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PROJECT PAPER SUPPLEMENT

BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT

(BST)

(Project Number: 936-5709)

Office of Energy

Bureau for Science and Technology

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PROJECT PAPER SUPPLEMENT

BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT  
(BST)

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TABLE OF CONTENTS

FACESHEET

EXECUTIVE SUMMARY

I. RATIONALE FOR EXTENSION OF PROJECT

- A. Current Project Content
- B. New Project Content

II. ELEMENTS OF THE PROJECT AS EXTENDED

- A. Introduction: Original Purpose Fulfillment
- B. Sub-Projects
  - 1. Cane Energy Program
  - 2. Rice Residue Utilization Program
  - 3. Wood Waste Energy Systems
  - 4. Other Activities
- C. Project Development Activities: Evaluation and New Project Design

III. FINANCIAL PLAN

- A. Estimated Budget
- B. Leveraging

IV. IMPLEMENTATION PLAN

- A. A.I.D. Project Management
- B. Administrative Arrangements

V. EVALUATION PLAN

- A. Meeting Project Objectives
- B. Leveraging Funds from outside U.S.A.I.D.
- C. Evidence of Credibility and Leadership

VI. PROJECT ANALYSIS

- A. Issues
- B. Ability of A.I.D. and TVA to Carry Out the Project Extension
- C. Budgetary Impacts: FY87 and FY88

## EXECUTIVE SUMMARY

Project authorization will be amended on the basis of this Project Paper Supplement to increase the life of project funding from \$8,710,000 to \$11,826,000, an increase of \$3,116,000 and to extend the life of project to 10 years with a new PACD of September 30, 1989. This amendment also authorizes use of money from the Select Development Account (Section 106).

This extension finances the following project activities: assessments of country potential for electricity generation from cane, rice, and wood residues; pre-feasibility and feasibility studies; research on combustion, ethanol production and management; field trials of cane and rice residue collection; and project evaluation

Cane and rice residue are targeted because these two crops are the most significant in many countries assisted by A.I.D. Cane is most significant in terms of tons of biomass produced; rice is most significant in product value. The cane industry now suffers because of static markets and low sugar prices that stall rural economies and decrease employment opportunities. The rice processing industry needs to modernize and expand to prepare for continued expansion of production. In both cases, revenue from energy production using mill and field wastes can increase earnings, maintain employment, provide badly needed electricity to rural areas, and increase the revenues available for better resource management. Wood wastes associated with forest product industries are also a widespread potential cogeneration feedstock, particularly in tropical countries. Sales of wood wastes to energy markets could provide revenues to enhance management of tropical forests. The success of the U.S. private sector in developing residue conversion systems and marketing energy products offers both expertise and experience that have great market potential in developing countries. Many of these companies are committed to investment to replicate such systems.

The extension will provide funds to evaluate BST activities under the project. The evaluation will assess to what extent the project has met past objectives, review what has been learned about implementing successful biomass energy conversion systems from project activities to date, and review whether integration with the private sector has helped achieve project objectives. The evaluation team will also recommend how the project might be modified to enhance its ability to meet objectives. These recommendations will be taken into consideration during design of a follow-on project.

The BST Project is currently implemented through a RSSA with the Tennessee Valley Authority (TVA). Since the beginning of this RSSA in August 1982, TVA has managed BST activities in conjunction with AID, drawn upon TVA expertise to support A.I.D. field investigations, and used subcontracts, grants, and cooperative agreements to access additional expertise for the benefit of A.I.D. when specialists were needed. It is proposed that project extension continue this implementation mechanism.

## PROJECT PAPER SUPPLEMENT

### BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT (BST)

(Project Number: 936-5709)

#### I. RATIONALE FOR EXTENSION OF PROJECT

##### A. Current Project Content

###### 1. Extension of Bioenergy Systems and Technology project Will Allow Completion of Field Project Preparation Work.

The extension of the BST Project through September 30, 1989 adds both time and funds to permit completion of on-going project development activity. The original BST project which began in 1979 was designed to develop ways for using biomass as feedstock for energy generation. Based on the understanding of biomass systems available at that time, BST evaluated and considered a variety of approaches in support of mission initiatives in biomass energy. Some of these approaches included developing new systems to produce biomass feedstocks which could be used for a variety of conversion technologies. Other approaches involved using residues from already existing production systems.

