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DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
Washington, D.C. 20523

PROJECT PAPER

I N D I A
ALTERNATIVE ENERGY RESOURCES DEVELOPMENT
(386-0474)

USAID/INIDA
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PROJECT DATA SHEET

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A. Initial FY 82 B. Quarter 3 C. Final FY 82

8. COSTS ($000 OR EQUIVALENT $1 = 9.00)

A. FUNDING SOURCE	FIRST FY B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	4630	370	5000	4630	370	5000
(Grant)	(4630)	(370)	(5000)	(4630)	(370)	(5000)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country		2285	2285		2285	2285
Other Donor(s)						
TOTALS	4630	2655	7285	4630	2655	7285

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) SD	B740	878				3500		3500	
(2) ARDN	B11	160				1500		1500	
(3)									
(4)									
TOTALS						5000		5000	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 160 | 950 | 960 | 242

11. SECONDARY PURPOSE CODE

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

A. Code	BR	RGEN	ENV	TECH			
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

(1) To expand India's technical capacity to exploit alternative energy resources and (2) to develop selected technologies to the application stage.

14. SCHEDULED EVALUATIONS
Interim MM 12 YY 83 | MM 12 YY 84 | Final MM 12 YY 85

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[XX] 000 [ ] 941 [XX] Local [ ] Other (Specify) _____

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Signature: Priscilla M. Boughton
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MM DD YY

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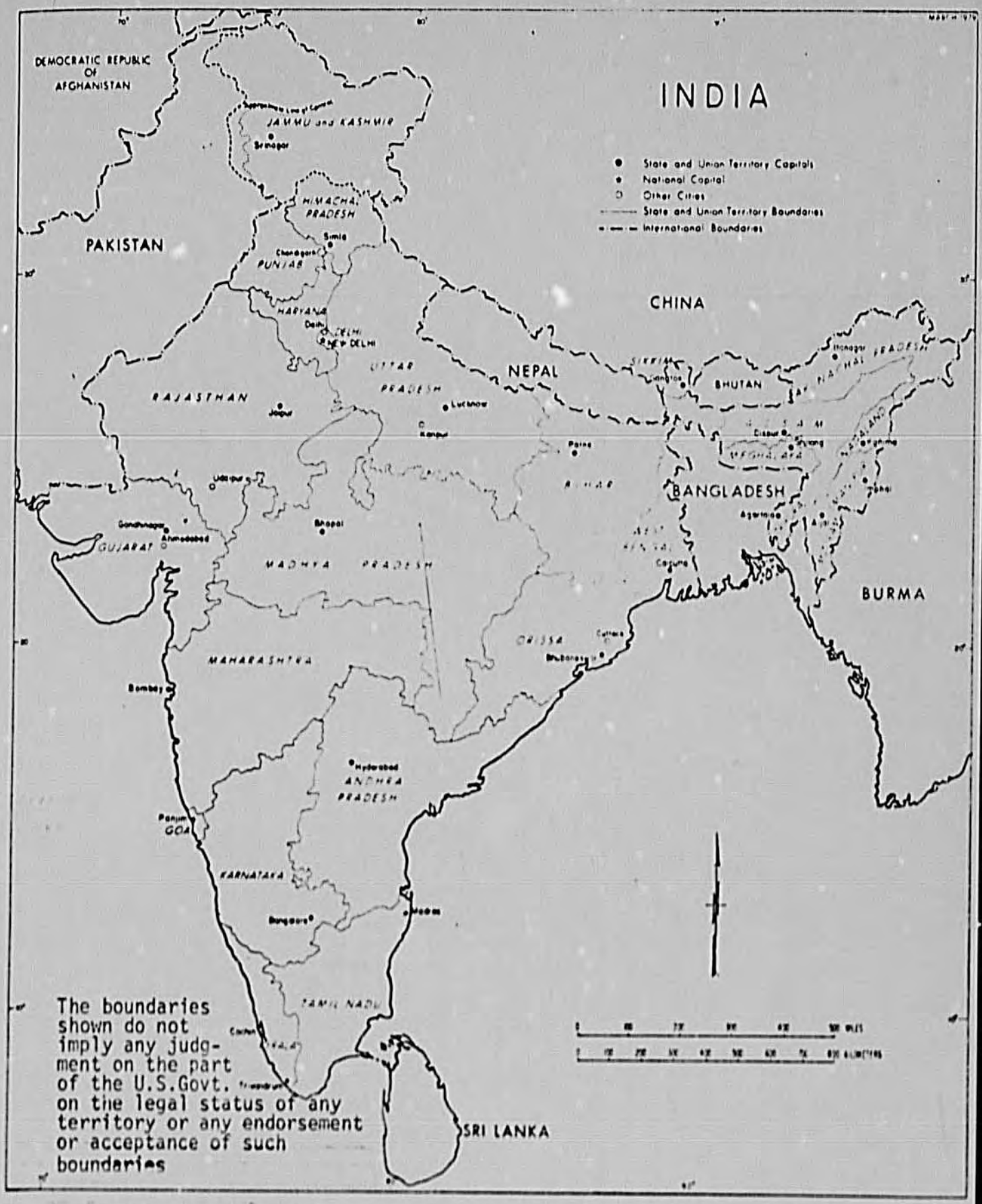

The boundaries shown do not imply any judgment on the part of the U.S.Govt. on the legal status of any territory or any endorsement or acceptance of such boundaries

CURRENCY		EQUIVALENTS
Currency Unit	=	Rupee (Rs.)
Rs.1	=	100 Paisa
U.S. $1	=	Rs.9.00
Rs.1	=	U.S. $0.11

ABBREVIATIONS AND ACRONYMS

AIEI	- Association of Indian Engineering Industry
CASE	- Commission for Additional Sources of Energy
BHEL	- Bharat Heavy Electrical Ltd.
CFRI	- Central Fuel Research Institute
DOE	- Department of Energy (U.S. Government)
DST	- Department of Science and Technology (GOI)
FBC	- Fluidized Bed Combustion
GOI	- Government of India
ICAR	- Indian Council of Agricultural Research
IIT	- Indian Institute of Technology
LBL	- Lawrence Berkeley Laboratories
METC	- Morgantown Energy Technology Center
MKU	- Madurai Kamraj University
NAS/NAE	- National Academy of Sciences/National Academy of Engineering
NBRI	- National Botanical Research Institute
PASA	- Participating Agency Services Agreement
PCR	- Project Completion Report
PETC	- Pittsburgh Energy Technology Center
USDA	- U.S. Department of Agriculture

DEFINITIONS

Kilometer (KM)	- 0.625 miles
Kilowatt (KW)	- 1,000 watts
Megawatt (MW)	- 1,000 kilowatts
Lakh	- A unit of value equal to 100,000
Crore	- A unit of value equal to 10,000,000
Hectare	- 2.47 acres
Biomass	- Plant and animal matter than can be converted into energy
Coal beneficiation	- Process of eliminating coal impurities
Fluidized bed combustion	- A process that achieves high energy value from impure material such as coal.

FISCAL YEAR

GOI April 1 - March 31

India - Alternative Energy Resources Development

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Alternative Energy Resources Development

Project Paper

I. Project Recommendation and Summary Description

A. Recommendation:

That a grant of $5.0 million be approved for expanding India's technical capacity to develop and use alternative energy resources and selected energy technologies.

1. Grantee: The President of India

2. Implementing Agency: Commission for Additional Sources of Energy (CASE).

3. Financing:

a. AID: $5.0 million grant.
b. GOI: $2.285 million equivalent.

B. Summary Description

1. Project Purpose & Goals

The purposes of the project are to expand India's technical capacity to exploit its alternative energy resources and to develop selected energy technologies to a stage of application. The purposes will be achieved through several collaborative sub-projects designed to transfer technical knowledge in the field of alternative energy development. Achievement of these purposes will in turn contribute to attaining the goals of (1) reducing India's dependence on oil imports, (2) reducing the rate of deforestation, and (3) increasing energy efficiencies in the transport and industrial sectors.

2. Project Description

Sub-projects will cover the following technical areas: (1) biomass production and conversion, (2) coal conversion, (3) energy efficiency in industry and transportation and (4) information exchange. They will be implemented through the collaboration of U.S. public and private sector organizations with Indian public

and private sector institutions. The modes of collaboration will involve (1) exchange of technical personnel (2) institutional support (including short-term training, small scale equipment and technical services), (3) applied research and (4) formalized technical information exchanges. The proposed U.S. organizations for implementing the several different components are: the Department of Energy (DOE) for coal conversion and bio-mass conversion technologies as well as for information exchange; the National Academy of Sciences/National Academy of Engineering (NAS/NAE) for conservation topics; and a university consortium for biomass production.

Although the nature of each collaborative relationship will differ in detail with each sub-project, generally the role of the U.S. organizations will be to provide technical knowledge in completing the design of specific sub-projects as well in their implementation. It will also include monitoring and evaluation functions. With some sub-projects, the U.S. organizations will be asked to arrange for the procurement of specialized services and equipment where required. A feature of most sub-projects in promoting the exchange of technology transfer will be the travel of U.S. and Indian scientists.

The completion of the overall project is estimated to take four years from the time grant funds are obligated or by June 1986.

3. Project Issues

The Asia Project Advisory Committee (APAC), in reviewing the PID, recommended that: (a) research activities supported should be adaptive in emphasis and offer the promise of near-term application and (b) project funds for fossil-fuel development and energy efficiency technology should be used for training and information exchange rather than for purchases of large-scale capital equipment. A duscussion of these issues which are listed in the APAC cable in Annex 2 follows:

a. Research Aimed at Near-term Application: Research activities proposed under the project are all oriented toward the near-term results of increasing fuel supplies. For example, field trials of fast growing trees, experimentation with producer gas systems utilizing wood or charcoal, and emerging technologies to improve the burning efficiency of impure coal are all contemplated under this project. They offer the promise of near-term application in augmenting the supply of fuel in rural India. Basic

research in such areas as photosynthesis, tissue culture, or biomass conversion to liquid fuels are recognized as important energy research subjects that are more appropriately pursued under central AID/Washington funding. They are not contemplated for this project.

b. Fossil-fuel Development and Energy Efficiency: Project activities proposed involve (1) coal as the principal fossil-fuel and (2) energy efficiency and conservation in industry and transportation. For each of these two components, major activities consist of exchange of technical personnel and professional development through short-term visits to the U.S. Initial workshops will be held to determine the precise nature of technical assistance required. Except for a small amount of instrumentation recommended for furthering research efforts in fluidized bed combustion systems, there are no large-scale capital purchases contemplated for this project.

4. Project Relationship to Country Development Strategy Statement (CDSS) and Host Country Priorities

Alternative energy development is included among the priority areas for USAID support. It's importance is underscored by India's need to augment all forms of fuel supplies for achieving employment and food supply objectives that are discussed at length in the CDSS. The CDSS outlines a broad mix of energy types which this project proposes supporting. Consistent with the CDSS, major emphasis of this project will be support of biomass production and conversion technologies.

The development of alternative energy supplies is an important element in poverty reduction because of the impact of rising fuel prices on the incomes of poor households. Biomass production (energy plantations) and conversion (gasification) offer prospects of near-term solutions to a diminishing supply of firewood and a lower cost alternative to diesel respectively.

The GOI's Sixth five-year Plan (1980-1985) has placed a high priority on the allocation of funds for research and demonstration programs in alternative energy development. It envisages an amount of over $56 million (Rs.500 million) for the plan period[1/].

1/ U.S. $1 = Rs.9.00

II. Background and Detailed Description

A. Overview of India's Energy Sector

India's energy resources are obtained from both commercial and non-commercial sources. The most important commercial forms of energy are coal, oil and hydroelectric power. Firewood, agricultural and animal wastes (dung) are important non-commercial sources. As Table 1 below shows, commercial sources have gained in importance over the last thirty years surpassing non-commercial forms of energy in meeting India's overall energy demands. Nonetheless, as Table 1 also shows, demand for traditional energy supplies have continued to rise during the same period. The increase in the demand for energy resulting from India's economic development efforts has led to problems as explained below in Section B, which are proposed to be addressed under this project.

Table 1

Commercial and Non-Commercial Energy Demand

1953/1954 to 1975/1976

	1953-54	1960-61	1965-66	1970-71	1975-76
Commercial	60.4	101.2	147.0	197.3	252.7
Non-commercial	125.9	145.5	159.6	172.2	194.6
Total	186.3	246.7	306.6	369.5	447.3

B. Energy Related Problems

1. Deforestation

According to a recent unpublished survey, fuelwood accounts for more than 50% of the energy used in urban and rural households and is used primarily for cooking and heating. However, India's forests are disappearing at an alarming rate as the needs for a growing population continue to rise. Deforestation has in turn led to the diversion of agricultural and animal wastes from their uses as valuable fertilizers for food production to meeting the requirements of household energy needs; lower agricultural production, income, and employment can be the result. The GOI has recognized the fuelwood crisis and has taken active steps in seeking practical solutions. Among these are establishment of two biomass centers, which have as

their broad objectives research and demonstration programs that would lead to the development of fast growing species of trees[1]. AID support of these centers is designed to strengthen and expand existing capacity to make their program a success. These centers will support major social forestry programs being undertaken by the states, such as those supported by AID in Madhya Pradesh and Maharashtra (proposed for FY 83 funding). The coordination of the biomass center activities with those of the state social forestry programs is a central objective of the AID support.

If the development and introduction of fast growing species are successful, increased supplies of fuelwood can be utilized directly in engine systems to produce gas that can in turn power irrigation pumps for agricultural production. Other technologies that utilize agricultural wastes (straw, rice husks, corn cobs, etc.) for the same purpose are also under experimentation. AID financing will support both of these options in determining their technical and economic feasibility as alternatives to diesel power or electricity in rural areas.

2. Oil Dependence

India's continued progress in expanding agricultural and industrial production depends in substantial measure on increasing inputs of energy. Oil has played a critical role in India's achievement of virtual self-sufficiency in food grains, serving as a fuel for irrigation pumps and tractors and as a feedstock for fertilizer production. India is a major consumer of oil products and is among the top five oil importing countries spending about 75% of its export earnings for oil. The cost of its 20 million ton crude oil bill in 1980-81 was $7 billion. Largely as a result of oil price increases, India finds itself today with a problem of declining foreign exchange reserves. In order to cope with this situation, the GOI has taken steps to increase domestic production and prices, and to encourage the substitution by other more abundant fuels such as coal. However, the use of Indian coal as an alternative raises operational and efficiency problems related to its high ash content. In removing this constraint, research efforts are underway in a variety of emerging technologies to maximize the energy value of poor quality coal. Some of these involve coal gasification and the design of boilers that can efficiently burn high ash coal. AID funded activities in coal technologies are designed to provide continued support of Indian research efforts aimed at arriving at options for optimizing conversion technologies.

[1] The term biomass refers to plant and animal material that can be converted into energy.

3. Energy Efficiency

The industrial and transportation sectors are heavy consumers of energy accounting for about 70% of total energy consumed. Since these sectors depend largely on commercial sources, they have been given priority attention under the current five year plan for realizing energy savings through more efficient use. AID financing will support studies and other activities to identify areas and to design programs for more efficient use of energy.

C. The Role of CASE

The newly established (March 1981) Commission on Additional Sources of Energy (CASE) will be the primary implementing organization for the project. It will be responsible for day to day project management and administration. Under its authority, committees to monitor and evaluate sub-projects will be established.

The Commission is composed of five high level GOI officials representing the Department of Science and Technology, the Department of Power, the Department of Expenditure in the Ministry of Finance, the Indian Council of Agricultural Research (ICAR), and the Khadi Village Industries Commission. It is chaired by the Secretary of the Department of Science and Technology. Principal among CASE's functions are (1) formation of policies and programs for the development of new and renewable energies, (2) the coordination of research activities in new and renewable energies, and (3) the implementation of the Government's policies with regard to these energy sources. CASE is also responsible for preparing and administering an annual budget, and unlike most other governmental bodies, CASE is able to authorize its own expenditures. Membership by the Department of Expenditure on the Commission provides the basis of this authority, a factor that will facilitate the approval of sub-project activities and the release of GOI Rupee funds.

The primary impetus behind the establishment of CASE is India's goal of becoming self-sufficient in energy supplies and its desire to develop all forms of indigenous energy resources. Prior to the formation of this new energy commission, the Department of Science and Technology was primarily responsible for promoting and coordinating research and development (R&D) efforts in new and renewable energies. These responsibilities will now shift to CASE, where in a single entity will be vested the financial and executive authorities for fulfilling the GOI's alternative energy programs. The creation of CASE and the powers it has been delegated reflect the importance the GOI places on energy issues.

Because CASE is a new organization, one of the problems that it may face in its initial stages is the absence of sufficient staff. This problem is being addressed by the establishment of a secretariat that will assist CASE in carrying out its technical, managerial, and administrative tasks. The secretariat presently contains the same professional and administrative personnel of the former New Energy Sources Division of the Department of Science and Technology (DST). They will remain as permanent CASE employees. Plans are being finalized for augmenting this staff to handle the increased work load expected during the current five year plan.

D. Logical Framework Narrative (See Annex 3 for Logical Framework Matrix

The goals to which this project will contribute are a reduction of India's dependence on oil imports, a reduction in the rate of deforestation, and an increase in the efficient use of energy in the transportation and industrial sectors. The project's purposes which in turn will contribute to the attainment of these goals are the expansion of India's technical capacity to exploit its alternative energy resources and to develop selected technologies to a stage of application. In order to achieve these purposes, a number of sub-projects that involve the collaboration between Indian and U.S. institutions will be formulated. AID grant financing of $5 million along with the GOI's estimated $2.3 million will fund these sub-projects. Several key assumptions govern the achievement of the project's goals, purposes and outputs as discussed below.

1. Goal Assumptions: Goal assumptions namely that coal is deemed economically viable fuelwood is considered an important energy source in rural India, and energy efficiency in the transport and industrial sectors is possible have reasonable chances of occuring. India has already taken policy decisions to switch from oil to coal in major sectors of its economy, chief among them the generation of power. Support of research programs to maximize the energy output of Indian coal has been given high priority. The importance of fuelwood to India is underscored by the fact that almost 90% of rural households depend on it for energy. Its continued supply is therefore a critical factor in the lives of India's population. Energy efficiency is regarded as an effective means of augmenting fuel supply. As fuel prices continue to rise, energy conservation and associated plans are important to India's industrial and transportation sectors, the major consumers of oil products.

2. Purpose and Output Assumptions: The two critical assumptions affecting the project's purpose and outputs respectively are the capability of India's technical capacity to build on technology transfer in alternative energy development and the availability of a

sufficient number of sub-projects in alternative energy for funding. The Indian scientific community is the third largest in the world and enjoys an international reputation that no other developing nation has today. Technology transfer should not pose a problem, as counterpart Indian scientists are well qualified to conduct research activities. Several proposals in each of the project's components have been identified for funding, therefore the availability of an adequate number of sub-projects should not pose any constraints to implementation. With regard to the provision of financial resources, the considerable amount of funds planned for CASE programs exceed project financial requirements.

III. Project Analyses

A. Technical Analysis - Summary

1. Biomass Production and Conversion

The Indian government is placing major emphasis on biomass production, particularly reforestation. The Sixth Five Year Plan calls for the establishment of 1,300,000 hectares of energy plantations. Reforestation efforts are underway or planned in the state of Gujarat, Madhya Pradesh, Uttar Pradesh (U.P.), Maharashtra, West Bengal, and other states. The Department of Forestry of the Ministry of Agriculture coordinates and supports these state-managed programs. The total budget for forestry programs in the Sixth Plan is $866 million, or roughly 10% of the total Sixth Plan investment in agriculture.

To support these programs, the GOI is increasing its financing of biomass research and forest management. A new Institute of Forest Management will be established at Bhopal in Madhya Pradesh. CASE has designated Madurai Kamraj University (MKU) and the National Botanical Research Institute (NBRI) as biomass research centers and has approved funding of $278,000 (Rs.2.5 million) for these centers over the next three years. The main objectives of these centers are:

(1) to assess the potential of plant species of proven adaptability to soil alkalinity for biomass production;

(2) to standardize agro-techniques;

(3) to study photo-synthesis in relation to plant productivity and nutrient cycling of selected species and nitrogen economy;

(4) to survey the land and water potential of the area and formulate programs on the utilization of municipal and agricultural wastes for energy conservation;

(5) to concentrate on energy crops of terrestrial and aquatic nature;

(6) to undertake feasibility studies on more efficient uses of biomass for obtaining maximum energy and on developing appropriate technology for energy crops, production systems, harvesting and collecting, pre-treatement and conversion.

This project will support the development of the research capabilities and programs of these two centers in woody biomass. At the end of the project, these centers will be able to make a major contribution to state forestry programs and will have established close links with selected programs. Annex 4 describes the proposed support activity. This aspect of the project envisions the development of institutional collaboration between a consortium of U.S. forestry schools and NBRI and MKU. Through this mechanism, training, technical advisory services, and specialized research equipment will be provided to develop a research program in the following six areas:

(1) Existing Plantation Assessments;
(2) Field Trial Implementation;
(3) Plantation Establishment Relationships;
(4) Seed Procurement and Maintenance;
(5) Nutrient Cycle Relationships;
(6) Insect and Disease Impacts;

Both NBRI and Madurai Kamraj University have well-trained scientists, but there is scope for further experience in forestry research. Technical exchange would thus be essential for an effective implementation of the research program.

On the biomass conversion side, the concentration will be on testing systems for the production of producer gas, or gasification of wood, charcoal, and crop residues. Small producer gas pumpsets (3-5 HP) will be installed and their performance and economics evaluated for different feedstocks. In some parts of India, available crop residues appear sizeable enough to use as a feedstock. With the benefit of residue-powered irrigation pumps, agricultural production and residue output can be increased. Annex 5 describes the proposals by Jyoti Solar Energy Institute and the Indian Institute of Technology (IIT), New Delhi, for field demonstration of producer gas systems and for the design of engines specifically for producer gas.

This area is one of great potential application in developing countries. For example, the Philippines has embarked on a major program in producer gas, and the opportunities for exchanging and accelerating knowledge on this technology will be enhanced by this project.

2. Coal Conversion Technologies

India has the largest coal deposits in the developing world (estimated at 85 billion tons), and the U.S. has the largest known deposits in the industrial world. Both countries are pursuing major coal development and utilization programs and the opportunities for mutually beneficial collaboration are ample. The basis for mutual technical cooperation in coal is related to on-going; research programs in India, the technical capabilities of Indian scientists, the size of India's coal resources, and the role of coal in India's current and likely future energy development programs. Annex 6 presents several areas for possible collaboration.

This project will involve technical exchange in five basic areas that are important from the standpoint of oil substitution and increasing efficiency in conversion of India's high ash coal:

(1) Coal mixtures (coal/water and coal/oil)
(2) Fluidized Bed Combustion (FBC)
(3) Coal beneficiation
(4) Coal liquefaction
(5) Combined cycle/coal gasification.

The technical exchange program, to be developed with Bharat Heavy Electricals Limited (BHEL) and Central Fuel Research Institute (CFRI), will focus on the first three areas, since they are of potential near or medium term applicability. The Department of Energy along with its constituent Energy Technology Centers is proposed for the role of U.S. technical coordinator for this component. An initial workshop will serve to set priorities and establish a specific work program for each of the five areas of this component.

