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AGENCY FOR INTERNATIONAL DEVELOPMENT

# PROJECT PAPER FACESHEET

1. TRANSACTION CODE: C (A = ADD, C = CHANGE, D = DELETE)

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2. DOCUMENT CODE: 3

3. COUNTRY/ENTITY: Worldwide

4. DOCUMENT REVISION NUMBER: 1

5. PROJECT NUMBER (7 digits): 936-5709

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7. PROJECT TITLE (Maximum 40 characters): Bioenergy Systems and Technology

8. ESTIMATED FY OF PROJECT COMPLETION: FY 85

9. ESTIMATED DATE OF OBLIGATION: A. INITIAL FY 79; B. QUARTER 4 (Enter 1, 2, 3, or 4); C. FINAL FY 84

10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 = )

| A. FUNDING SOURCE | FIRST FY B. FX | FIRST FY C. L/C | FIRST FY D. TOTAL | LIFE OF PROJECT E. FX | LIFE OF PROJECT F. L/C | LIFE OF PROJECT G. TOTAL |
|---|---|---|---|---|---|---|
| AID APPROPRIATED TOTAL | 1,510 | | 1,510 | 8,710 | | 8,710 |
| (GRANT) | ( 1,510 ) | ( ) | ( 1,510 ) | ( 8,710 ) | ( ) | ( 8,710 ) |
| (LOAN) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) |
| OTHER U.S. 1. | | | | | | |
| OTHER U.S. 2. | | | | | | |
| HOST COUNTRY | | | | | | |
| OTHER DONOR(S) | | | | | | |
| TOTALS | | | | | | |

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

| A. APPROPRIATION | B. PRIMARY PURPOSE CODE | PRIMARY TECH. CODE C. GRANT | PRIMARY TECH. CODE D. LOAN | E. 1ST FY 79 F. GRANT | E. 1ST FY 79 G. LOAN | H. 2ND FY 80 I. GRANT | H. 2ND FY 80 J. LOAN | K. 3RD FY 81 L. GRANT | K. 3RD FY 81 M. LOAN |
|---|---|---|---|---|---|---|---|---|---|
| (1) F/N | | | | 1,510 | | 200 | | 1,000 | |
| (2) | | | | | | | | | |
| (3) | | | | | | | | | |
| (4) | | | | | | | | | |
| TOTALS | | | | | | | | | |

| A. APPROPRIATION | N. 4TH FY 82 O. GRANT | N. 4TH FY 82 P. LOAN | Q. 5TH FY 83 R. GRANT | Q. 5TH FY 83 S. LOAN | LIFE OF PROJECT T. GRANT | LIFE OF PROJECT U. LOAN |
|---|---|---|---|---|---|---|
| (1) F/N | 1,000 | | 1,700 | | 8,710 | |
| (2) | | | | | | |
| (3) | | | | | | |
| (4) | | | | | | |
| TOTALS | | | | | | |

12. IN-DEPTH EVALUATION SCHEDULED: MM 08 YY 82

13. DATA CHANGE INDICATOR. WERE CHANGES MADE IN THE PID FACESHEET DATA, BLOCKS 12, 13, 14, OR 15 OR IN PRP FACESHEET DATA, BLOCK 12? IF YES, ATTACH CHANGED PID FACESHEET.

[ ] 1 = NO, 2 = YES

14. ORIGINATING OFFICE CLEARANCE

SIGNATURE

TITLE: Alan B. Jacobs, Director, Office of Energy

DATE SIGNED: MM DD YY

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

AID 1330-4 (3-78)

PROJECT PAPER:

"BIOENERGY SYSTEMS AND TECHNOLOGY"

(A Continuation of the "Bioresources for Energy" Project)

ST/EY, AID, WASHINGTON

August 4, 1981

# I. SUMMARY

## I 1 Recommendation

The Office of Energy of Science and Technology Bureau (ST/EY) recommends that the "Bioresources for Energy" project be extended through FY84. The total life of project cost will be $8.71 million (FY79 to FY84). The project name is changed to "Bioenergy Systems and Technology" to reflect greater project emphasis on implementation. Project activities will continue to be carried out through a PASA with the U.S. Department of Agriculture Forest Service and Office of Science and Education.

## I-2 Background

The continuing world energy crisis is adversely affecting LDC development efforts in a variety of ways. National development budgets in many fossil fuel poor countries are being severely strained by the need to spend foreign exchange on expensive petroleum fuels. High kerosene prices are forcing the poor to substitute lower quality fuels for domestic cooking and to get by on less household lighting. Both small and large scale industries are seeing their profit margins and productivity squeezed by sudden across the board increases in fuel prices as the competition for all fuels heightens. Remote regions and countries are losing their hard won access to markets because of the high cost of transport.

Of all these effects, the strain on LDC national development budgets by itself is sufficient stimulus for LDC's to re-examine their national energy picture. The aggregate real cost, in 1980 dollars, of oil imports to LDC's rose from $5 billion in 1970 to $29 billion in 1978, and to $58 billion in 1980. The World Bank estimates that these import costs will reach $107 billion by 1985, and $198 billion by 1990, assuming an annual increase of 3% in the real price of oil throughout the 1980's.

Many LDC's (particularly the lower-income group of countries that receive AID development assistance) are already heavily dependent on imported petroleum to meet their commercial sector's current needs. Planners in many LDC's sense the vulnerability inherent in basing further development on imported fuels with extreme price volatility and want to curb the growth of this dependency. Planners in these countries, and even in countries with currently adequate petroleum supplies, see the need to develop alternative sources of energy based on their country's domestic renewable resources. Increasingly the fossil fuel deposits found in LDC's are viewed more as an

export commodity rather than as an expendable energy resource for domestic use.

Among the energy resources with recognized potential for meeting long term national energy needs are those derived from biological sources, through both innovative and traditional practices of forestry and agriculture. The useful energy products include alcohol, charcoal, biogas, firewood, producer gas, and vegetable oils. Evidence for recognition of the potential of biofuels comes from the fact that several countries have already begun major bioenergy programs. For example Indonesia, Brazil, and the Philippines, are already involved in alcohol programs ultimately expected to meet a significant fraction of their national liquid fuel needs. Other countries have programs to produce charcoal for use in a variety of sectors: household, small scale industrial, and for iron smelting in Brazil. In the Philippines trees are being grown to fuel thermal generation of electricity.

These bioenergy programs are being developed to meet specific uses or market demands. The design of these and other bioenergy systems is guided by a working knowledge of the national energy budget, on both the demand and supply sides. Such knowledge coupled with sectoral demand projections provide the most reliable indication of the priority of fuel needs. Seen from the national perspective, some countries will find that liquid fuels for the transport sector are their greatest need. In other countries the greatest need will be seen to be for electricity generation or for industrial fuels. Once the national priorities for fuel needs are known, all domestic resources, including hydropower, geothermal, solar, wind, and biomass, must be assessed as to their relative <u>suitability</u> and <u>potential</u> for meeting those needs.