Project experience to date shows that the latter approach is the more effective. Over the middle years of the BST project (1982 to 1984) it became increasingly clear that adding the necessity of creating and managing new biomass feedstocks to the management of conversion systems unnecessarily complicated the development of biomass energy systems. Scrutiny of successful biomass energy systems increasingly showed them to be affiliated with existing enterprises producing agricultural or forest products that have their own captive biomass feedstock (residue) supplies. Such processing facilities generally have sufficient volume of residue feedstock and the ability to market by-products of energy conversion systems. Selling byproducts greatly improves the economics of biomass energy systems.

The current BST program has thus evolved to incorporate knowledge gained during the first few years of project life and now stresses the approach of using existing residues to produce energy products. Because of the focus on residues, the importance of close working relationships and inputs from private companies producing agricultural and forest products increased. Current project emphasis is structured to attract private sector investment in sugar cane, rice and wood residue energy systems, both for power and for ethanol.

The Cane Energy Program was initiated three years ago and the Rice Residue Utilization Program one year ago. BST staff now give primary attention to these two thrusts, allocating the majority of time and funds to their development because of their potential for significant near-term impact. Success with these systems will establish broader legitimacy for biomass energy systems in general. Wood residue activities have been part of the project since it began and continue to receive attention. Wood residues are not as widely available in countries assisted by AID but still represent a significant captive feedstock from which successful energy products can easily be developed.

Under each program, BST assesses innovations in national policies and incentives that will stimulate wider use of biomass resources for energy production where conditions in a particular country make such systems economically attractive. Each program also does pre-feasibility analyses as well as extensive pre-implementation project design work. These efforts, which are described in more detail below, are designed to create model field projects by mid-1989. To support field projects, new institutional relationships both in the U.S. and in LDCs are being established and require additional testing and nurturing if they are to achieve original project objectives. Commitments to complete assessments of country-wide potential, finish on-going prefeasibility studies, enhance working relationships with the financial institutions involved in international development, and improve mechanisms for cooperation with the U.S. and LDC private sectors will be completed under the project extension and will lead to the implementation of field projects under a follow-on project expected to be authorized for FY89.

The purpose of the BST project extension is to allow completion of field project preparation work as described above. Conditions established under the current project extension will serve as the base for implementation and management of field activities under a planned follow-on project to begin October 1, 1989.

## 2. Evolution and Current Status of Project Elements

### a. Rationale for Current Project Focus on Cane and Rice

Cane and rice residue are targeted by BST because these two crops are the most significant in many of the developing countries assisted by A.I.D. Cane is the most significant in terms of biomass volume of crops produced; rice is most significant in terms of product value. In many A.I.D.-assisted countries sugar cane and rice are the basis of the agricultural economy and account for a very high percentage of rural employment. Providing economic growth options to these agricultural industries is therefore crucial for national economies.

The sugar cane industry worldwide suffers from decreasing prices and static markets with concomitant decreasing earnings. The Cane Energy Program offers the industry diversification opportunities

which can stimulate new revenue. In addition, production of energy products can help meet economic development goals to increase rural employment and expand value-added processing in rural centers as well as to strengthen rural infrastructure.

The rice industry faces a different but equally serious problem. Increased demand for rice over the next 20 years will require modernization of rice mills and expanded capacity to handle larger volumes of rice. Rice residue power systems can create new revenue for millers to support investment in required modernization and expansion.

The past two years of concentrated effort by BST in the Cane and Rice Energy Programs have produced high-level support from various USAID missions, increasing world recognition of A.I.D.'s role in assisting cane and rice millers through development of energy options, and cooperative relationships with centers of expertise and with private U.S. developers of commercially proven cane and rice energy systems.

#### b. Status of On-going Project Activities

Current project activity of BST is described below. This work is underway and can be completed by the end of the proposed extension. Each on-going activity is part of the evaluation, assessment, planning, and research considered essential to fulfill project objectives and to build the foundation for a follow-on project. The list provides expected completion date and current status for each project activity.