India faces major decision with respect to investments and R&D priorities in coal. Present plans call for the construction of eleven 500 megwatt (MW) coal-fired units, arranged in four strategically located central stations. Fluidized bed combustion (FBC), coal-to-oil, and combined cycle plants are planned between now and 1985/86. A key outcome of this collaboration will be an improved understanding by Indian scientists and decision-makers of the costs, benefits, and risks associated with different options. The costs involved are miniscule compared to the costs of uniformed decisions by Indian officials.

3. Energy Efficiency in Industry and Transportation

Energy efficiency refers to energy use per unit of output or, in transportation, per unit of transportation service (e.g., ton per kilometers). The industrial and transportation sectors are large and growing consumers of commercial energy. The consumption of energy in the industrial sector is highly concentrated. Seven industries in 1977/78 accounted for nearly two-thirds of total sectoral consumption: steel, cement, fertilizer, textiles, aluminum, sugar and bricks.

Experience in both the United States and India suggests that fuel efficiency measures resulting in near and medium term energy savings are possible and cost-effective. Annex 7 discusses the potential for improvements in energy efficiency in industry.

The project will support a U.S. and Indian technical exchange program in energy efficiency focusing initially on three specific industries: pulp and paper, sugar, and cement. An initial workshop will be held to review energy use in these industries and plan a program of collaboration. The main purpose will be to compare experiences and increase the awareness of Indian industrial managers of the available U.S. energy control technologies and energy management techniques that might be applicable in India. Key areas for examination include: maintenance, waste heat recovery, fuel substitution and capital investment in new equipment or control techniques. Proposed collaboration between the National Academy of Sciences (NAS) and the Association of Indian Engineering Industry (AIEI) will facilitate the exchanges of engineers, managers and energy specialists in these industries. Both organizations have broad access to industrial companies in their respective countries. AIEI membership consists of many private companies, and one goal of the organization is to increase the economic efficiency of its members so they can compete more effectively in international markets. Improved energy efficiency is seen as one approach. AIEI strongly supports joint ventures with U.S. companies.

A similar arrangement is envisioned for the transportation sector. The Indian transportation sector is the largest single oil-consuming sector and the fastest growing. It accounts for over 55% of total oil consumption. Yet it is highly inefficient by international standards and, as noted in Annex 8, a transportation system inefficient in moving goods and people is energy inefficient by definition. The major reasons for this energy inefficiency are: congestion, outdated engine technology, poorly maintained vehicles, vehicle over-utilization, poor intermodal coordination and limited infrastructure. Again, working through NAS and AIEI, a technical exchange will be initiated that will bring together experts and industry officials concerned with engine and vehicle production, transportation system construction and planning and other facets of transportation to identify and assess possible solutions to these problems. An initial workshop will define a specific program of technical collaboration. Activities would include seminars, industry assessments and transportation studies, plant audits, industry missions to the U.S. and internships and longer-term personnel exchanges.

4. Information Exchange in New and Renewable Energy

One of the functions of the Indian Commission for Additional Sources of Energy (CASE) will be to function as a data bank on all aspects of new and renewable energy sources. Specialized centers for

solar, biomass, and wind systems are being established that will assist CASE in maintaining and updating the data bank on renewable energy sources, disseminating technical information, providing guidance to potential users of renewable energy systems and undertaking projects in the field.

This project will help support the information collection and dissemination function of CASE by developing a formalized link between CASE and information sources in the United States through DOE sources, possibly the Solar Energy Research Institute (SERI) or some other acceptable alternative. A wide range of information sources on new and renewable energy exists in the United States: non-profit research institutes, government-owned research facilities, national trade and professional associations, regional networks, DOE offices, state energy offices, energy extension services, special libraries and information centers, commercially-available computerized data bases and directories. SERI's Energy Information Data Bank (EIDB) in Golden, Colorado contains a number of data bases of interest and relevance to India.

5. Conclusion

The above components and recommended sub-projects are based on the detailed technical reports prepared by two separate design teams consisting of experts in the fields of coal, transportation, and biomass production and conversion. They have concluded that the project's technical design is sound and that the Indian institutions contemplated have the requisite technical expertise in implementing activities in each of the project's four areas. Based on the teams' technical analyses and the cost estimates contained therein, the project satisfies FAA 611(a) requirments. For detailed cost estimates and budgets see section III E. and Annex 10.

B. Institutional Analysis

1. CASE

CASE is a newly established commission and is in the process of defining the specifics of a long-range program of activities consistent with its broad set of responsibilities. These include the planning, monitoring, and financial support of a national integrated research and development program encompassing a wide range of technologies. The technologies of interest are solar, wind, biomass production and conversion, and the development of decentralized energy systems. CASE may support public and private sector entities in pursuing programs to develop technologies. Other major CASE responsibilities are to: (1) coordinate on-going R&D work in new and renewable energy resources, (2)

function as the national agency for international cooperation in these energy fields, (3) recommend incentives for commercializing breakthroughs, and (4) function as a data bank on all aspects of new and renewable energy sources. A more detailed list of responsibilities can be found in Annex 9..

The staff of the former New Energy Sources Division of DST now forms the nucleus of the CASE secretariat and consists of 14 professional scientific and administrative officers. An additional staff of approximately 20 individuals provide technical and administrative services for CASE. The present number of individuals appears adequate to manage the CASE program (including the AID financed project) over the immediate term. A much larger staff is required to carry out future programs, and to this end plans are being finalized to meet projected requirements. It is anticipated that by March 1984, CASE will have tripled its staff size to manage its program. Based on current and projected staff levels, AID is reasonably assured of effective management and administration in project implementation.

One of the principal advantages of CASE is its authority to expend funds. This derives from membership of the Secretary of Department of Expenditure of the Ministry of Finance (MOF). GOI funds for sub-projects can therefore be approved by CASE without prior approval of parent ministries and the MOF. It is also envisioned that CASE will approve the specific activities in each of the project's separate components.

While CASE has been given a large set of responsibilities with regard to research and development, its primary role will be to manage and administer the programs it funds to assure consistency with GOI policy directives concerning new and renewable energies. Day to day implementation of specific research proposals will be the responsibility of local institutions receiving CASE grants. The proposed Indian institutions which will collaborate with US organizations in implementing this grant are described below.

2. Biomass Centers

The biomass production consultant's report has highlighted a number of strengths as well as weaknesses in each institution[1/]. In some cases, the shortcomings are common to both institutions such as their limited experience in analyzing biomass problems and finding solutions. Both institutions have a staff of capable scientists and have a successful record of research achievements. However, they differ in their present orientation to solving biomass problems. NBRI is embarking on a program that emphasizes the practical application of their research results. For instance, they are informally coordinating with the local forestry officials and agricultural research stations.

1/NBRI and MKU

On the other hand, MKU's strengths lie in a fairly well developed faculty in statistics, computer science, economics, sociology, and the biological sciences. It lacks the same degree of orientation toward a practical approach exhibited by NBRI.

AID financing is intended to strengthen each institution in developing and implementing a practical and viable biomass production program. Collaboration with a U.S. university will provide an institutional relationship for strengthening the Biomass Centers. For a detailed analysis of the recommended programs as contained in the consultant's report, see Annex 4.

3. Jyoti Solar Energy Institute - Biomass Conversion

The Jyoti Solar Energy Institute (Jyoti) is attached to a well-known engineering college in Gujarat State1/. Since its establishment in 1979, this institute has undertaken a number of research programs with success. It is one of the first Indian institutions to engage in research work on gasifiers. It is currently conducting field testing of a 25 kilowatt (KW) gasifier in conjunction with Twente University of Technology, a Dutch organization. The research work is funded by the Ford Foundation. AID financing will support similar research on smaller gasifiers which sould be designed to power individual pumpsets. Because of its experience with work on gasifiers its association with an engineering college, the Jyoti Institute is well equipped and has a qualified staff to implement the AID-financed research proposed at this institution.

4. IIT/Delhi - Biomass Conversion

Research and demonstration activities in biomass conversion technologies (producer gas, pyrolysis, etc.) will be carried out in the Department of Chemical Engineering at the Indian Institute of Technology, (IIT), Delhi. The Department of Chemical Engineering has a current staff of fourteen including the director and is involved in a variety of research projects within its own department as well as with other IIT departments, principally the Department of Mechanical Engineering and the Bio-Engineering Research Center. The Department of Chemical Engineering is also engaged in collaborative work with the University of Swansea, South Wales, U.K. It is currently experimenting with gasification systems using biomass material. The design of engines utilizing gas produced from biomass is also under experimentation. AID-financed collaboration with DOE will assist in refining the design monitoring, and evaluation process of on-going biomass conversion work. The IIT staff involved in this work are well qualified to carry out the necessary research tasks envisioned.

1/Birla Vishvakarma Mahavidyalaya

5. BHEL - Coal

Bharat Heavy Electrical Ltd. (BHEL), a government owned company engaged in the production of power generation equipment and machinery, has been given the lead role for developing fluidized bed combustion (FBC) boilers. The boiler plant at Trichy, Tamil Nadu has been assigned the responsibility of developing feasible FBC systems under the guidance of the fossil energy group. BHEL's corporate R&D center is located in Hyderabad and is currently working on the technical and economic feasibility of coal gasification and combined cycle generation systems that have longer range implications. Both BHEL groups are well staffed with trained scientists and are generally well equipped to carry out their research and demonstration programs.

Proposed collaboration with DOE will provide the necessary expertise that will assist in solving technical problems related to BHEL's coal program. The particular coal laboratory which is finally recommended for collaboration with BHEL will have access to other DOE laboratories, such as Oak Ridge National Laboratories, Tennessee and Argonne from which specialized coal expertise can be obtained for BHEL1/. Because of BHEL's past and continuing involvement in technology transfer arrangements with U.S. companies such as Combustion Engeneering, this component will serve to faster technical contact and collaboration between BHEL and U.S. private and public sector institutes.

6. The Central Fuel Research Institute (CFRI), a government laboratory located near the Dhanbad coal fields in Bihar, conducts applied and basic research covering all aspects of coal technology. Among other activities, the Institute is conducting research on problems associated with coal liquefaction with oil and water mixtures, FBC systems (although on a smaller scale than BHEL), and coal beneficiation processes. Since its establishment in 1950, CFRI has enjoyed the reputation of being India's leading coal research facility. CFRI has a staff of approximately 1400 and an ample resources for research expenditures. Its budget for the Indian fiscal year 1980-81 was approximately $4 million. Because of its technical capability and experience gained in experimenting with FBC systems, CFRI provides technical assistance to BHEL's FBC program.

DOE collaboration with CFRI is also recommended in the areas of coal beneficiation and liquefaction. This can also be accomplished through the provision of services by one of its coal laboratories. One of the principal tasks of this laboratory will be to coordinate the work of CFRI and BHEL.

7. AIEI - Efficiency

The Association of Indian Engineering Industry (AIEI) is the

1/The Morgantown Energy Technology Center has been recommended as the lead DOE coal laboratory that can provide technical services required.

association for the Indian engineering industry, public and private, with about 1700 members representing small, medium and large units. Its basic objective is to provide information and consultative services to industry and government. It is particularly interested in the expansion of Indian industrial exports. Energy is a major concern in relationship to the interests of its members in efficiency and competitiveness internationally. In this regard, it recently sponsored a workshop on energy conservation and has prepared a proposal for incentives for energy conservation for Indian government consideration. It plans to pursue this line of activity in the future and is looking forward to a collaborative relationship with a U.S. private sector organization such as the National Academy of Sciences. This relationship will involve principally the joint sponsorship and execution of a workshop for Indian local industry and transportation designed to define major problem areas in industry and the transport sectors where efficiency and conservation measures show promise. Specific activities generated from the workshop would be defined; recommendations for addressing specific problems through the provision of technical expertise or needed studies would be followed up by the U.S. organization selected.

C. Economic Analysis

This project supports accelerated development of India's capacity to produce non-petroleum forms of energy and reduced requirements through greater efficiency in the use of energy. The ultimate economic test of each non-petroleum alternative is simple: it costs less than domestic or imported petroleum, or it does not. For energy technologies in the early stages of development, the issue is whether there are reasonable prospects that costs will eventually fall below the cost of the equivalent unit of petroleum. Since the appropriate economic analysis for this type of activity is an analysis of costs only, the activities under this project have all been selected on the grounds that they have reasonable prospects of reducing energy costs or producing energy at costs competitive with petroleum. In some cases the sub-projects will include a specific economic analysis component. These issues are discussed for each sub-project in the consultant reports prepared for the project and are summarized below for coal and biomass, the two major project components. The energy efficiency component is to help assess the costs/savings potential of different technology and management options in specific industries.

1. Coal

India is the largest coal producer among the developing countries. Annual production is currently 114 million tons, and is projected to increase to 260 million tons by 1990[1]. Estimated

[1] World Bank 1981 "Economic Situation and Prospects of India" quoting Department of Coal figures.

reserves are 85 billion tons, or enough to last 75 years at a constant demand growth of 4% a year.

The activities identified in the coal component would enhance the attractiveness of coal as an energy resource by reducing costs (through improved efficiencies in distribution and utilization) or by producing gaseous or liquid fuels from coal to compete directly with petroleum. Of the five coal activities which receive the largest allocations under the project, three are in the former category (improved efficiencies) and two are in the latter category (gaseous or liquid fuels). The three in the former category - fast fluidized bed combustion, coal beneficiation, combined cycle power generation would all reduce costs by permitting the fuller utilization of India's high-ash coal. The two in the latter category-coal/oil and coal/water suspension fuels and coal liquefaction - could potentially provide substitutes for petroleum. Coal/water suspension fuels could replace residual fuel oil, whose current annual consumption is 3.1 million tons, equivalent to $769 million at current world oil prices. Coal liquefaction is a long-term option for producing either fuel oil or middle distillates, depending on the process. Coal/oil mixtures have been demonstrated to be economically viable in certain U.S. conditions (i.e. Florida Power and Light Co.) Coal/water suspensions and fluidized bed combustion are currently in the demonstration phase and improved economic and technical data should be available by 1983. Combined cycle and coal liquefaction are longer-term options whose economics appear promising as international oil prices approach $40-45 barrel. Major demonstration plants are being built in the U.S. and Indian access to the results of these programs will aid in decisions on whether to invest in construction of demonstration plants or purchase of U.S. processes. Thus, economic as well as technical feasibility will play a major role in the exchange of information among the various collaborators. This will provide the basis for decisions on which technologies to pursue to the stage of large-scale application. Because the Indian organizations involved are all run on a commercial basis, only those technologies which are economic will survive.

2. Biomass

Biomass in the form of wood, agricultural wastes and dung still provides a large percentage of India's energy requirements, as noted above. This project supports increased production of woody biomass through an expanded research effort and the development of technologies for conversion of biomass into gaseous fuels.

The research program for woody biomass production is directed at increasing the yields or productivity of available land and other resources, and thus reducing costs. The National Botanical Research Institute (NBRI) and Madurai Kamraj University, as the designated national Biomass Centers, will work closely with the Forest Research Institute (FRI), the agricultural universities and the state forestry departments in developing and testing new tree varieties for use in various forestry programs throughout India, particularly social forestry. The economic analyses for the World Bank-assisted social forestry projects in Gujarat, Uttar Pradesh and West Bengal and AID-assisted project in Madhya Pradesh demonstrate that the economic rates of return to social forestry are satisfactory when existing varieties are used. The development of improved varieties would reduce production costs and thus increase the economic rates of return to social forestry projects. This would enhance the competitiveness of fuelwood and make social forestry activities more attractive to the villages and states involved. The research program for woody biomass includes funding for economic and social assessments to provide more detailed information on the economics of various fuelwood production alternatives. The economic analysis in the Madhya Pradesh Social Forestry paper projects an Internal Rate of Return (IRR) of 13% for the stand model that consisted primarily of firewood. Where commercial products were mixed with firewood, the IRR was in excess of 19%.

The proposed activities in biomass conversion emphasize the development of gasification processes based on wood or charcoal, principally for powering engines suitable for irrigation pumping on small holdings. The rates of return to ground-water irrigation are generally very attractive, as is shown in the Project Paper for the AID Agricultural Development Credit project. The issue is whether small engines powered by producer gas can pump irrigation water at costs competitive with existing diesel or electric engines. The preliminary economic analyses cited in the consultant's report indicate that there are good prospects that producer gas engines could be competitive. The three complementary producer gas subprojects to be carried out by the IIT and Jyoti Energy Institute will permit a technical and economic comparison of charcoal vs. direct gasification for small (3-5 horsepower) engines. As noted in the consultant's report the data generated by the project could provide the basis for a marketing study to assess the prospects for commercial development of producer gas pumpsets. Economic analysis of operating systems in the Philippine suggests that they are at least half the cost of diesel systems.

D. Social Analysis

Social analysis is intended to assess several dimensions of project soundness, including socio-cultural feasibility, participation in decision making by project beneficiaries, incidence of benefits among socio-economic groups, prospects for replication or "spread", and impact on women. The role of social analysis in projects such as this is circumscribed by the fact that the project supports the development of various alternative energy technologies, but does not itself support the subsequent stage of extension or commercialization. Also some of the technologies (e.g. those involved in more of the coal and energy efficiency sub-projects), will simply produce lower-cost fuels or processes for existing power plants, industries or modes of transport. As intermediate inputs into existing activities, they do not raise social issues in any significant sense. Consequently the discussion below is limited to some observations on the woody biomass research and producer gas sub-projects, based partially on previous USAID social analyses.

1. Socio-cultural Feasibility

Full utilization of research results from the two Biomass Centers will depend among other things on the social and cultural acceptability of social forestry programs. This will no doubt vary by region, and will be the subject of studies and evaluations undertaken under the social forestry projects now being initiated in nearly every one of India's major states. The social analysis prepared for the AID-assisted Madhya Pradesh Social Forestry Project, as well as the more limited analyses prepared by the World Bank for the Gujarat, Uttar Pradesh and West Bengal projects, indicate that the social stratification typical of village India could be a constraint to the development of successful models for local management of forest resources. A major task of the forestry extension organizations will be to assess the nature of these constraints and devise ways to minimize their negative impact. The problems are not insurmountable and are not a reason for delaying the development of a better research base for social forestry.

With respect to producer gas, a major question will be whether the operation and maintenance of the gas producers and engines will be feasible in Indian villages. Village skills in the operation and maintenance of diesel and electric pumpsets developed rapidly in the 1960's as the use of these technologies spread, and it is reasonable to expect that these skills could be adapted to gasifiers and producer gas-powered engines (which would be very similar to their diesel counterparts). Nevertheless, the operation

and maintenance of gasifiers may prove difficult until new skills are acquired. Experience in the Philippines is however positive on the capabilities of the irrigation cooperatives to operate and maintain these systems. This issue will be investigated during the testing and demonstration phases of the sub-projects on alternative gasifier technologies.

2. Participation

Participation is not a major issue for the producer gas sub-projects, since it is likely that the technology, if successful, would be disseminated commercially. The extent and quality of local participation in decisionmaking will have a decisive impact, however, on the success of social forestry projects. The issue of participation is closely related to the issue of social feasibility discussed above. Fostering appropriate forms of participation through village councils (Panchayats) will be a major objective of social forestry extension activities, and will be closely monitored by AID under the Madhya Pradesh Social Forestry Project and the proposed Maharashtra Social Foresty project.

3. Incidence of Benefits

It is difficult to estimate the incidence of benefits of agricultural research programs, and the forestry research to be undertaken by the Biomass Centers is no exception. As in the case of agricultural research, benefits to consumers from increased production are very important in assessing impact. Just like foodgrains, forest products in India probably have the greatest relative importance in the consumption patterns of the poor. The poor are heavily dependent on wood as a fuel source and on other forest products such as building poles and indigenous fruits. They would be the major losers if deforestation is not arrested and reversed, and are therefore key beneficiaries of research programs oriented toward tree varieties appropriate for village use.

The poor will also be major beneficiaries of plantation development and the increased production made possible by better research. Additional employment generated will benefit primarily landless laborers and marginal farmers. Small and marginal farmers could also benefit as producers, particularly from the adoption of tree varieties which permit productive use of non-agricultural lands. To the extent that research results from the Biomass Centers are used in social forestry programs, the incidence of benefits will follow the pattern indicated in the Project Paper for the Madhya Pradesh Social Forestry project (386-0475). Inasmuch as the viability of village plantations requires broad cooperation from all village residents, the prospects for equitable sharing of production benefits are reasonably good.

The distribution of benefits from irrigation pumping with producer gas will not differ from the distribution of benefits from irrigation with diesel or electric engines of a similar size (e.g. 3-5 horsepower). The incidence of benefits should be highly favorable, since pumping with engines in the 3-5 horsepower range is generally economic even for holdings smaller than one hectare. This means that small and marginal farmers are likely to be major beneficiaries of producer gas irrigation pumping. Landless laborers also benefit substantially from employment created by irrigation. For a more detailed discussion, see the Project Paper for the Agricultural Development Credit project (386-0466).

4. Replicability

The maturity of India's agricultural research system demonstrates that institutions such as the Biomass Centers are sustainable without indefinite infusions of external resources. The evolving division of labor for forestry research and extension appears to offer a cost-effective framework for further extension.

Determining the potential for replicability, i.e., whether producer gas engines can be manufactured and marketed in India, will be a major objective of the producer gas sub-projects.

5. Role of Women

Women play a major role in forestry projects as both participants and beneficiaries. In most areas of India women are the primary gatherers of firewood and minor forest products, as well as the primary users. For a detailed discussion of the potential for involving women as a resource in forestry projects, and the scope for benefitting women, see the PP for Madhya Pradesh Social Forestry.

The effect on women of irrigation pumping with producer gas engines will parallel the effects of irrigation development based on other energy sources. Women will benefit primarily through increased household incomes. For further discussion see the PPs for the Agricultural Development Credit project and the Rajasthan Medium Irrigation project (386-0467).

E. Financial Analysis and Plan

1. Project Costs

Project cost estimates are based primarily on estimates and projections prepared by AID's project design teams in consultation with the GOI and various representatives of the Indian organiza-

tions proposed for implementing specific components of the project. The estimates include an inflation and contingency rate of 30% over the life of the project. While the cost figures represent reasonable estimates at this time, firm costs will be indicated in the workplan for each of the U.S. and Indian collaborating institutions to be submitted for AID CASE approval. Firm estimates are not expected to differ greatly from current estimates but may reflect differences in amounts allocated for specific line items for each sub-project activity. Table I below provides a summary of the project costs and source of financing.

Table 1 Summary Cost Estimates and Financial Plan

($000)[1/]

Component	A.I.D.			GOI	Grand Total
	FX	LC	Total		
Bio-mass	1930	370	2300	930	3230
Coal	1500		1500	955	2455
Conservation	500		500	200	700
Information Exch.	500		500	100	600
Other Renewables	200		200	100	300
Total	4630	370	5000	2285	7285

As indicated in the table above, approximately 93% financing of the AID contribution will be utilized for foreign exchange costs. The remaining 7% will be used to defray local currency costs related to the salaries of selected scientists at the two biomass institutions. AID local financing of these costs is intended to provide an incentive to these institutions to recruit and appoint local scientists in specialized fields to strengthen the research and outreach capacities of the biomass programs. AID financed instrumentation represents 20% of the total AID grant and is based on current estimates including air freight charges from the U.S. For detailed costs pertaining to each of the project's major components, see Annex 10 tables 2 to 5.

