad Deep cycling battery			X	X			X	X
12. BHEL, Tiruchi Fluid.bed gasifier in a Demo IGCC plant	X		X		X	X	X	

6.2 Research Projects

Eight research projects have been approved of which two have been completed and the drafts of three submitted. A summary description of these projects is given in Table 6-3. More information is given in Annex 6-B.

An analysis by types and institutions is given in Table 6-4 below.

TABLE 6-3
PACER RESEARCH PROJECTS.

GRANTEE	PROJECT BEING FUNDED	TOTAL COST	PACER SHARE	DISBUR--SEMENT
		(Rupees, Lakh)		
1. TERI I	Policy for smoothening of load duration curves	20.9	20.9	14.7
2. TERI II	Assessing efficiencies domestic appliances	18.25	18.25	11.35
3. TERI III	strategies for indigen-isation of wind gen.	2.31	2.31	2.31
4. NIMBAKAR INSTITUTE	Feasibility study, 10 MW bio-mass power station.	2.9	2.9	2.12
5. I.J.RAJU & ASSOCIATES	Optimum utilisation of natural gas.	4.32	4.32	2.16
6. IGIDR	Compressed nat.gas for transportation sector	4	4	3.2
7. DR. RAO ASSOCIATES	Solar process heat supply for industries	4.5	4.5	2.6
8. ANDHRA UNIVERSITY	Cogen plant with phased out aero engine	9	9	5
TOTAL		66.18	66.18	44.44
TOTAL, million $ (at exchange rates on the day of sanction)		0.415	0.415	

TABLE 6-4: Research Projects Analyzed

Category	No.	No. (%)	Amount ($000)	Amt. (%)
1. Policy related studies	4	50	202	49
2. Surveys	2	25	165	30
3. Technology oriented feasibility studies	2	25	48	12
TOTAL	8	100	415	100

The composition of the participants is as follows:

Category	No.	No.(%)	Amount ($000)	Amt. (%)
1. Research Institutes	3	50	307	74
2. Consultants	2	33	55	13
3. University	1	17	53	13
TOTAL	6	100	415	100

Although the category "research" appears to correspond naturally to Component Two of PACER, in practice -- except for the Lotus subproject (in modified form) -- all of the research projects so far have been technically funded under Component Three.

6.3 Expenditures

Of the $20 million authorized for PACER, $10 million has been obligated so far, in three installments. Table 6-5 shows the allocations of funds obligated to the three components and other activities associated with the project.

TABLE 6-5
SUMMARY OF PACER FUND ALLOCATIONS
(First 3 installments obligated = $ 10 million)

(All amounts in millions of $)

CATEGORY	USAID CONTRIBUTION.	GRANTEE CONTRIBUTION	TOTAL
1. CONSORTIA PROJECTS	5.5	5.5	11
2. COMPETITIVE AWARDS PROGRAMME	2	0.5	2.5
3. SUPPORTING ANALYSIS/ OUTREACH	1.35		1.35
4. US ST TECH ASSISTANCE	0.35		0.35
5. PROJECT ADMINSTRATION	0.75		0.75
6. PROJECT EVALUATION	0.05		0.05
TOTAL	10	6	16

Out of this total amount authorized, the PACER grant funding actually slated for approved and ongoing projects aggregate to $5.14 million, comprising $4.72 million for consortium projects (see Table 6-1) and $0.41 for research (see Table 6-3). (The summation discrepancy is due to rounding off).

7. PROJECTS IN PIPELINE

A significant number of proposals are now being considered for PACER funding.

7.1 "Pipeline" Projects Data

Numerous proposals or "project profiles" have received some processing within the PACER system and await further action. Some have been discussed by the PRC and have been sent back to the secretariat for revision. Others are still being processed within the Secretariat prior to possible submission to the PRC.

Table 7-1 summarizes the projects "in the pipeline."

Table 7-1 Projects in the Pipeline

1. Projects Reviewed by PRC, under Formulation/Revision:

Proposal	Firm I.D.	Comments	Cost Rs.lakhs
Efficient lighting	BSES	Participation of other firms being facilitated	90
800 KV isolators	S&S	Secretariat reformulating	82
Briquette	Arun Fuels	Secretariat appraising	50
FBC drying of bagasse	Sika	PRC mandated consultant report	151
Paddy cogeneration	Punjab	Organization of firms under way	1000
PV	Suryovonics	Development content under review	222
Battery bus	BHEL	Relative priority under review	52
Electrode membrane	Centr. Elec.	Need suitable manufacturing unit in consortium	524
Stirling	Stirling Engines	Proposal being reformulated	18
SUBTOTAL			2189

(continued overleaf)

Table 7-1 (continued)

2. Projects submitted or discussed at Secretariat level only:

Description	Cost Rs.lakhs
Recuperative air preheaters	700
Vacuum recloser, distribution	30
Coking technology, Indian coal	150
Waste combustible enrichment	50
Anerobic digestion of waste	600
CNG kit for vehicles	100
Pinch technology heat exchanger networking	150
Solar pond desalination	108
Microprocessor energy management	187
Gasification of black liquor	220
Methane from molasses, gas turbine	850
SUBTOTAL	3145
GRAND TOTAL (PRC-reviewed and non-reviewed):	5334

7.2 Pipeline Disbursement outlook

The maximum possible expenditure from PACER funds (at an estimated maximum PACER contribution of 65%) would be, from Table 7-1, some Rs. 35 crores or about $17 million. Such a level of disbursement would exhaust the present PACER funding. An alternative guideline might be to consider only the projects that have already undergone PRC review. At a 65% PACER

contribution, the total from these reviewed projects would be some Rs. 14 crores or $7 million.

In either case, the estimates above do not take into account that in the past, a large proportion of projects submitted have been eventually rejected, so disbursements on either reviewed or unreviewed "present pipeline" projects should be much less than that the figures mentioned. Extrapolating from the admittedly small past experience, the amount of the PACER contribution that might realistically be expected to be expended on both reviewed and unreviewed pipeline projects -- neglecting all future proposals and the current plans for projects to be let through RFPs -- could be some $8 million.

With more stringent project review, -- as suggested below in the Recommendations (Section 9) -- it might be estimated that actual PACER grants to all projects now included in the pipeline would amount to about $5 million.

The extremely speculative nature of such estimates must be underlined. However, these estimates would imply that total expenditures on projects to date and probable pipeline projects would be $10-13 million -- plus future administrative and research and policy study costs. This should leave adequate leeway to fund additional unsolicited proposals as well as RFP-generated projects within the $20 million total budget.

PART TWO: ISSUES, RECOMMENDATIONS AND CONCLUSIONS

8. ISSUES

Issues examined during the midterm evaluation included both the status and outlook for the PACER objectives (see Section 3) and issues associated with the day-to-day functioning of the Secretariat and the rest of the project organization.

8.1 Issues -- PACER Objectives

The five PACER objectives are energy technology development, commercialization, research utilization, industrial institution-building, and financial innovation.

More detailed descriptions of the subprojects mentioned in the discussions below will be found in Annexes 6-A and 6-B.)

8.1.1 Energy Technology Development

The concept and procedures of PACER are novel and somewhat unconventional and it has taken time to percolate down to R&D institutions and industry. The expectation was that PACER would be able to attract proposals with ease, from the very start. This has not happened. The PACER Secretariat under the guidance of ERDAC and PRC had to devise techniques of information dissemination and project solicitation. The projects approved

so far indicate that the response from all the sectors has not been uniform. There is a general feeling that the power sector, for example, which was identified as one of the priority sectors in the PP, has not been able to come up with innovative projects -- perhaps because of economic constraints or rigidities in the industry structure.

The technology associated with projects approved are of various kinds. While some of them (e.g., the regenerative burner under Project 2 and the combustion control system under Project 3) are capable of immediate commercialization, there are others (e.g., the fuel cell under Project 4 and the PFB gasifier under Project 12) that will take time to commercialize. Furthermore, technologies involving geographical or feedstock limitations (e.g., wind, fuel cells) may not fit well into Indian energy priorities. However, overall, the choice of projects and the variety of technologies has been encouraging.

The PACER Secretariat has organized numerous promotional activities to disseminate information relating to the PACER project: participation in energy conferences and seminars, presentations to exclusive audiences in different parts of India. The PACER Secretariat has shown enthusiasm and earnestness in attracting good projects from various energy sub-sectors, and if the response has been slower than desirable, it cannot be attributed to the lack of effort of the Secretariat.

The question of priority in energy areas is beginning to arise. PACER's goals and objectives are very wide ranging but its resources are limited. The objective of making a major impact therefore makes it all the more essential to examine any

implicit priorities in the PACER selection process. So far, because of the small number of suitable projects identified, this problem has been in abeyance. But in the future, it seems reasonable that a policy of "well-roundedness" -- within the overall framework of Indian national priorities -- would best suit a demonstration project of the modest size of PACER.