##### Cane Energy Program

1. Procurement of Cane Field Trash Collection Equipment /December 1987/CBD Announcement for Competitive Bid by May 15, 1987
2. Field Trials for Cane Field Trash Collection in Jamaica /June 1988/to begin after procurement completed
3. Advanced Combustion Systems Research at Princeton University /July 1988/initial contract in place
4. Cane Electricity Project in Thailand--Cost Share with USAID, Bangkok /24 months beginning June 1987/project definition team in Thailand June 1987
5. Cooperative Research Agreement with Hawaiian Sugar Producers Association /18 months beginning July 1987/SOW under negotiation
6. Hawaii Natural Energy Institute Cane Energy Workshop /June 1987/being held in April 1987
7. Cooperative Research Program with Land Authority of Puerto Rico /12 months/planning in process

8. Trials for Field Residue Collection in Philippines /Twelve months/planning in progress, workshop scheduled May 1987
9. Field Support for Jamaica Cane Energy Project /June 1988/in progress
10. Cane Energy Assessment for India /six months/terms and starting date under discussion with USAID New Delhi
11. Cane Energy Assessment for Pakistan /six months/terms and starting date under discussion with USAID Islamabad
12. Cane Energy Assessment for Dominican Republic/six months /terms and starting date under discussion with USAID Santo Domingo
13. Cane Energy Workshop for Africa /four months/venue being sought
14. General Technical Services for Cane Energy Program /Eighteen months/in progress

#### Rice Residue Utilization Program

1. Assessment of U.S. Rice Power Resources by Louisiana State University /six months/contract under negotiation)
2. Development of Institutional Relationships to Support Private Sector Investment in Rice Husk Power in the Philippines through Agri-Energy Roundtable /four months/in progress
3. Rice Power Potential Assessment for Indonesia /six months/under discussion with ANE and USAID Jakarta
4. Prefeasibility Study for Rice Husk Power Plant for Indonesia /three months/under consideration
5. Participation in Rice Husk Power Plant Feasibility Study for Indonesia /six months/pending decision by TDP
6. Prefeasibility Study for Rice Husk Power Plant in the Philippines /three months/pending outcome of Agri-Energy Roundtable meeting
7. Participation in Rice Husk Power Plant Feasibility Study for the Philippines /six months/pending outcome of Agri-Energy Roundtable meeting
8. Support to Research on Ethanol Production from Rice Residue /12 months

## Other/General

1. TVA RSSA Support/thru 9-89/in progress
2. Costa Rica Wood Gasification Project/12 months/in progress
3. Support to Producer Gas Roundtable/24 months/in progress
4. Support to Biomass Users Network/6 months/awaiting proposal
5. Sponsor system research on using energy markets to sustain tropical forests/24 months

Additional detail on any one of these project activities may be found in the Office of Energy program plan.

## B. New Project Content

1. Description of new BST Project that will manage a program of field projects devolved from original BST Project

The new BST Project to begin October 1, 1989 will be oriented primarily toward field projects. By September 1989 BST expects to have a large number of on-going field activities in cane and rice residue energy. The new project will manage these activities and continue to evaluate bioenergy options using other residues, such as cassava and cotton or municipal solid waste and sewage as energy feedstock. Field projects will serve both to create working models as well as to inform research priorities.

The new Project will support research on specific subjects to promote innovations important to the evolution of new systems and to facilitate improved cane and rice energy systems management. This research will be a direct outgrowth of field activities as is the case with the current field trash collection equipment research and the Princeton gas turbine research listed above.

2. New mechanisms (via new project) needed to facilitate work with private sector and missions

The design for the new BST Project will differ considerably from the original project. In addition to the much more clearly defined mandate and scope of work to be expressed in the new document, increasing success of BST work has resulted in demand for buy-ins by USAID missions. The current project paper prohibits such buy-ins. Ability to accept mission buy-ins must be incorporated in the new project design to ensure success of field projects.