2. Host Country Contribution

CASE has allocated for its use a sum of Rs.500 million

1/ Rate of Exchange: $1.00 = Rs.9.00

or approximately $56 million for alternative energy activities during the current GOI Sixth Five-Year Plan (1980-1985). Each of the specific activities under the major project components represent priority research areas for CASE. The rupee amounts estimated reflect a minimum level of effort required from CASE's budget. As is the case with the dollar budgets, the final rupee budget for specific sub-project activities will be completed by the collaborating institutions as part of their workplans. As a result the rupee allocation is likely to increase given the size of the CASE budget. In any event our current estimates of the GOI contribution show that the GOI more than satisfies the 25% requirement stipulated in FAA 110(a).

F. Environmental Analysis

At the time of the PID submission, an Initial Environmental Examination (IEE) was prepared recommending a Negative Determination be made as the required environmental action. Since project activities reflect controlled experimentation for the purpose of research which is confined to small areas carefully monitored, an Environmental Assessment, consistent with Regulation 216.2(b), was not required. The recommendation was approved by the Assistant Administrator. (See Annex 15).

IV. Project Management and Administration

A. Project Management

1. Sub-Project Planning

The broad areas of Indo-U.S. collaboration and problems to be addressed have been identified and estimates of costs made. Nonetheless detailed sub-project design and cost estimates will be made during project implementation after the collaborating institutions have been selected. Selection of the U.S. institutions is expected to take three to six months after the signing of a Project Agreement with the GOI. Depending on the U.S. organization, a Participating Agency Services Agreement (PASA) with ECE or direct AID contracts with a university consortium and with NAS will be used. Among other things, a requirement of each contractual arrangement will be the preparation of a work plan by the Indian and U.S. collaborators. The workplan is intended to provide detailed design and cost data as well as the following information: (a) sub-project objectives (b) activities and responsibilities and (c) an implementation schedule. The workplans are to be forwarded to CASE and USAID for approval prior to the start of research activities.

2. Sub-Project Monitoring and Reporting

a. Monitoring

USAID plans to make site visits to each of the collaborating Indian institutions approximately twice a year for the first two years of the sub-project and once thereafter. It is planned that a USDH will participate in these visits at least once a year. More frequent monitoring visits will occur as warranted. The purposes of the field visits will be to: (a) observe sub-project progress (b) review sub-project financial records and accounts (c) monitor disposition of AID financed equipment where applicable and (d) resolve any implementation problems that may arise. A technical back stop committee chaired by AID/Washington with representatives from DOE and the U.S. Department of Agriculture (USDA) will provide assistance in finding solutions to particular technical problems as they arise.

CASE has indicated a willingness to participate with AID in monitoring project progress and the establishment of monitoring committees are contemplated for this purpose. However, the exact composition and scope of such committees have not been defined.

b. Reporting

Progress reports will be requested of each collaborating group every six months, more frequently if warranted. For USAID project management purposes, these reports are expected to contain basic information related to sub-project status in meeting sub-project objectives, the degree to which specific tasks and activities are proceeding on schedule, and the type and extent of problems encountered. Where possible, attempts will be made to obtain this information prior to AID's bi-annual Project Implementation Reporting (PIR) deadlines for inclusion in the PIRs.

c. Evaluation

The evaluation program will review progress in meeting project objectives. Annual reviews are proposed for each project component with the primary purpose of reviewing the technology being applied. The first review is expected to occur in the last quarter of 1983 when sub-project activities are expected to be fully operational. The results of the annual reviews and the findings of AID's monitoring visits would be incorporated into a regular evaluation report that would assist project management in making interim decisions. Apart from these reports, an independent evaluation is also proposed by the end of 1985. A team of AID/Washington representatives is proposed for such an evaluation; the exact team composi-

tion, its scope and timing would be determined at a later date. The team would examine among other things (a) the success of the institution building efforts with NCRI and MKU, (b) the effectiveness of the selected U.S. organizations in involving the U.S. private sector in expanding Indian access to technology in coal and energy conservation, (c) the effectiveness of U.S. technology transfer, and (d) the overall management of the project and the effectiveness of CASE in this process. It is expected that funding for the team would be made available from mission resources. A Project Completion Report (PCR) will be prepared in addition to all other proposed evaluations.

USAID intends to pay close attention to the monitoring and evaluation program in the interests of disseminating findings of interest to areas outside India.

3. Procurement

U.S. technical services and commodities will be procurred consistent with AID regulations.

(1) Technical Services

During the course of PP development several options were discussed for obtaining the technical services for each of the project's components with a view to an optimum mix of U.S. public and private sector involvement. Below is a list of proposed U.S. institutions and a brief rationale for their recommendation.

a. DOE

For coal and biomass conversion work as well as for information exchange on new and renewable energies, DOE offers a wide access to both public and private sector services. Several coal laboratories - Morgantown Energy Technology Center (METC), Pittsburgh Energy Technology Center (PETC), Lawrence Berkely Laboratories (LBL) and other DOE laboratories - are conducting work of interest to BHEL. Based on DOE recommendations, AID will approve a PASA with one of these laboratories, which if needed, would be able to obtain the specialized services of the other laboratories without resorting to special arrangements. It is also contemplated that the same PASA will provide the services of the Solar Energy Research Institute (SERI) for services related to biomass conversion and information exchange. The collaborative relationship proposed with DOE is acceptable to GOI officials responsible for project implementation. In considering DOE as a source of technical services, a number of factors

were considered such as cost, wide access to public and private sector services, GOI past familiarity with DOE and PASAs[1]. In addition to the foregoing, coordination in the planning and implementation of energy activities with DOE is consistent with FAA Section 106(c). If a PASA is not possible, a competitive procurement for a non-profit research organization is proposed covering the same services mentioned above.

b. University Consortium

Since the recommended biomass program is quite comprehensive in scope and one that demands a wide variety of technical skills, a university consortium was considered as the best option. A consortium offers broader access to the type of services called for in establishing sound institutional relationships with the Indian biomass centers. Competitive procurement for obtaining the services of a university consortium is anticipated. A direct AID contract is also recommended, as neither NBRI nor MKU are familiar with AID procedures for hostcountry contracts.

c. NAS/NAE

The National Academy of Sciences/National Academy of Engineering offer the best network of wide access to U.S. public and private organizations that are engaged in energy conservation in industry and transportation. We envision a predominant capability contract consistent with AID regulations.

(2) Procurement of Commodities

As currently envisioned, the procurement of equipment will be the responsibility of the PASA agent or contractor as applicable. Of primary consideration when procuring will be compliance with U.S. source/origin rules governing AID grant financing and adherence to applicable AID procurement regulations.

B. Project Administration

1. Implementation Plan

Shortly after the Project Agreement is signed, USAID staff will finalize scopes of work (see draft versions in Annex 11) and

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[1] JPL/BHEL solar energy sub-project under the Technologies for the Rural Poor grant.

prepare PIO/Ts for contractual services. In order to expedite timely completion of each contract or PASA, AID/W will be authorized to negotiate on behalf of the mission. Sufficient time has been buegeted to accomplish these tasks as indicated in the schedule below. Periodic follow-up will be made to avoid or minimize any slippage.

2. Implementation Schedule

	Activity	Action Agent	Target Compl. Date	
(1)	Project Authorization:	USAID/New Delhi	June	1982
(2)	Agreement Signed:	USAID/New Delhi	June	1982
(3)	Impl. Letter No.1 issued:	USAID/New Delhi	August	1982
(4)	CPs Met	CASE	September	1982
(5)	PIO/Ts Prepared For:			
	Consortium Contract:) NAS Contract:) DOE PASA:)	USAID/Delhi	July/August	1982
(6)	DOE PASA signed:	AID/Washington	October	1982
(7)	NAS Contract signed:	AID/Washington	October	1982
(8)	University Contract 1/ signed	AID/Washington	February	1983
(9)	Workplans submitted:			
	DOE)		February	1983
	NAS)	USAID/CASE	February	1983
	Consortium)		August	1983
(10)	Workplans Approved:			
	DOE)		March	1983
	NAS)	USAID/CASE	March	1983
	Consortium)		September	1983
(11)	Monitoring Plan Prepared	USAID/Delhi	March	1983

1/ Assumes following schedule:

- PIO/T reaches AID/Washington : September 1982
- AID/W prepares solicitation for bids: October 1982
- Bids closed : December 1982
- Bids evaluated : January 1983
- Contract signed : February 1983

Activity	Action Agent	Target Comp. Date
(12) First Annual Review:	CASE/USAID	December 1983
(13) Second Annual Review:	CASE/USAID	December 1984
(14) In Depth Evaluation:	USAID/Delhi) CASE) AID/W)	December 1985
(15) Project Completed :	CASE/USAID	June 30 1986
(16) Project Completion Report :	USAID/Delhi	August 1986

3. Staffing Implications

It is currently proposed to assign project management and administrative responsibility to USAID's Project Development Office. Together with three other projects (Agricultural Development Credit, Rural Electrification, and Technologies for the Rural Poor), PD's project portfolio will total four projects. Agricultural Credit and Rural Electrification are scheduled to terminate in June 1982 and June 1983 respectively. Major responsibility will therefore focus on the Alternative Energy and the Technologies for the Rural Poor (TRP) projects which include a total of 12 sub-projects at seven locations. Furthermore, it is anticipated that USAID's forestry advisor would be able to assist in the monitoring efforts for the biomass programs at NBRI and MKU thus lessening the overall load to some degree. In managing the sub-projects, staff time will normally be allocated to two main areas of responsibility: monitoring (field visits and reports) and administration (voucher review, correspondence and logistics). Below is an estimated level of effort required to carry out the monitoring and administrative responsibilities:

Level of Effort for Monitoring and Administration
Figures in Individual Work Months

	TRP[1/]	Alternative Energy[2/]	Total
1982	4.0	1.0	5.0
1983	4.0	4.0	8.0
1984	3.0	4.0	7.0
1985	.0	2.0	2.0
Total	11.0	11.0	22.0

1/Six sub-projects. Overall project terminates December 31, 1984.
2/Six sub-projects. Overall project terminates August 31, 1986.

The amount of time allocated to each sub-project assumes an average of 6 workdays for a monitoring visit and approximately two workdays a year for administrative details. The calculations also assume two site visits to each sub-project, once it becomes operational, for a period of two years and one visit thereafter in the last year. Although it is evident from the table above that the amount of effort increases substantially 1983 and 1984 for project management, USAID/PD staff resources should be able to handle this load with the phase out of the other on-going projects.

4. Disbursement Procedures and Schedule

Disbursements will be made for foreign exchange costs related to the two contracts and PASA as well as for local costs directly related to sub-project implementation. Disbursement methods will differ according to type of contract and expense, but they are generally expected to be on a cost reimbursable basis supported by prescribed documentation for the PASA. With regard to non-profit organizations such as NAS, and universities the Federal Reserve Letter of Credit (FRLC) procedures may be used. Disbursements for local costs will be made against the GOI submission of claims along with appropriate supporting documentation. Specific details concerning documentation requirements will be set forth in an Implementation Letter.

a. Disbursement Schedule

FY82	FY83	FY84	FY85	FY86
-	1.2	1.4	1.5	.9

C. Conditions and Covenants

In addition to the standard conditions and covenants, the following would be included in the Project Agreement:

1. Prior to any disbursement of the Assistance, or to the issuance by A.I.D. of documentation pursuant to which disbursements will be made, the Grantee will, except as A.I.D. may otherwise agree in writing, furnish to A.I.D. in form and substance satisfactory to A.I.D.:

Designation by the Grantee of an implementing entity for the project and a statement of procedures to be followed in approving research activities to be financed under the Grant.

2. Covenants

(a) In order to implement the subprojects under each major component of the Project, the designated implementing entity will ensure that work plans for each component (bio-mass production, bio-mass conversion, coal, energy efficiency and information exchange) consistent with the Project objectives are developed by the U.S. and Indial collaborating institutions in about six months after A.I.D. has signed agreements with the identified U.S. institutions for collaboration.

(b) The designated implementing entity will ensure the establishment of an adequate number of additional positions and also ensure the employment of qualified staff to fill these positions for the bio-mass production programs at the National Botanical Research Institute (NBRI) and Madurai Kamraj University (MKU) with reference to A.I.D. financed activities by approximately December 1983.

(c) The designated implementing entity will conduct economic and social assessments in the areas of bio-mass production and conversion program.

PROJECT AUTHORIZATION

Alternative Energy Resources Development
A.I.D. Project Grant No. 386-0474

INDIA

Pursuant to Sections 103 and 106 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Alternative Energy Resources Development Project (the "Project") for India (the "Cooperating Country") involving planned obligations of not to exceed Five million United States Dollars ($5,000,000) in grant funds, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the Project.

The Project is designed to help India to expand its technical capacity to exploit its alternative energy resources and to develop selected energy technologies to a stage of application. Project financing will be utilized to support research and demonstration activities that can be broadly categorized into four major technical areas as follows: (1) bio-mass production and conversion, (2) coal conversion, (3) energy efficiency in industry and transportation, and (4) information exchange and prototype equipment.

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

a. Source and Origin of Goods and Services

Goods and services, except for ocean shipping, financed by A.I.D. under the Project shall have their source and origin in the Cooperating Country or the United States, except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the Project shall be financed only on flag vessels of the United States except as A.I.D. may otherwise agree in writing.

b. Condition Precedent to Disbursement

Prior to any disbursement of funds under the Grant, or to the issuance by A.I.D. of documentation pursuant to which disbursement will be made, the Cooperating Country will, except as A.I.D. may otherwise agree in writing, furnish to A.I.D. in form and substance satisfactory to A.I.D.:

Designation by the Grantee of an implementing entity for the Project and a statement of procedures to be followed in approving research activities to be financed under the Grant.

c. Covenants

The Cooperating Country shall covenant to:

(a) Ensure that work plans for each component (bio-mass production, bio-mass conversion, coal, energy efficiency and information exchange) consistent with the Project objectives are developed by the U.S. and Indian collaborating institutions in about six months after A.I.D. has signed agreements with identified U.S. institutions for collaboration.

(b) Ensure the establishment of an adequate number of additional positions, and also ensure the employment of qualified staff to fill these positions for the bio-mass production programs at the National Botanical Research Institute (NBRI) and Madurai Kamraj University (MKU) with reference to A.I.D. financed activities by approximately December 1983.

(c) Conduct economic and social assessments in the areas of bio-mass production and conversion program.

Signature

Priscilla M. Boughton

Priscilla M. Boughton

June 29, 1982

Date

Clearance:

USAID/LEG:BMRao (in draft)
GC/ASIA:Stephen Tisa (in draft)
RLA:Spielman (in draft)
CO:LWight (in draft)
DD:RMBrown

NNNOV NDO379
PP RUEHND
DE RUEHC #3419 1731519
ZNR UUUUU ZZH
P 211201Z JUN 80
FM SECSTATE WASHDC
TO AMEMBASSY NEW DELHI PRIORITY 9062
BT
UNCLAS STATE 163419

AIDAC

E.O. 12065: NA

AGS:

SUBJECT: ALTERNATIVE ENERGY RESOURCES DEVELOPMENT PROJECT (386-0474)

1. ASIA PROJECT ADVISORY COMMITTEE (APAC) REVIEWED SUBJECT ON JUNE 18 AND APPROVED PID.

2. APAC FULLY SUPPORTS PROPOSED INITIATIVE IN FIELD OF ALTERNATIVE ENERGY RESOURCE DEVELOPMENT, CONSISTENT WITH AID PRIORITIES. WE RECOGNIZE THE NEED FOR A MECHANISM TO SUPPORT ACTIVITIES IDENTIFIED BY THE INDO-U.S. JOINT SUB-COMMISSION ON SCIENCE AND TECHNOLOGY. HOWEVER, APAC AGREED WITH MISSION THAT LIMITATIONS TO SCOPE OF ACTIVITIES TO BE SUPPORTED SHOULD BE SPELLED OUT EARLY IN PROJECT DESIGN TO AVOID MISUNDERSTANDINGS.

3. TO THIS END, APAC SUGGESTED THE FOLLOWING AS GUIDELINES:

(A) PP SHOULD MAKE CLEAR THAT WHILE BASIC RESEARCH IS NOT APPROPRIATE FOR FUNDING UNDER THIS PROJECT, ADAPTIVE RESEARCH AND DEVELOPMENT AIMED AT EARLY USE OF RENEWABLE ENERGY TECHNOLOGIES - PARTICULARLY IN RURAL AREAS - BE SUPPORTED.

(B) WHILE DEVELOPMENT OF FOSSIL-FUEL TECHNOLOGIES (PIO PART 1.A) IS NOT APPROPRIATE FOR FUNDING UNDER THIS PROJECT, TRAINING AND INFORMATION EXCHANGES IN THESE AREAS MAY BE SUPPORTED.

(C) WHILE EQUIPMENT PROCUREMENT TO PROMOTE CONVENTIONAL ENERGY-USE EFFICIENCY WOULD NOT BE FUNDED UNDER THIS PROJECT, TRAINING, INFORMATION EXCHANGE, AND SOME TECHNICAL ASSISTANCE IN THIS AREA MAY BE SUPPORTED.

4. APAC AGREED WITH MISSION IDENTIFICATION OF OTHER PROJECT ACTIVITIES SUGGESTED IN PIO, PART 1, B (ITEMS 2, 3, 4, and 5), BUT EXPRESSED CONCERN THAT PROJECT DEVELOPMENT BE AIMED AT EARLIEST ACHIEVEMENT OF CONCRETE RESULTS. TO THIS END, APAC SUGGESTS PROPOSED FIRST-PHASE OF DESIGN EFFORT BE STRUCTURED TO IDENTIFY THOSE TWO OR THREE AREAS THAT OFFER THE BEST POTENTIAL FOR APPLICATION/REPLICATION IN INDIA. WITH THIS IN MIND, MISSION MAY WISH TO EXPAND FIRST PHASE DESIGN TEAM TO INCLUDE SOCIOLOGIST

AND, IF NECESSARY, EXTEND TIME ALLOWED FOR THIS PHASE OF THE DESIGN EFFORT. APAC RECOMMENDS AN ASIA BUREAU OR DSB PERSON BE INCLUDED ON DESIGN TEAM. ONCE THE MOST PROMISING AREAS ARE SELECTED, WE ASSUME SECOND-PHASE DESIGN TEAM WOULD THEN ANALYZE TECHNICAL FEASIBILITY AS WELL AS RECEPTIVITY AND AFFORDABILITY OF PROPOSED INTERVENTIONS. BUREAU WOULD APPRECIATE CHANCE TO REVIEW REPORT ON FIRST PHASE OF DESIGN BEFORE SECOND PHASE IS LAUNCHED AND PP IS WRITTEN.

5. PP SHOULD CLARIFY WHAT IS MEANT BY QUOTE APPLICATION STAGE UNQUOTE CITED IN THE PROJECT PURPOSE. DOES MISSION INTEND TO INCLUDE PROTOTYPE AND FIELD TESTING IN THIS CONCEPT? IF SO, PP SHOULD EXAMINE COST IMPLICATIONS FOR PROJECT, AS WELL AS IMPLICATIONS FOR DURATION OF PROJECT.

6. IEE RECOMMENDATION FOR NEGATIVE DETERMINATION WAS ACCEPTED BY APAC.

7. FINALLY, APAC WAS CONCERNED THAT FACTORS THAT HAVE SO FAR DELAYED IMPLEMENTATION OF THE TECHNOLOGIES FOR THE RURAL POOR PROJECT SHOULD BE IDENTIFIED AND, TO MAXIMUM EXTENT POSSIBLE, AVOIDED IN THE FINAL DESIGN OF THIS PROJECT. CHRISTOPHER
BT
#3419

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: Alternative Energy Resources Development - (386-0474)

Life of Project
From FY 82 to FY 86
Total U.S. Funding: $5.0 million
Date Prepared: March 1982

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Sector Goal: 1. Reduce deforestation 2. Reduce FX expenditures on energy supplies. 3. Increase efficiency of energy use	The R&D work in this project will have measurable impact on goal attainment in the long run once technologies being developed reach a stage of commerical application. While it is possible to list indicators of goal achievement, it would be difficult to measure progress in the short run attributable to this project.	Evaluation of testing and demonstration programs	1. Coal is deemed an economic alternative to oil. 2. Fuelwood is an important energy source in rural and urban areas. 3. Energy efficiency in transportation and industry sectors is possible.
Project Purpose: 1. Expand India's technical capacity to develop alternative energy resources. 2. Develop selected energy technologies to the application stage.	Conditions indicating purposes achieved: 1. Biomass production programs that lead to energy plantation development developed. 2. Selected technologies developed in: a. producer gas b. engine development for producer gas c. pyrolysis d. fluidized bed combustion of coal. 3. Syst of information exchange developed. 4. Solutions recommended to remove constraints in energy efficiency in transport and industrial sectors.	Sub-project evaluations and monitoring reports.	Existing technical capacities capable of building on transfer.
Outputs: Sub-projects identified in biomass production and conversion, conservation in industry and transportation and information exchange.	Magnitude of outputs (Approx.): 2 sub-projects in biomass production 3 sub-projects in biomass conversion 5 sub-projects in coal 4 sub-projects in conservation-industry 3 sub-projects in conservation-transportation. 3 areas of information exchange	Project Records.	Sub-projects can be identified in alternative energy fields.
Inputs: AID : $5 million GOI : $2.3 million	Implementation Targets: ($ million) FY82 - ; FY83 1.2 ; FY84 1.4 ; FY85 1.5 ; FY86 .9	GOI records	GOI provides sufficient funds.

Biomass Production Program*

1.0 SUMMARY AND RECOMMENDATIONS

1.1 Summary

This report focuses on a single, narrowly defined aspect of India's complex alternative renewable sources of energy program: the Production of Woody Biomass. Although the non-commercial sector is emphasized, the program results are applicable to both the commercial and non-commercial sectors. The justification for this focus is provided by Flanigan (1) and its high likelihood of success within a 3 to 5 year period reinforces the strategy.

An intensive, seven-point, practically-oriented research program on woody biomass production is suggested. This program could be implemented in conjugction with on-going biomass research programs in the Biomass Centres at Lucknow and Madurai. However, the programs success depends on the Biomass Centers coordinating and collaborating with each other, the Forest Research Institute, state social forestry programs, agricultural universities, and other selected research laboratories. The state social forestry programs critically need the research results that will be produced and will likely be the most effective mechanism for placing them into practice.

A plan for implementing the research program on woody biomass production is proposed. It requires the development of multidisciplinary research teams that apply systems approaches to the solution of woody biomass production problems. A key feature of the plan is the participation of a U.S. biomass production specialist throughout its life to provide technical expertise, to provide a mechanism to insure cooperation between the various organizations doing biomass research, and to provide continuity between USAID energy and social forestry programs. The plan identifies project coordination, institutional strengthening, and research components and suggests funding levels. In addition, a proposed time sequence for the research activities and anticipated research program outputs are included with the plan.

A list of the organizations that were visited and consulted is presented in Appendix F of the detailed report.

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*Sections of this document have been excerpted from the complete report which is on file with USAID/New Delhi and ASIA/TR/EFE.