The next question is: are the goals of PACER served more effectively by concentrating on a large number of smaller projects or a preponderance of high-budget projects which can only be a few in number due to budgetary limitations? Should rough targets be indicated: e.g., two thirds of the budget to be reserved for projects costing less than so many millions of dollars? The consequence of such a policy would be to virtually rule out any new projects in the coal or larger power plant technologies. A prudent solution might be to aim for an equality of shares between big and small projects and give ERDAC/PRC the flexibility to make adjustments depending on the targets of opportunity.

The next question is about the selection of organizations. Are larger firms more likely to produce timely results of the desired quality? Here again there are no universally valid answers: the quality of company operations (especially regarding the speed of their decision making process), the commitment of the top management (financially as well as managerially), the composition and motivation of the team and the caliber of the team-leader, and the availability of internal funds and facilities to carry out the project are key decision factors. Bigness by itself is no advantage: after all, one of the PACER

subprojects with the slowest startup pattern is with two organizations which are giants in their fields!

Nevertheless, the present restrictions on the size of the PACER budget may suggest some reasonable project size limits for the near term.

8.1.2 Commercialization.

The PACER Secretariat has been successful in identifying entrepreneurs with imaginative engineering design ideas that show promise of ready commercial sales, in particular, the oxygen-sensing combustion control, the regenerative burner, and the fluidized bed for heat treatment -- all of which seem to be adapted to specific markets for equipment for small-scale industry.

The market for electric power from new sources like the biomass gasifier (Project 5) and the aeroengines (Project 8) will depend somewhat on attitudes of electric boards, but the commercialization potential is there. For the amorphous-core transformers, the market prospects seem good, under a mandated policy of a fixed market share for the new product.

A specific "sleeper" market of great promise is that for the deep-cycling lead batteries (Project 11), in the context of a vast unfilled need for cheap, reliable backup power.

There is a always a problem in choosing a precise definition of commercialization and the connected questions related to the selection of projects and technologies during the evaluation of projects. In many cases, where development groundwork has already been done, the logical step is to choose

projects that can be developed to full commercialization and market penetration with the support of a PACER grant. However, the phrase "Acceleration of Commercial Energy Research" leaves some ambiguity about the status that a product or system should have attained before it becomes eligible for consideration under the PACER program. Is "development," sufficient, or must true "commercialization" be the PACER goal?

This issue becomes a topic of discussion in the context of projects such as the one on fuel cells (Project 4), which is in no way capable of generating any funds for a considerable period of time. While every technology development fund typically supports some high potential, high risk, long-gestation-period projects, these projects should not produce a neglect of other high priority projects. In other words, a suitable balance between "development" and "commercialization" needs to be established.

Then comes the question of energy economics. Commercialization plans that do not take into account the insights gained by trained energy analysts in their studies of the history of attempts to develop new energy technologies run the risk of foundering on predictable technical and marketing difficulties -- especially in the field of renewable energy technologies. Naturally, since some simplistic methods of financial comparisons may be loaded against high-capital cost renewable and clean technologies, appropriate methods of comparison must be based upon life cycle costing, take into account the direct and indirect costs of pollution, consider ecological damage in the short as well as the long term, take

into account subsidies and hidden costs, and consider local national problems such as shortage of foreign exchange.

The PACER staff does not presently have the competence to deal adequately with such questions: the addition of outside consulting help from qualified organizations in the early stages of the appraisal process is indicated (see Section 8.2 below).

8.1.3. Research Utilization

A large gap is widely recognized to exist between the knowledge and expertise available in research institutions and universities and their utilization by the industry. This impression has been reaffirmed in many of the conversations the team members had with a wide spectrum of concerned individuals.

At a national level, the task of attacking this problem of generating indigenous technologies was initially assigned to the CSIR laboratories -- which till recently did not have any linkage to the marketplace in the energy and power sectors. Even in the relevant engineering fields, the motivation of the research workers has been publication of research reports rather than the commercialization of engineering prototypes. The reluctance of government agencies to fund R&D projects in the private sector has further discouraged a closer cooperation with CSIR institutes with industry.

There have been a number of contacts between the PACER Secretariat and R&D institutions under Council of Scientific and Industrial Research (CSIR), and cooperation has been noted wtih ERDA under the Amorphous Transformer subproject (Project 10). However, in practice in most subprojects the primary R&D support

comes from in-house capabilities -- in those cases in which R&D support derives from external institutions, it is mainly in the form of testing, mathematical modeling and system engineering and problem solving during prototype development.

Other potential resources, like the universities and the Indian Institute of Technology (IIT), normally concentrate on teaching and basic research rather than on industrial applications. The IITs do, however, have a policy to encourage their staff to interact with the industry and permits them to sell their expertise and knowledge through consultancy arrangements. They often therefore provide theoretical backup and analytical and software inputs to industry, but they cannot be expected to take a leadership role in the process of commercialization of technologies. It is in such backup roles that they have been observed to figure in the ongoing PACER studies.

Under such conditions, the linkage with outside research in the consortia projects has been weak.

PACER supports research directly, however, under components Two and Three of the project. These projects have served to foster bonds between the research community and industry -- if often only indirectly.

8.1.4 Industrial Institution-Building.

The PACER concept of bringing together of the manufacturer, the user and a research organization to undertake a project makes a great deal of sense, especially in the current Indian context, although the introduction of a certain degree of flexibility may improve its functioning.

In the consortium projects PACER has quite rightly put the emphasis on industrial organizations taking the leading role. The industrial firms must typically identify their knowledge gaps and find research organizations and experts to provide the missing inputs. PACER has now provided a new approach to institutionalizing these arrangements -- under a "consortium" of whatever nature --which can help to increase the frequency of such interactions.

There have been difficulties in setting up consortia in the classical sense of the word -- companies venturing jointly on a project, sharing investments and profits or losses. The pattern, instead, has been for one consortium member to act as the entrepreneur -- while the other one(s) acts as a guinea pig (end-user) or a consultant (research institution.)

In summary, creating a pseudo-research organization simply for the sake of fulfilling the conditions set down for a PACER subproject may sometimes not be either possible or desirable. If a two member consortium has adequate technical and scientific expertise and fulfills other criteria for obtaining PACER support, the inclusion of a third member may be pointless.

In Component Two or Three research projects, incidentally, where inputs of national or international experience on technical, economic, or operational matters would improve the quality of the conclusions, a consortium approach for research with Indian or non-Indian membership may be useful.

One of the contributions of the PACER program which must be very highly rated is its emphasis on bring the users and manufacturers together in joint programs. As in any sellers' market, the role of the user in technology development has been weak in India. This is also true of the energy and power sectors. PACER projects have been observed to help bring about a change both in the attitude of the manufacturers and of the end-users by making them share the risks of the development process -- even though there may be no direct financial involvement of users in many of the current projects, their involvement in testing and operations is of immense advantage in the evolution of market oriented reliable products and systems.

As part of the institution-building aspect of PACER, the desirability of involving a large number of different firms in the project may be noted. Furthermore, the role of alternative avenues of funding for given subprojects and organizations may well be taken into account.

8.1.5 Financial Innovation

Conditional grants were used in India in the PACT programs, for one, but the idea has received much publicity as a result of PACER: PACER may fund up to 50% (now informally 65%) of the total cost of a project, or $3 million -- whichever is less.

The project grantee promises to pay back 200% of the PACER financing upon commercialization of the technology; however, if the technology does not succeed in being commercialized, the grantee does not owe anything to PACER. Essentially, the conditional grant is a form of risk financing, where the grantee pays back only if successful.

In fact, it is in the area of financing that perhaps some of the major achievements of the PACER project have been made. While the idea of conditional grants is novel, potential grantees seem to be becoming accustomed to the idea. Some see it as a rapid, red-tape-free loan for development. Alternately, it is looked on by others as analogous to the familiar pattern of royalties paid under a licensing agreement. The solid reputation of ICICI in Indian credit circles, plus the familiarity of many potential grantees with the PACT program, has evidently aided in the growing acceptance of the PACER approach. There is also some evidence that despite the conditionality of the grant, some grantees would feel pressed to make repayment under any conditions to preserve a good credit rating. The maximum of 50% financing was felt too rigid by PACER Secretariat and project developers, and this maximum is in the process of being increased to 65%. Except for some complaints from ongoing project sponsors about the rigidity of the 50% rule, the conditional grants, once explained, seem to be viewed positively. One dissenting comment, however, came from a grantee who felt that the conditional grant was actually an incentive to fail because, then, the grant would not have to be paid off. This was a reference to the possibilities of

manipulating the technology and the institutional arrangements so as to give the perception of failure. Although the possibility of this exists, the presence in the PACER project of a strong development bank with extensive dealings in the Indian private and public sector is a constraint to manipulation. Grantees felt that they could not afford to default on ICICI's grant, to avoid any negative impressions of their company and future possibilities of borrowings.