The suitability of bioenergy systems for a range of applications is unequaled by any other renewable energy resource. Conversion technologies are already well known for the production of gaseous, liquid, and solid biofuels capable of substituting for almost all uses of fossil fuels.

The potential for production of bioenergy is similarly broad because, unlike hydropower, wind energy, etc., which are limited to specific situations and locations, convertable biomass of one or several species can be produced in any part of the tropical and temperate zones. However, it is the existence of so many alternative possible energy crops and production systems which makes difficult any comparison with other renewable energy resources. For other renewables, the existence of a developable resource, such as a dammable river or a steam field within drill reach, leads easily through standard (and universally accepted) engineering and economic analyses to a relatively accurate prediction of the role that resource is capable of playing in the national energy budget. However, it is harder to make the same kind of prediction with a proposed bioenergy system. There are no "off the shelf" bioenergy programs; they must be tailored more closely to local conditions. Yet the capacity to make this kind of prediction with confidence is critical to choosing among alternative energy crops and to comparing the proposed bioenergy systems with other renewable resources.

Predicting the role bioenergy can play in a particular location requires analysis of a complex set of factors relating to land capability, land use, climate, and the country's economic situation. To be useful this analysis must describe in detail all aspects of a bioenergy program including energy crop production, biomass conversion, and biofuel marketing. In effect, more

so than with better understood technologies, this analysis must be a planning effort which addresses questions of implementation and management. Such an effort needs an interdisciplinary team of planners of wide experi- ence. The team should include those knowledgeable about the cultivation of plant species to be grown in the project; about the technology of biomass conversion; about the social factors which might impinge on the project, such as land tenure issues; and, about the economics and marketing of the biofuel product.

The broad objective, or sector goal, of this project is to increase the significance of the role of fuels of biological origin in LDC energy planning. The BST project will assist LDC planners by providing information and technical assistance to enable them to evaluate the potential contribution of their country's bioresources to national energy needs, as well as to help host countries plan specific bioenergy systems. Since many of these systems are highly innovative, this project will support limited applied field studies as required to complete the design of specific projects.

## I-3 Relationship of the project to AID forestry and agriculture activities

For the last several years concern has grown over the deteriorating state of the world's tropical forests. With the publication of Erik Eckholm's book, Losing Ground, in 1977, this concern spread from the environmentalists to the international donor community. The World Bank, AID, and other donors have held workshops and published papers aimed at furthering the recognition of the role of forests, alongside agricultural land and the seas, as the foundation of world biological productivity. Donor financed project planning studies are being encouraged to call attention to the ways that gains in long term economic productivity are dependent on forests. For example, agricultural irrigation projects are increasingly recognized as requiring forestry components for stabilizing the project's catchment area.

Against this background of general concern, a specific concern has been voiced by many donor agencies for the interdependency between forests and the rural poor. On the one hand there is the worry that the rising demand of the LDC rural poor for firewood is leading to loss of forests. On the other hand there is the worry that loss of forests will ultimately lead to severe shortages of firewood for the world's poor.

In the last three years there has been rapid growth in the number of projects which address some aspect of the relationship between forests and the rural poor. AID alone has a wide variety of projects which seek to better the lives of the rural poor through some kind of tree planting activity. Examples are: upper watershed soil conservation through terraces planted with trees and grasses rather than with food crops that offer poor erosion cover; dry land fodder production and protection from wind erosion through various leguminous tree plantings; planting of village woodlots as sources of firewood to provide firewood hungry rural peoples with an alternative to taking firewood from areas better left undisturbed; etc. AID has pushed programs, notably in the Africa Bureau, aimed at increasing the efficiency of biofuel use. Examples are: introduction of cookstoves which are designed to burn a particular fuel such as stemwood quality firewood or a uniform agricultural residue such as rice husks more efficiently; introduction of more efficient charcoal kilns.

While there is no doubt about the importance of the relationship between the rural poor and the continued health of the world's forests, there are many unanswered questions about the exact nature of the interdependency. As of the present the importance of forests, both to LDC national and local economies, is not well enough understood to permit routine inclusion of the forest sector in LDC development planning. This need is recognized in the Asia region by AID which is planning a conference for early next year on the economic importance of forest products. The Science and Technology Bureau of AID has recently formed an "Office of Forestry and Natural Resources" to support AID activities in the traditional forestry sector.

Energy needs are often cited as a major cause of deforestation. While this may be true in certain special situations as in very arid Sahelian countries or in countries such as Nepal which exhibit other extreme (and unique) climatic and soil conditions, the majority of tropical forests are threatened more by world need for food, timber, and paper than by the need of rural poor for firewood. In less densely settled regions of the world, indiscriminate, unplanned logging leads to long lasting forest degradation. In more densely settled parts, opening of forests for food crop production is a major cause of deforestation. In the sub-saharan regions of Africa, the fodder needs of overly concentrated grazing herds has led to severe degradation of brushlands through too frequent burning in an increasingly vain effort to stimulate grass production.

The chief distinction between the emerging AID forestry programs and the BST project is the emphasis placed on the purpose of silviculture. The BST project considers trees as one of many possible phytomass resources, which also include sugar cane, sorghum, corn, other grains, and a variety of root crops. One of the objectives of the BST project is to gain the experience necessary to make meaningful economic and environmental comparisons between all the candidate crops to be considered in the development of an particular bioenergy system. By no means will the bioenergy systems to be developed under this project rely on trees exclusively. Even in the case where the species to be cultivated for bioenergy production is a woody plant, there will still be a major difference between the approach of this project and traditional forestry. Any treecrop cultivated as a source of bioenergy will be managed for that end as a primary, and in many cases sole, output.

Bioenergy cultivation requires a technology and a R&D program that is significantly different than traditional forestry practice. The characteristics of bioenergy cultivation which emphasize this difference are: use of short-rotation, quick yielding species and varieties; use of species with wood properties suitable to particular conversion technologies; more intensive cultivation and management; location on soils of a higher class than traditional forestry projects; and, cooperation with many different LDC government agencies other than forestry departments, etc.

## I-4 Other donor agency activity in the bioenergy area

The Organization of American States (OAS) is spending approximately $500,000 per year in support of research and development projects to produce fuels from biomass. Most of these funds are channeled to Latin American institutions. OAS coordinates its activities through its Science and Technology Office. OAS has no joint project with AID. At the present indications

are that the OAS Office of Regional Programs will support a study to explore the environmental and economic implications of increased use of bioenergy.

The International Bank for Reconstruction and development (IBRD, or World Bank) supports firewood plantations through capital loans. During FY 1980 the total was $125 million, a total which is expected to continue to increase. Most of this effort is in Africa. IBRD also supports ethanol production from sugar cane through financing of infrastructure. IBRD has established a Renewable Energy Unit in its Energy Department to monitor LDC renewable energy project activity. Other banks have only minor programs in bioenergy.