1.2 Recommendations

- Provide supplemental funding for the Government of India's research program on woody biomass production
- Allocate $336,600 for project coordination and institutional strengthening
- Allocate $754,800 to the National Botanical Research Institute to complement their on-going research program in biomass production
- Allocate $601,600 to Madurai-Kamaraj University to assist in initiating their proposed research program in woody biomass production
- Emphasize growth regulation and economic and social assessment projects at Madurai-Kamaraj University
- Formulate multidisciplinary research teams that can apply a systems approach to the solution of woody biomass production problems
- Contract a U.S. biomass production specialist to provide research coordination for the woody biomass production program and to maintain continuity between the USAID energy and social forestry programs
- Formally involve the Forest Research Institute, state social forestry programs, agricultural universities, and appropriate national research laboratories with the Biomass Centres in collaborative activities.

2.0 INTRODUCTION

The role of alternative renewable sources of energy in relaxing India's dependence on oil as its price rose became an important issue in the mid 1970's. This topic is thoroughly discussed in a paper reporting on a United Nations Conference in Nairobi on New and Renewable Sources of Energy (9), in an overview of energy problems, policies and programs in India by Ichord (5), and most recently in a report by Flanigan emphasizing energy use in India's non-commercial sector (1). India's Sixth Five Year Plan especially recognizes the need to develop new and renewable sources of energy and sets forth a program to deal with the problem (4). As a result of that planning effort, the problem is being attacked from many different directions described in the Department of Science and Technology's recently prepared state of the art report on the production and availability of biomass (2).

This report focuses on a single, narrowly defined, aspect of India's complex alternative renewable sources of energy program: the Production of Woody Biomass. Although the emphasis is on the non-commercial sector, the program results are applicable to both the commercial and non-commercial sectors. This is illustrated by the fact that methodologies developed in this program are applicable to the production of woody biomass for India's pulp and paper industries, construction industries, commercial bio-energy conversion facilities and the like.

3.0 WOODY BIOMASS PRODUCTION: IT'S IMPORTANCE

Although 75 million ha of land or 23% of India's area is classified as forest, only 40-50% of this area is actually under adequate tree cover and an estimated 20 million ha is seriously affected by erosion. Thus, no more than 12% of India's land area is forested, as against a target of 33% recommended in the National Forest Policy of 1952 (10).

Forestry is an old and well-established activity in India. In 1865 the first Indian Forestry Act was passed to regulate exploitation of forests. The importance of improving the productivity of Indian forests was not generally recognized, however, until the early 1970's when the National Commission on Agriculture (NCA) extensively reviewed India's forestry prospects and policies. The NCA report recommended that India's strategy for forestry development focus on a "production forestry" to supply the growing needs of the domestic wood products industry and "social forestry" to supply fuelwood, fodder, small timber and other forest products to the rural population (10).

The Sixth Five Year Plan (4) states that

> the main objectives of the forestry programme...will be the conservation of existing forests and the launching of country-wide afforestation and social forestry programmes...In conformity with this objective the major area of thrust will be the promotion of a people's forestry movement.

Currently, social forestry [1] programs exist or are being established in all of the major Indian states.

Given the strong dependence of the rural population on non-commercial fuels, particularly firewood, and the high probability that this demand will continue, the central question becomes: what is required to make supplies more nearly equal to demand? In addition to the Sixth Five Year Plan, this question is addressed in the report from the working group on Science and Technology on energy policy (3). This focused concern has been assimilated by Flanigan into a suggested strategy that will support India's

---

[1] The term social forestry is being applied to programs encompassing farm forestry, extension, recreational forestry and community forestry as defined by the FAO and, in some cases, soil and water conservation as a part of waste land reforestation efforts are also included.

comprehensive effort in renewable energy and provide wise use of USAID funds (1). The strategy topics in descending priority are:

1. reforestation (social forestry and energy plantations)
2. producer gas pump sets
3. plantation harvest planning
4. other conversion processes

Although India has a significant infrastructure for the management, research and development of her biomass resources, the Department of Science and Technology established two specialized centers with a view to promote time-targeted and result-oriented development work and accelerate demonstration projects in the area of biomass research (9). One center was established at the National Botanical Research Institute (NBRI) in Lucknow and the other at Madurai-Kamraj University (MKU) in Madurai. The complete objectives and functions of these two centers are included in Appendices A and C. The objectives of these research centers can be summarized as (7):

- Assess the potentials of plant species for biomass production
- Standardize agricultural techniques for energy plantations
- Study photosynthesis of selected species in relation to plant productivity, nutrient cycling, and nitrogen economy
- Survey the land and water potential of an area and formulate programs for the utilization of municipal and agricultural wastes for energy conversion
- Concentrate on terrestrial and aquatic energy crops
- Undertake feasibility studies on more efficient uses of biomass for obtaining maximum energy and develop appropriate technologies for energy crops, i.e. production systems, harvesting, pretreatment, and different conversion processes

The Sixth Five Year Plan provides the Department of Science and Technology an appropriation of Rs.50 crores over the next 5-years for biomass research[2]. To date Rs.25 lakhs have been allocated to each institution (7). Additional programs in the Sixth Five Year Plan which support and complement the Biomass Centres include the establishment of a Forest Survey of India to provide reliable information on existing and potential forest resources; establishment of an autonomous Institute of Forest Management; expanded forestry research programs at the Dehra Dun Forest Research Institute (FRI), at institutes under the Indian Council of Agricultural Research, and at State Forest Departments and agricultural universities; and establishment of a Division of Forestry Extension at FRI.

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[2] Discussions held with Mr. M. Dayal, Energy Advisor, Department of Science and Technology, September 1981.

7.0 WOODY BIOMASS PRODUCTION: A RESEARCH PLAN FOR USAID

This report proposes that USAID's strategy be directed at providing the needed research for Flanigan's (1) first priority: reforestation. This can be accomplished by implementing a program directed at Woody Biomass Production similar to the one outlined in Section 4.0 and cooperatively supported by the Government of India, Department of Science and Technology and USAID.

This program should be implemented through the Biomass Centres at Lucknow and Madurai. The GOI and USAID need to emphasize the coordination of Biomass Centre projects with FRI, state social forestry departments and agricultural universities in addition to on-going programs at other institutions, specifically tissue cultural work at the National Chemical Laboratory (NCL), Pune.

This section suggests USAID support in terms of the overall woody biomass production research program and in terms of each Biomass Centre. In each case, the support is related to the research program outlined in Section 4.0.

7.1. Project Coordination and Institutional Strengthening

As discussed in Section 6.0, the success of the USAID program depends on the biomass production research efforts in India being focused and coordinated. This requires the development of comprehensive research teams that apply a systems approach to the solution of woody biomass production problems.

It is suggested that USAID contract a biomass production specialist to work with the Biomass Centres, forestry organizations and agricultural universities in coordinating the activities of the research program. This would provide the research institutions needed assistance in

1. focusing their programs,
2. applying systems approaches to problem solving, and
3. modeling biomass production systems.

It would also insure USAID of needed coordination between research institutions and provide a continuing evaluation of the program.

It is suggested that program focus and coordination be initiated with a biomass plantation assessment tour. The tour should include:

1. the biomass production specialist,
2. two scientists from NBRI
3. two scientists from MKU
4. one agronomist from the Agricultural University at Madurai,
5. conservator of Forests, Research and Development Circle, U.P.

6. one forest silviculturist from FRI

Upon completion of the tour the group could prepare a study plan to guide the initial direction of the research program in woody biomass production. The study plan would identify critical soil types, woody plant species, intercrop plant species, spacings, and agronomic practices that should be scientifically evaluated. The plan would serve as the focal point for the two Biomass Centres biomass production research programs.

In addition to the plan, the tour would expose foresters, agriculturists, and biologists to each others problems, identify areas in critical need of coordination and collaboration, and formally initiate a dialogue between the research institutions associated with woody biomass production.

The biomass production specialist would continue as the laison person for the life of the project, cooperating with NBRI and MKU in the coordination of the complete GOI/USAID woody biomass production program.

7.2. National Botanical Research Institute - Lucknow

NBRI had a program directed at the use of biomass as an alternative energy source in 1980 when they received their Biomass Centre designation. Since then they have increased the scope of their activity and have initiated parts of the program they proposed in their Biomass Centre proposal (Appendix A).

NBRI has an excellent record of implementing practices and programs associated with their research projects. They successfully use the Banthra Research Station in this capacity. Past projects have resulted in successes in medicinal plants, non-traditional agricultural crops, and aquatic programs to name a few. A further example of their desire to implement research is illustrated in their Annual Report. It lists scientific publications directed at professtional and subprofessional cliental which are written in both English and Hindi as well as a broad array of workshops and seminars. Their Economic Botany Information Service and Library is excellent both from the standpoint of staff as well as from the number and thoroughness of the tasks they undertake.

Although the NBRI scientists have excellent credentials and have a history of conducting field experiments at Banthra Research Station, they are inexperienced in the area of woody biomass production, both in terms of awareness of problems as well as methodologies to address the problems. They recognize this deficiency and have initiated cooperation with knowledgeable woody biomass researchers. Thus, their desire to remedy this deficiency is apparent.

The following subsections of this report present, in a summarized form, suggested projects for involving NBRI in a woody biomass production research program as outlined in Section 4.0. Complementary preproposals have been submitted by NBRI scientists and are included in Appendix B.

7.2.1. Existing Plantation Assessment: Research Emphasis

. Continue and strengthen on-going projects tabulating bibliographies on biomass production
. Participate in reviewing and assessing existing biomass production programs throughout India
. Provide leadership in collaboration with the biomass production specialist for the overall biomass research program

Principal Investigator - Dr. S.D. Khanduja
Mr. B.P. Juneja

Strengths - Excellent facilities
Strongest Biomass Centre biomass research program

Deficiencies - Need assistance in providing focus to the woody biomass production program
Need assistance in quantification of research results

Coordination - Agricultural universities

Collaboration - MKU, FRI, State Social Forestry Programs

U.S. Assistance - Biomass Production Specialist Information Scientist

7.2.2. Field Trial Implementation: Research Emphasis

. Continue and expand studies evaluating the performance of selected plant species
. Increase project emphasis on studies focused at production rates under various agronomic practices
. Initiate a project to evaluate the impact of interplanting woody plants, grasses and/or agricultural crops in biomass plantations
. Initiate a project relating biomass production to soil, climatic, intercrop, and agronomic practices
. Determine energy budgets associated with biomass plantations

Principal Investigator - Mr. P.N. Misra

Strenghs - Banthra Research Station
Have on-going projects for several species
Have field trial experience
Collaboration with State Spcial Forestry Programs

Deficiencies - Need to increase the scope of the on-going projects
Need assistance in quantification of research results
Need to replicate studies in the laboratory and the field

Coordination - MKU, FRI, Agricultural universities

Collaboration - State Social Forestry Programs

U.S. Assistance - Biomass Production Specialist

7.2.3. Plantation Establishment Relationships: Research Emphasis

. Initiate a project to determine the minimal and optimal characteristics of plants to insure high survival and rapid initial growth
. Initiate a project to determine the optimum time for planting
. Initiate a project to determine the minimal and optimal rates, timing, and types of irrigation and fertilization during the initial year of the biomass plantation and relate these practices to plant survival

Principal Investigator - Mr. P.N. Misra

Strengths - Banthra Research Station
Excellent laboratory facilities

Deficiencies - Not an on-going research project
Need assistance in quantification of Research results

Coordination - MKU, FRI

Collaboration - State Social Forestry Programs

U.S. Assistance - Reforestation Specialist

7.2.4. Seed Procurement and Maintenance: Research Emphasis

. Initiate a project to select woody biomass plants with genetically desirable characteristics
. Initiate a project to develop seed collection criteria
. Initiate a project to identify seed storage methodologies
. Develop mass seedling propagation methodologies

Principal Investigator - Dr. P.D. Dogra
Dr. M.N. Gupta
Dr. H.C. Chaturvedi

Strengths - Excellently trained scientists
Experienced researchers

Deficiencies - Lack experience in specific woody plant species

Coordination - FRI, State Social Forestry Programs, Indo-Danish Forest Tree Seed Collection Program

Collaboration - MKU, NCL

U.S. Assistance - Tree and Shrub Improvement Specialist

7.2.5. Nutrient Cycle Relationships: Research Emphasis

. Initiate field and laboratory projects to determine the minimal and optimal rates, timing, and type of fertilization to maintain long-term soil productivity in biomass plantations
. Initiate field and laboratory projects to evaluate the use of interplanted plant species to biologically maintain or supplement fertilization in biomass plantations

Principal Investigator - Dr. S.D. Khanduja
Mr. P.N. Misra

Strengths - Excellently trained scientists
Experienced researchers

Deficiencies - Lack specific field experience

Coordination - FRI, State Social Forestry Programs, Agricultural universities

Collaboration - MKU

U.S. Assistance - None

7.2.6. Insect and Disease Impacts: Research Emphasis

. Assess potential animal, insect and disease problems in biomass plantations and relate them to species, soil, climatic, intercrop, and agronomic practices and factors
. Assist in the preparation of guidelines for an Integrated Pest Management research program

Principal Investigator - Forest Entomologist (open position)

Strengths - None

Deficiencies - Not an on-going research project
Lack woody plant insect and disease expertise
Need assistance in quantification of research results
Need assistance to develop an Integrated Pest Management research program

Coordination - FRI, State Social Forestry Programs

Collaboration - MKU

U.S. Assistance - Forest Insect and Disease Specialist

7.2.7. Economic and Social Assessments: Research Emphasis

. Initiate a project to evaluate biomass plantations using economic investment criteria

Principal Investigator - Resource Economist (open position)

Strengths - None

Deficiencies - Not an on-going research project
Lack economic expertise
Need assistance in undertaking economic assessments

Coordination - FRI, State Social Forestry Programs

Collaboration - MKU

U.S. Assistance - Resource Economist

7.3. Madurai-Kamaraj University - Madurai

MKU had a limited biomass production program prior to their designation as a Biomass Centre. It does not appear that the limited biomass program has perceptively changed since that designation. They are, however, currently beginning to increase the scope of their activity and to initiate parts of the program they proposed in their Biomass Centre research proposal (Appendix C).

MKU's strength lies with its faculty and its educational programs. The fact that it is a university with disciplines in statistics, computer science, mathematics, sociology, economics as well as biological sciences makes it a unique Biomass Centre. USAID should capitalize on this feature.

The faculty's experience in implementing the practical aspects of their scientific endeavors is limited. Although MKU scientists have excellent credentials they are inexperienced in the area of woody biomass production; both in terms of awareness of problems as well as methodologies to address the problems. Although they verbally acknowledge this deficiency, to date they have not formally cooperated with scientists experienced in the field problems associated with woody biomass production. MKU's expertise is training researchers and solving fundamental biological problems.

If MKU's activities are closely coordinated by the U.S. biomass production specialist and if they actively collaborate with state social forestry programs and agricultural universities, MKU could contribute positively to biomass production field projects. Their initial thrust, however, should concentrate on growth regulation projects (see 7.3.3 and 7.3.5) and on economic and social assessments (see 7.3.7).

The following subsections of this report present, in a summarized form, suggested projects for involving MKU in a woody biomass production research program as outlined in Section 4.0. Complimentary proposals have been submitted by MKU scientists and are included in Appendix D.

7.3.1. Existing Plantation Assessments: Research Emphasis

. Participate in reviewing and assessing existing biomass production programs throughout India

Principal Investigator - Forest Silviculturist (currently being recruited)

Strengths - None

Deficiencies - Need assistance in providing focus to the woody biomass production program
Need assistance in quantification of research results

Coordination - Agricultural universities

Collaboration - NBRI, FRI, State Social Forestry Programs

U.S. Assistance - Biomass Production Specialist

7.3.2. Field Trial Implementation: Research Emphasis

. Initiate proposed biomass production studies
. Initiate a project to estimate biomass production rates under various agronomic practices
. Initiate a project to evaluate the impact of interplanting woody plants, grasses and/or agricultural crops in biomass plantations
. Initiate a project relating biomass production to soil, climatic, intercrop, and agronomic practices
. Determine energy budgets associated with biomass plantations

Principal Investigator - Forest Silviculturist (currently being recruited)

Strengths - Field laboratories
• Initiated projects for several species

Deficiencies - Lack experienced expertise
Need to increase the scope of the on-going project
Need assistance in quantification of research results
Need to replicate studies in the laboratory and in the field

Coordination - NBRI, FRI

Collaboration - Agricultural universities, State Social Forestry Programs

U.S. Assistance - Biomass Production Specialist

7.3.3. Plantation Establishment Relationships: Research Emphasis

. Initiate a project to determine the minimal and optimal characteristics of plants to insure high survival and rapid initial growth
. Initiate a project to determine the optimum time for planting
. Initiate a project to determine the minimal and optimal rates, timing, and types of irrigation and fertilization during the initial year of the biomass plantation and relate these practices to plant survival

Principal Investigator - Dr. A. Gnanam

Strengths - Excellently trained scientists
Experienced researchers

Deficiencies - On-going research projects are not oriented at these problems
Need assistance in quantification of research results

Coordination - NBRI, FRI

Collaboration - State Social Forestry Programs

U.S. Assistance - Reforestation Specialist

7.3.4. Seed Procurement and Maintenance: Research Emphasis

. Initiate a project to select woody biomass plants with genetically desirable characteristics
. Initiate a project to develop seed collection criteria

Principal Investigator - Forest Silviculturist (currently being recurited)

Strengths - None

Deficiencies - Not an on-going research project
Lack woody plant genetics expertise

Coordination - FRI, State Social Forestry Programs, Indo-Danish Forest Tree Seed Collection Program

Collaboration - NBRI

U.S. Assistance - Tree and Shrub Improvement Specialist

7.3.5. Nutrient Cycle Relationships: Research Emphasis

. Initiate field and laboratory projects to determine the minimal and optimal rates, timing, and type of fertilization to maintain long-term soil productivity in biomass plantations
. Initiate field and laboratory projects to evaluate the use of interplanted plant species to biologically maintain or supplement fertilization in biomass plantations

Principal Investigator - Dr. A. Gnanam

Strengths - Excellently trained scientists
Experienced researchers

Deficiencies - Lack field experience

Coordination - FRI, State Social Forestry Programs, Agricultural universities

Collaboration - NBRI

U.S. Assistance - None

7.3.6. Insect and Disease Impacts: Research Emphasis

. Assess potential animal, insect and disease problems in biomass plantations and relate them to species, soil, climatic, intercrop, and agronomic practices and factors

Principal Investigator - Forest Silviculturist (currently being recruited)

Strengths - None

Deficiencies - Not an on-going research project
Lack woody plant insect and disease expertise
Need assistance in quantification of research results

Coordination - FRI, State Social Forestry Programs

Collaboration - NBRI

U.S. Assistance - Forest Insect and Disease Specialist

7.3.7. Economic and Social Assessments: Research Emphasis

- Initiate a project to determine energy consumption patterns in rural areas
- Initiate a project to develop supply/demand relationships for alternative sources of energy in rural areas
- Initiate a project to undertake investment analyses of biomass plantations

Principal Investigator - Dr. John D.K. Sundarsingh
Dr. (Mrs.) L. Thara Bhai

Strengths - Excellently trained scientists
Experienced researchers

Deficiencies - Not an on-going research project

Coordination - FRI, State Social Forestry Programs

Collaboration - NBRI

U.S. Assistance - Resource Economist
Rural Sociologist

8.0 PROGRAM IMPLEMENTATION AND CONTROL

Figure 1 illustrates the beginning and ending points of projects and periods of participation by U.S. specialists for the suggested research program in woody biomass production. The participation of a biomass production specialist throughout the program provides the technical expertise required for Components 4.1 and 4.2 and will also provide the mechanism to ensure cooperation between forestry organizations, agricultural universities, national research laboratories, and the Biomass Centres. It is also suggested that this specialist continue to monitor biomass production programs associated with the Biomass Centres after the completion of the GOI/USAID program. Approximately three months of support is suggested during a 2-year period following this project and the expenditure has been included in the budget. This would provide continuity between this program and continuing USAID supported social forestry programs dependent on the outputs.

In Section 9, USAID salary monies provided the GOI for new sciertist position are viewed as continuing, permanent positions. If the Biomass Centre program is to be successfully continued following USAID's participation, the GOI must continue financing these positions and add additional positions in forest entomology, forest pathology, resource economics, silviculture, agronomy, and forest genetics as needed.

Annual workshops are suggested and programmed to insure communication between cooperating scientists and scientific organizations and to provide a formal mechanism for reporting annual progress. The third year workshop should present final results of the GOI/USAID program and prioritize researchable problems for continued Biomass Centre programs. Table 1 indicates products that should result from this research program by the end of the third year.

Appendix G suggests an activity and budgeting schedule and desirable Covenants and Conditions Precedent. Appendix E suggests individuals and organizations with the technical expertise USAID would need to acquire for this project. Appendix H gives an indication of the scope of work to be provided by each of these specialist.