Increasing the maximum amount of PACER financing from 50% to 65%, however, should provide enough flexibility to the program implementers. A further increase in percentage financing might dilute the value of financial commitment from the project sponsors and provide less of an incentive for strong commitment to project success.

8.2 Issues -- Program Functioning

The evaluation team considers that the PACER program has functioned extremely well under a very difficult set of boundary conditions. The support provided by ICICI management and organization to PACER is exemplary and it is hoped that this will be continued in the future.

The startup period was slow: PACER was a new concept and that the staff was necessarily on a long learning curve. There has been a marked change of pace recently, perhaps reinforced by public awareness generated at the PACER conference in April 1990, and there is likely to be a considerable pick-up in the tempo of PACER activities in the coming years. It will therefore be essential to become more critical in the selection

of projects. The present resources available for this purpose will not be able to cope with the increased work and still preserve quality of decisions and indeed improve them in the area of energy economics and technology analysis. Indeed, The PACER staff are new to the energy sector but have acquired knowledge of many of the technologies involved both in conventional and new energy areas. They discharge their functions with confidence and have been taking considerable initiative in soliciting projects. However, they do not have, nor can they be expected to have, in depth knowledge of the many technologies and markets they deal with. DNES staff have given a great deal of help in this area, and it is indeed fortunate that an agency involved in nonconventional energy is project coordinator -- but DNES help is necessarily restricted by the nature of conflicting time demands. The PS must then often depend largely on literature survey and studies for assessing proposals. Specialists (individuals as well as consultancy companies, IITs and engineering colleges, and research institutions) could usefully be retained as consultants by PACER to assist the PRC and the project staff in carrying out the technical evaluation of proposals received. One or more experts, chosen for their expertise related to a specific project, might be given the assignment on a case to case basis, or one or two firms might be able to handle all proposals.

As the discussion above implies, The PACER Secretariat (PS) is in danger of becoming understaffed, especially after the introduction of RFPs. The staff could well be strengthened with one or two more engineers and additional support help -- in

addition to indicated new outside consulting services in energy economics and technology.

In regard to the research components of the project: given the very wide scope of activities which Component Three is planned to support, all the projects chosen by the staff seem to be consistent with the objectives of PACER Program. The formulation of the project proposals have generally been comprehensive and the evaluation by PACER Secretariat satisfactory. There is, however, a need to make Component Three of the PACER Program more focussed. Those proposals for studies and feasibility reports that focus on areas and systems likely to lead to projects under Component One (Consortia projects) should be given strong preference.

Monitoring of the projects is being done regularly but a closer look at the data and results provided by the customers may be better. A quarter term, a half term and a completion review might be carried out by a team consisting of a member of the PRC, the consultant specialist(s) involved in the project appraisal, and the project staff.

The eventual financial self-sufficiency of the PACER program in the short as well as the long term context is an issue worthy of attention. Unless a substantial part of the money invested by PACER begins to pay back, it will have to depend on grants and loans to carry on its activities. While it is still too early to start talking about the self-sufficiency of the PACER program, it is not too early to start thinking of a long-term financial plan that would set goals defining a projected time frame for the generation of internal funds and the

period within which a defined percentage of its activities should be self-financed.

One of the biggest improvements introduced by PACER has been to provide access to the private sector to venture capital funds for technology development and to do so with an lack of hassle and red tape unknown in India. This unique style of program management should in no case be lost under the pressure of heavier work load expected in the future. Both the public and the private sector industries are beginning to appreciate the advantages of sharing the risk of development with PACER. Its impact as a model and in terms of technologies actually commercialized can be far beyond its modest level of capital employed -- provided the style of its operation and the manner of its interaction with the customers can be maintained. The efficient operation of the PACER Secretariat and the brisk style of ICICI management gives one the hope that this can be done.

9. RECOMMENDATIONS AND CONCLUSIONS

The recommendations presented here are organized in the same sequence as in the "Issues" Section, above -- according to the five PACER objectives and project functioning.

The Team strongly urges that the following recommendations be implemented as soon as possible and that all projects that have not been cleared and that are currently in the pipeline should be reviewed and evaluated accordingly.

9.1 Recommendations -- PACER Objectives

The following recommendations are made in the fields of encouraging energy technology development, promoting commercialization, making better utilization of research in the energy sector, building new institutions in the Indian energy industry, and innovating in energy-related financial markets.

9.1.1 Energy Technology Development

PACER does not have an established set of priority areas for the sifting and selection of projects. So far, because the number of projects have been below the level of funding anticipated, there has not been any real need to establish strict priorities.

RECOMMENDATION 1: A WELL-ROUNDED AND FLEXIBLE APPROACH TO THE VARIOUS FIELDS OF ENERGY TECHNOLOGY SHOULD BE MAINTAINED, AND NO STRICT PRIORITIES SHOULD BE ESTABLISHED, AS LONG AS THEY ARE CONSISTENT WITH THE GENERAL PRIORITY PHILOSOPHIES OF THE NATIONAL ENERGY PLAN.

One of the most important objectives of PACER is to maximize the impact of the $20 million funded under the program, and it is therefore crucial to take into account in the design of subprojects any potential for inducing a multiplier effect. It is also important to have an optimum mixture of small, medium and large projects in order to balance potential benefits with the risks of failure.

RECOMMENDATION 2: THE MAXIMUM AMOUNT OF PACER CONTRIBUTION TO ANY PROJECT BE LIMITED TO $ 2.0 MILLION.

For a maximum multiplier effect, it is important to spread PACER funds among as many organizations as possible.

RECOMMENDATION 3: NO SINGLE ORGANIZATION BE THE PRIME CONSORTIUM OR RESEARCH PROJECT LEADER ON MORE THAN TWO PROJECTS.

In order that PACER become a catalyst in providing financing to the small and medium-size manufacturers, end-users, and research organizations, it is important that a strong evaluation be made of the prospective grantees, whether PACER

funds are absolutely necessary for their proposals and if the project would continue even without PACER funding.

RECOMMENDATION 4: NO ORGANIZATION THAT HAS ADEQUATE FUNDS FOR PROPOSED SUBPROJECTS EASILY AVAILABLE FROM ITS INTERNAL SOURCES OR HAS READY ACCESS TO FUNDS OTHER THAN PACER SHOULD BE GIVEN PACER FINANCING. THIS EVALUATION SHOULD BE CONDUCTED AT THE PRE-APPRAISAL STAGE ITSELF, SO THAT COMPANIES THAT ARE NOT ELIGIBLE DO NOT HAVE TO GO THROUGH THE PROPOSAL AND APPRAISAL STAGES.

The PACER program is due to start issuing Request for Proposals (RFPs) for technology development and commercialization areas that have not been covered so far and are critical to the Indian energy sector. It is important that unsolicited proposals and RFPs coexist side by side, with the RFPs filling in some niches that the unsolicited proposals are not covering.

RECOMMENDATION 5: THE RFP TOPICS SHOULD BE CAREFULLY REVIEWED BY THE PRC/ERDAC AND SOME EXPERT INDIVIDUAL/ORGANIZATION SELECTED FOR THIS PURPOSE, BEFORE THEY ARE PUBLISHED AS RFPS.

The PACER Secretariat, after receiving proposals, goes through a stringent project review and appraisal process. Although the process is going fairly well, some of the technical areas are not receiving the amount of coverage that is necessary.

RECOMMENDATION 6: PROJECT APPRAISALS SHOULD INCLUDE COMPETENT EVALUATIONS OF TECHNICAL, ECONOMIC AND FINANCIAL ASPECTS OF THE PROJECTS. THE ECONOMIC ANALYSIS SHOULD INCLUDE METHODOLOGIES WHICH TAKE INTO ACCOUNT ALL RELEVANT FACTORS RELATED TO CONVENTIONAL AND RENEWABLE ENERGY TECHNOLOGIES, INCLUDING LIFE-CYCLE COSTING, HIDDEN COSTS AND SHORT- AND LONG-TERM ENVIRONMENTAL IMPACTS. A FORMAL LIST OF ORGANIZATIONS AND INDIVIDUALS BE CREATED WITH EXPERIENCE IN THE TECHNOLOGY AND ECONOMIC AREAS. ONE OR MORE OF THE MOST RELEVANT ORGANIZATION OR INDIVIDUAL, CHOSEN FOR THEIR PARTICULAR EXPERTISE, WOULD BE CALLED UPON TO REVIEW EACH PROPOSAL APPRAISAL AND BRIEF THE PRC/ERDAC. THEY SHOULD NOT BE MEMBERS OF ERDAC/PRC AND THEIR TIME SHOULD BE COMPENSATED.