The United Nations (UN) actively sponsors global conferences on energy, with particular emphasis on renewable energy options. There are several UN agencies with bioenergy programs. The UN Development Program maintains a small staff concerned with energy at its New York headquarters. The Food and Agricultural Organization promotes firewood projects as part of its larger programs to develop LDC capacity to manage natural and plantation forests. The UN Industrial Development Organization devotes a small effort to promote biomass conversion technologies. No dollar estimate of the portion of these programs that is devoted to bioenergy is available from the UN.

## I-5 Administrative arrangements

This project continues the "Bioresource-Energy Production" project, which is funded until the end of fiscal year 1981 under the management of the Science and Technology Bureau Office of Energy. The activities of that project are being carried out through a PASA arrangement (AID/USDA PASA AG/DSB 5709-6-79) with the U.S. Department of Agriculture Forest Service and SEA. The personnel seconded under this PASA, which will be continued for the duration of the project, will be providing technical assistance to USAID field missions directly, as well as assisting ST/EY in selecting private sector contractors as required to develop bioenergy systems.

A four year program is planned; the program schedule is shown in Appendix V-2. Total costs are projected to be $8.71 million, of which $1.71 has been obligated in FY 79 and FY 80. An additional $1.00 million is expected to be obligated before the close of FY 81.

# II PROJECT DESCRIPTION

## II-1 Background and history

The proposed project will continue the same kinds of activities under the same PASA arrangment as the present project. However, the scope of the activities is changed as a result of experience gained under the present project. Since the changes are evolutionary, the present project's activities are reviewed as an introduction to a description of the proposed project's activities.

The activities of the present project can be conveniently grouped under three headings: assistance to USAID field missions; provision of information about bioenergy systems; training of LDC energy planners. The following list contains all completed and ongoing activities:

Activity 1: Assistance to USAID field missions

In response to direct mission requests nine assignments have been carried out in eight countries to date (June, 1981). These assignments have involved the services of Forest Service and SEA personnel for a total of seven workmonths, AID ST/EY personnel for three workmonths, and contractors for nineteen workmonths. The tasks carried out in these assignments are as follows:

1) Panama

A two man mission of private contractors went to Panama in July, 1980, to write a report on specifications for a 300kw electricty plant to serve a rural community. The plant is to use wood as fuel. The report's recommendations are expected to be acted on by the GOP.

2) Guyana

One private contractor went to Guyana in July of 1980 to devise a scope of work for a feasibility study of electric power generation using rice husks as a fuel. AID and the GOG have entered into a tentative agreement to carry out the feasibility study. Contractor selection is now underway for this joint endeavor between ST/EY and the LAC Bureau.

3) Costa Rica

One private contractor was sent to Costa Rica in November, 1980, at the request of the Mission to review biomass energy options for the national alcohol fuel program. Particular emphasis was placed on ethanol production from sugar where sugar could be derived from various biomass sources.

4) Ecuador I

A team of one USDA PASA member and one contractor traveled to Ecuador in November, 1980, to assist the Mission and GOE in developing a biomass for energy program. The team evaluated the potential for biomass to energy conversion based on resource availability. One of the team's recommendations called for development of a program to produce low Btu gas from animal dung and other waste.

5) Ecuador II

As a followup to the first mission to Ecuador, a second team of two private contractors went to Ecuador in March, 1981, to advise the Mission and GOE on development of such a program.

6) Morocco

A team of two USDA PASA members and one private contractor traveled to Morocco in July, 1980, to advise the Mission and GOM on biomass need in facility design of a proposed Renewable Energy Center to be Located in Marrakech. The team assessed the potential of forestry and agriculture biomass for energy production in Morocco and included recommendations for specific projects. Based on the team's report the Mission has prepared a PID for a reforestation project and the GOM has included a project for portable metal charcoal kilns in its program of work for the Renewable Energy Center.

7) Indonesia

A team of one USDA PASA member and three private contractors spent three weeks in Indonesia during November, 1980, formulating plans and projects to be carried out by the PUSPIPTEK Energy Resource Laboratory. The team also specified the biomass energy laboratory layout, facility and equipment requirements, a staffing plan and a training schedule. Follow-up activities are anticipated.

8) Tunisia

In December, 1980, a team of two private contractors visited Tunisia and developed information requirements needed to conduct an assessment of biomass for energy in the agricultural and forestry sectors. The Team's report resulted in a request from the Mission and GOT to send another team to assess the potential for forestry and agricultural biomass in the production of energy in Tunisia.

9) Sri Lanka

A team of one USDA PASA member and two University Contractors visited Sri Lanka in March 1981 to evaluate the economics of reforestation and afforestation activities in terms of firewood production.

Activity 2: Information for mission and host country use

A major undertaking of the present project is the development of a series of reviews of the "state of the art" of bioenergy technologies. As of the present (June, 1981) ten reviews have been written and are in the final stages of editing. These reviews are supplemented by eight reports on miscellaneous topics related to bioenergy systems. Both reports and reviews are meant for use by both general and technical audience and emphasize the problems and possibilities of bioenergy systems in LDCs. These materials will be distributed to concerned mission staff, host country counterparts, AID/W personnel, and other selected organizations and individuals. To help the intended audience make more effective use of these materials a "Data Management Handbook" is being prepared as a guide to the series of reviews and reports. This handbook provides entry to the subject matter by bioresource or feedstock, by conversion technology, and by country or ecological zone. With the use of these materials USAID missions will be in a much stronger position to work with host country governments to define the important issues which must be addressed before a major bioenergy program is considered. A brief summary of the reviews and reports follows:

1) Review of Direct Combustion technologies

This paper examines the alternatives available for combustion of wood as well as agricultural and forest residues for electricity generation, process steam, and mechanical power.
Contractor: Nor'West Pacific Corporation, Seattle, Washington

2) Review of Char-Oil Slurry technology

This paper examines the direct combustion of char-oil slurries as a conservation/biomass substitution for large direct combustion systems.
Contractor: SRI International, Menlo Park, California

3) Review of Pyrolysis technologies

This paper examines pyrolysis systems for wood and agricultural residues to produce gas, oil and char.
Contractor: Mr. Anil Chatterjee, private consultant, Menlo Park, California

4) Review of Mobile and Small Stationary Gasifiers technologies

This paper examines past experiences with mobile gasification systems (auto, truck, tractors) and small stationary applications (pumps, diesel, electric, etc.).
Contractor: University of California at Davis

5) Review of Large Gasification Systems technologies

This paper examines large gasification systems for industrial and electric power generation from biomass.
Contractor: Battelle Pacific Northwest Laboratory, Richland, Washington