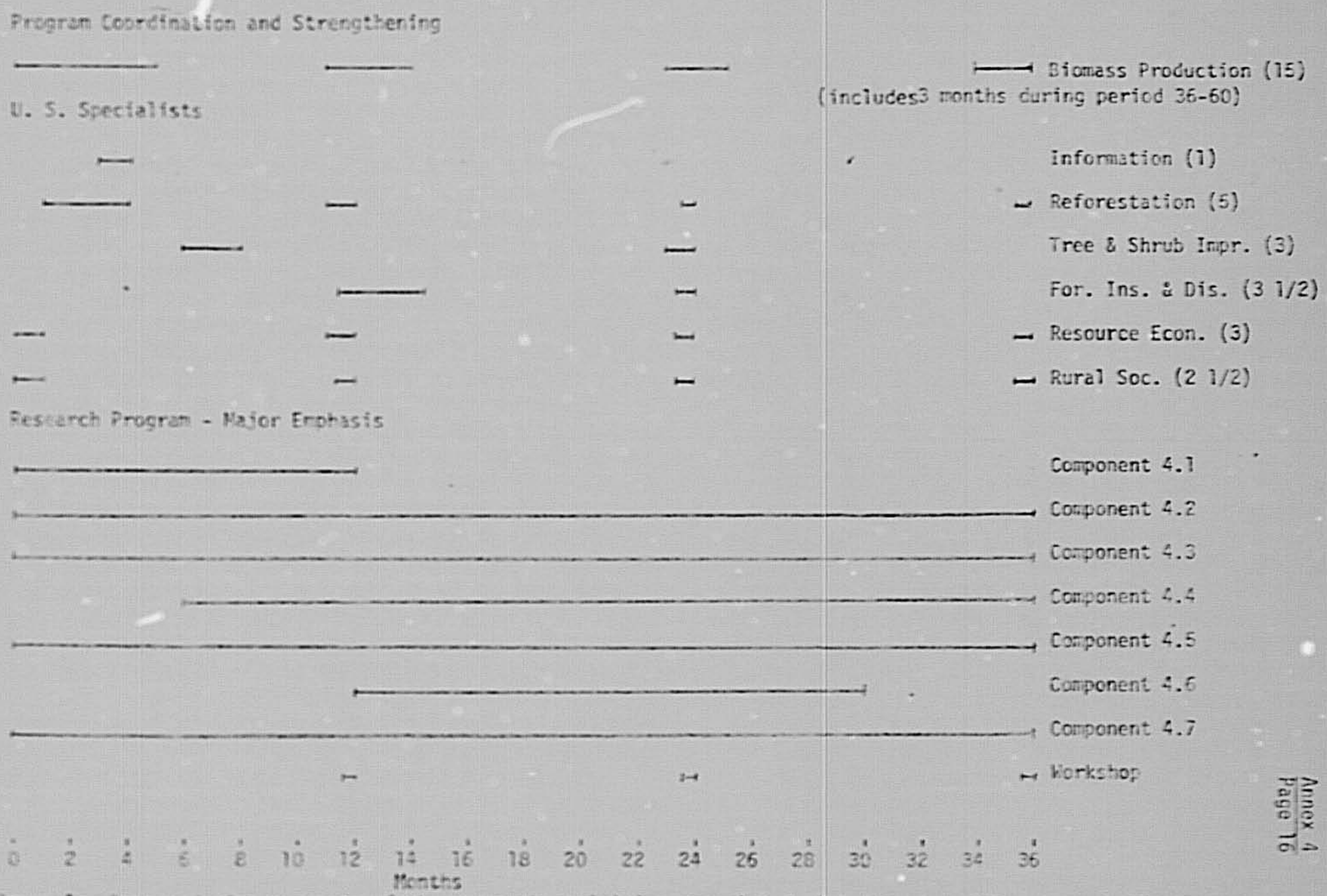

Figure 1. Proposed time sequence of the research activities associated with the woody biomass production program

Table 1. Anticipated Woody Biomass Production Research Program Products

Product	Year Completed
Bibliography of published information on biomass plantations in India and the surrounding region	First
A compendium listing the location, soil type, species, date of planting, density, agronomic practices employed and yield for energy and social forestry biomass plantations throughout India	First
Mathematical models that predict biomass plantation production as a function of species, soil, climate, density, intercrop, and agronomic practices and factors for marginal and submarginal lands throughout India	Third
Guidelines specifying desirable characteristics and agronomic practices for species, soils, and climates needed to insure high survival and rapid initial growth of plants in woody biomass plantations	Third
Guidelines specifying desirable timing, rates, and types of fertilization including intercrop plant species needed to insure long-term soil productivity in woody biomass plantations	Third
Guidelines specifying seed collection, seed storage, and plant propagation procedures for important woody plant species	Third
A compendium listing location, type and amount of animal, insect and disease damage, and the agronomic, biological, and edaphic characteristics of energy and social forestry biomass plantations throughout India	Second
A document outlining an Integrated Pest Management research program for woody biomass plantations in India	Second
Guidelines specifying investment levels by species, soils, climate, and agronomic practices resulting in desirable rates of return in woody biomass production for plantations throughout India	Third
Mathematical models that predict short-term, economic demand and supply curves for biomass as a function of energy costs, village social value systems, and energy supplies in selected rural villiages in southern India	Third

9.0 BUDGET SUMMARY - 3 YEARS

		USAID	GOI
Project Coordination and Institutional Strengthening		$336,600	Rs 3,91,500
National Botanical Research Institute		754,800	27,23,500
Existing Plantation Assessments	$109,800		
Field Trial Implementation	100,400		
Plantation Establishment Relationships	201,500		
Seed Procurement and Maintainence	197,200		
Nutrient Cycle Relationships	25,300		
Insect and Disease Impacts	97,500		
Economic and Social Assessments	23,100		
Madurai-Kamaraj University		601,600	25,51,500
Existing Plantation Assessments	51,300		
Field Trial Implementation	104,000		
Plantation Establishment Relationships	126,400		
Seed Procurement and Maintainence	56,300		
Nutrient Cycle Relationships	25,300		
Insect and Disease Impact	56,300		
Economic and Social Assessments	182,000		
Total		$1,693,000	Rs 56,66,500

APPENDIX G. Implementation Plan

1. Scheduling and Budgeting

a. 6-month Start-up Period
   1. Recruit staff (US/Indo)
   2. Preliminary work plans are developed
   3. Intensify the literature review effort
   4. Order equipment not dependent on project design

b. Project Work Plan Development and Approval (6-month period)
   1. U.S. consultants are in place at the Biomass Centres
   2. Indian staff is hired and in place
   3. Project development tour is completed
   4. Formal work plans are prepared per schedule

c. Project Execution and Reporting (30-month period)
   1. Research program is carried out
   2. Annual workshops are held and progress reports are prepared and submitted to GOI/USAID
   3. Research products are distributed to social forestry organizations and the scientific community

d. Project Budgeting
   1. Funding will be in two tranches. The initial tranch is to cover funds for the first 12 months of the project (a and b). The second tranch is to begin after the approval of the formal work plans.

   2. Annual expenditures

	Year 1	2	3	4	5
	Rs (Lakhs)				
AID	51	51	51	0	0
GOI	19	19	19	33	33
Total	70	70	70	33	33

Total project Cost = Rs 276 Lakh
$ 3.1 million
($1.7 million U.S. and $1.4 million GOI)

APPENDIX H. Technicial Expertise: Scope of Work

Biomass Production Specialist

1. Work directly with the Biomass Centre Directors in coordinating woody biomass production research program activities between the two biomass centers, forestry organizations and agricultural universities

2. Assist Biomass Centre Directors in focusing the direction of the woody biomass production research program on critical energy and social forestry plantation needs

3. Work directly with U.S. specialists in coordinating individual research components into the woody biomass production research program

4. Formulate and conduct a biomass plantation assessment tour in collaboration with the Biomass Centre Directors, forestry organizations, and agricultural universities

5. Provide assistance with and identify training needed in methodologies associated with the quantification of research results

6. Prepare written reports 1) identifying individuals needing quantitative training, 2) describing the specific type and length of training needed, and 3) assessing, upon completion, the impact of the training on the program.

7. Prepare written reports 1) evaluating the progress of the woody biomass production program, 2) defining problems and constraints affecting woody biomass production program results, and 3) recommending needed woody biomass production program modifications

Information Scientist

1. Formulate a computer-compatible system for indexing biomass literature that is consistent with NBRI's needs and compatible with its current information services and library

2. Determine the type of training needed in computerized information management systems

3. Prepare a written report 1) describing a computer-compatible system for indexing biomass literature, 2) identifying individuals needing computerized information management systems training, and 3) describing the specific type and length of training needed

APPENDIX H. Continued

Reforestation Specialist

1. Tour selected forest nursery production facilities and biomass plantations and identify critical factors and practices affecting plant survival

2. Work directly with the Biomass Production Specialist to identify ways of coordinating factors affecting plantation establishment into the woody biomass production research program

3. Formulate a research problem analysis that addresses nursury management and plantation survival needs

4. Determine the type of training needed by research scientists working in the nursery management and plantation survival research program

5. Prepare a written report 1) describing the research problem analysis, 2) identifying individuals needing nursery management and plantation survival research training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the plantation establishment relationships component of the woody biomass research program

Tree and Shrub Improvement Specialist

1. Tour selected biomass plantations and natural forests on marginal and submarginal lands and identify factors which may suggest apparent genetic differences in woody plants

2. Formulate a genetic tree and shrub improvement program for woody plant plantations

3. Determine the type of training needed by research scientists working in the genetics research program

4. Prepare a written report 1) describing the genetic tree and shrub improvement program, 2) identifying individuals needing genetics training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the seed procurement and maintainence component of the woody biomass research program

APPENDIX H. Continued

Forest Insect and Disease Specialist

1. Tour selected biomass plantations and natural forests on marginal and submarginal lands, identify apparent animal, insect and disease damage, and assess factors that may result in future animal, insect and disease problems

2. Work directly with the Biomass Production Specialist to identify ways of coordinating animal, insect and disease factors affecting biomass plantation production into the research program

3. Formulate an Integrated Pest Management research program for woody biomass plantations

4. Determine the type of training needed by research scientists working in pest management research programs

5. Prepare a written report 1) describing the integrated pest management research program, 2) identifying individuals needing pest management research training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the insects and disease impacts component of the woody biomass research program

Resource Economist

1. Identify factors which influence biomass investments and supply/demand relationships

2. Work directly with the Biomass Production Specialist and the Rural Sociologist to coordinate economic and social factors affecting biomass plantation production into the research program

3. Formulate a research problem analysis that addresses biomass plantation investment needs both in terms of economic and social factors

4. Determine the type of training needed by research scientists working in the resource economics research program

5. Prepare a written report 1) describing the research problem analysis, 2) identifying individuals needing resource economics training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the economic and social assessments component of the woody biomass research program

APPENDIX H. Continued

Rural Sociologist

1. Identify factors which influence a village's consumption habits, goals and value systems

2. Work directly with the Biomass Production Specialist and the Resource Economist to coordinate economic and social factors affecting biomass plantation production into the research program

3. Formulate a research problem analysis focused at social factors influencing biomass plantation production and consumption

4. Determine the type of training needed by research scientists working in the rural sociology research program

5. Prepare a written report 1) describing the research problem analysis, 2) identifying individuals needing rural sociology training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the economic and social assessment component of the woody biomass research program

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Summary Description of Biomass Conversion Program*

An investigation of the energy use levels in the noncommercial sector of India shows that the supply of energy in this sector is derived from the conversion of firewood, crop residue, and animal dung. The processes for converting these fuels to other forms of energy, were reviewed for their possible application to the present demands and projected needs of the economy. These three products constitute the principal biomass resource of India whose energy policies were reviewed in relation to them. From this review, a strategy for providing increased biomass fuel stocks through reforestation, irrigation, and planned harvesting techniques has been developed.

It is suggested that the forestry program be given top priority and that a research development program for producer gas pump sets be initiated. The biomass fuel for the pump sets could be either crop residue or fuelwood. Systems for the use of crop residue or fuelwood are recommended wherever the products are to be charred first and then gasified or gasified directly. The results would provide an evaluation for either of the two options. The pump sets would be instrumental in supplying irrigation for crops or wood plantations, and for both, the consumed biomass would increase the biomass product. Crop residues presently appear to be the only biomass material from which there is a small surplus, and the potential use of this surplus to increase the supply is attractive. Also, a planned harvesting system for a maturing fuelwood plantation is recommended so that the plantation's harvest could be maximally utilized to drive a planned 1.5 MW power station.

The last topic of concern is to provide limited support in the area of alcohol fuels, and it is suggested that funds be provided for pretreatment work at IIT Delhi. The steam explosion process is considered to be adaptable to India's biomass feeds, and a pilot scale system utilizing this process could be modified to accept such feeds for improved performance.

The projects suggested in this report should make minimal demands on USAID's limited financial resources and still create a high potential for increasing the fuel supply of India. It is proposed that IIT Delhi be established as biomass center for studying conversion processes along with the Botanical Research Institute at Lucknow and Madurai Kamraj University at Madurai as biomass centers for production.

CONCLUSIONS

1. India has a severe firewood crisis that has been brought about through large scale harvesting and denuding of its timber resources.

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*Detailed Report is on file with ASIA/TR/EFE and USAID/New Delhi

2. Reforestation is absolutely essential, and the program needs the total support of all the Indian people who must provide the highest priority to the task. This priority has not been established to date.

3. Crop residues appear to provide a small surplus, which can be used as fuel. Increased productivity of the residue can be realized much more quickly than reforestation.

4. Charcoal production systems will make it easier to use crop residue as a fuel, and they could provide a valuable commercial product for villagers and reduce their use of firewood.

5. Commercial, producer gas pump sets will increase residue production and energy plantation yields. They will decrease India's demand for imported light distillates (diesel).

6. Biogas systems can be introduced to India's villagers to supply them with energy for cooking and lighting.

7. Plantation planners need to design efficient, low-cost harvesting systems that properly define and consider the use of the end product.

8. India's planners have structured a well-worded energy plan and have given considerable attention to the renewable (biomass) sector.

9. The strategy recommended in this report should aid in providing knowledge and equipment information for a workable energy plan.

RECOMMENDATIONS

1. Funding of a village level, charred biomass project for irrigation: ($191,000).

2. Funding of a Jyoti Solar Institute biomass gasification demonstration: ($130,530).

3. Funding of a proposal entitled "Producer Gas Powered Small Horsepower Utility Engines" ($127,930).

4. Funding of a project for the pretreatment of biomass by steam explosion: ($162,000).

5. A grant for plantation harvest planning should be solicited from the Gujarat Energy Development Agency and funded at a later date.

6. An effort should be made to coordinate and fund on a limited basis the tissue culture work at the National Chemical Laboratory at Pune.

7. DST should consider IIT Delhi as a Biomass Center for conversion processes.

8. The Biocenter should consider soliciting funds from the new AID agency account entitled "Scientific and Technological Cooperation". The funds would provide the Biocenter with resources to continue their leading role in hydrocarbon euphoria research and guayule development.

9. DOE's Biomass Energy Systems Branch should be requested to provide technical monitoring of the funded conversion and planning projects.

STRATEGY

It is hoped that the suggested strategy outlined below in descending priorities will support India's efforts in renewable energy and provide wise use of USAID funds.

1. Reforestation (social forestry and energy plantations)
2. Producer gas pump sets
3. Plantation harvest planning
4. Other conversion processes

REFORESTATION

The critical state of the firewood needs of India and the debilitating effects that these needs have already had on the country's forest preserves necessitate an immediate decision. A strong and decisive reforestation program must be undertaken as soon as possible. Biomass centers need to be established, and their operations geared to near-term reforestation goals as quickly as possible. Dr. Seckler of the Ford Foundation in suggesting a second Green Revolution analyzed the situation economically and determined the cost of production of the needed plantations. He recommended that advanced payments be made to local land owners for planting village forests and suggested that small gasifiers be used to operate diesel engine powered water pumps to irrigate the plantations to increase production. Recommendations of this type have to be expedited with haste and maximum efficiency for the benefit of all.

PRODUCER GAS PUMP SETS

Producer gas pump sets are of special importance in the conversion processes, because they serve as small biomass gasifiers that produce the gas needed to fire the internal combustion engines of the pumps. However, the pump sets at this stage require further laboratory development and field testing before they can be applied commercially in the rural areas of India as suggested by the country's government planners.

The availability of the necessary fuel must be considered first. In reviewing the noncommercial sources, the agricultural residue data indicate that there is at least 1000+tonnes of equivalent residue accessible to some villages. In considering this residue and its use in a downdraft gasifier, several questions arise with regard to gasifier design, fuel characteristics, operating performance, maintenance, and reliability

The downdraft system is normally chosen for running engine systems because of the reduced tar levels in the produced gas and the increase in gasification rates per cross sectional area of the gasifier. This type of gasifier requires careful fuel selection (preparation) and controlled moisture content. The fuel selection requires that the fuel must contain particles that are of reasonably constant size. If such fuels as rice hulls, rice straw and wheat straw are to be used, this requirement would be difficult to satisfy. To offset this difficulty, Dr. Rogers[20] of the Ford Foundation has suggested a small downdraft gasifier, which would use charcoal instead of raw biomass. The 1000+tonnes per village residue surplus could be charred and prepared as fuel for the gasifier. The gasification then becomes

$$C + 1/2O_2 \qquad CO$$

$$C + 2H_2O \qquad CO_2 + 2H_2$$

in which both the CO and H_2 are combustible. This gasification of the charred residue greatly reduces the need for gas clean-up, because the volatiles are removed in the charcoal process. The hot gas from the gasifier passes through a small cyclone and filter combination into the engine. The disadvantage of this process is the considerable loss of energy in the charring (pyrolysis) process (Figure 7), but the advantage is that it is near-term and can use the residue. Either a diesel or gasoline engine in the 3 to 5 horsepower range can be used, but the engine gasifier systems that use prepared char are at a development stage where questions of engine reliability, gasifier operation, and gas quality have not as yet been satisfactorily answered.

The charcoal system suggested is of a beehive kiln type design with trays that permit the use of residue. The charcoal is prepared by extruding a blended charcoal clay mixture through a hand-operated sausage grinder.

Estimates show that the cost of production would be 0.35 rupees per kilogram. This includes the capital investment and the residue and operating costs. The cost of charcoal in Delhi is 1.3 rupees per kilogram. Current estimates, however, do not consider several other pyrolysis and extrusion possibilities, such as Tatom's designs and other innovative concepts. He also recommends the use of wood in the charring process so that it can be compared with the residue in the pumping systems. The most important thing is to demonstrate and develop the system in the field where its operation will define its merit. The important features for using residue to pump irrigation water are that 1) biomass material is plentiful and regenerative, 2) their use increases productivity, and 3) productivity produces a surplus through irrigation, 4) provides a new village industry in charcoal production, 5) provides additional jobs, 6) increases economic income from the sale of the charcoal, and 7) improves cooking efficiency through the use of the charcoal.

The concept, which is schematically illustrated in Figure7, has one principal disadvantage: the loss of energy from the pyrolysis process. The pyrolysis process can be used only to the point of driving off the necessary harmful tars, but whether villagers of average intelligence could control the system to this degree is questionable.

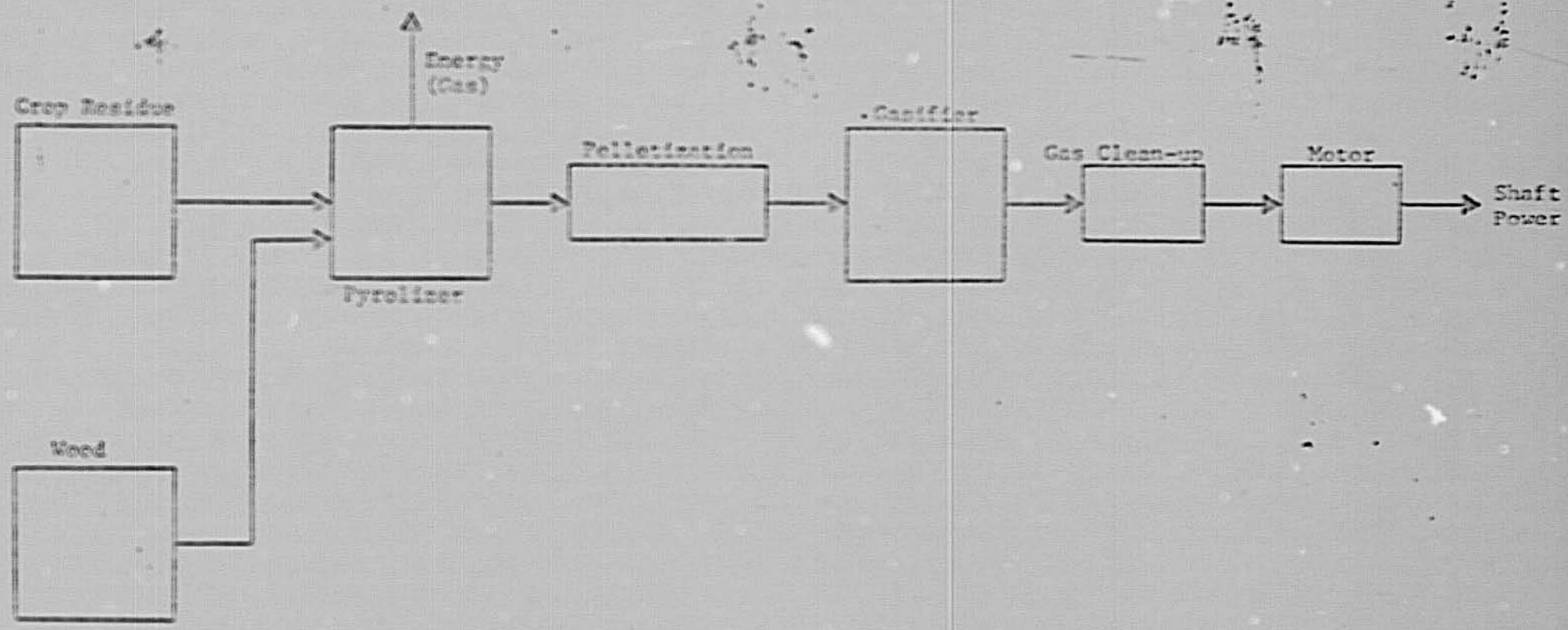

Figure 7. Residue/Wood Pyrolysis Driven Gasifier Pump Set

Dr. Seckler, on the other hand, suggests direct gasification of the biomass product, as demonstrated schematically in Figure 8. The investigators at the Jyoti Solar Energy Institute have prepared a proposal to investigate the possibilities of this option. They propose a three-year program, which would involve one year for design and laboratory development and two years for field demonstration. The unit's size would be in the 3 to 5 horsepower range. The feedsotcks would be primarily wood with crop residue as an alternative if it proves to be a feasible input material. The fuel preparation step would be given considerable attention, and the decision to pelletize or beneficiate would be evaluated in the experimental and design phase. In the system shown in Figure 8, the wood or residue would be fed to the gasifier either through the pelletizer or directly into the producer unit. The gas would then pass through the filtering system into the engine. Because the gas would contain increased tar levels, the filter's performance and the operational characteristics of the engine would be key factors in the evaluation of the process.

Once the two projects are completed, it is essential that their relative performances be evaluated and compared. The initial programs should contain controls for data collection and design quality so that the projects will not be completed without the representative and complete results being expressed in terms of the highest quality of data and equipment. A strategy for providing this quality assurance would require that the data collection system and design be reviewed in the initial stages by the personnel in the Biomass Energy System Branch of the U.S. Department of Energy and that the two systems shown in Figures 7 and 8 be evaluated at the completion of the project by the same people.

The results of the projects will be used in the evaluation and will make it possible to compare the two processes. After the decision-makers have settled on a proven method of using producer gas generators for lift irrigation, they can provide additional assistance to the irrigation problem and add engine design changes that will be beneficial. Research work at IIT, Delhi, has already initiated a development project in which there will be an evaluation on a short-term basis of either diesel or petrol engines, their cooling by either air or water, their engine life, and maintenance requirements. Evaluation on a long-term basis will provide an engine design specifically for producer gas, evaluate the materials for construction, and suggest the degree of emissions from the engine. A judgement about its applicability to either the char or biomass driven system will be made. This work will need to be evaluated by the personnel from the Department of Energy on their initial visit, because data will be important in the final review process. The proposal for this work is included as Appendix B in the detailed report.

The scheduled time period is three years for the development projects. Six months of this time will be devoted to a final assessment and recommendations. The Hindustan Brown Boveri Co. of India and Sweden has expressed interest in the commercialization of the pump set technology. A USAID supported market feasibility study will provide some interesting information about the marketability of the process especially when there are already 4.4 million diesel pump sets in India today. This market study should be carefully considered after the first year of the research project.