RECOMMENDATION 7:THE PROJECT APPRAISAL SHOULD INCLUDE A SEPARATE SECTION ON "ENVIRONMENTAL CONSIDERATIONS". BECAUSE OF THE IMPORTANCE OF ENVIRONMENTAL ANALYSIS IN ENERGY PROJECTS, THIS SHOULD BE AN IMPORTANT CONSIDERATION FOR ALL PACER-FUNDED PROJECTS.

No standard, uniform methodology exists for carrying out a fair and comprehensive comparison of conventional and renewable energy technologies, taking into account life cycle costing and current and future environmental costs.

RECOMMENDATION 8: PACER SHOULD FUND AT A MODEST LEVEL A RESEARCH PROJECT TO ESTABLISH AN EVALUATION METHODOLOGY TO BE UTILIZED IN ALL EVALUATIONS OF SUBPROJECTS.

The outside advisory sources could also be tapped for suggestions for new PACER projects.

RECOMMENDATION 9: PACER SHOULD COMMISSION SURVEY STUDIES TO GENERATE CLASSES OF NEW IDEAS FOR SUBPROJECTS.

ERDAC is the apex policy making and guiding body to PACER. Its role and responsibility is to ensure that PACER funds and objectives are committed to projects that have the maximum impact on the energy sector, whether conventional or renewable.

RECOMMENDATION 10: THE COMPOSITION OF ERDAC SHOULD BE EXTENDED TO ALSO REFLECT ENERGY SECTORS LIKE OIL & GAS AND INSTITUTIONS LIKE CSIR AND THE PLANNING COMMISSION.

PACER is seen as being a catalyst in India's energy sector by trying out innovative strategies to develop technologies and bringing them to the commercialization stage. In the project selection section, we have made certain recommendations -- like size limitation, number of projects any organization can undertake -- that would result in PACER having more of a multiplier effect.

RECOMMENDATION 11: PACER SHOULD AT PERIODIC INTERVALS, ARRANGE SEMINARS/WORKSHOPS, NOT ONLY TO FAMILIARIZE THE INDUSTRY WITH the PACER CONCEPT, BUT ALSO TO PROMOTE THE GENERATION OF NEW IDEAS WHICH MAY LEAD TO CONSORTIUM PROJECTS.

9.1.2 Commercialization

Commercialization is perhaps the most important pillar of PACER. It is specifically because know-how and technologies are not coming to the commercialization stage that the PACER program was designed.

RECOMMENDATION 12: THE PACER SECRETARIAT SHOULD GIVE PRIORITY TO EFFORTS TO PULL IN EXPERTISE FROM ITS PARENT ORGANIZATION TO ASSIST IN THE COMMERCIALIZATION STAGE OF THE CONSORTIUM PROJECTS, ON AN AS-NEEDED BASIS.

9.1.3 Research Utilization

PACER has three components: consortium projects, research projects directly related to consortia, policy studies and outreach. So far, there are no research studies that directly deal with assisting areas dealt with under consortium projects, as the project design envisaged.

RECOMMENDATION 13: COMPONENTS TWO AND THREE SHOULD BE MERGED. ALL RESEARCH PROJECTS BE DIRECTLY LINKED WITH CONSORTIA PROJECTS, EITHER ON TOPICS THAT ARE BEING DEALT WITH BY CONSORTIA OR WILL LEAD TO CONSORTIA PROJECTS.

PACER's strength is in providing funding to projects that deal in technology development and commercialization. There are many policy areas that are valid to the Indian energy sector, but there are many other funding sources that fund such projects.

RECOMMENDATION 14: PACER SHOULD NOT FUND ANY POLICY STUDIES. ONLY CONSORTIUM PROJECTS AND RESEARCH PROJECTS THAT ARE DIRECTLY RELATED TO CONSORTIUM PROJECTS SHOULD BE FUNDED.

9.1.4 Industrial Institution-Building

The classical consortium definition has not really been applied as of now. But we believe that because of the innovative nature of consortia and its importance and timeliness in the Indian energy context, the consortia concept has been useful.

RECOMMENDATION 15: THE CONSORTIUM CONCEPT SHOULD BE CONTINUED UNDER THE PACER PROGRAM. CONTINUED ATTENTION SHOULD BE PAID TO THE MANUFACTURER/END-USER COLLABORATION.

9.1.5 Financial Innovation

The conditional grant is a new concept that PACER introduced into India. Although project promoters had difficulty understanding the concept at first, once they did understand, many were very receptive to the idea. While some fine-tuning has already been done with conditional grants, for example, by increasing PACER funding to a maximum of 65%, caution needs to be exercised.

RECOMMENDATION 16: THE MAXIMUM AMOUNT OF PACER FINANCING SHOULD NOT BE INCREASED TO MORE THAN THE PRESENT 65%.

Having a uniform 200% return policy is not fair to the firm that pays back in two years versus one that pays back in 10 years; in other words, the rate of return should take the time value of money into account. PACER Secretariat should, with ICICI financial staff assistance, look into setting up a

categorization of the required returns according to the payback period.

RECOMMENDATION 17: CONDITIONAL GRANTS SHOULD TAKE INTO ACCOUNT THE PAYBACK PERIOD.

PACER, as envisaged, is a continuing organization; although USAID assistance will cease, the program should be self-supporting by then. It is not too early to think about planning towards self-sustainment.

RECOMMENDATION 18: PACER SECRETARIAT SHOULD DRAW UP A "FINANCIAL PLAN" TO BE SUBMITTED TO PRC AND ERDAC NO LATER THAN DECEMBER 31, 1991. THIS FINANCIAL PLAN SHOULD INDICATE THE LIKELY PAYBACK AMOUNTS AND THE ANTICIPATED PERIODS, AND WHEN IT IS LIKELY THAT PACER WILL BE SELF-SUPPORTING. AN ORGANIZATIONAL AND IMPLEMENTATION PLAN OF PACER BEYOND THE USAID ASSISTANCE STAGE SHOULD ALSO BE INCLUDED, IDENTIFYING POSSIBLE SOURCES OF ADDITIONAL VENTURE CAPITAL FUNDS.

9.2 Recommendations -- Program Functioning

The PACER concepts and objectives are valid and timely for India. The slow pace of funding can be attributed more to the novelty of the concepts -- consortium, conditional grant -- rather than anything else. Moreover, especially after the April 1990 PACER conference, the program has gained a lot of momentum and the Team sensed a lot of interest in PACER. Time is needed, however,to complete the on-going projects and to clear and complete new projects, a large number of which are in the pipeline.

RECOMMENDATION 19:THE PACER PROGRAM SHOULD BE EXTENDED BEYOND ITS PRESENT COMPLETION DATE OF JUNE 30, 1993 BY 3 YEARS TO JUNE 30, 1996.

There is at present a stringent project monitoring process. Project grantees submit a Quarterly Progress Report. Secretariat members make regular visits to project sites. However, there is the need for some outside monitoring and evaluation mechanism to be included in the formal process.

RECOMMENDATION 20: THE PRC/ERDAC AND THE OUTSIDE EXPERTS CONSULTED DURING THE PROJECT SELECTION AND APPRAISAL STAGE SHOULD BE INVOLVED IN MID-TERM EVALUATION OF EACH ONGOING PROJECT.

DNES has played a key role in the evolution and implementation of the PACER program and provides intensive guidance to the PACER Secretariat.

RECOMMENDATION 21: THE ROLE OF DNES IN THE PACER PROGRAM SHOULD BE MAINTAINED DURING THE REST OF THE PROGRAM PERIOD.

ERDAC meetings have been infrequent; excessive lapses of time between meetings could lead to a delay in the review and approval of subprojects.

RECOMMENDATION 22: ERDAC SHOULD HAVE MORE REGULAR MEETINGS, AT LEAST 4 TIMES A YEAR.

The PACER Secretariat should be commended for their implementation efforts and their enthusiasm for the PACER program. The PACER Secretariat is understaffed. This will be even more apparent when they start the RFP process, which takes much time and effort to conduct.

RECOMMENDATION 23: THE SECRETARIAT SHOULD BE STRENGTHENED BY THE ADDITION OF STAFF (E.G., AN ELECTRICAL ENGINEER, AN ADMINISTRATIVE AIDE) TO AID IN SUBPROJECT EVALUATION AND TO ASSIST WITH THE RFP PROCESS AND THE UNSOLICITED PROPOSALS.