It is also increasingly clear that new mechanisms for contracting with sectors of private industry must be investigated and incorporated in BST project design. This is a generic problem facing A.I.D. During the proposed extension period BST will

identify and investigate options for efficient interaction with private companies. These options will then be incorporated in the new project paper.

## II. ELEMENTS OF THE PROJECT AS EXTENDED

### A. Introduction: Original Purpose Fulfillment

The goal of the BST project as stated in the original project paper was "to increase the significance of the role of fuels of biological origin in LDC energy planning." The BST project as extended will continue this by assisting LDC planners with 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 as extended will support limited applied field studies as required to complete the design of specific projects.

Since initiation of the cane and rice energy programs of BST, this original goal has been only partly achieved. Field studies, supportive research, and country assessments are underway and need to be completed to achieve the original project goal as designed. These efforts will provide the basis for specific field projects to be implemented and managed under the new BST project to begin October 1989.

### B. Sub-Projects

#### 1. Cane Energy Program

##### a. Purpose

The BST Cane Energy Program will support USAID missions in evaluating diversification opportunities for the sugarcane industries of A.I.D. countries and in implementing such diversification programs.

##### b. Justification for a cane energy sub-project

Many countries receiving U.S. foreign assistance rely greatly on the production of sugar to provide rural employment and to earn foreign exchange. Among agricultural commodities in A.I.D. countries sugarcane is by far the largest crop by volume; at 660 million metric tons annual cane production is more than three times that of rice paddy and more than five times that of wheat and corn. Consistent employment data in the sugarcane industry is difficult to obtain, but some seven million people are employed full-time in A.I.D. countries, with over 30 million directly dependent on sugar industry income.

The sugar industry's performance has declined markedly in past years. Over-production of sugar in countries with price supports has resulted in excess stock buildups worldwide and long term depression in world prices. While internal sugar prices in many countries have remained sufficient to cover costs, many industries rely on exports for substantial revenue and these prices have generally been well below production costs.

The situation is further exacerbated by shrinking U.S. and European Community sugar quota markets, negligible consumption growth during the past five years, state take-overs of heavily indebted private sugar companies in order to preserve employment, poor management in many locations, and the lack of resources for maintenance and new investment. As a result, many sugarcane industries in A.I.D.-assisted countries have suffered consistent financial and employment losses, declines in foreign exchange earnings and government revenues, and reduced stability in agricultural regions.

Based on two years of effort in feasibility studies, research and field project development, BST views energy and new product markets as significant opportunities for exploitation by producers of sugarcane. The BST program thus concentrates on commercial energy production from the sugar industry because of the importance of sugarcane to the economies of many A.I.D. countries and because of the increasing needs for energy in expanding sectors of these economies. Electricity sales to public utilities as well as possible alternative products such as fuel alcohol, boiler fuel, and animal feed also appear to offer promise as new commercial avenues for the sugarcane industry.

c. Services to be carried out under the project extension

In addition to the specific activities listed above using FY87 and earlier funding, the project as extended through September 30, 1989, will carry out the following types of activities:

1. Preliminary consultations to assess the appropriateness of detailed investigations.
2. Field services to carry out technical and economic analyses of on-site specific cane energy options using teams of specialists.
3. Pre-feasibility studies suitable for submission to financing institutions.
4. Assistance in project development for mission and host governments wishing to pursue cane energy as part of their economic program.
5. Assistance in locating private sector participants in instances where the investment prospects appear favorable.

d. Country Targets

The following countries and sectors of the industry are targetted by BST for its most intensive work under the Cane Energy Program:

1. Expansion of the Cane Energy Program to additional A.I.D. countries including Pakistan, India, Bolivia, Belize, Malawi, Indonesia, Dominican Republic, Kenya, Fiji. (Studies have already been completed for Jamaica, Honduras, Thailand, and the Philippines.)
  2. Implementation of recommendations of four already completed cane energy assessments: Project feasibility studies, facilitation of private investment, supportive research. These studies were done for Jamaica, Thailand, Honduras, and the Philippines.
  3. Joint research on system components in conjunction with U.S. private investment in the Jamaica project, beginning with field trash collection equipment and tests. Extension of research to field trials in the Philippines and Thailand. Research collaboration with research institutions in Louisiana, Hawaii, and Puerto Rico.
- e. Products expected