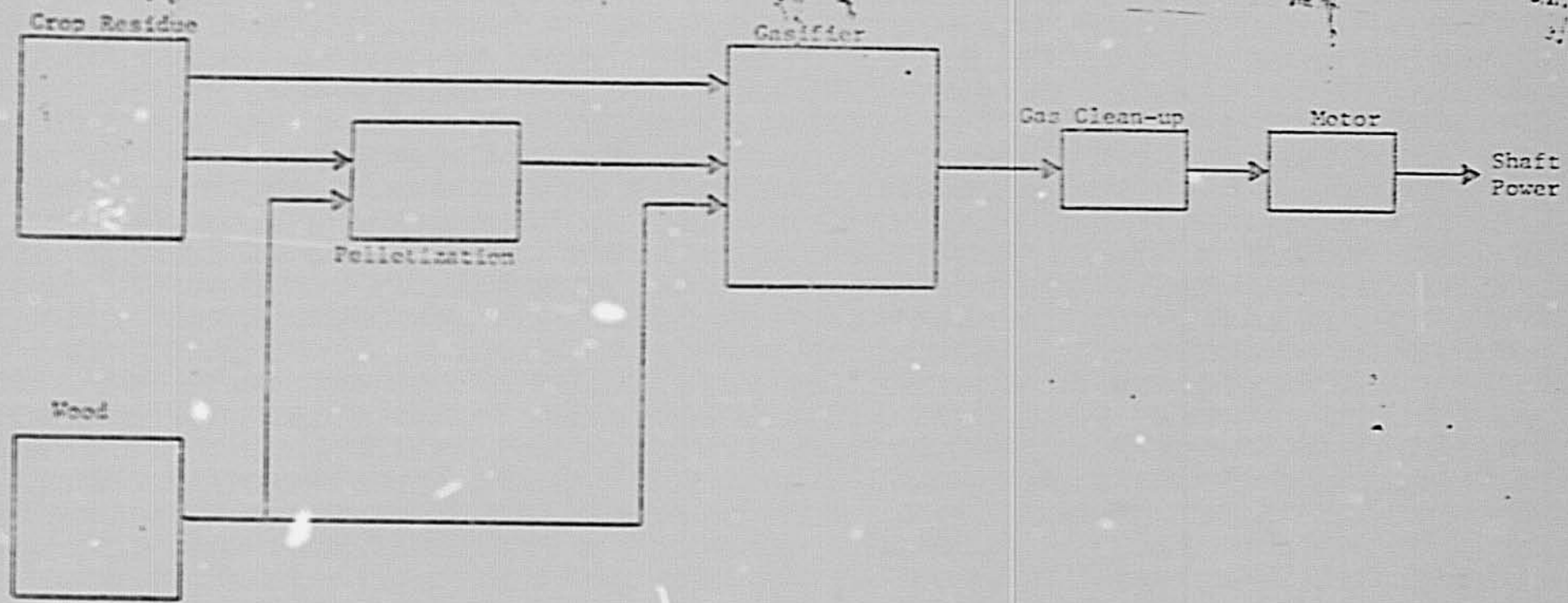
Crop Residue
Pelletization
Wood
Gasifier
Gas Clean-up
Motor
Shaft
Power

Figure 8.

Summary Description of Coal Program*

1. INTRODUCTION

The investigation and identification of areas for technical collaboration in the coal sector between the Governments of India and the United States occurred in India during the period 18 May to 5 June 1981.** Follow-up investigations to resolve policy issues relevant to coal sector collaboration occurred in Washington shortly thereafter through discussions within AID and with the Department of Energy. The list of organizations contacted in India is shown in Table II-1. The Office of Energy in AID/Washington conducted the investigations.

India is the largest coal producer in the developing world, and the United States is the largest coal producer in the developed world. Both countries face the same problem in their energy sectors, namely: how each should best utilize its vast coal resource to minimize the importation of petroleum. Both countries support substantial research and development institutions and facilities, and both are actively engaged in research and development programs to find effective solutions to the petroleum-import minimization problem.

Thus, a well-conceived technical collaboration program in the coal sector can provide benefits to both countries, and progress toward achieving the ultimate solutions can be accelerated. Activities can be chosen, to avoid duplication, to provide confirmation of findings, to complement individual findings and avoid gaps, and to provide synergism in the conception of ideas and approaches to problem solving.

The exploration, extraction, distribution, and utilization of coal are activities which, in India, are largely managed, owned, and planned entirely within the public sector. The institutions involved are either direct arms of the government, or largely limited liability firms wholly owned by the Indian government. Research and development activities in the coal sector are conducted by institutions in either of these categories.

In the United States, the corresponding activities in the coal sector are largely conducted by institutions in the private sector, owned by private investors seeking attractive returns from their invested capital. However, research and development activities are conducted both in the private and in the public sectors; the public sector involvement concentrating largely on the longer term technology prospects that enhance the position of coal relative to petroleum as an energy source.

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* The complete report is on file in ASIA/TR/EFE, ST/EY and USAID/Delhi.

**See Bliss/Mallick memorandum, New Delhi, 4 June 1981. The contents of the attachment to this memo have been incorporated in this Annex.

TABLE II-1

LIST OF ORGANIZATIONS CONTACTED IN INDIA

Department of Science and Technology, New Delhi

Petroleum and Minerals Attache, U.S. Embassy, New Delhi

The World Bank, New Delhi

Department of Coal, Ministry of Energy, New Delhi

National Thermal Power Corporation, New Delhi

Rail India Technical and Economic Services Ltd., New Delhi

Bharat Heavy Electricals Ltd., Tiruchirapalli

Bharat Heavy Electricals Ltd., Hyderabad

Bharat Heavy Electricals Ltd., New Delhi

Regional Research Laboratory of Council for Scientific and Industrial Research, Hyderabad

Central Fuels Research Laboratory of Council for Scientific and Industrial Research, Dhanbad

Council for Scientific and Industrial Research, New Delhi

Institute for Reservoir Studies of the Oil and Natural Gas Commission, Ahmedabad

Gujarat Industrial Investment Corporation Ltd., Ahmedabad

Industries, Mines and Power Department, Government of Gujarat, Ahmedabad

Office of the Chief Minister, Gujarat State, Ahmedabad

Rail India Technical and Economic Services, Ltd., New Delhi

The differing coal-sector ownership structures in the two countries indicate that the potential topics for technical collaboration are likely to fit into either of two categories, namely: (a) collaboration between Indian Government institutions and U.S. Government institutions, and (b) collaboration between Indian Government institutions and U.S. private sector organizations. The nature of the fit should be characterized for each area or topic identified for potential collaboration.

2. PURPOSE AND SCOPE

The basic purpose of the collaboration is to accelerate the utilization of coal in the energy sector of both countries and thereby reduce the consumption of petroleum-derived products. This purpose is to be realized through facilitating between the countries (a) access by technical personnel to current and future experimental work activities undertaken as the result of the research and development programs which have been adopted in each country and (b) concept and idea generation that can occur from discussions among personnel of similar technical interests.

The basic scope for the collaboration was set by the Department of Science and Technology (DST) of the Government of India. DST sees the problem in the Indian coal sector in terms of assuring that this sector will feed a substantial growth and development of the Indian economy. Ultimately, through the use of indigenous coal resources, India is to live within its own indigenous production of oil. Substantially, this is the same perception that exists for the United States efforts in its coal sector. The Government of India priorities in this respect are in technology development and in the professional development of its scientists and engineers. Both of these priorities can be met through the prospective technical collaboration activities.

DST's priorities in technology development are: (a) the newer technologies in the fields of aboveground and underground gasification, liquefaction, fluidized-bed combustion, carbonization, and slurry pipeline transportation and (b) those technologies which have a potential for development both in the near and in the medium term.

The detailed scope for the collaboration resulted from the investigation in India and is presented below in a specific format as follows:

Part A - India's Coal Sector - Problem Areas and Problem Solving.

Part B - Policy Issues and Resolutions

Part C - Substantive Description of Collaboration Areas

Part D - Implementation and Management

Part E - Budget Allocation

PART A. INDIA'S COAL SECTOR - PROBLEM AREAS AND PROBLEM SOLVING

1. COAL PRODUCTION AND CONSUMPTION

India's coal resource has been estimated by the Geological Survey of India at 85.4 billion* tons, based on including the coal seams that are greater than 1.2 meters (4 ft.) thick and not deeper than 600 meters (about 2000 ft.) below the surface. Proven reserves are 24.6 billion tons. The balance of the reserves are indicated or inferred. Of the proven reserves, about 4.5 billion tons represents prime coking coal. These reserves are largely located in the eastern part of the country. They are equivalent to about 350 billion barrels of oil in energy content, and at current rates of production, they should last about 700 years.

The coal resource is probably greater, given a more intensive exploration than exists today. An additional 27 billion tons of coal are thought to exist, if seams as thin as 0.5 meters and as deep as 1,200 meters are included.

India also possesses significant resources of lignite in the south, estimated at about 2.1 billion tons, 75% of which are in thick seams. Additional but deep sources of lignite occur in the west, in Gujarat State.

India's production and utilization of coal for 1979-80 (April thru March), and as projected for 1984-85, are shown in Table II-2. Current annual production (1980-81) is 114 million tons, up from the 1979-80 production of 104 million tons. About 28% of the 1979-80 production came from open-pit mines. The increase in the 1980-81 production is largely attributed to an even greater reliance on open-pit mining, the proportion having increased to 35%.

The major coal consuming industries are also shown in Table II-2. Major coal utilization, in order of the quantity consumed in 1979-80, occurs in power generation (32%), in brick making and similar producton (24%), in iron and steel manufacture (21%), and in railway operation (12%). A minor quantity is exported to Bangladesh. Metallurgical coal, largely imported from Australia, is used to help meet the supply-demand gap in the Indian iron and steel manufactoring center. It is used as a blending stock to limit the ash content to 17% in the raw coal in coke production.

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* 1 billion is 1000 million.

TABLE II-2

MATERIAL BALANCE FOR COAL: 1979-80 & 1984-85

(Million Tonnes)

Consuming Sector	1979-80	1984-85
Coking Coal		
1. Steel Plants (hot metal)	22.52	34.50
2. Coke Ovens etc.	22.52	34.50
Non-Coking Coal		
3. Power	33.34 (1.52)	65.00 (3.50)
4. Railways	12.53	11.70
5. Cement	4.53	8.60
6. Fertilisers	2.11	5.60
7. Soft Coke/LTC	3.38	6.00
8. Brick and Others	24.51 (0.70)	32.70 (1.50)
9. Colliery Consumption	3.55	3.50
10. Export	0.09	0.40
11. Total requirement	106.56 (2.22)	168.00 (5.00)
12. Production	103.96	165.00
13. Imports	1.88*	3.00
14. Changes in stocks	0.72	3.00

*Indigenous raw coal equivalent of 0.94 million tonnes of imported coal.
Figures in brackets indicate middlings.
Source: Table 3.17, p. 43, Sixth Five Year Plan (1980-85) Government of India Planning Commission, New Delhi

2. COAL CHARACTER

Indian coals are largely bituminous, high in ash content, but low in sulfur and phosphorus. Moisture content varies, tending to be low (1%) in metallurgical coking coal and higher (5-10%) in the non-coking coals. Coals generally range from hard to very hard.

The ash in Indian coals is highly disseminated, and hence Indian coals tend to be difficult to beneficiate by washing. 14 washeries have been constructed to date having a total capacity of 25.37 million tons annually of raw coal, with individual capacities ranging from 0.4 to 2.84 million tons annually. These installations concentrate largely on treating metallurgical coal to meet the final ash content specification, set by the Indian steel industry at 17% maximum.

3. SECTOR STRUCTURE

(a) Production

India's coal production lies almost entirely in the public sector, and is represented by the operations of Coal India Limited (CIL). CIL is a holding company, wholly owned by the national government. CIL, in turn, operates through five wholly-owned subsidiary companies, whose shares of the national production in 1980-81 were the following:

Subsidiary	1980-81 Production million tons	Increase from 1979-80 Percent
Eastern Coalfields Limited (ECL)	22.72	10.7
Bharat Coking Coal Limited (BCCL)	21.42	6.5
Central Coalfields Limited, CCL	27.45	13.2
Western Coalfields Limited, WCL	28.74	10.3
Northeastern Coalfields Limited, NECL	0.61	8.9
TOTAL	100.94	

The balance of current (1980-81) production is accounted for partly by a sixth producing company, Singareni Collieries Company Limited (SCCL), jointly owned by the Government of India and by the Andhra Pradesh state government. Its production was 10.1 million

tons, up 7.4% over the previous year. In addition, the captive mines of Tata Iron and Steel Company (TISCO) in the private sector, the Indian Iron and Steel Company (IISCO) in the public sector, and the Damodar Valley Corporation (DVC) added a total of nearly three million tons. Lignite production amounted to about five million tons (in 1980-81), with nearly 93% coming from the Neyveli Lignite Corporation (NLC).

(b) Power Generation

India's power generation sector is decentralized through the allocation of generation, transmission, and distribution responsibilities to State Electricity Boards (SEBs). Interties between systems are minimal, and each system must accomodate the demand variations between peaks and base loads through adjustment to the output levels of individual generation units. Little opportunity exists for transfer of large blocks of power from one system to another.

Each SEB fixes its own level and structure of electricity tariffs. These levels and structures have been subjectively established and in most cases have failed to generate new investment capital for increasing installed capacity, while, at the same time, encouraging load growth. The net result has been a general imbalance between supply and demand. During the period from April 1979 through December 1980, the shortfall between supply and anticipated requirement has averaged about 16% of the requirement.

Gross electricity generation in 1980/81 is estimated by the Central Electricity Authority to have been the following:

Source	Total Installed Capacity (MW)	GWH	Percent Total
Hydroelectric		46,492	41.6
Thermal		62,016	55.7
Nuclear		3,006	2.7
Non-Utility*	2,750	----	----
TOTAL	33,200	111,514	100.0

*Most likely this capacity is almost entirely thermal.

The supply of 111,514 GWH is up about 12% over the 1979/80 supply of 99,302 GWH.

Present plans call for the construction of eleven 500 MW coal-fired units, arranged in four strategically located central stations. The power generated from these stations will be sold to

the SEBs. Thus, it is likely that the new stations will be base loaded, leaving the presently installed units in the SEB systems receiving this external power to provide the intermediate and peak loads.

(c) Transportation and Distribution

The Indian transportation system in 1977/78 carried, by rail and by highway, 69.3 million tons of coal an average distance of 673 km., of which 92.2% moved an average of 691 km. by rail and almost 7.8% an average of 408 km. by truck. Coastal shipping carried 670,000 tons of coal, but the proportion accounted for in the above total figure and the average distance hauled are not reported.

Some of the truck haulage occurs within the mining areas but, as the averaged movement shows, significant haulage distances are often involved. Indian trucks are designed for 18 tons with an allowed 25% overload. However, overloading beyond the allowable weight is common.

India has one dedicated unit train system to transport coal for power generation. In contrast to the practice in the United States, the entire system - the track, locomotives, and cars - are owned and operated by the power company. The system is closed to all other traffic and is not part of the local railroad. Bottom-discharge hopper cars are used, and it takes 10-15 seconds to discharge the coal from each car. The train speed during discharge is 4 to 6 km/hr (2-4 mph). Loading takes place from a silo at one car per minute at about 1 km/hr.. Cars carry about (60 tons), and the power plant is about 50 km (30 miles) from the mine. Trains are 30-40 cars long.

Normal rail shipment of coal is much different. General purpose open-top, side-opening cars, are used in non-dedicated service, i.e., at times the cars can carry other bulk commodities. Loading and unloading methods are often mechanical, but some have been reported as manual. The cars can be shipped in regular freight trains in small groups, or arrangements can be made to ship full trainloads which avoid many switching delays. This latter arrangement, called a block train, is not a unit train since it is not made up of dedicated equipment and since some marshalling yards are not bypassed. Traction power usually is changed when one of the boundaries among the nine railway zones is crossed. While the full 75,000 km (about 47,000 miles) of track is owned and operated by the Government of India, the nine zonal railroads do the actual day-to-day operation, and exhibit significant independence. Delays due to railway bottlenecks are reported as relatively common. Lastly, most of the rail system is limited to 18 tonnes (20 tons) per axle with certain portions at 21 tonnes (23 tons). This, with the tare weight of the car, limits the amount of coal per car. In the U.S. 91 tonne (100 ton) loads are the norm.

Coal is distributed by direction of the Linkage Committee on Coal (LCC). Each user is linked to the closest mine of the proper coal type based on the routing of the railway systems and on knowledge of their bottlenecks. Coal shipping rates are telescoped, i.e., the first 100 mile haul is charged at a higher rate than the second, the second higher than the third, etc. Thus, a user close to a mine pays less than one farther away, but not in direct proportion to distance. Telescoping rates for coal have been faulted for causing excessive transport, i.e., industries tend to locate farther from their input sources than if the rates were constant on a per mile basis. In contrast, freight equalization may be practiced for other commodities. For example, the delivered cost of cement is the same anywhere in the country.

Railroad signaling, dispatching, and communications need improvement, if these are to be comparable to U.S. standards. The Indian railways are installing a microwave network and have in place computerized information systems. Many of the problems of ineffective coal shipment of the past have solutions in the offing. Successful implementation requires some rethinking by a management tied to old railway traditions.

The National Transportation Policy Committee projects a 313% increase in the tonnage of coal to be hauled between 1977/78 and 2000/01. The sixth 5-year plan emphasizes that the railways will continue to haul the bulk of the nation's freight and that the shift to trucks must be discouraged and reversed, if only for energy consumption reasons. But the plan allocates a budget of $6.0 billion to the railways and $5.5 billion to highways. This is not a strong emphasis on the rail mode. Considering that many highway and no railway vehicles are privately financed, it seems the total investment in the highway mode will overshadow the investment in the railways.

While coal-slurry pipelines are understood in India, and ongoing assessments of their potentials are being made, no firm construction plans exist.

(d) Conversion and Utilization

The Government of India supports, through its agencies, a broad range of activities directed to experimentation with new and existing technologies of coal conversion and utilization. Not all facilities were visted during the investigation on (see Table II-1). The major government organizations responsible for research and development activity in coal conversion and utilization are Bharat Heavy Electricals Limited (BHEL) and the Council for Scientific and Industrial Research (CSIR). BHEL activities tend to be more utilization oriented and hence to focus on direct combustion technologies and on the gasification of coal. CSIR activities tend to be oriented toward promoting utilization in terms of petroleum-product substitution, and to focus on coal conversion technologies as the means.

BHEL's facilities at Tiruchirapalli are equipped, among others, with installations for the fluidized-bed combustion of coal at atmospheric pressure and with direct combustion equipment involving research in burner atomization spray patterns and in combustion. CSIR's facilities in Hyderabad (Regional Research Laboratory) include equipment for low-temperature coal carbonization and for the agglomeration of the char to smokeless domestic fuel briquets and coal gasification. The CSIR Dhanbad facility has equipment for coal beneficiation research and development. This facility has developed a process which shows promise for significant reduction in ash content of Indian coals through the oil agglomeration technique. It also has completed small-scale work to produce samples of solvent refined coal (SRC) containing the original ash content, where the properties have been altered such that a potential blending stock for metallurgical coke production is produced. Interest also exists in the alternative methods for coal liquefaction, pipeline transportation of coal, and in the fluidized bed combustion of coal under pressure. The CSIR Dhanbad facility is one of the reputed institutions in the world for coal research equipped with facilities to conduct a wide range of basic and applied research in coal beneficiation and utilization.

The Central Mine Planning and Design Institute (CMPDI) at Ranchi (not visited) of the Department of Coal in the Ministry of Energy has responsibility for research and development in the field of mining technology, including method for conservation of resource, safety, and measuring and monitoring systems. CMPDI has interest in beneficiation, stowage to fill mine voids, control of underground fires, hydraulic mining, and in increased use of semi- and weakly-coking coals.

In Ahmadabad, in Gujarat State, the Institute for Reservoir Studies of the Indian Government Oil and Natural Gas Commission (ONGC) is interested in, and has the responsibility for, the development of the local deep lignite resources through underground coal gasification. The interest is based on the remote distance of Gujarat, in the west of the country, from the sources of coal for power generation by the local SEB.

The Government of India has recently established a Department of the Environment. The prospective activities of this new agency were not explored during the investigation. But, serious environmental problems are evident resulting from the particulate emissions from the central electric generating stations and from the open coal-burning operations in the fields, near Durgapur, to produce low-temperature char for smokeless domestic fuels.

Energy Use in the Industrial Sector

The industrial sector is the second largest consumer of energy in the Indian economy and the single largest user of commercial energy. It is particularly difficult sector to analyze due to the large number of small, unregistered shops and establishments. This unorganized sub-sector is estimated to have produced one-third of the value added in the industrial sector in 1975-76. The 1971 census reported an estimated 2.2 million household industries as part of this sub-sector. These small industries use significant quantities of non-commercial fuels as well as commercial fuels.

I. Structure of Industrial Production

India has a diversified industrial sector producing a wide range of products and intermediate goods for the domestic market. Table I shows the value of the output and value added for major industries that account for over one-third of total output value. Textiles, iron and steel and sugar industries are among the leading producers. Not shown in the table are the electricity generating industry and the drugs and pharmaceutical industry, which both have substantial output.

An important factor for considering energy supply/demand is the location of industrial production. Industrial production is highly concentrated in India. The top four states in terms of output value in 1977-78 (Maharashtra, Gujarat, West Bengal, and Tamil Nadu) accounted for 60% of the total output value of industries covered in the Annual Survey of Industries; and the top ten out of the twenty states and union territories produced 92.6% of the total output value. See Table II. No major changes in this pattern appear to have taken place between 1973-74 and 1977-78.

II. Major Consuming Industries

The consumption of energy in the industrial sector is also highly concentrated. Seven industries in 1977-78 accounted for nearly two thirds of total sectoral consumption: steel, cement, fertilizer, textiles, aluminium, sugar and bricks. (See Table III)

Overall commercial energy consumption in industry has been growing steadily, at a compound rate of 6-7% per year (over the period between 1953 and 1978). The total fuel costs of the industries surveyed was about 1.8 billion rupees in 1977-78 or roughly $236 million. Between 1970-71 and 1977-78 the average increase in fuel costs per annum was about 19%.

III. Fuel Mix and Oil Substitution

Coal, electricity and oil are the major commercial fuels consumed in the industrial sector. Coal and electricity each supply about 45% of the commercial energy requirements, with fuel oil providing the remaining 10%. The steel and cement industries are large consumers of coal, while textiles, aluminium, fertilizers, and steel account for about 37% of electricity consumption in industry. Table IV contains a breakout of the fuel mix by industry

IV. Energy Intensity

The intensity of commercial energy use in industries has been steadily increasing, as was pointed out in Annex I, due in large measure to the adoption of electricity. Detailed physical energy consumption data over time by industry were not available for the analysis; however, cost data were obtained. Analysis of the latter reveal that energy costs as a percentage of both input and output value have increased between 1973-74 and 1977-78. (See Table V.) Energy costs remain, however, a relatively small proportion of total material input costs -- 6.3% in 1977-78.

The cement and aluminium industries are particularly energy intensive, with energy costs accounting for 25.6% and 21.1% respectively of output value in 1977-78. The energy costs have risen significantly in the aluminium industry as a percentage of material input costs and output value. Interestingly, the fertilizer industry shows a decrease in the energy cost factor over this period, despite the increasing consumption of fuel oil (see Table V).

The energy intensity of the industrial sector in India is high relative to other industrial countries. The Working Group on Energy Policy cited the following basic reasons for this relatively high intensity in energy use.

(1) The proportion of heavy industry to light industry is different in India;

(2) The share of primary metal industries like steel and aluminium in the total industrial mix is high in India;

(3) In the production of specific commodities like paper, fertilizer and cement, though new units are of a size now being adopted in the world, there are many small and old units which are relatively inefficient users of electricity.

(4) Capacity utilization of industry in India is low and energy use in industries does not get reduced with lower levels of utilization of capacity.

(5) The normal correctives to these factors were not available as energy, particularly in the form of coal and electricity have been by and large underpriced.

This above analysis suggests both opportunities as well as inherent limitations to improving energy efficiencies in India.

V. Potential for Improvement in Energy Efficiency

Experience in both the United States and India suggest that fuel efficiency measures resulting in near and medium term energy savings are possible. The Petroleum Conservation Research Association of India reports that savings of 1.62 lakh kilolitres of fuel oil have already been realized due to housekeeping measures, process modifications, energy substitution, and equipment modernization. A study by the PCRA found that about two-thirds of industrial fuel oil consumption was in boilers, most of which were of inefficient design. They estimated that an investment of Rs. 75 crores (1978 prices) in replacing the inefficient boilers would save 210,000 tons of fuel oil and replace foreign exchange expenditures of Rs. 46.2 crores.