Annex 1-A: Evaluation Scope of Work

PROJECT FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH: (386-0494)

SCOPE OF WORK FOR THE MID-TERM EVALUATION

BACKGROUND

The purpose of PACER is to develop, introduce, and test operational mode for indigenous technology innovation and development in the Indian energy sector. To achieve this, PACER provides financial assistance to catalyze the creation of goal-oriented, market-responsive consortia of manufacturers, research institutions, and/or end-users for carrying out research leading to the commercialization of energy technologies. Support of up to US$3 million authorized to co-finance R&D subproject costs of technology development consortia on a conditional grant basis. If the R&D subproject succeeds, the promoters repay twice the grant over a period of commercialization; if the R& subproject fails, the grant is written off. Criteria for consortia eligibili are:

(a) It envisages the development of a new or innovative product or process relevant to the Indian energy sector;

(b) It represents a consortium of Indian and/or U.S. manufacturers, researcl institutions, and end-users; and

(c) It shows significant potential for commercialization within a period of five years.

In addition to this main component of developing R&D consortia, PACER a] includes two other, closely related components: (1) a competitive awards component for supporting energy research, and (2) an analysis and outreach component. The latter component includes project strategy formulation, polic analysis, and information dissemination through training and promotional activities.

PACER is being implemented by the Industrial Credit and Investment Corporation of India Ltd. (ICICI) in Bombay under a US$20 million grant agreement which was signed in August 1987 and which became fully operational mid-1988. An apex Energy Research and Development Advisory Committee (ERDAC) comprising distinguished experts from government, academic, private sector, a professional bodies has been set up to provide policy and strategy guidance f the project. This apex advisory committee, as well as a working-level Peer Review Committee (PRC) through which R&D sub-projects are screened, are both chaired by the GOI Ministry of Energy's Department of Non-Conventional Energy Sources (DNES), which provides operational guidance to PACER.

To date, PACER has approved and funded twelve (12) consortia R&D subprojects and nine (9) research studies (including one conference) at a cos of US$2.4 million. These approved subprojects cover product/process development in energy conservation, power generation through renewables, and supporting analytical studies on management and policy in the Indian

power/energy sector. As of January 1991, two (2) consortia R&D subprojects a five (5) research studies will be completed.

STATEMENT OF WORK:

The first purpose of this evaluation is to provide - for both the United States Agency for International Development (USAID) and for the Government of India (GOI) - a set of specific and feasible recommendations for enhancing and further the accomplishments of the Project for Acceleration of Commercial Energy Research (PACER) during the remaining life of the project. Under present plans, PACER will continue for at least three more years, and the recommendations from this evaluation have great potential for directly affecting the future of the project.

However, in order to provide these recommendations, the contractor must first evaluate comprehensively the design, implementation, and impacts of the project. Accordingly, developing this "status report" constitutes the second purpose of the evaluation.

Specific Issues and Sample Questions To Address

The evaluation will focus on five (5) specific questions about the PACER project. These five questions are listed below, along with a number of possible sub-questions for each. While these represent the main concerns of USAID and GOI at the present time, the contractor's first task will be to review this listing and to develop a final set of evaluation questions and sub-questions.

Question #1 - Is the DESIGN of the PACER project appropriate to address effectively the four guiding premises which encouraged USAID and the GOI to proceed with the project?

The idea of developing consortia of manufacturers, research institutions and/or end-users to promote R&D is new for India, and this "consortia" concept is based on four important premises:

1. The first premise 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. When technology innovation has taken place, regardless of its quality, it has often been in isolation from the commercial and industrial sector and has, as a result, been irrelevant to the demands of the marketplace.

2. 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, rapidly growing markets for more technologically advanced products, and growing concern with the local and global environment 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 in the world market, are also favorable to technology innovation.

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

4. The final premise is that, in order for market-driven R&D interactions tc be successful, the institutional infrastructure to facilitate the process mus 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 relevanc of sponsored research, and stimulating public awareness and discussion of important R&D issues.

If effective in the energy sector, the concept of using consortia to promote development of goal-oriented and market-responsive technological innovations could be adapted to other sectors. However, this concept must first be validated in the context of the above premises. Possible sub-questions include:

* What are the various consortia models examined by PACER?

* Is there any one (or more) consortia model more suitable for encouraging commercial R&D than other models?

* How appropriate is PACER's evaluation of the fitness of consortia while appraising proposals?

* Is the concept of using consortia for encouraging energy R&D a feasible concept for India?

* What has been the overall response/general reaction to PACER (e.g., number of inquiries, number of groups meeting with ICICI)?

* What are the attitudes of project participants in regard to technology development consortia, and how likely are they to participate in future consortia?

* What are the attitudes of other, potential participants, and how likely are they to participate in future consortia?

* Is there any evidence that others are emulating the consortium concept?

* Is there any evidence of increased GOI interest and encouragement for tl consortium concept?

* Why aren't more consortia being formed (e.g., 50% promoter's contributi complicated and time-consuming procedures, insufficient flexibility)?

* How can consortia best be encouraged?

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Question #2 - How well has the PACER design been IMPLEMENTED?

The initial project plans call for a wide array of activities to be accomplished under PACER. Consortia are to be formed, priorities established RFPs issued, proposals received and reviewed, subprojects funded, etc.

Fundamental questions here include whether the integrity of the project conce has been maintained during implementation, whether PACER has the potential tc set the energy R&D agenda for India, and whether timely progress is being mad in the necessary activities. Possible sub-questions include:

* Has the concept of PACER been modified during its implementation?

* If so, why, with what consequences, and what lessons can be learned fron these modifications?

* What needs to be done to move PACER to "center stage" in the Indian ener arena?

* Have areas for R&D support been identified?

* How well do these R&D emphases mesh with India's energy needs and priorities?

* What are the roles and contributions of the ERDAC and the PRC?

* How well is the sub-project approval process working? Is there a need t adjust the frequency, scheduling, and/or competencies of the two main groups?

* What is the quality of interaction among ERDAC, DNES, ICICI, and USAID?

* Have annual operating plans been prepared and implemented? If not, how could this be done?

* Has an effective data collection and monitoring system been designed and operated?

* Has the RFP process been implemented?

* How effective and appropriate is the RFP process in the Indian context?

* How effective is the peer review process?

* Are the proper types of consortia R&D subprojects and energy research studies being funded?

* How rapidly are these subprojects and studies progressing?

* What efforts are involved in creating and maintaining these R&D subprojects and studies?

* How effectively are project managers interacting with project participants?

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* Have useful policy analyses been undertaken?

* Has there been increased information dissemination and/or public discussion on issues of importance to energy technology and energy research?

Question #3 - What are the current and expected ACCOMPLISHMENTS of the two (2 consortia R&D subprojects and the five (5) research studies completed to date

Subprojects and research studies are not being done simply for the sake testing the consortia concept. Each activity is expected to produce tangible benefits, either immediately or in the not-too-distant future, for India's energy sector. Possible sub-questions include:

* What types of subprojects and studies have been completed to date?

* What has been the quality and relevance of the research that was sponsored?

* How well did each subproject perform in relation to its original propose objectives?

* What specific benefits have been forthcoming from these efforts?

* What is the potential for these benefits to prove financially profitable to the consortia members?

* To what extent and in what ways will these benefits help India to achie its energy sector goals?

* How do these benefits relate to the initial investments?

* Is there any evidence that these benefits will be sustained?

Question #4 - Based on progress to date, is it likely that ADJUSTMENTS will b necessary in the project's completion date, funding levels, or both?

To date PACER has not expended funds proportional to the time it has be operating. Given that all projects, especially those with complex organizational arrangements, require reasonable start-up times, what can be predicted for the remainder of PACER? Possible sub-questions include:

* What have been the expenditures to date?

* How does this compare to original plans?

* Is it likely that a project extension and/or a budget adjustment will be necessary to accomplish PACER's objectives?

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Question #5 - What RECOMMENDATIONS can be offered to improve PACER for future years?

As noted earlier, the main purpose of this evaluation is to provide a se of effective and feasible recommendations to improve PACER even further. All activities by the contractor should be aimed at developing and refining these recommendations. To guide this process, possible sub-questions include:

* How can PACER be improved in each of these areas?

* What exactly should be done to implement each of these recommendations?

EVALUATION METHODS

This evaluation requires three separate types of data: (1) original plan for the PACER project, (2) qualitative perceptions of knowledgeable informant of the progress and impediments to date, and (3) whenever possible, quantitative data documenting the acccomplishments of PACER to date. The following sources of information are suggested for the use of the evaluation team:

(a) Available documents such as:

* PACER Project Paper
* Descriptions of projects approved with PACER funding
* Status reports on each project approved
* Descriptions of projects currently being developed or in the "pipeline"
* PACER brochure
* Semi-annual reports of PACER.