The following products are expected to result from the two year extension of BST:

Cane Energy Country Assessments

Prefeasibility Studies

Feasibility Studies

New Equipment Development

New Energy Technology Development

Workshops

Technical/Policy Papers

2. Rice Residue Utilization Program (RRUP)

a. Purpose

The BST RRUP Program under the extended project will stimulate development and implementation of systems to convert rice residue (husk and straw) into energy and other commercial products (steam, ethanol, lignin, gypsum, chemicals) to strengthen the rice processing industry through diversification.

b. Justification

To meet projected rice demand beyond the Year 2000, both rice growing and rice processing will need to increase efficiency. Increased efficiency requires capital investment. Diversification of rice processing through the conversion of rice residue into energy products increases income and capital accumulation for re-investment. Creation of these new income streams will also result in new jobs, new rural infrastructure and new economic activity in rural areas. Identifying products from components of the entire rice plant and establishing markets for them stimulates improved and sustainable resource management. Ultimately rice farmers will also benefit as the value of rice husk and straw is reflected in farmgate produce prices. Because of the prospect of increasing value derived from the entire rice plant, RRUP has received encouragement from the International Rice Research Institute (IRRI) at Los Banos, Philippines.

A.I.D. is in a unique position to play a critical role in developing the potential of rice residue energy systems. U.S. companies involved in successful rice residue system development and potential developing country users alike have little previous experience in either international technology transfer or international finance. A.I.D. can provide the institutional framework needed to identify and coordinate rice residue use opportunities. In collaboration with groups such as IRRI, TVA, TDP, OPIC and the international business community, A.I.D. can establish these relationships and encourage their success.

c. Services to be provided under the project extension

Services to be provided under the rice program are still in the final design stage. Some specific studies and activities are listed above under the project status discussion. The strategy for other services being followed in the RRUP includes:

1. Identification of economic conversion systems (combustion, hydrolysis).
2. Identification of new sites for such systems in target countries (Philippines, Indonesia, Thailand, India, Pakistan).
3. Identification of and coordination with with centers of U.S. and International expertise: USDA, LSU, Agrilectric, Helix, IRRI, etc.
4. Stimulation of private investment in power plants and refineries
5. Reduction of risk associated with private investment (new technologies, new companies, new byproducts).

6. Catalysis of new institutional mechanisms for: feasibility funding, project financing, ownership and management, product marketing and distribution.
  7. Support for correlative research such as TVA agrirefinery, rice straw collection techniques, byproduct utilization (gypsum, lignin, ethanol, etc.).
  8. Activation of public and private sector networks to support USAID rice-to-energy activity: UN system including IBRD, ADB, FAO, ESCAP, UNIDO; Chambers of Commerce; National Cooperative Business Association; National Rural Electrification Cooperative Association; OPIC; TDP; Eximbank; commercial banks.
  9. Sponsorship of investment missions and seminars to share results of feasibility studies and country assessments with possible new consortia of investors.
- d. Country Targets

The major emphasis of RRUP during the extension period is on the following:

1. Rice Husk Power Plant Construction in Asia (Indonesia, Thailand, Philippines, India, Pakistan)
  2. Encouragement and partial sponsorship of joint research between the Tennessee Valley Authority (TVA) and the International Rice Research Institute (IRRI) to delineate an agrirefinery using acid hydrolysis to convert rice husk to ethanol and other byproducts with markets in developing countries such as Philippines or Indonesia.
  3. Identification and coordination of U.S. resources in rice residue utilization, for example at the Post-Harvest Technology Institute, Louisiana State University and for application in Thailand, Indonesia and the Philippines.
- e. Products

As above for cane energy.

### 3. Wood Waste Energy Systems

Current BST effort in wood waste energy systems is concentrated on a small scale bioelectrification project using wood waste in Costa Rica (150 kW) to generate electricity for an off-grid system for the rural community of Horquetas. This project uses a gasification system and when completed will demonstrate the potential for wood waste systems to allow economic and environmentally sound management of forests by providing alternative markets for waste products.