6) Review of Hydrolysis technologies

This paper examines the hydrolysis processes applied to biomass feedstock in preparation of subsequent fermentation to produce alcohol fuels. Feedstocks considered are lignocellulosic such as trees, shrubs, and municipal solid waste.
Contractor: USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin

7) Review of Methane Fermentation technologies

This paper examines methane fermentation for the production of biogas using various crop, animal, and urban residues. Evaluation of urban (municipal sludge digestion) and large scale cattle operations and community and household scale systems for rural application.
Contractor: Olympic Associates, Seattle, Washington

8) Review of Ethanol from Sugar Crops technologies

This paper examines the microbial conversion processes for the production of ethanol from sugar cane, sugar beets and other sugar crops.
Contractor: Battelle Columbus Lab., Columbus, Ohio

9) Review of Biomass Fueled Small Heat Engines technologies

This paper examines heat engines and their application for a variety of end uses. Requirements of types of biomass used and their economic potential in developing countries.
Contractor: Meta Systems, Cambridge, Massachusetts

10) Management System Handbook

The handbook presents a management system for the collection and organization of information on bioresources and conversion technologies. The handbook is a loose-leaf guidebook (for USAID mission and host country

use) containing a summary of the conversion technologies available, type of bioresources available, forms and quantities of biofuels used in AID countries, suppliers of equipment, and factors to be aware of in implementation of bioenergy projects.
Contractor: MITRE Corporation, McLean, Va.

11) Report: Economic Evaluation of Non-Conventional Energy Alternative

This paper discusses the different methods available to make economic evaluations of non-conventional energy systems.
Contractor: Meta Systems, Cambridge, Massachusetts

12) Report: Village Scale Industries

This report is a concept paper on the appropriateness of village scale industries and their use of biomass as fuel.
Contractor: Mr. John Arnold, Cambridge, Massachusetts

13) Report: Business-oriented Survey of Biomass Potential

This report identifies countries of the world where major biomass opportunities exist.
Contractor: SRI International (multi-client study), Menlo Park, California

14) Report: Survey of Resources and Capacities of U.S. Institutions in Bioenergy R&D

This report reviews bioenergy activities of U.S. educational institutions and identifies a number of institutions which appear to have the necessary experience, resources and interest to conduct special training programs.
Contractor: Dean B. Mahin, Private Consultant, Front Royal, Virginia

15) Report: Survey of Woody Biomass Production in Developing Countries (ongoing)

This report presents existing data on woody biomass production in 69 developing countries, the sources of data, tables of species, quantities and geographic distribution.
Contractor: University of Idaho, Moscow, Idaho

16) Report: Survey of Agricultural Crop Production in Developing Countries (ongoing)

This report inventories crop production and associated wastes and residues in 69 developing countries.
Contractor: Economic Botany Laboratory, USDA-SEA, Beltsville, Maryland

17) Report: Botanical Description of 65 Firewood Species (ongoing)

This report gives botanical descriptions of 65 common tropical firewood species.
Contractor: Elbert L. Little, Private Consultant, Washington, D.C.

18) Report: Effect of Intensive Harvesting on Nutrient Supply and Sustained Productivity (ongoing)

This paper examines the effects of intensive harvesting on nutrient balance and soil productivity.
Contractor: USDA - Forest Service, Washington, D.C.

Activity 3: Training of LDC energy planners

A series of workshops have been held to bring together LDC energy planners and technical experts in the area of bioenergy systems. The purpose of these workshops is to begin to open lines of communication between the diverse groups and organizations involved in bioenergy development planning. The following workshops have been held or will be held in the near future:

1) Workshop: Bioenergy - 1980

Conducted by International Institute for Education at Meridian House, Washington, D.C. - April 16 to 18.
The workshop dealt with the latest developments in biomass conversion and production technologies with emphasis on application in LDCs. Social, economic, and political aspects were considered in addition to purely technical matters. The workshop afforded the opportunity for exchange of information between LDC officials and U.S. specialists. Attendance consisted of 28 officials from 20 LDCs and 38 U.S. specialists and invited guests.

2) Workshop: Data Management - 1980

Conducted by MITRE Corp. at MITRE Headquarters in McLean, Virginia, in July.
The workshop crystallized thinking on how a large volume of data could be managed. As a result instructions for the state-of-the-art reviews were amplified and the terms of a contract for a data management handbook form-

ulated. Attendance was by specialists from USDA Forest Service and Science and Education Office, AID, academia, and the private sector.

3) Workshop: Charcoal - 1981

To be conducted by Acesita Florestal in Brazil, in October.
A workshop on charcoal making in Brazil is in preparation. Attendance will largely be by LDC officials. The workshop will cover all aspects from growing woody biomass to the manufacture and marketing of charcoal.

## II-2 Project Description

The proposed project continues the activities of the present project and adds several new areas of effort, all to be implemented over a four year period. These activities, which are described below, are: provision of technical assistance to the missions; preparation and dissemination of information for mission and host country counterpart use; training LDC energy planners; and, support of R&D on specific bioenergy systems.

The logical framework for the proposed project is presented in Appendix V-1 and the project budget and schedule in Appendices V-2 and V-3, respectively.

### II-2.1 Goals

The overall goal of the program of the Office of Energy in The Science and Technology Bureau is to assist LDC's to increase the use of indigenous, and to the extent possible, renewable, energy resources by: 1) increasing fuel supplies in such a way that national development goals are furthered with out increasing dependency on imported and/or expensive fuels; 2) using energy more efficiently and effectively.

### II-2.2 Purpose

The broad development objective toward which the proposed project is designed to contribute is an increase in the significance of fuels of biological origin in LDC energy planning. The purpose of the project itself is to demonstrate the suitability of bioenergy systems as sources of fuel for development applications, and to promote the development of the technology of cost-evvective bioenergy production systems. This purpose is to be accomplished through coordinated efforts to improve, adapt and expand technologies of energy production from biological resources. These efforts are to be placed in the context of a series of LDC projects aimed at the development of complete bioenergy systems, which encompass all phases of biomass production, conversion, and marketing. Derived from the project's overall purpose are the following subsidiary purposes:

- to develop literature which assists in the evaluation of the cost-effectiveness of bioenergy systems in the LDC context.

- to identify and to link LDC and U.S. institutions involved in bioenergy research.

- to identify priority R&D needs through a series of workshops and seminars involving technical personnel.

- to identify training needs and institutional arrangements necessary for development of LDC institutions capable of planning and managing bioenergy systems.

- to examine the economic impact of operational bioenergy systems, particularly those impacts deriving from the land and water resource allocation demands of large-scale bioenergy systems, as well as implications for LDC import requirements of technologies and commodities such as fertilizer.

- to examine the social impact of operational bioenergy systems, particularly on traditional patterns of marginal land use.

- to examine the environmental impact of bioenergy systems, with particular emphasis on arid and tropical lands.