(b) Visits and interviews with knowledgeable persons such as:

* USAID, including the relevant technical office and other offices;
* GOI's Department of Non-Traditional Energy Sources (DNES);
* Industrial Credit and Investment Corporation of India (ICICI);
* Members of the project's Energy Research and Development Advisory Committee (ERDAC);
* Members of the project's Peer Review Committee (PRC);
* Consortia members, including private firms, research, institutions, and academics;
* Potential consortium members who have not joined a consortium;
* Other informed experts in the field.

(c) Secondary analysis of data from the project's data collection and monitoring system and from other sources.

It is anticipated that data will need to be collected in three separate geographic locations: Delhi, Bombay and Madras.

REPORTS

USAID requires frequent contact during this evaluation; regular discussions will be held among the lead analyst, the Chief, PPE (or his designee) and other USAID offices. In addition, a "story conference" will be held immediately upon completing all field work - but before beginning any writing - to discuss the emerging findings, to consider additional data which might be needed, to suggest possible further analyses, and to discuss best presentations of the findings and recommendations.

All raw data from the study, including copies of all data-gathering instruments and any compiled data sets, will be provided to USAID. Information from any confidential interviews will not be required to be made available.

The prescribed format for the evaluation report to be submitted to USAID/India includes the following:

1. Executive summary (covering main findings and recommendations)

2. Table of contents

3. Body of the report (with one chapter/section devoted to project background and status, evaluation issues and methods, evaluation team and time schedule). The rest of the report should be devoted to major issues, recommendations, and conclusion.

4. Annexures

5. References

RELATIONSHIPS AND RESPONSIBILITIES

Two Indian energy experts will be contracted via separate purchase order to work with two American experts as a four-person team. The team will have composite in-depth expertise in (a) energy technologies, (b) research and demonstration (R&D) efforts, (c) the approaches and operations of USAID, and (d) evaluation expertise.

Team Responsibilities

The team leader will take the lead and :

1. finalize the protocols before the team leaves on its field trip;

2. finalize the specific responsibilities of each team member with regards report writing;

3. finalize and submit to USAID a draft report 2 days before the presentation;

4. complete and submit the final report within ten days of receiving USAID written comments.

The contractor will:

1. focus on aspects as assigned by the team leader;

2. provide historical perspective of PACER project to the team;

3. act as a liason for contacts with GOI and energy groups; and

4. contribute to the production and revision of the draft and final reports

USAID official(s) will also accompany the team, as and when required, as resource person(s) with observer status mainly to expedite and facilitate the evaluation work. The contractor will receive technical directions from Mr. N.V. Seshadri, the Project Officer, TDE.

PERFORMANCE PERIOD

This evaluation will begin in mid-April 1991 and be completed by the end of May 1991. Within this time period, approximately 24 working days are required from each team member. In general, the following schedule will be followed:

Activities/Tasks	Work Days
In U.S.	
Review background materials and identify additional data needed	02
In India	
Study of additional documents, briefing and work plan	02
Discussions and site visits	11
Sharing observations and planning for the report	02
Team report writing/consolidation	03
Debriefing and feedback on the report	01
Revision/finalization of the report (for Group leader)	03

NOTE: For team leader, the workdays will be 27 days, 3 days more than the other team members.

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WORK DAYS ORDERED

Team leader	27 days
American energy expert	24 days
Indian energy specialist #1	24 days
Indian energy specialist #2	24 days

SPECIAL PROVISIONS

A. DUTY POST

New Delhi, Bombay, and Madras.

B. LANGUAGE REQUIREMENTS AND OTHER REQUIRED QUALIFICATIONS

None.

C. ACCESS TO CLASSIFIED INFORMATION

Contractor shall not have access to any Government classified material

D. LOGISTIC SUPPORT

ACSA food and recreation only.

E. WORK WEEK

A six-day work week is authorized for the field work.

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Annex 1-B: Data Sources for Evaluation

1-B-1. Documents:

a. PACER Project Paper
b. PACER Project Appraisal reports
c. Project Progress reports
d. Project Implementation Letters
e. PRC Meeting Minutes
f. ERDAC Meeting Minutes
g. TERI: "Future Themes And Directions for PACER".

1-B-2. Visits:

<u>Delhi</u>:

a. BHEL
Ramakrishnan, K. Director.

b. Department of Non-Conventional Energy Sources (DNES)
Gururaja, Dr. J. Advisor.
Meena, Jai Ram Principal Scientific Officer.
Sharma, R.K. Secretary.

c. IREDA
Bakthavatsalam, V. Managing Director.

d. Tata Energy Research Institute
Pachauri, Dr. Rajendra K. Director.

e. USAID
Beckman, R.W. Director, TDE.
Grant, John Chief, PDPS/PPE
Hendricks, Michael
Seshadri, N.V. Program Specialist.
Tran, Elyssa.

<u>Bombay</u>:

a. Bombay Suburban Electricity Supply (BSES)
Sishoo, M.L. Chairman.

b. ICICI/PACER Secretariat
Advani, A.J. Deputy General Manager.
Bhatt, Bharat.
Deodhar, V.M.
Tamhane, Sanjeev.
Vaghul, N. Chairman & Managing Director.
Vaidya, Dr. P.H. Assistant General Manager.

c. IGIDR
Parikh, Dr. Jyoti K. Senior Professor.
Parikh, Dr. Kirit. Director.

d. IIT, Bombay
Sukhatme, Dr. S.P. Professor of Mechanical Engineering.

e. Other Organizations
Betrabet, S.S. (Member, ERDAC)

Pune:

a: Thermax Limited
Joshi, Dr. N.D. Director, R&D

b. Trinity Forge Ltd.
Basu, Jagadish C. Chairman and Managing Director

c. National Chemical Laboratory
Patwardhan, Dr. V.S. Assistant Director, Chemical Engineering Division

Baroda:

a. Ankur Scientific Energy Technologies
Jain, Dr. B.C. Managing Director.
Jain, N.C. Director.

b. ERDA
Murthy, Prof. S.S. Director.
Padbidri, Dr. M.S. Additional Director.

c. Gandhi and Associates
Punater, M.B. Partner.

d. Powerlite
Patel, S.C. Partner.

e. Voltamp Transformers Limited
Mahajan, S.K. Assistant Manager

Hyderabad:

a. BHEL
Basu, K. Deputy General Manager.
Lahiri, K.C. Executive Director.
Ramakrishnan, N.N. Deputy General Manager.
Ramani, N.V.S. Manager (Gasification).

b. Hyderabad Batteries Limited
Prasad, Dr. A.J. Chairman.

c. Dr. Rao Associates
Rao, Prof. M. Ramakrishna, Chief Consultant

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Madras:

a. ENMAS Process Technologies
N. Chandrasekaran.
Ratho, Loknath.

b. Fluidtherm Technology
Gopinath, N. Managing Director

c. Nagadi Energy Systems
Jayaraman, T. Director
Prasad, Dr. Krishna V. Managing Director.

d. S&S Power Switchgear Limited
Balakrishnan, G.N. Management Accountant.
Madhavan, K.S. President.
Shah, Atul S. General Manager - Marketing.
Surendra, L. Manager Exports.

e. SPIC Science Foundation
V.P. Parathasarathy, Director of Research

Tiruchchirappalli:

BHEL
Ananthakrishnan, R. Manager.
Arunachalam, Dr. S.A. Deputy General Manager.
Malarkkan, K.M.V. Addl. General Manager.
Manivannan, T. Senior Manager/CCDP.
Narayanan, A.V. General Manager.
Srivastava, Dr. S.N. Senior Manager.

Washington, D.C.:

USAID
Archer, Robert Deputy Chief, Energy and Infrastructure, Office of Development Resources
Ichord, Robert Chief, Energy and Infrastructure, Office of Development Resources
Jhirad, Dr. David Senior Advisor, Office of Energy
Padmanabhan, S. Senior Energy Analyst, EPIC Program

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ANNEX 5-A: A Sample Project Review Case

The following is an example of the process of review, illustrated by Project 4 relating to the development and demonstration of a low cost combustion control system.

The project was received as a profile by the PACER Secretariat. It was submitted to PRC for review. The PRC recommended development of the profile as a project. The proposer developed the project with the guidance of PACER Secretariat. The project was reviewed by PRC at its meeting when the proposers made a presentation. The proposal was accepted by PRC. As the project cost was within the delegated powers of PRC the project was sanctioned by PRC and reported to ERDAC. This project has since been completed. The calendar of events in respect of this project is as follows:

- Date of Profile: February 16, 1989
- Review of Profile by PRC: March 29, 1989 (3rd PRC Meeting)
- Review of appraisal and approval by PRC: June 28, 1989 (4th PRC Meeting)
- Issue of sanction letter by PACER Secretariat: July 26, 1989
- Signing of Agreement for PACER Assistance: October 21, 1989
- Project commencement: November 1, 1989
- First disbursement: November 3, 1989
- Second disbursement: February 7, 1990

- Third disbursement: September 14, 1990

  Project completion: October 15, 1990.