The Indian Aluminium Company has significantly reduced its energy use between 1974 and 1979 (See Table VI).. For example, at the casting stage steps taken to improve combustion efficiency included: improved burner operations, better air/fuel ratio control, improved thermal efficiency and reduction in batching time.

Efficiency improvements have also been made in the steel industry, where 66% of the total heat input becomes waste heat. Thus, waste heat recovery is a prime conservation strategy, as is the introduction of new technologies that minimize use of coking coal and the optimization of by-product fuels, such as coke-oven gas. Tata Steel has reduced their overall fuel rate per ton by 11% since 1970-71.

The Petroleum Conservation Research Association believes that an accelerated R & D program aimed at equipment efficiency upgrading is desirable. Some of the recommended areas of concentration are: low temperature waste heat recovery, low excess air burner development, fluidized bed combustion, and insulation materials.

The process of matching of energy sources with end-use requirements can also achieve improved energy efficiencies. For example, a significant fraction of the process heat required in Indian industry is below 140°. Dr. B.C. Jain of Jyoti Limited advocates the use of solar process heat technologies for meeting these low temperature process heat and steam requirements. (See Table VII.)

Finally, there seems to be a general opinion among Indian experts in this field that an improved institutional capacity in energy audits and conservation technology needs to be established in both the public and private sectors. In particular, technical assistance to small and medium industries is cited as a high priority, since they lack both the awareness of the potential and the technical skills to initiate action and monitor results. The AIEI workshop on Energy Conservation considered the development of an "Energy Clinic" of 10-15 experts that would service small and medium industries.

TABLE I

Structure of Industrial Production
(Rs. Crores)

Industry	- Value of Output - 1973-74	1977-78	- Value Added - 1973-74	1977-78
Chemicals	313.92	652.56	94.68	165.69
Paper	273.93	503.12	80.36	142.11
Sugar	713.47	1075.16	93.90	137.55
Aluminium	132.46	283.52	17.23	49.72
Fertilizer	433.68	1119.97	76.18	146.44
Cement	213.61	438.25	32.96	102.96
Iron & Steel	1090.70	2189.58	238.54	415.77
Textiles	2767.86	5130.73	824.18	1083.29
Pet. Refineries	346.57	1928.89	43.97	194.06
	6286.2	13321.78	1502.00	2437.59
TOTAL (All Industries)	18,252	35,863	4,100	7.023
	34%	37%	37%	30%

TABLE II

Output and Value Added

by State: 1973-74 & 1977-78
(Rs. Crores)

State	- Output Value - 1973-74	1977-78	- Value Added - 1973-74	1977-78
Andhra Pradesh	1103	1983	234	397
Assam	256	652	59	186
Bihar	964	2130	228	395
Gujarat	2009	4222	441	832
Haryana	479	1005	100	217
H. Pradesh	35	69	10	38
Jammu & Kashmir	27	65	4	9
Karnataka	829	1612	235	395
Kerala	513	1177	132	236
Madhya Pradesh	893	1673	224	352
Maharashtra	4964	9334	1241	2030
Manipur	.48	1.15	.26	.36
Meghalaya	11	8	4	3
Orissa	313	615	91	163
Punjab	669	1403	101	227
Rajasthan	404	995	85	190
Tamil Nadu	1862	4111	433	802
Tripura	2	5	.5	1.2
Uttar Pradesh	1397	2680	297	519
West Bengal	2378	4078	617	942
TOTAL(including Union Territory)	18,252	35,863	4100	7,023

Source: EIS, Annual Survey of Industries, November 1980.

TABLE III

Major Energy Consuming Industries (1978)

(MTCR)

Industry	Energy Consumption	% of Total
Steel	26.563	16.7
Cement	9.363	5.9
Fertilizers	7.105	4.4
Textiles	10.090	6.3
Aluminium	3.552	2.2
Sugar	30.819	19.4
Bricks	15.345	9.6
Sub-Total	102.837	64.7
TOTAL	158.924	

TABLE IV

Fuel Mix and Industry
Share of Commercial Consumption
by Fuel 1977/78 (%)

Industry	Coal		Electricity		Oil	
	% Industry	% total coal	% Industry	% total elect.	% Industry	% total oil
Steel	80.7	41.6	19.2	11.1	0.1	.00
Cement	41.2	7.6	25.0	4.7	33.0	35.4
Fertilizers	24.9	3.5	54.7	7.9	20.4	16.3
Textiles	25.6	5.0	52.1	10.6	22.3	25.3
Aluminium	--	--	100	7.2	--	--
Subtotal MTCR	29.292		20.523		6.858	
Total MTCR	50.671		49.351		8.902	
% above ind.	57.8%		41.6%		77.0%	

TABLE V

Energy costs as a % of Total Output Value 1973-74 & 1977-78

Industry	1973 - 74 Fuel Cost (Rs. Crores)	1973 - 74 % Materials	1973 - 74 % of Output value	1977-78 Fuel cost	1977-78 % Materials	1977-78 % Output value
Steel	111.51	15.1	10.6	232.97	14.1	10.6
Cement	53.58	32.1	25.1	112.36	35.5	25.6
Fertilizer	41.98	24.9	16.6	149.26	17.1	13.3
Textiles	107.58	5.8	3.8	259.61	6.5	5.0
Aluminium	18.80	18.2	14.2	59.87	27.7	21.1
All Industry	737	5.4	4.0	1771	6.3	4.9

Source: EIS, Annual Survey of Industries, November 1980.

TABLE VI

ENERGY EFFICIENCY IMPROVEMENT

at the Indian Aluminium Company

	1974	1979	% Reduction
1. Oil in aluminium (litre 1 ton)	240	200	17
2. Power in Smelters (Kwh 1 ton)	17,850	16,110	10
3. Anode Paste (kg 1 ton)	541	498	8
4. Oil in Carbon Plants (litre 1 ton)	51	36	29
5. Oil in Remelts (litre 1 ton)	18	10	44
6. Oil in Fab. & casting (litre 1 ton)	164	119	28
7. Power in Rolly Mills (Kwh 1 ton)	1,750	1400	20

Source: M.S. Thakar, "Energy Conservation at INDAL" Background Paper for AIEI Workshop on Energy Conservation."

TABLE VII

Heat Requirements of Selected Indian Industries

Industry	Percentage of Thermal Energy Consumed Below 100°c.	Percentage of Thermal Energy Consumed Below 140°c
Coffee	100%	-
Dairy	85	88
Cotton Textiles	74	90
Silk & Art Silk	40	85
Sugar	20	33
Chemicals & Pharm.	-	60-80%

Source: B.C. Jain, "Power Conservation in Industrial Heating Systems By Solar Energy", Electricity Conservation Quarterly, Vol. 1, No. 4, April 1981, p.1

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Summary Description of Energy Efficiency in Transportation*

The transport sector in India is the country's largest and fastest growing consumer of petroleum-based fuels. This is due primarily to the fast rate of growth in per capita consumption transport since 1947, particularly in the highway transport sector. Over the three decade period, 1950-1978, growth in the use of highway transport, particularly in the movement of manufactured goods over short-haul distances, has far outstripped the growth of rail transport. The Indian Government's subsidy of diesel fuel and the overall greater reliability of truck cargo services probably accounts for this trend. Other factors include the inability of the rail system to keep up with the dispersal of industries and raw materials supply centers, and the general low level of public investment in the maintenance and expansion of the railways. Hence, the potential for conservation of energy in the transport sector, particularly petroleum-based energy, is substantial.

Highway transport of both goods and passengers accounts for over three-fourths of all petroleum consumed in India, most of it concentrated in the trucking industry. The underlying causes of energy inefficiency in transport---congestion, outdated engine technology, poorly maintained vehicles, vehicle under utilization, poor intermodal coordination, and limited infrastructure---are well-recognized by Indian transport planners. Piecemeal, there are measures that can be taken. Better time scheduling, particularly on the railways, can address problems of congestion and vehicle under utilization. Better engine maintenance, proper tire inflation, better road maintenance can improve highway freight movements and increase vehicle utilization in that mode.

However, the basic requirement for long-term, sustainable conservation in the transport sector is for better system planning and evaluation. The constraints to doing this are formidable. They

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*The detailed report prepared by Martin J. Bernard of Argonne Laboratories, Chicago is on file with USAID/New Delhi and ASIA/TR/EFE

include: national policy, continued shifts in demand patterns, capital availability, inadequate infrastructure, management resistance, spatial location of industries, size of vehicles, age of vehicle technology, lack of sufficient planning information, and energy availability and cost.

Each of these constraints is discussed in detail in the report prepared by AID-financed transportation consultant, Martin J. Bernard. In the realm of national policy, India's emphasis on self-sufficiency and labor intensity has limited the country's capacity to absorb relatively sophisticated, energy-saving technologies which have a higher capital intensity. Also, the subsidy of diesel and cross-subsidization of various classes of commodity shipment lead to less than optimal shipping distances for many goods. The transport system has had to react to shifts in demand to respond to the emergence of new industries and new product lines having different transport needs. Public capital available for investment in transportation is increasingly difficult to come by with competing budget demands for irrigation and power. Although the amount spent on the transport sector has increased 30-fold over the six plan periods, the relative shares going to railways and road transport has decreased. Infrastructure in terms of upgrading road quality to handle heavy trucks, overhead highway structures, lack of a railway computerized information system, and separate operation of the nine zonal railways seriously hinders efficiency. In the energy area, the subsidy of diesel fuel mentioned above, and the low quality of coal impede the efficient use of truck and rail transport. Finally, a lack of good planning data makes economic analysis of various transport investments impossible.

In response to these constraints, GOI transport policy as enunciated in the Sixth Five-Year Plan includes the following major points: accelerate the pace of railway electrification; improve fuel efficiency of diesel-based road vehicles; encourage other energy-efficient modes of inland transportation (water-ways, bicycles, pipelines, etc.); renewed efforts in alternative fuels research; and begin pricing schemes so all transportation services cover costs plus a reasonable return on investment. However, realization of these objectives will be constrained to the extent that adequate systems analysis is not carried out both on individual modes of transport as well as on an intermodel basis to rationalize India's approach toward the sector to achieve improved energy efficiency.

Funds allocated to this component of the project will be used for a variety of activities, some of which are described in summary below. It should be noted that the studies mentioned below are illustrative only and represent a wide range of possible options. They will be the subject of detailed discussion during the initial workshop that will be held between the designated U.S. and Indian organizations for implementing the conservation component. The primary purpose of the workshop will be to identify key topics for study and specific Indian institutions that may undertake these studies as required.

Study 1: Effect of Energy Cost on Indian Transport and the Choice of Mode

This is a macro-level study to determine the role of the cost of energy in travel and shipping. Adapting methodology developed by the Interstate Commerce Commission, the overall demand for transport and the choice of mode for both goods and passengers will be analyzed for bulk and manufactured products, and for local work/non-work trips and intercity travel. The study, which may take up to 10 months, will determine the proportion of energy to total operating cost and tariff of each mode, the elasticity of demand vis-a-vis energy cost for each commodity and trip type, anticipated shifts to cheaper energy modes as energy costs increase, and what proportion of shipments and trips may be foregone with higher energy prices. Possible Indian collaborators may be the Directorate of Transportation Research (DTR), Ministry of Shipping and Transport, and the Indian Institute of Technology (IIT), New Delhi.

Study 2: Diesel Engine, Fuel and Vehicle Improvement

This research focusses on problems of sulphur content of fuels which affect engine life, the level of engine technologies, and the problems of vehicle weight to load capacity of trucks. The objective is to produce a report which identifies specific tehnology options in each of three areas:

1) What technological fixes can be made to increase engine life given the high sulphur content of fuels being used, and how can exhaust emissions be reduced?

2) What cost-effective modifications can be used to upgrade engine quality without major changes in production lines?

3) How can overall vehicle weight be reduced to increase the vehicle weight ratio using domestic materials and current vehicle and vehicle component parts?

Study 3: Public Bus Inventory Management

The purpose of this activity is to undertake a seminar in inventory stores and spare parts management, and route and bus scheduling for selected managers from a number of local and intercity bus corporations. The seminar will be conducted by two U.S. consultants in the fields of inventory management and route scheduling. Following the seminar, the two U.S. consultants will visit the operations of selected bus corporations to observe and offer advice on management and scheduling at the field level. A report in collaboration with the Central Institute of Road Transport in Pune on areas for further training and research in this area is suggested.

Study 4: Multimodal Goods Transport System Analysis

The research will be a case study with implications for developing a model of comparing costs of shipping goods by rail, road and waterway. The National Traffic Planning and Automation Center (NATPAC) in Trivandrum, has substantial data on commodity flows for the three modes of transport. This data will be augmented with detailed vehicle energy consumption forecasts and suggest, through subsequent analysis, a plan for optimizing the freight system in Kerala's four central districts utilizing minimum energy consumption.

Annex 9

Government of India (Bharat Sarkar)
Cabinet Secretariat (Mantrimandal Sachivalaya)

New Delhi, 12 March 1
21 Phalguna 1

RESOLUTION

1. Energy is an essential requirement for development. In recent years, there has been a significant and continuing increase in the price of oil and also uncertainties about its availability on a guranteed and steady basis. Apart from the impact this development has on the balance of payments position, it has serious effects on many facets of the economy such as the transport, industry, agricultural and household sectors. It is, therefore, essential that the nation pledge itself to achieve energy self-sufficiency as soon as possible. In this context, it is vitally important to develop all the indigenous sources of energy in India. A major effort is needed to expand energy supply from the conventional sources; hydro, coal and nuclear energy as also to expand domestic oil production. Apart from these, new and renewable energy sources like solar, wind and biomass area of particular interest for supplying the energy needs of the decentralised and rural sectors, as well as several potential industrial uses. A considerable base of Research and Development for harnessing these energy sources has also been established under the programmes of the Department of Science and Technology. The time is now ripe to initiate a major and sustained effort for rapid development of these renewable energy sources. This requires intensification of the R&D efforts for developing technologies in this field as well as conscious steps for commercial exploitation of the technologies already developed or being developed.

2. It is also necessary to have institutional arrangements for a well-coordinated approach in the area of new and renewable sources of energy in order to accelerate the pace towards achieving the goal of energy self-sufficiency. The Government of India, therefore, consider it necessary to set up a mechanism, free from all non-essential restrictions and needlessly inelastic rules, which will have responsibility in the entire field of development of new and renewable energy sources.

3. After careful consideration, the Government of India have decided to establish a Commission for Additional Sources of Energy (CASE) with full executive and financial power.

4. CONSTITUTION

(a) The Commission for Additional Sources of Ene shall consist of full time and/or part time memb The total number of members shall not be less th four but not more than seven.

(b) The Chairman of the Commission will be t Secretary to the Government of India in t Department of Science and Technology.

(c) The Secretary, Department of Power and Secretary from the Ministry of Finance will members of the Commission.

5. FUNCTIONS

The Commission shall be responsible for—

(a) formulating policies and programmes fc development of new and renewable sources c energy;

(b) coordinating and intensifying research an development activities in new and renewabl sources of energy;

(c) ensuring implementation of Government's policie in regard to all matters concerning new anc renewable sources of energy; and

(d) preparing the budget of the Commission.

6. Within the limits of the budget provision, approved by Parliament, the Commission shall have the powers of the Government of India, both administrative and financial, for carrying out its work.

7. CHAIRMAN

(a) The Chairman shall be responsible for arriving at decisions on technical questions and advising Government on matters of policy relating to new and renewable sources of energy. All recommendations of the Commission on policy and allied matters shall be put up to the Prime Minister through the Chairman.

(b) The Chairman shall have the power to over-rule the other Members of the Commission, except that the Member for Finance shall have the right to ask that any financial matter, in which he does not agree with the Chairman, be referred to the Prime Minister and the Finance Minister.

(c) The Chairman may authorise any member of the Commission to exercise on his behalf, subject to such general or special orders as he may issue from time to time, such of his powers and responsibilities as he may decide.

8. The Commission shall have the power to frame its own rules of procedures. It may meet as such times and places in India as may be fixed by the Chairman.

9. Broad areas of responsibilities of the Commission have been listed in Annexure.

10. The following have been nominated as members of the Commission:

Chairman

*Prof. M.G.K. Menon, Secretary, Department of Science and Technology.

Members

*1 Shri D.V. Kapur, Secretary, Department of Power.

*2 Shri V.B. Eswaran, Secretary, Department of Expenditure.

*3 Dr O.P. Gautam, Director General, Indian Council of Agricultural Research.

4 Shri A.M. Thomas, Chairman, Khadi & Village Industries Commission.

Secretary

*Shri Maheshwar Dayal, Adviser, Department of Science and Technology.

*ex-officio

Sd./-
(R. Parameswar)
Joint Secretary to the Cabinet.

(F.No. 64/1/80-Cab.)

Order

Ordered that the Resolution be published in the Gazette of India.

Ordered also that a copy of the Resolution be communicated to the Ministries Departments of the Government of India and all others concerned.

Sd./-
(R. Parameswar)
Joint Secretary to the Cabinet

Annexure

BROAD LIST OF RESPONSIBILITIES OF THE "COMMISSION FOR ADDITIONAL SOURCES OF ENERGY"

1 Plan, initiate, financially support, monitor and undertake integrated national research and development programmes involving government laboratories, public and private sector companies and academic institutions that exist as also those which may come into being in the future, including those the Commission may set up, aimed at generating all the know-how necessary for production programmes in —

(a) development of appropriate technology for harnessing solar energy like solar thermal devices and systems based on the thermal effects of solar radiation and development of photovoltaic devices and systems for direct conversion of solar energy into electricity;

(b) development of wind energy;

(c) development of bio-mass and bio-conversion technology;

(d) development of decentralised energy systems; and

(e) other new areas as may be entrusted.

2 Survey the R&D work done by various agencies with a view to co-ordinating their programmes and providing appropriate direction for Research and Development efforts keeping in view long term requirements.

3 Function as the national agency for international cooperation in the field of new and renewable energy sources.

4 Interface research and development with production, by amongst other measures —

(i) promoting the acquisition of technical capability and providing finances for design and engineering of pilot plants and prototype production facilities based on locally invented processes and designs and setting up such pilot plants and prototype facilities, wherever required for rapid commercialisation of new and renewable energy technologies;

(ii) taking special steps such as subsidies to ensure that the high cost of limited volume production which our needs call for, does not become an obstacle to start commercial manufacture of products based on local know-how.

5 Survey, plan and approve and undertake programmes in the public, private and small scale sectors for production of materials, components, equipment and systems for commercial exploitation

of know-how in areas of alternative energy sources in consultation with other ministries and industries.

6 Recommend to Government various incentive measures for commercial use of the new and renewable energy technologies by industries.

7 Function as a data bank on all aspects of new and renewable energy sources and advise Government on import of technology in the area of new and renewable sources of energy.

8 Be responsible for operating all necessary industrial and import licensing policy and procedures as far as the industries in the new area are concerned.

9 Develop and coordinate with other agencies schemes oriented to the needs of rural India keeping in view the rural sources of energy available and train manpower for operating decentralised systems of energy.

Annex 10
Table 1

Summary Cost Estimate and Financial Plan

($000)

Project Component	A. I. D.												
	Salaries		Travel		Equip.		Contg.		Total		Total	GOI	Grand
	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	AID	SEquiv.	Total
Bio-mass	710	165	375	180	645	-	200	25	1930	370	2300	930	3230
Coal	680	-	420	-	300	-	100	-	1500	-	1500	955	2455
Conservation	150	-	330	-	-	-	20	-	500	-	500	200	700
Information Exchange	150	-	330	-	-	-	20	-	500	-	500	100	600
Other Renewable Energy Sources/ Mini Hydro	100	-	50	-	50	-	-	-	200	-	200	100	300
T O T A L	1790	165	1505	180	995	-	340	25	4630	370	5000	2285	7285

COST ESTIMATES OF BIOMASS PRODUCTION AND CONVERSION PROJECTS BY SUB-ACTIVITY

($000)

COMPONENT	Salaries U.S. FX $	Salaries Local LC $	Travel Int'l FX $	Travel Local LC $	Equipment FX $	Equipment LC $	Contingency FX $	Contingency LC $	TOTAL FX $	TOTAL LC $	Total AID $	GOI Contribution $ Equivalent
1.A. BIOMASS PRODUCTION NBRI, LUCKNOW												
Sub-activity:												
1	12	9	13	7	60	-	8	1	93	17	110	30
2	-	7	40	20	26	-	7	1	73	28	101	52
3	42	9	13	-	121	-	15	1	191	10	201	46
4	18	-	13	36	115	-	11	4	157	40	197	62
5	-	7	13	2	-	-	1	3	14	12	26	43
6	30	7	40	13	-	-	7	-	77	20	97	40
7	6	-	13	1	-	-	2	1	21	2	23	30
Sub-Total NBRI	108	39	145	79	322	-	51	11	626	129	755	303
MKU, MADURAI												
Sub-activity: 1	-	9	-	2	36	-	4	-	40	11	51	23
2	-	7	40	20	30	-	6	2	76	29	105	46
3	18	9	13	-	75	-	10	1	116	10	126	46
4	18	9	13	10	2	-	2	2	35	21	56	29
5	-	7	13	2	2	-	1	1	16	10	26	50
6	11	7	13	20	-	-	2	4	26	31	57	30
7	60	54	25	7	22	-	10	4	117	65	182	59
Sub Total MKU	107	102	117	61	167	-	35	14	426	177	603	283
Coordination & Institutional Strengthing	180	11	27	40	-	-	79	-	286	51	337	44
Sub Total Biomass Production	395	152	289	180	489	-	165	25	1338	357	1695	630
1.B. BIOMASS CONVERSION												
Sub-activity:												
Village level Gasification (IIT)	65	-	40	-	75	-	15	-	195	-	195	129
Jyoti Solar Institute	65	-	20	-	39	-	10	-	134	-	134	70
Producer Gas Powered small horse power utility engines	65	13	13	-	42	-	10	-	130	13	143	101
DOE Technical Monitoring	120	-	13	-	-	-	-	-	133	-	133	-
Sub Total Biomass Conversion	315	13	86	-	156	-	35	-	592	13	605	300
TOTAL BIOMASS	710	165	375	180	645	-	200	25	1930	370	2300	930

Annex 10
Table 3

($000)

Component	Salaries FX	Salaries LC	Travel FX	Travel LC	Equip. FX	Equip. LC	Contg. FX	Contg. LC	Total FX	Total LC	Total USAID	GOI Contribution in Dollar equiv.
2. COAL CONVERSION												
Sub Activity:												
Fludized Bed Combustion	85	-	60	-	300	-	30	-	475	-	475	845
Coal Mixtures	125	-	85	-	-	-	15	-	225	-	225	20
Coal Beneficiation	100	-	50	-	-	-	10	-	160	-	160	20
Coal Liquifaction	20	-	40	-	-	-	5	-	65	-	65	20
Combined Cycle Gasification	85	-	60	-	-	-	15	-	160	-	160	20
Implementation & Management	115	-	45	-	-	-	10	-	170	-	170	-
Workshops	150	-	80	-	-	-	15	-	245	-	245	30
TOTAL	680	-	420	-	300	-	100	-	1500	-	1500	955

Table 4

3. CONSERVATION												
Seminars (4)	40	-	100	-	-	-	10	-	150	-	150	70
Industry Assessment Studies and Transp. Studies (3)	50	-	30	-	-	-	-	-	80	-	80	50
Plant Audits (4)	-	-	80	-	-	-	-	-	80	-	80	50
Industry Missions	-	-	25	-	-	-	-	-	25	-	25	10
Internships and longer term personnel exchanges (3)	-	-	50	-	-	-	-	-	50	-	50	20
NAS/NAES Overhead	60	-	45	-	-	-	10	-	115	-	115	-
TOTAL	150	-	330	-	-	-	20	-	500	-	500	200

($000)

Annex 10
Table 5

	Salaries		Travel		Equip.		Contg.		Total		TOTAL	GOI
	FX	LC	FX	LC	FX	LC	FX	LC	FX	LC	USAID	Contribution
4. Information Exchange												
Catalog	60	-	40	-	-	-	10	-	110	-	110	10
Data Exchange	70	-	170	-	-	-	10	-	250	-	250	50
Wind Energy Workshop	20	-	60	-	-	-	-	-	80	-	80	30
Attendence and Travel to Conferences	-	-	60	-	-	-	-	-	60	-	60	10
T O T A L	150	-	330	-	-	-	20	-	500	-	500	100
5. Other Renewable Energy Sources/ Mini Hydro	100	-	50	-	50	-	-	-	200	-	200	100

Draft Scopes of Work
for
U.S. Collaborating Institutions

I. University Consortium: Biomass Production

Task 1 - Prepare implementation plans for the program with each institution containing specific objectives, activities, budget, management and technical responsibilities, equipment specifications, and schedule. These plans will be submitted to DST and AID for approval.