II-2.3 Approach

The outputs of the proposed project will be organized under activities in the same fashion as the present project. These activities will be the same as the present project with one addition, an activity supporting R&D in bioenergy. These are described below:

Activity 1: Assistance to USAID field missions

As in the present, the project will stand ready to provide technical assistance directed toward development of LDC bioenergy systems. This assistance typically will follow a three step process. Each step is taken on request by the field mission through the regional bureau to the Energy Office of the Science and Technology Bureau (ST/EY). Upon approval of a scope of work by the, mission, the regional bureau energy officer, ST/EY, and the USDA PASA team leader, members of the PASA team, AID/W staff, or contractors, as appropriate, are sent to the field. As the process proceeds step by step, the active participation of host country counterpart agencies become more important, and indeed crucial for the last step. It is expected that this sequence will be started with the first step, although the existence of a report equivalent to the output of either step one or two would allow the consideration of skipping one or both of the first steps. These steps are described below:

Step 1: Reconnaisance

This step involves sending a small team on a first visit to a country to make an initial characterization of the alternatives for bioenergy resource development. Over the four year life of the project 50 to 70 such recon-

naisance visits are anticipated. The output of this step is a report written from secondary sources and counterpart conversations which identifies one or more bioenergy systems that warrant further study as to their development potential. Areas covered in such a report will include one or more of the following:

- a review of the national energy budget as a context for consideration of the role open to biofuels.

- an evaluation of the energy resource situation, emphasizing resources such as forests, agriculture, aquaculture, animal and municipal solid wastes.

- a description of the conversion technologies which might be appropriate to a country's renewable resource base and its national priority fuel needs.

Step 2: Identification of appropriate bioenergy system.

A small team is sent for a longer visit to a country where the AID mission and host country counterparts have already discussed development of a bioenergy project. Over the four year life of the proposed project 10 such identification missions are expected. The output of these missions is an analysis of a specific bioenergy system from the energy crop through conversion to the biofuel's role in meeting national fuel/energy needs. The level of analysis contained in the output document should be adequate to serve as the basis for a "Project Identification Document," or "PID." The source of data for the analysis will come from country energy surveys and other published materials. Areas covered in the output report include:

- an analysis of the costs of production and conversion of the biomass to be produced in the context of that country's economy.

- a survey that determines the market for the biofuel in competition with other renewable and nonrenewable fuels.

Step 3: Feasibility study and project plan.

A larger team works directly over a period of several months with host country counterparts to write a detailed project plan. Over the course of the four year life of the proposed project six plans are expected to be written. These plans will be sufficiently complete to be fundable by lending institutions or private sector investors. A variety of joint funding/financing arrangements, including private sector participation, are pos-

sible. It is expected that primary data sources from surveys will be required for the analysis. Land to be used for the energy crop will be identified. Areas to be covered in the final report include:

- an analysis of the economics of competing uses for the land designated for the energy crop cultivation.
- an analysis of the fuels competing with the biofuel in the contexts of the country's domestic energy market.
- identification of the institutional issues which are critical to the success of implementation of bioenergy systems.
- identification of social issues.
- identification of environmental issues, both those of general concern and those specific to the chosen sites.
- identification of an applied research program to assist the implementation of the bioenergy system.

Activity 2: Information for mission and host country use

The proposed project will continue the development of information resources concerning all aspects of bioenergy. As there is a large and growing body of literature concerning bioresources, the main function of this project activity is to filter this literature for those developments of possible application in LDCs. As before this information will be made available to USAID mission staff, host country counterparts, AID/W staff, and the general community of researchers and technichians working in bioenergy. To help intended readers to obtain and use this information, the reports and reviews will be published in several forms each conforming to a set format. In addition trip reports of reconnaisance missions will be circulated in draft to all regional bureaus and interested missions. The formal series are described below:

Series 1: Reviews of the "state of the art" of bioenergy technologies.

Under the present project ten conversion technologies have been reviewed as to their applicability to LDCs. Under the proposed project reviews will be written of five additional technologies not covered by the first reviews.

Series 2: Reports on bioresource data and technological developments

As useful current statistical reports and surveys on bioresources and their use become available from host countries, donor agencies, and other sources, they will be reviewed, abstracted, and published as needed. Similarly developments in bioenergy technology will also be prepared and sent to field missions in the form of a periodic newsletter.

Series 3: Case studies of bioenergy systems

the project will write and publish in an uniform format approximately ten case studies of operational LDC bioenergy systems. The feasibility studies that result from step 3 of activity 1 will also be published in this same format. Examples are:

- charcoal production activities in Brazil
- implementation of a wood-fueled steam electric plant in Panama
- utilization of rice husks to produce steam and electricity in Guyana
- production of fuel from biomass in arid lands
- use of agricultural residues as fuel

Series 4: Data management handbook

The data management handbook will be updated from time to time to reflect developments in technology as well as experience gained in AID project activity.

Activity 3: Training and linking bioenergy institutions

Workshops and meetings for the purpose of bringing together LDC energy planners and researchers will be continued under the proposed project. The workshops are intended to provide an opportunity for technology transfer and for obtaining an LDC perspective on bioenergy systems and technology. These workshops will meet in the U.S. or in LDCs as appropriate to the individual workshop's subject. Areas that have been suggested for possible future workshops are:

- training and manpower needs in the LDCs for bioenergy program development and management.

- special problems of energy crop production in arid and semi-arid tropical areas.

- research priorities for implementation of bioenergy systems in LDCs.

- environmental effects of removal of total biomass productivity from fields where energy crops are grown.

- biomass production in fast growing firewood plantations.

- technology evaluation of using vegetable oils as a substitute for diesel oil.

- comparison of utilization of agricultural residues which are available in central locations such as rice husks and coffee hulls, which are available in large quantities at mills.

Activity 4: Project related applied studies

Large scale bioenergy production is one of the most innovative areas of renewable energy technology. The field is characterized by rapidly developing technology and active applied research programs. Most of this research is concerned principally with three areas: improvement of energy crop species and varieties, development of new and better conversion technologies, and the adaptations necessary for efficient end use of the biofuel. Research and development (R&D) programs in all of these three areas may be found in developing and developed countries alike; however, the smooth transfer of new developments from developed country R&D institutions to similar LDC institutions is hindered in two ways: by the lack of experience in management of large scale bioenergy systems, and by the major differences in techniques of energy crop production between temperate and tropical countries. Therefore there is a need to adapt technologies of production as well as conversion to local conditions.

This project will fund studies aimed at providing results needed for a full feasibility study of a bioenergy system. The scope of these studies will be determined at the time of step three of the bioenergy system design process. The studies may be carried out either prior to, or concurrent with, the final feasibility study. It is expected that the majority of these studies will take the form of a small pilot study carried out in cooperation with an already ongoing host country agricultural or forestry R&D institution.