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Annex 6-A: Details of Current Subprojects

The following are brief descriptions of the currently approved PACER projects:

PROJECT 1 -- ENGINEERS - HINDUSTAN (UDAIPUR)

Timing and Costs:

The original date of completion of this project was October 1991 -- actually the agreement has never been signed because of disagreements between the consortium members. PACER support is supposed to be Rs. 38 lakhs.

Goal:

Development and commercialization of a new software-hardware configuration that will optimize parameters of processes like regrinding after the two initial ore crushings. The prototype would then be scaled up and used in Hindustan Zinc Ltd.'s other plants and marketed to other mining operations.

Comments:

Unfortunately, it is uncertain if the consortium disagreements will ever be settled, and the future -- if any -- of the project is uncertain.

PROJECT 2 -- THERMAX - TRINITY (PUNE)

Timing and Costs:

The original date of completion of this project was October 1990 -- actual completion date cannot be estimated. Total project cost was Rs. 16 lakhs. PACER support was Rs. 8 lakhs, of which Rs. 7.5 lakhs were reported expended as of 31 March, 1991.

Goal:

Development and commercialization of a regenerative burner system that would increase energy efficiency in the forging industry -- by rapid cycling of air and combustion gases in an oil-fired furnace through a heat-retentive small-pebble medium.

The product would fill an empty market niche in smaller forging operations. Applications to the glass, aluminum, and ceramic industries are a possibility.

Comments:

Prototype and early field tests under production conditions on furnaces at Trinity Forge (a consortium member) were reported successful. In later field trials, which were handicapped by labor problems, the burner failed to achieve energy saving goals, possibly owing to air intake problems -- according to reports from the user. A conference is planned soon between ICICI and the consortium to plan for the installation of new field tests in a new Trinity facility planned for June startup.

Despite the failures, relations between the engineering firm and the end user appear good -- while the engineering firm bears the burden of the financial investment, the end-user has been willing to devote valuable production time and materials to the tests, believing that the process works in other countries and could also be effective here.

A problem has arisen in commercialization: Thermax will not be able to market the finished system, and licensees will have to be found.

PROJECT 3: NAGADI CONSULTANTS (MADRAS)

Timing and Costs:

The original date of completion of the project was October 15, 1990. The project was finished six months behind schedule, mainly due to last quarter pressures and increase in number of demonstration sites. Total project costs were Rs. 8 lakhs, with 4 lakhs supplied by PACER.

Goal:

To develop and demonstrate low cost combustion control system based on oxygen sensing.

Comments:

This is PACER's initial success story. The technology is developed, Nagadi has already sold one unit, and PACER has received its first payment.

Technology development is in the totality of the system and in the retrofit. The theoretical concept is nothing new. The potential fuel savings from using the combustion control systems is reported to be approximately 5%, although the end-user Brakes India reported savings as high as 13%.

Commercialization has started with one unit already sold. Nagadi plans to sell 88 units during the 91-92 fiscal year, which might be possible with some good marketing. Their first customer is very pleased with the results, and is almost committed to buying two more units. The developers do not seem to have very good marketing skills, however. The marketing and financial plans have not been well thought out.

The sponsors are a small business, and PACER funds were critical in proceeding with the development of Combcons.

The consortium approach has worked very well here, except that the first user pulled out for lack of commitment. In this project, there are elements of a true consortium where the members share the financial risks as well as the rewards. Besides Nagadi Consultants, Micro Controls has put in Rs.0.5 lakhs of the total $4.0 lakhs contribution from the sponsors.

One issue is, should the PACER Secretariat be more involved in the commercialization phase of the projects? The question is being able to balance time commitments between promoting projects versus ensuring projects already underway are successful.

PROJECT 4: SPIC (MADRAS)

Timing and Costs:

The subproject was scheduled to start in October 1989 and expected to be completed in 1992. commercialization was expected to start in 1994. The total cost of the project is estimated at Rs.21.0 million of which SPIC will contribute Rs.11.0 million and PACER conditional grant will be Rs.10.0 million.

So far two disbursements aggregating Rs.5.5 million have been made. An expenditure of Rs.5.93 million has been incurred up to 31.3.1991.

Goal:

Development and demonstration of solid polymer electrolyte fuel cells (SPEFC) stacks in the range of 1 to 5 KW. The demonstration unit will be set up in the existing chloralkali unit of SPIC at Manali near Madras, where supply of hydrogen is available on a continuous basis. After successful demonstration of the technology, SPIC proposes to commercialize the product.

Comments:

A few electrodes fabricated by SSF have been tested satisfactorily at the Centre for Electrochemical systems and Hydrogen Research (CESHR), Texas A&M University. Efforts to scale up electrode and design stacks are in progress. There have been some delays in procurement and import of materials due to recently imposed import restrictions.

Commercialization would depend on the cost of fuel cells and also the cost of fuel used.

PROJECT 5: ANKUR (BARODA)

Timing and Costs:

The projected end of the project and the beginning of commercialization is March 1992. The project seems to be on schedule. The total project cost is Rs. 29 lakhs, of which PACER is disbursing Rs. 14.5 lakhs.

Goal:

To develop a 500 KWe power generation system based on biomass gasification.

Comments:

Technology development consists of scaling up from a 100 KW wood gasifier, designing and installing an automatic feed system and an automatic control system.

Commercialization looks very feasible. Ankur has already sold 40 units of their 48 KW and a few units of their 100 KW wood gasifier. They know there is a demand for larger capacity gasifiers. The Rs.7000/KWh generating cost looks promising.

The sponsors of this project are not really members of a consortium. Both companies are owned by Dr. B.C. Jain, and ERDAC approved it as a special case.

PACER was a true catalyst in this project, since Ankur would not have been able to conduct this project without outside financial backing. Some issues:

1. How important is the consortium approach? This project is an example of one with all the right ingredients for PACER, except that -- in the final project form, omitting an earlier provision for a power sector end-user -- a consortium was not needed. However, efforts were subsequently made to construct a "consortium" in order to satisfy the rules for grantees.

2. The sponsors of the project complained about the rigidity of PACER funding rules. They felt that PACER should make distinctions between a) small vs. large business b) the group's ability to finance c) lower initial capital investment versus higher royalty upon commercialization. This is a critical issue that needs to be examined in further detail.

3.The sponsors also felt that a conditional grant was perhaps a motivation to fail, in that if the product could not be commercialized then the sponsors would not have to pay back anything to PACER. Perhaps PACER can build in stronger incentives to pay as well as to pay on time by staggering the required returns according to the payback time. It is not financially fair to charge a 200% rate for a project that is able to make the full return in 3 years versus another project that might take 10 years or more.

4.Wood as a fuel always presents the problem of deforestation. However, wood fuels are widely used under any circumstances, and the promotion of wood plantations and more rational management of forest resources present viable options.

PROJECT 6: FLUIDTHERM, MADRAS

Timing and Costs:

The project is scheduled for completion in Oct 1991. The total project cost is Rs. 82 lakhs, of which the PACER contribution is Rs. 41 lakhs

Goal:

To develop continuous fluidized bed heat treatment furnaces and their auxiliary systems.

Comments:

FLUIDTHERM is a company which was formed to develop and commercialize a new technology for heat treatment furnaces based on fluidized bed systems. The concept has many advantages but there are as yet only a few companies around the world engaged in its design and manufacture. With the drive, enthusiasm and commitment of its founder, FLUIDTHERM has been able to make a remarkable breakthrough in the marketplace in less than four years since its formation and sold about 60 furnaces.

The PACER project is a continuation of product development and commercialization activities of the company. It attempts to improve the operational flexibility and reduce the operating costs of the present intermittent furnaces by designing a system which will enable such furnaces to be operated continuously.

The owner of FLUIDTHERM is an unusual entrepreneur who without any formal technical education seems to have mastered the workings of a furnace and the intricacies of fluidization. His working methods appear unconventional and solutions appear to be evolved on the shop floor by a process of "solving by doing". For an industrial plant, the conditions appeared rather chaotic. There has been a fair amount of turnover of engineers in the first phase which has delayed the project but we were told that a good team of several engineers and process specialists has now settled down. A professor from IIT Madras acts as as a part time technical advisor to the team. There was an accident which damaged the equipment and necessitated a redesign of the system but FLUIDTHERM appears confident that the new furnace can be commissioned soon.

The project is ultimately likely to succeed but it may take longer to get to the final design than presently anticipated.