Task 2 - Provide the following technical specialists to assist NBRI and MKU in developing their research programs:

(a) Biomass Production Specialist

(b) Information Scientists

(c) Reforestation Specialist

(d) Tree and Shrub Improvement Specialist

(e) Forest Insect and Disease Specialist

(f) Resource Economist

(g) Rural Sociologist

Task 3 - Provide and arrange for training and provision of the equipment identified in Technical Annex 4.

Task 4 - Prepare progress reports as mutually agreed but at least every six months and a final report summarizing the entire project and the progress made by NBRI and MKU toward becoming centers of excellence in biomass production research.

II. Morgantown Energy Technology Center: Biomass Conversion

Task 1 - Prepare implementation plan with IIT (New Delhi) and Jyoti Industries for the component, including specific objectives of collaboration, activities, budget, management and technical responsibilities, equipment specifications and schedule. This plan will be submitted to DST and AID for approval..

Task 2 - Provide a technical project manager who is experienced in small-scale gasifiers and who could make periodic visits to India to participate in the project design and implementation.

Task 3 - Subcontract to technical organizations, such as Battelle, who have experience in the design and operation of small-scale gasifiers for technical advice.

Task 4 - Provide technical publications and arrange technical visits and training for Indian engineers from IIT (New Delhi) or Jyoti Industries to U.S. companies and sites.

Task 5 - Prepare progress reports as mutually agreed but at least every six months and a final report summarizing the entire project.

III. Pittsburgh Energy Research Center and Morgantown: Coal Conversion Technologies

Task 1 - Prepare an implementation plan with BHEL and CFRI for collaboration in the areas of fluidized bed combustion, coal/oil and coal/water mixtures, coal beneficiation, combined cycle/coal gasification, and coal liquefaction, within guidelines provided by AID and DOE HQ. The plan will detail objectives, activities, outputs, budgets, management and technical responsibilities and schedule. It will be submitted to DST and AID for approval.

Task 2 - Each laboratory will provide a technical manager to coordinate the collaborative program, make periodic visits to India to participate in the design and implementation of the program, and arrange for visits of Indian technical specialists to the laboratories as appropriate. Provide specialists in areas of laboratory expertise and programatic interest for short-term advisory assignments in India.

Task 3 - Arrange for experts from other DOE laboratories and facilities, as appropriate to participate in the technical program and to visit India as required.

Task 4 - Facilitate contact between BHEL and CFRI and U.S. private companies, research institutions, universities, associations (e.g. EPRI), power companies (Florida Power and Light in coal/oil mixtures), organizations (e.g. TVA in fluidized bed combustion) in the five technical areas of the component and serve to further U.S. commercial interests where possible (i.e. licensing agreements). Arrange for visits, and internships to these institutions in the U.S. and for the participation of technical experts from these organizations in the exchange program to the maximum extent possible.

Task 5 - Arrange to procure and provide the equipment specified by BHEL for research under the FBC sub-activities.

Task 6 - Prepare periodic progress reports, at least every six months, and a final report at the end of the three-four years.

IV. National Academy of Engineering: Energy Efficiency in Industry and Transportation

Task 1 - Prepare an implementation plan with AIEI for collaboration in specific industries and transportation subsectors. The plan will detail objectives, activities, outputs, budgets, management and technical responsibilities and schedule. It will be submitted to DST and AID for approval.

Task 2 - Provide a project manager to coordinate the collaborative program and make periodic visits to India to participate in the design and implementation of the program.

Task 3 - Using normal Academy procedures, arrange for professional engineers and technical managers in the specified industry and technology areas to visit India to work with AIEI and its members in exploring opportunities for improved energy efficiency and U.S.-Indian technical cooperation, particularly between U.S. and Indian private sector enterprises.

Task 4 - Arrange for AIEI industrial missions to the U.S. and facilitate the development of on-going communications between U.S. and Indian engineering companies and professionals.

Task 5 - Provide on a regular basis copies of important private and public documents on energy efficiency in the U.S., particularly information on energy control technology available from U.S. companies.

Task 6 - Prepare periodic progress reports on the status of the technical exchange and a final report at the end of the project.

V. Department of Energy (DOE): Information Exchange in New and Renewable Energy

Task 1 - Prepare an implementation plan with CASE/DST or its designate for a formal program of information exchange in new and renewable energy. This plan will detail objectives, specific activities (i.e. project catalogue, workshops, transfer of SERI and other automated data bases, and attendance at technical conferences), budgets, schedules, mechanisms for effective acquisition, storage, dissemination of information by both SERI and CASE/DST, and the management and technical responsibilities under the collaboration.

Task 2 - Provide a technical information specialist on a part-time basis to manage this component and to make periodic visits to India for the planning and implementation of the information exchange program.

Task 3 - Sub contract to technical organizations, such as Mitre or Battelle, who have experience in technical information systems in new and renewable energy.

Task 4 - Prepare periodic progress reports on the information exchange and a final report at the end of the project.

INDIA
Alternative Energy Resources Development Project
Checklist

5C(2) PROJECT CHECKLIST

Listed below are statutory criteria applicable generally to projects with FAA funds and project criteria applicable to individual funding sources: Development Assistance (with a subcategory for criteria applicable only to loans); and Economic Support Fund.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE?
HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?

A. GENERAL CRITERIA FOR PROJECT

1. Continuing Resolution Unnumbered; FAA Sec. 634A; Sec. 653(b).

   (a) Describe how authorizing and appropriations Committees of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that amount)?

   (a) Formal notification will be given to Congressional Committees.
   (b) Yes, in country OYB.

2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?

   Yes.

3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?

   No legislation is required.

A. 4.	FAA Sec. 611(b); Continuing Resolution Sec. 501. If for water or water-related land resource construction, has project met the standards and criteria as set forth in the Principles and Standards for Planning Water and Related Land Resources, dated October 25, 1973?	Not applicable.
5.	FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	Yes.
6.	FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	Sub-projects financed under the grant are not expected to be of a regional or multilateral nature.
7.	FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; and (c) encourage development and use of cooperatives, and credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	a. Procurement of commodities financed under the grant will be imported from the U.S. b. Some subprojects financed under the grant will be executed by U.S. & Indian private institutions c. No effect. d. No effect. e. Project will improve technical efficiency of industry and agriculture. f. Not applicable.
8.	FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S.	U.S. university consortium and other U.S. private organizations are expected to receive contracts for their services. See PP Section IV.A.3.

A.8. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).

9. FAA Sec. 612(b), 636(h); Continuing Resolution Sec. 508. Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized in lieu of dollars.

GOI is contributing local resources to project. U.S. owned local currency (Rupees) will be used to the maximum extent possible in defraying international travel costs related to project.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?

Yes, the U.S. is using these rupees for joint Indo-U.S. projects and has plans for their eventual liquidation.

11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?

Yes.

12. Continuing Resolution Sec. 523. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity?

Not applicable.

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(b), 111, 113, 281(a). Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-

The purpose of this project is to increase the level and effectiveness of U.S. technica input into Indian efforts to develop alternative energy resources and technologies. Energy inputs to irrigation, fertilizer and

B.1.a. intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?

b. FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.)

(1) [103] for agriculture, rural development or nutrition: if so (a) extent to which activity is specifically designed to increase productivity and income of rural poor; 103A if for agricultural research, full account shall be taken of the needs of small farmers, and extensive use of field testing to adapt basic research to local conditions shall be made; (b) extent to which assistance is used in coordination with programs carried out under Sec. 104 to help improve nutrition of the people of developing countries

crop cultivation are critical to the goal of increasing agricultural input.

B.1.b.(1) through encouragement of increased production of crops with greater nutritional value, improvement of planning, research, and education with respect to nutrition, particularly with reference to improvement and expanded use of indigenously produced foodstuffs; and the undertaking of pilot or demonstration of programs explicitly addressing the problem of malnutrition of poor and vulnerable people; and (c) extent to which activity increases national food security by improving food policies and management and by strengthening national food reserves, with particular concern for the needs of the poor, through measures encouraging domestic production, building national food reserves, expanding available storage facilities, reducing post harvest food losses, and improving food distribution.

(2) [104] for population planning under sec. 104(b) or health under sec. 104(c); if so, (i) extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.

(4) [105] for education, public administration, or human resources development; if so, extent to which activity strengthens nonformal education, makes formal education more relevant, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;

8.1.b.(4) and (ii) extent to which assistance provides advanced education and training of people in developing countries in such disciplines as are required for planning and implementation of public and private development activities.

(5) [106; ISDCA of 1980, Sec. 304] for energy, private voluntary organizations, and selected development activities; if so, extent to which activity is: (i) (a) concerned with data collection and analysis, the training of skilled personnel, research on and development of suitable energy sources, and pilot projects to test new methods of energy production; (b) facilitative of geological and geophysical survey work to locate potential oil, natural gas, and coal reserves and to encourage exploration for potential oil, natural gas, and coal reserves; and (c) a cooperative program in energy production and conservation through research and development and use of small scale, decentralized, renewable energy sources for rural areas;

(ii) technical cooperation and development, especially with U.S. private and voluntary or regional and international development, organizations;

(iii) research into, and evaluation of, economic development process and techniques;

(iv) reconstruction after natural or manmade disaster;

(v) for special development problems, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(vi) for programs of urban development, especially small laborintensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

The project involves a mix of technical exchange, institutional development, collaborative research & development and technology demonstration activities in three areas: (1) Biomass - production and conversion, (2) Coal Conversion Technologies, and (3) energy efficiency in industry and transportation. These three energy sources represented India's major options for reducing petroleum imports and meeting energy needs of the bulk of the population in the near and medium term. Project activities address (i)(a)(c) and (ii).

B.1. c. [107] is appropriate effort placed on use of appropriate technology? (relatively smaller, cost-saving, labor using technologies that are generally most appropriate for the small farms, small businesses, and small incomes of the poor.)	
d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least developed" country)?	Yes, the 25% requirement will be more than met.
e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?	Not applicable as no capital assistance involved.
f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental processes essential to self-government.	The project will use Indian and U.S. intellectual resources to develop, test and demonstrate alternative sources of energy.
g. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase of productive capacities and self-sustaining economic growth?	Yes.
2. Development Assistance Project Criteria (loans only)	
a. FAA Sec. 122(b). Information and conclusion on capacity of the country to	Not applicable.

B.2.a. repay the loan, at a reasonable rate of interest.

b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete with U.S. enterprises, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan? — Not applicable.

3. Project Criteria Solely for Economic Support Fund

a. FAA Sec. 531(a). Will this assistance promote economic or political stability? To the extent possible, does it reflect the policy directions of FAA Section 102? — Not applicable.

b. FAA Sec. 531(c). Will assistance under this chapter be used for military, or paramilitary activities? — Not applicable.

5C(3) - STANDARD ITEM CHECKLIST

Listed below are the statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by imposing limits on certain uses of funds.

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. Procurement

1.	FAA Sec. 602. Are there arrangements to permit U.S. small business to participate equitably in the furnishing of commodities and services financed?	Yes.
2.	FAA Sec. 604(a). Will all procurement be from the U.S. except as otherwise determined by the President or under delegation from him?	Yes, unless otherwise determined.
3.	FAA Sec. 604(d). If the cooperating country discriminates against U.S. marine insurance companies, will commodities be insured in the United States against marine risk with a company or companies authorized to do a marine insurance business in the U.S.?	Not applicable.
4.	FAA Sec. 604(e); ISDCA of 1980 Sec. 705(a). If offshore procurement of agricultural commodity or product is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity? (Exception where commodity financed could not reasonably procured in U.S.)	Not applicable.
5.	FAA Sec. 603. Is the shipping excluded from compliance with requirement in section 901(b) of the Merchant Marine Act of 1936, as amended, that at least 50 per centum of the gross tonnage of commodities	Yes.

A.5. (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S.-flag commercial vessels to the extent that such vessels are available at fair and reasonable rates?

6. FAA Sec. 621. If technical assistance is financed, to the fullest extent practicable will such assistance, goods and professional and other services be furnished from private enterprise on a contract basis? If the facilities of other Federal agencies will be utilized, are they particularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs? — Yes.

7. International Air Transport. Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will provision be made that U.S. carriers will be utilized to the extent such service is available? — Yes.

8. Continuing Resolution Sec. 505. If the U.S. Government is a party to a contract for procurement, does the contract contain a provision authorizing termination of such contract for the convenience of the United States? — Yes.

B. Construction

1. FAA Sec. 601(d). If capital (e.g., construction) project, are engineering and professional services of U.S. firms and their affiliates to be used to the maximum extent consistent with the national interests? — Not applicable.

B. 2.	FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable?	Not applicable.
3.	FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the U.S. not exceed $100 million?	Not applicable.
C.	Other Restrictions	
1.	FAA Sec. 122(b). If development loan, is interest rate at least 2% per annum during grace period and at least 3% per annum thereafter?	Not applicable.
2.	FAA Sec. 301(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights?	Not applicable.
3.	FAA Sec. 620(h). Do arrangements exist to insure that United States foreign aid is not used in a manner which, contrary to the best interests of the United States, promotes or assists the foreign aid projects or activities of the Communist-bloc countries?	Yes.

C. 5. Will arrangements preclude use of financing:

a. FAA Sec. 104(f). To pay for performance of abortions as a method of family planning or to, motivate or coerce persons to practice abortions; to pay for performance of involuntary sterilization as a method of family planning, or to coerce or provide financial incentive to any person to undergo sterilization?	Yes.
b. FAA Sec. 620(g). To compensate owners for expropriated nationalized property?	Yes.
c. FAA Sec. 660. To provide training or advice or provide any fipancial support for police, prisons, or other law enforcement forces, except for narcotics programs?	Yes.
d. FAA Sec. 662. For CIA activities?	Yes.
e. FAA Sec. 636(i). For purchase, sale, long-term lease, exchange or guaranty of the sale of motor vehicles manufactured outside U.S., unless a waiver is obtained.	Yes.
f. Continuing Resolution Sec. 504. To pay pensions, annuities retirement pay, or adjusted service compensation for military personnel?	Yes.
g. Continuing Resolution Sec. 506. To pay U.N. assessments, arrearages or dues.	Yes.
h. Continuing Resolution Sec. 507. To carry out provisions of FAA section 209(d) (Transfer of FAA funds to multilateral organizations for lending.)	Yes.
i. Continuing Resolution Sec. 509. To finance the export of nuclear equipment fuel, or technology or to train foreign nationals in nuclear fields?	Yes.

C.4.	j. Continuing Resolution Sec. 510. Will assistance be provided for the purpose of aiding the efforts of the government of such country to repress the legitimate rights of the population of such country contrary to the Universal Declaration of Human Rights?	No.
	k. Continuing Resolution Sec. 516. To be used for publicity or propaganda purposes within U.S. not authorized by Congress?	Yes.

D.O.No.2(16)AID/80 Annex 13

Purshottam Lal
Director(AC)
Tel.No:373210

भारत सरकार
वित्त मंत्रालय
आर्थिक कार्य विभाग
Government of India (Bharat Sarkar)
Ministry of Finance (Vitta Mantralaya)
Department of Economic Affairs (Arthik Karya Vibhag)

नई दिल्ली/New Delhi 29th june 1982

Dear Mrs. Boughton,

Please refer to Mr. Nachtrieb's letter of May 28, 1982 regarding the proposed Project Grant Agreement for Alternative Energy Resources Development Project. The provisions in the draft agreement have been examined in consultation with the Department of Science & Technology, Government of India now hereby request a grant from the Government of United States in the amount of $ 5 million. The proposed Grant assistance for Alternative Energy Resources Development is being sought with a view to expanding India's technical capacity to exploit its alternative energy resources and to develop selected energy technologies to a stage of application.

2. We would appreciate your earliest consideration of this request for assistance.

With regards,

Yours sincerely,

(Purshottam Lal)

Mrs. Priscilla M. Boughton,
Director,
USAID, American Embassy,
Chanakyapuri,
New Delhi.

A.I.D.Project No. 386-0474

Summary Project Description

The purposes of the project are to expand India's technical capacity to exploit its alternative energy resources and to develop selected energy technologies to a stage of application. The purposes will be achieved through several collaborative sub-projects designed to transfer technical knowledge in the field of alternative energy development. Achievement of the project's purposes will in turn contribute to the goals of reducing India's dependence on oil imports, of reducing the rate of deforestation, and of increasing energy efficiency in the industrial and transport sectors.

A.I.D. and the designated implementing entity financing will be utilized to support research and demonstration activites that can be broadly categorized into four major technical areas as follows: (1) biomass production and conversion, (2) coal conversion, (3) energy efficiency in industry and transportation, and (4) information exchange and prototype equipment.

Within each of these areas, a number of topics have been identified for study and investigation. They are as follows:

1.A. Biomass Production

a. Existing Plantation Assessments

b. Field Trial Implementation

c. Plantation Establishment and Maintenance

d. Nutrient Cycle Relationships

e. Insect and Disease Impacts

B. Bio-mass Conversion

a. Gasification of wood

b. Gasification of charcoal and crop residues

c. Producer gas powered small horsepower utility engines

2. Coal Conversion

a. Coal mixtures (coal/water and coal/oil)

b. Fluidized bed combustion

c. Coal beneficiation

d. Coal liquefaction

e. Combined cycle/coal gasification

3. Efficiency

a. Seminars

b. Industry assessments

c. Transportation studies

d. Plant audits

e. Co-generation studies

4. Information Exchange and Prototype Equipment in New and Renewable Energies and Coal Technologies

a. Catalogs

b. Data exchange

c. Wind and solar energy workshop

d. Visits, study tours and travel to conferences

e. Prototype equipment for field trials such as wind electric generators, bio-mass conversion units and micro hydel units etc.

The above activities are illustrative of the type of activities that AID intends to support under the project and may be modified by mutual agreement between the parties. The research activities that would be eligible for A.I.D. financing will,generally, be based on the potential for near-term results.

The principal mode of implementation for each of the project's four components will be through collaborative mechanisms involving U.S. and Indian public and private sector organizations. The final choice of these U.S. and Indian collaborating institutions will be made jointly by the designated implementing entity and A.I.D. The choice of U.S. institutions will be consistent with AID policy and procedures and may involve U.S. government agencies where possible, academic institutions, and private profit or non-profit organizations as the situation warrants. Indian institutions will be chosen consistent with the designated implementing entity's policies and mandates. An indicative list of the collaborating institutions is provided in Appendix 2 to Annex 1 of this Agreement.

Once chosen, the Indian and U.S. institutions will develop a work plan that will provide the following information: (a) detailed design of individual research activities and objectives (b) detailed budgets (c) an implementation schedule. A specific format for the work plan and further details will be provided in an Implementation Letter.

The AID grant will finance U.S. and Indian technical services and equipment needed to accomplish each of the objectives of the project's major components. Equipment eligible for AID financing will consist primarily of instrumentation needed for measuring the performance of

fluidized bed combustion systems and laboratory equipment for conducting the bio-mass research programs at the Grantee's designated bio-mass research centers. An indicative list of the laboratory equipment is provided in Appendix 3 to Annex 1 of this Agreement.

While specific Indian institutions will be responsible for separate aspects of the Project, the designated implementing entity will have the major responsibility for overall project management and administration including the following: (1) approval of work plans along with A.I.D. which are prepared by collaborating institutions for their assigned areas of interest and expertise; (2) the authorization and release of rupee funds for the collaborating Indian institutions; and (3) the periodic review and monitoring of work progress as delineated in the work plans. AID plans to work in close collaboration with the designated implementing entity to expedite project implementation.

Appendix 1 to this description sets out the indicative budget and financial plan proposed to carry out the activities under this grant. The allocations are illustrative and may be modified during the course of project implementation as situations warrant.

Appendix 1

PROJECT FINANCIAL PLAN
($000)

Project No. 386-0474

Project Components	A.I.D.	G O I	T O T A L
Biomass	2300	930	3230
Coal	1500	955	2455
Energy efficiency	500	200	700
Information Exchange and Other Renewables	700	200	900
T O T A L	5000	2285	7285

Appendix 2

List of Collaborating Institutions

A. Indian Institutions

I. Bio-mass

(i) Production

1. National Botanical Research Institute (NBRI)
2. Madurai Kamraj University (MKU)

(ii) Conversion

1. Jyoti Solar Energy Institute
2. Indian Institute of Technology

II. Coal Conversion Technologies

1. Bharat Heavy Electricals Limited (BHEL)
2. Central Fuel Research Institute (CFRI)

III. Energy Efficiency

Association of Indian Engineering Industry (AIEI)

IV. Information Exchange

Commission for Additional Sources of Energy (CASE)

B. U.S. Institutions

1. Department of Energy (DOE)
2. University Consortium
3. National Academy of Sciences(NAS)

Appendix 3

Bio-mass Research Programs

List of Laboratory Equipment

I. National Botanical Research Institute (NBRI)

Large microcomputer - word/data processor

Soil moisture meter and probes

Drying oven for plant materials

Bomb calorimeter

Root growth chamber

Deionizer

Growth chambers

Mist chamber

Germinators

Small walk-in freezer

Low temperature incubators

Moisture meter

Photomicrography unit

II. Madurai Kamraj University (MKU)

Small micro computer - word/data processor

Field data recorders

Meterological

Soil moisture meter and probes

Growth chambers

Mist chamber

Data recorders

Camera

Annex 15

Alternative Energy Resource Development

Initial Environmental Examination

Project Location	: India
Project Title	: Alternative Energy Resource Development
Life of Project	: 3 years, FY 82 commencement
Funding	: LOP: $5.0 Million
I. E. E. Prepared by	: John R. Westley, USAID/India - May 1980
Environmental Action Required	: Negative Determination
Mission Concurrence	: Priscilla M. Boughton Priscilla M. Boughton Director, USAID/India Date May 25, 1980
Assistant Administrator Decision:	Approved J. H. Sullivan Disapproved _____ Date 6/27/80