This project will also help to build confidence in the planning of bioenergy systems two additional ways: project funded workshops will serve to strengthen the linkages between all institutions engaged in bioenergy R&D; and, project publications will continue to emphasize the problems of adaptation of bioenergy technologies to LDCs and to tropical areas.

## III. PROJECT ANALYSIS

This section discusses technical, social, economic, and environmental issues which must be addressed if bioenergy systems are to be a major component of LDC national energy plans. The barriers now limiting the development of large-scale bioenergy systems in LDCs can be conveniently grouped under three questions: What is the cost of production? Is the biomass resource sufficient? and, What are the institutional arrangements necessary to assure adequate production? The ways the activities of the project work to overcome these barriers will be examined in detail

### III-1 Technical analysis

The technical issues associated with the development of large-scale bioenergy plantations arise primarily from the newness of both biomass production systems and conversion technologies. On the production side, current experience is insufficient to allow direct technology transfer because of extreme local variation in soils, climate and species that have been tried. Similarly conversion processes that are particulary appropriate to the fuel needs and bioresources of tropical developing countries are not well understood. Very often quoted statistics on yields, and on the efficiency of conversion processes have been shown to be unreliable in new situations or in scaled-up operations.

The Bioenergy Systems and Technology project aims to foster LDC and donor agency confidence in the planning of bioenergy systems. Therefore projects must be planned with careful regard to fuel markets and to the overall costs for the delivered biofuel. The ultimate product of this project will be fundable project proposals which are complete in every technical aspect.

Since large-scale bioenergy systems are not yet routine in their design and management either in developing or developed countries, the project will fund applied studies directed toward lessening the risk of planning bioenergy systems. The need for these studies will be identified before the writing of the final feasibility study. For example these studies might address site specific production problems such as adaptation of silvicultural systems to local conditions.

### III-2 Social analysis

In spite of the widespread negative feelings among development planners about the national importance that can be attached to the present and future role of bioresources for energy, there exists in almost every LDC a highly organized market system for the production, transport, conversion, and use of biomass for fuels. These indigenous systems are almost invariably dominated by the private sector. Notwithstanding the current concern for the "firewood energy crisis," these systems have a long history of supplying bioenergy. One of the major institutional considerations in any bioenergy project is the capacity of government agencies to manage such large scale projects. One of the major stumbling blocks to the development of more efficient bioenergy systems is the distance between governmental forestry and agricultural agencies and the biofuel trade. These agencies must overcome a long history

of a laissez-faire or even a corrupt relationship with the established biofuel distribution systems.

There are a number of social impacts arising from the extensive land requirements of bioenergy systems which do not occur with other renewable options. The form and seriousness of these issues vary greatly from country to country and from culture to culture. However, certain social issues recur frequently in consideration of bioenergy systems.

One set of issues revolves around the change from a multiple land use system supplying low firewood yields to a monocrop system of high yielding firewood species. Often the economic cost to local peoples from the loss of these other uses of forest lands are not included in project cost-benefit calculations. If these other uses can be characterized, it may be possible to include plantings of an appropriate secondary crop along with the firewood crop.

Another issue is the profitability of the energy crop. There is an initial period in the establishment of a plantation when labor requirements are high and when financial returns are minimal. Labor and financial needs have to be planned for carefully if the overall bioenergy system is to be successful. Land tenure, including traditional use rights, is often an issue in bioenergy plantations. Frequently the use of marginal lands where ownership is not clear and where shifting agriculture or grazing is the predominate land use leads to conflict over land use. Before any large-scale bioenergy system is considered for final approval, the social issues peculiar to the project sites and to the culture of the country involved must be identified and addressed in the overall project design.

## III-3 Economic analysis

Renewable energy technologies are frequently thought of by planners as having relatively high initial investment cost and long payback periods. The high initial investment costs of bioenergy systems derive from the cost of land preparation over extensive areas as well as from the cost of the establishment of a trained cadre of extension workers. These workers must be trained to provide technical information to participating farmers and/or plantations operators about production techniques that are significantly different from the traditional agricultural or forestry techniques. Such investments make sense only if they can be shown that the biofuel produced is economically substitutable for imported petroleum fuels. It is further assumed that the world price of petroleum will continue to increase rapidly.

Often high initial investment costs can be balanced by environmental side benefits. For example, the use of sanitary landfills to generate methane gas has a major benefit in that a landfill capable of producing gas must be sealed to the air, hence providing an environmental benefit. Similarly well managed firewood cultivation is likely to prevent erosion of marginal lands. These benefits and costs should be recognized in the development of feasibility studies for each particular bioenergy system.

Because of the lack of experience in large-scale bioenergy systems, overall economic analysis is currently a difficult proposition. Individual components of bioenergy systems such as conversion technologies, production

management systems, transport of fuel, etc. all present their own unique difficulties. If such analyses are to be useful, they need to be made more reliable, at both the resource and market levels. At the market level the ability of biofuels to compete with other fuels, both renewable and nonrenewable, will be critical for the success of the bioenergy systems. At the resource level the ability of energy crops to compete for land resources must be considered. In many food-deficit LDCs serious questions have to be asked about the trade-offs between use of marginal lands for food or energy crops. If the energy crop is woody, then its use as fuel or construction timber must also be addressed. However bioenergy systems are thought to be an attractive option in many LDC's because of favorable climatic conditions and the greater labor intensity of biomass energy systems in comparison with other energy systems.

The improvement of the reliability of such analyses is a major goal of this project. The project will assist the accuracy of such economic analyses by providing limited funding of case studies of successful bioenergy systems whether or not AID-funded. An example of such a case study already underway is of the charcoal production system in Brazil. Such case studies along with the results of full-scale feasibility analyses of bioenergy systems done under this project will be made available to AID missions to guide their selection of project ideas.

## III-4 Environmental analysis

Biomass energy systems invariably have a range of positive and negative environmental impacts. One output of this project is the development of full-scale feasibility studies for bioenergy systems. Each of these feasibility studies will address environmental issues as they arise in the context of each project design. At the earlier project identification stage, Initial Environmental Examinations will be made for each project according to the procedures of each bureau.

By their nature, the activities of this project, such as technical assistance, training, and information dissemination, do not require an environmental impact assessment; nonetheless, there are general environmental issues likely to be important in the design of many bioenergy systems. In the humid tropics, the design of an energy crop cultivation system must balance the opportunity for extremely high year-round productivity against the high rate of loss of soil nutrients from constant removal of total crop biomass from the growing field. In the arid tropics a similar balance must be made between increased productivity in relatively favorable rainfall years and an assured minimal productivity in drought years. These are examples of concerns that must be addressed as each project is planned.

On the positive side, bioenergy systems require more intensive land management. The establishment of a bioenergy system therefore provides an opportunity for sounder environmental management of marginal land resources. This is a benefit of the project that should be included, if quantifiable, in cost-benefit calculations. To be judged properly this benefit should be contrasted with the environmental cost of leaving such marginal lands untouched.