Project 7 -- MECON - BOKARO (RANCHI, BOKARO)

<u>Timing and Costs</u>:

The original date of completion for this project was January 1992. the agreement has not been signed yet, but signing is expected shortly. PACER support is scheduled at Rs. 5.5 lakhs.

Goal:

Development of a 15-kw desiccant cooling system that utilizes waste heat.

Comments:

The construction of a prototype desiccant cooling system is reportedly underway at Ranchi.

Project 8 -- LOTUS - NAL (BANGALORE)

Timing and Costs:

The original date of completion for this project was October 1990. Delays are reportedly due to obtaining licenses and permits.

PACER support is budgeted at Rs. 7 lakhs, of which 3.6 lakhs have been disbursed as of March 31, 1991.

Goal:

Conversion of phased-out aircraft engines and incorporation in an automated system that cogenerates 1000 KVA of electricity and 600 kg/hr of steam. Fuels are natural gas or methane from sewage sludge.

Comments:

The technical situation is this: the alternator system itself is reportedly working, but the noise problem has necessitated getting IISc help in redesigning the air intakes and constructing an acoustic enclosure.

PROJECT 9: FRP BLADES (BARODA)

Timing and Costs:

The project is schedules to be completed in April 1992. PACER support is scheduled at Rs. 16 lakhs.

Goal:

To develop Fiberglass Reinforced Plastics (FRP) blades for large size wind electric generators.

Comments:

Technology development involves process and manufacture of 11 meter long FRP blades with built-in air brake system. Gandhi Associates has previously developed blades up to 4.5 meters long for cooling tower fans.

Commercialization potential is questionable, since the only customer definitely identified so far for the product is GEDA, a state organization. Since GEDA has still not given a firm commitment to buying the FRP blades, Gandhi Associates has not started the project. This project was approved in April 1990 and was due to start in May 1990.

PACER funds are essential for this project. Gandhi Associates has an annual turnover of only Rs. 36.15 lakhs (annualized) and would not have been able to undertake a Rs. 32 lac project.

The sponsors were enthusiastic about the conditional grant mechanism, and the associated terms and conditions for payment.

One issue is whether having a sole possible buyer, a government agency at that, is enough to label a product as "commercializable".

PROJECT 10: PATSON (BARODA)

Timing and Costs:

The cost is estimated at Rs.4.8 million. PACER conditional grant is Rs.2.4 million. The balance Rs.2.4 million will be shared by Patson Transformers Ltd and its associates. The project started in September 1990 and is scheduled for completion in August 1993. Field testing will be done for 2 years from March 1993. Commercialization will start from September 1993.

Goal:

Development and demonstration of cost effective 3 phase 63 KVA amorphous core distribution transformers in order to reduce core losses and improve the efficiency of the distributive systems.

Comments:

The proposal is to make 25 prototype transformers of different sizes. One transformer of 25KVA has already been built and is ready for testing at ERDA.

This is an important project from the points of view of energy conservation and reliability of power supply. The proposers are a set of enterprising entrepreneurs and are keen on proceeding with the project. Though the formalities are still to be completed, they do not expect any difficulties in completing the project.

PROJECT 11: PLUMAC, HYDERABAD

Timing and Costs:

The project is scheduled to be completed September 1992. The total cost will be Rs. 55 lakhs, of which PACER will contribute Rs. 25 lakhs.

Goal:

To develop deep cycling lead acid batteries.

Comments:

Both the technology development and commercialization aspects have been very well thought out in this project. Despite the increased cost, Deep Cycling Lead Batteries have the advantages that are sought by many clients of Plumac.

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This is not a consortium project. Plumac is a wholly owned subsidiary of Hyderabad Batteries Limited.

The project sponsors and management are extremely qualified, and this increases the confidence of the Evaluation Team in the probable success of the project.

Project start-up has been problematic. Although the project was approved in August 1990, a consortium agreement has still not been signed. This is even more puzzling, given that Plumac is a wholly owned subsidiary of HBL. One issues is, how important is having a consortium to developing a technology and commercializing it? In this case, time and effort were apparently spent is trying to package the project to meet the consortium requirements of PACER.

PROJECT 12: BHEL (TRICHY)

Timing and Costs:

The cost is estimated at Rs.120 million. PACER contribution will be Rs. 55 million as conditional grant and BHEL will provide the balance Rs. 65 million. The R&D project will start in July 1991 and is scheduled to be completed in June 1994 (36 months). Commercialization is expected to begin in July 1994.

Goal:

Development and demonstration of 150 TPD Pressurized Fluidized bed coal gasifier (PFBG) for retrofitting to existing 6.2 MW combined cycle power plant at BHEL, Trichy.

Comments:

The proposal was approved recently at the 6th ERDAC meeting. The MOU and the agreement for conditional grant are expected to be signed shortly. BHEL has already established an 18 TPD PFBG pilot plant in Hyderabad, which has been test run for an aggregate 1000 hours with different kinds of coals. BHEL proposes to scale up from this plant the design for 150 TPD PFBG. BHEL has already been operating the 6.2 MW CCPP at Trichy using gas from an experimental fluidized bed gasifier. The proposal is to retrofit this power plant to the proposed PFBG. The site for the PFBG is earmarked.

This is the biggest project in terms of cost and commitment of PACER Grant and would require close monitoring. The technology development proposed is important from the point of view of coal utilization in India. BHEL could probably have funded the project with its own funds or R&D funds from the Government. This project does not fit into the consortium concept. The association of IIT-M is for assisting in mathematical modeling and simulation and testing -- the main R&D support is from within BHEL.

BHEL's commercialization strategy envisages building nine 15- or 30-MW IGCC plants by the year 2000 and perhaps, in addition, PFBG-fired gas turbines as a topping cycle for old small steam power plants and PFBGs to substitute for natural gas in existing CCPPs. Commercialization based on these concepts can only materialize in the long term, and PACER repayment is linked to total sales revenue from an uncertain pattern of

future plant orders. The CCPP at Trichy, retrofitted with the PFBG, does propose to continue to generate electricity and feed it into Tamil Nadu power grid. Since power from it is intermittent, however, BHEL gets only 45 paise per Kwh as tariff (compared to Rs. 1.20 it pays for the power they produce from TNEB). BHEL will not include this loss-producing revenue in the repayment plan -- unless the tariff were to be later revised consistent with the pricing policy followed for absorbing power from other new sources such as wind power.

Several issues may be raised:

1. Should such major projects be funded by PACER?

2. Should organizations such as BHEL receive PACER assistance?

3. How relevant and important is the consortium approach in the case of organizations such as BHEL, which have in-house R&D capability?

4. It is necessary to have a more definitive repayment plan in the case of such major projects?

Annex 6-B: Comments on Completed Research Projects

6-B.1 Technology Development for Solar Thermal Process Heat Applications in Medium Temperature Range.

This is a comprehensive feasibility study which fits in very well with Component Three goals. The technological and economic aspects of medium temperature process energy applications have been examined from the point of view of replacing coal by solar energy using vacuum tube parabolic collectors. The capability of the Indian Industry to design and build such systems has been studied, the costs of indigenous and imported components estimated and the economic boundary conditions for the viability of the solar system has been defined vis-a-vis coal. In the absence of an universally accepted methodology for comparing fossil and clean (renewable) energy technologies, standard methods have been used for the economic analysis which may need to be reexamined.

The report will form a solid base for formulating a RFP proposal for building one or more demonstration plants as a part of the commercialization program from which suitable Component Two research projects may also result. The results will also be useful for DNES in formulating their strategy regarding incentives and/or subsidies for promoting a technology which will save energy and reduce pollution.

The cost of the study appears reasonable and the results cost-effective.

6-B.2 Techno-economic Assessment of Compressed Natural Gas in Transport Sector in India.

This study also fits in well with the goals of Component Three research projects. If its recommendations are implemented, it could lead to the substitution of a substantial quantity of diesel fuel by natural gas, leading to a saving of foreign exchange and the reduction of pollution from over 120000 buses.

A technology review was done to establish that indigenous development of a conversion kit was possible and that the safety risks and fire hazards were no higher than in petrol or diesel buses. A calculation model was developed to examine the extent of substitution under various possibilities, taking the relevant costs and regional linkages into account. The results showed that the substitution of diesel by CNG would be the most appropriate solution under Indian conditions and conversion of diesel buses in urban centers the best way of doing that. The cities where such buses could be introduced were identified and discussion were held with industrial organizations interested in participating in a demonstration project. Adequate information has been provided to examine the possibility of formulating a RFP for a demonstration project. The report should also be sent to other concerned ministries and government agencies and attempts should be made to involve them in the consortium for

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implementing the project. Suggestions regarding government policies on gas pricing should also be conveyed to the concerned ministries for their consideration.

The project appears reasonably priced and results quite cost-effective.