Biomass conversion also has a range of positive and negative impacts. These impacts vary with the conversion process as well with the bioresource

being used. These impacts are properly a subject for analysis at the time of a full feasibility study.

III-5 Estimated budget

The estimated budget outlined in Annex V-1 covers the four activities for the period FY 81 through FY 84. This budget includes funds for overall program activities for technical assistance, reports and publications, training, and project related applied studies. No estimates are included to account for likely sharing by missions and bureaus of the cost of development of feasibility studies for particular projects.

The average cost for PASA personnel is estimated on the basis of $100,000 per direct person year (travel and per diem included). Contractors are estimated on the basis of $12,500 per person month. The division between use of contract and PASA personnel is as follows: PASA personnel time will account for approximately two thirds of the time needed for steps one and two; contract personnel will provide the remaining one third for steps one and two; and all of the time for step 3 will be contracted.

# IV IMPLEMENTATION PLAN

## IV-1 AID project management

The project will be managed by the Office of Energy, Science and Technology Bureau. The Office of Energy will provide centralized project supervision and a mechanism for dissemination and interpretation of project results as to their usefulness for the Agencywide policy and programing purposes. A ST/EY staff member will be the project manager.

The project manager will be assisted by a technical advisory committee composed of a representative from each of the regional bureaus, ST/EY personnel representing different energy areas and specialists from other disciplines in other ST Bureau offices whose expertise may be needed on specific issues and projects. The technical advisory team will meet regularly , at least quarterly, to review plans and progress of project activities.

## IV-2 Administrative arrangements

To implement this project the PASA between AID and the U.S. Department of Agriculture (USDA) will be extended to assure a smooth continuation of the two-year working relationship between the Forest Service (FS) and Science and Education Office (SE) and the Office of Energy (EY) of the AID Science and Technology (ST) Bureau. If the USDA is unable to supply expert personnel needed to implement the PASA, then another appropriate institution will be selected to serve as the contractor for the project.

Because of its experience, both over the two year history of the Bioresources for Energy Production project and in other activities, the USDA is uniquely qualified to supply expertise to assist in development of all technical aspects of the project and to assist in the design of bioenergy systems. The FS and SE have considerable international experience through their programs in India, Pakistan, Taiwan, etc. In addition USDA supports a large and diverse domestic program in the bioenergy area.

Because of the great range of issues, such as sociological, legal, economic, environmental, etc., which arise in the course of planning bioenergy systems, there will be need for expertise not available at USDA. In such instances, the PASA personnel will advise AID technical staff in the missions, bureaus, and the Office of Energy as to the selection of qualified contractors. Since the USDA is already involved in an extensive network of bioenergy experts, the identification of the best qualified contract personnel for particular activities. For example, if an anthropologist from a specific academic institution were needed in project planning, the FS, through existing cooperative agreements between univeristies and the Regional Experiment Station, could recruit this individual directly. If a cooperative agreement did not exist, one could be established easily. SE has similar arrangements to recruit personnel.

The management of project operations will be the responsibility of a core staff. As under the present project, the staff will be four full-time senior scientists and a secretary. The duties of the core staff will include: organizing meetings, preparing scopes of work, recruiting and

supervising consultants, leading field missions, coordinating activities with other US Government and other donor agencies, etc.

The work will require the services of experienced technical specialists. The core staff will be composed as follows: one economic specialist, one woody biomass production specialist, one agricultural biomass production/conversion specialst, plus one generalist.

## IV-3 Implementation timetable

The schedule, which is shown in appendix V-2, presents the timing of project activities. Where specific missions are anticipated, these are indicated under the appropriate activity heading. The timing of other activities is scheduled only approximately.

The activities of this project are expected to evolve in response to the needs of the missions. A major effort to insure that the project is providing the maximum field support is the regional workshops which are expected to occur mid FY 82. These workshops are meant to provide a forum for: dissemination of "state of the art" technology reviews, presentation of the data management handbook, determination of regional needs for development of bioenergy projects, etc. Out of these meetings will come the establishment of a framework for closer mission/Washington cooperation in the bioenergy area.

## IV-4 Evaluation plan

At yearly intervals ST/EY will chair a review of the project's program with participation from USDA, principal contractors, and appropriate representatives of other agencies involved in project activities. The members of the bioenergy technical working group, as well as other representatives of the regional bureaus, will participate in these annual reviews. At the end of FY 81, AID will make an overall evaluation of the first two years of the Bioresources for Energy Production project experience. This first overall evaluation will be repeated in FY 84.

AID 1020-25 (1-72)

# PROJECT DESIGN SUMMARY
## LOGICAL FRAMEWORK

Life of Project:
From FY _____ to FY _____
Total U.S. Funding _____
Date Prepared: _____

Project Title & Number: BIO-ENERGY SYSTEMS AND TECHNOLOGY

APPENDIX V-1

| NARRATIVE SUMMARY | OBJECTIVELY VERIFIABLE INDICATORS | MEANS OF VERIFICATION | IMPORTANT ASSUMPTIONS |
|---|---|---|---|
| Program or Sector Goal: The broader objective to which this project contributes:<br><br>To increase the significance of the role of fuels of biological origin in LDC energy planning. | Measures of Goal Achievement:<br><br>More bio-energy systems in use in LDC's.<br><br>Bioresources supplying a greater percentage of LDC energy needs | AID and multilateral projects.<br><br>World Bank reports. | Assumptions for achieving goal targets:<br><br>1. Continued development requires more energy.<br><br>2. Fuels from bioresources are necessary to meet LDC energy needs. |
| Project Purpose:<br><br>To demonstrate the suitablity of bio-energy systems as sources of fuels for development applications, and to promote the development of the technology of bio-energy production systems. | Conditions that will indicate purpose has been achieved: End of project status.<br><br>Requests for information on AID bio-energy pilot projects and AID-supported applied research projects. | Summaries of AID information requests. | Assumptions for achieving purpose:<br><br>1. Bio-energy systems will be proven efficient and suitable for LDC's<br><br>2. LDC governments and development assistance agencies will adopt bio-energy systems for relevant application, and will support R&D programs for bio-energy technology. |
| Outputs:<br><br>Field consultancies<br>Resource/technology assessments<br>Pilot projects<br>LDC participants trained<br>Workshops<br>Research background papers<br>R&D needs assessment<br>Project related applied studies | Magnitude of Outputs:<br><br>30 to 50 reports<br>8 to 10 studies<br>6 to 10 detailed planning studies<br>100 to 150 participants<br>4 to 8 meetings<br>5 to 7 research reviews<br>1 workshop<br>3 to 5 funded proposals | Reports, reviews, field visits, and trip reports. | Assumptions for achieving outputs:<br><br>1. The bio-energy systems chosen for pilot projects are suitable for LDC application.<br><br>2. The technical, social, and economic feasibility of bio-energy systems can be demonstrated through pilot projects. |
| Inputs:<br><br>1. AID funding<br>2. Forest Service personnel<br>3. Consultants | Implementation Target (Type and Quantity)<br><br>$8,710,000 (FY 79 to FY 84)<br>30 person years<br>As necessary | Vouchers.<br><br>Copies of Requests for Proposals. | Assumptions for providing inputs:<br><br>Continued use of U.S. Department of Agriculture/Forest Service personnel. |

**ST/EY BIO-ENERGY SYSTEMS AND TECHNOLOGY**
**PROJECT SCHEDULE**
**(by fiscal year/month: FY 81 to FY 84)**

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ACTIVITY                          FY 81                 FY 82                 FY 83                 FY 84
                                  :                     :                     :                     :
                                  O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O
                                  :                     :                     :                     :
Technical assistance              :                     :                     :                     :
                                  :                     :                     :                     :
   Reconnaissance mission.........xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   Prefeasibility study           :                     :                     :                     :
       Tunisia....................:.....................xxxx                 :                     :
       Other......................xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   Feasibility study              :                     :                     :                     :
       Guyana.....................:.....................xxxxx                :                     :
       Other......................:.....................:....................xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
Publications                      :                     :                     :                     :
                                  :                     :                     :                     :
   State of the art reviews.......XXXXXXXXXXXXXXXXXXXXXXXxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   Data management handbook.......XXXXXXXXXXXXXXXXXXXXXXXXxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   Newsletter.....................:.....................XXXXXXXXXXXXxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   Technical reports..............xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   Case studies...................:.....................xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
Workshop/training                 :                     :                     :                     :
                                  :                     :                     :                     :
   Technical workshops            :                     :                     :                     :
       Brazil - charcoal..........xxxxxxxxxxxxxxxxxxxxxxxXXX                  :                     :
       Other......................:.....................xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                                  :                     :                     :                     :
   AID regional workshops.........:.....................xxxxxxxXXXXXX         :                     :
                                  :                     :                     :                     :
   Wood Energy Congress...........:.....................:..xxxxXX             :                     :
                                  :                     :                     :                     :
   Conferences                    :                     :                     :                     :
       Research needs.............:.....................:...........xxxxxxxxxxxXX                    :
       Training needs.............:.....................:......xxxxxxxxxxxXX   :                     :
                                  :                     :                     :                     :
Project related applied studies....:.....................:...........xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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APPENDIX V-2a

ST/EY BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT
FINANCIAL BUDGET TABLE
FY 81 to FY 84 (year of obligation)
(thousands of dollars)

| ACTIVITY | 81 | 82 | 83 | 84+ | total |
|---|---|---|---|---|---|
| Technical assistance | | | | | |
| Reconnaissance mission | 50 | 225 | 250 | 400 | 925 |
| Pre-feasibility study | | | | | |
| Tunisia | 50 | | | | 50 |
| Other | 50 | 250 | 300 | 350 | 950 |
| Feasibility study | | | | | |
| Guyana | 100 | | | | 100 |
| Other | | 475 | 475 | 675 | 1625 |
| Publications | | | | | |
| State of the Art Reviews | 175 | 40 | 40 | 40 | 295 |
| Data Management Handbook | 50 | 5 | 5 | | 60 |
| Newsletter | 60 | 20 | 20 | 30 | 130 |
| Technical Reports | 75 | 50 | 50 | 50 | 225 |
| Case Studies | 60 | 50 | 50 | 100 | 260 |
| Workshops/training | | | | | |
| Technical workshops | | | | | |
| Brazil charcoal | 80 | | | | 80 |
| Other | 100 | 100 | 200 | 200 | 600 |
| AID Regional workshops | 100 | 200 | | | 300 |
| Wood Energy Congress | 50 | | | | 50 |
| Conferences | | | | | |
| Research needs | | | 150 | 150 | 300 |
| Training needs | | 150 | | | 150 |
| Project related applied studies | | 250 | 250 | 400 | 900 |
| TOTAL | 1000 | 1815 | 1790 | 2395 | 7000 |

ST/EY BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT
MANPOWER BUDGET TABLE
FY 81 to FY 84 (year of obligation)
(in person-months)

ACTIVITY I: TECHNICAL ASSISTANCE FOR AID MISSIONS

| | Step 1: Reconnaissance mission | | | | | | Step 2: Pre-feasibility study | | | | | | Step 3: Feasibility study | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ITEM | (unit study) | 81 | 82 | 83 | 84+ | total | (unit study) | 81 | 82 | 83 | 84+ | total | (unit study) | 81 | 82 | 83 | 84+ | total |
| Generalist | (1.5) | 1.5 | 13.5 | 15.0 | 22.5 | 52.5 | | | | | | | | | | | | |
| Team leader | | | | | | | | | | | | | (4.0) | 2.0 | 8.0 | 8.0 | 10.0 | 28.0 |
| Conversion specialist | | | | | | | (1.0) | 2.0 | 5.0 | 6.0 | 7.0 | 20.0 | (2.0) | 1.0 | 4.0 | 4.0 | 5.0 | 14.0 |
| Bioresource specialist | | | | | | | (1.0) | 2.0 | 5.0 | 6.0 | 7.0 | 20.0 | (2.0) | 1.0 | 4.0 | 4.0 | 5.0 | 14.0 |
| Economist | | | | | | | (1.0) | 2.0 | 5.0 | 6.0 | 7.0 | 20.0 | (2.0) | 1.0 | 4.0 | 4.0 | 5.0 | 14.0 |
| Sociologist | | | | | | | | | | | | | (2.0) | 1.0 | 4.0 | 4.0 | 5.0 | 14.0 |
| Environmentalist | | | | | | | | | | | | | (2.0) | 1.0 | 4.0 | 4.0 | 5.0 | 14.0 |
| Soils specialist | | | | | | | | | | | | | (1.0) | 0.5 | 2.0 | 2.0 | 3.0 | 7.0 |
| Cropping specialist | | | | | | | | | | | | | (1.0) | 0.5 | 2.0 | 2.0 | 3.0 | 7.0 |
| Systems specialist | | | | | | | | | | | | | (2.0) | 1.0 | 4.0 | 4.0 | 5.0 | 14.0 |
| TOTAL PERSONMONTHS: | (1.5) | 1.5 | 13.5 | 15.0 | 22.5 | 52.5 | (3.0) | 6.0 | 15.0 | 18.0 | 21.0 | 60.0 | (18.0) | 9.0 | 36.0 | 36.0 | 45.0 | 126.0 |

TOTAL OF TECHNICAL ASSISTANCE PERSON MONTHS TO BE SUPPLIED TO MISSIONS BY FY: 81-15.5; 82-64.5; 83-69.0; 84 and beyond-88.5.