Additional wood waste power cogeneration activity is also expected to develop in Asia, initially in Indonesia where U.S. private sector interests are exploring lumber mill waste-to-electricity plants with BST assistance.

#### 4. Other Activities

Exploration of potential of other agricultural residues for energy production, including those from cassava and cotton.

Examination of the role of energy markets in waste management: effluent from agro-industrial processes, municipal waste.

### C. Project Development Activities: Evaluation and New Project Design

#### 1. Goals of evaluation

A full project evaluation will be conducted during the extension period to ascertain achievement of the original project objectives and to outline the substantive basis for new project design. This evaluation will be completed before the end of FY87 to permit early work on the new project paper.

Subjects to be treated during the evaluation include:

Appropriateness of project activities to project purpose.

Prospective economic benefits of technologies developed.

Effectiveness of technical assistance provided to USAID field missions.

Usefulness of studies and reports written under contract.

Effectiveness of workshops held under project sponsorship.

Relationship between project activities and those of other donor agencies.

Ability of project to work with U. S. and developing country private firms.

Consideration of sustainability of systems under development and of environmental consequences.

#### 2. Relationship between evaluation and new project design

The conclusions and recommendations of the evaluation team will form part of the basis for new project design. S&T/EY is considering the possibility of using the same or a slightly modified team for both the evaluation and the new project paper to ensure continuity of perspective. The team will include a panel of individuals representing private firms that have been

successful in stimulating or developing cane, rice, or wood energy systems in the United States.

S&T/EY expects to conclude the project evaluation in 1987 so new project design can be completed, approved and in place to ensure smooth continuation from the current project to the new one. (Continuity is essential to maintain credibility with the private sector as well as with missions.)

3. Timing

An evaluation team should be selected and under contract by June 15, 1987. A draft of the evaluation report should be completed by July 30, 1987 and final by August 31, 1987.

4. Products

Draft and final versions of evaluation report.

III. FINANCIAL PLAN

A. Obligation Plan

The FY87 obligation includes \$300,000 still available within the current project authority. The intention is to obligate \$3,160,000 in FY88 and FY89.

Following is a Pipeline Analysis for the proposed project extension:

PIPELINE ANALYSIS

Incremental Funding through September 30, 1989

Total obligations to date	\$8,710,000
Total actual expenditures thru 6/01/87	7,790,000
Total estimated expenditures thru 9/30/87	620,000
Funds available for expenditure beginning 10/1/87	\$ 300,000
Budget for period 10/1/87-9/30/89	\$3,416,000
Funds available in project as of 10/1/87	300,000
Funds needed in this project	\$3,116,000

B. Estimated Budget

The budget estimated below covers all activities for the period FY88 through FY89. Financial contributions by missions and other agencies to BST work are not indicated.

The average cost for RSSA personnel is estimated on the basis of \$125,000 per direct person year (travel and per diem included). Contractors are estimated on the basis of \$12,500 per person month.

FINANCIAL BUDGET TABLE

S&T/EY BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT

FY88 and FY89  
(thousands of dollars)

<u>ACTIVITY</u>	<u>88</u>	<u>89</u>	<u>FY88-89 Total</u>
Consultancies/ Prefeasibility	236	145	381
Feasibility Studies	586	310	896
Research	486	225	711
Technology Identification	16	15	31
Project Implementation	406	184	590
Investment Facilitation and Monitoring	145	96	241
Other Activities	170	96	266
<u>TOTALS</u>	<u>2045</u>	<u>1071</u>	<u>3116</u>

PROGRAMMATIC EXPENDITURE TABLE

S&T/EY BIOENERGY SYSTEMS AND TECHNOLOGY PROJECT  
FY87 - FY89  
(thousands of dollars)

	<u>FY87</u>		<u>FY88</u>		<u>FY89</u>		<u>Total</u>
	<u>ST/EY</u>	<u>Other</u>	<u>ST/EY</u>	<u>Other</u>	<u>ST/EY</u>	<u>Other</u>	
Cane Energy	822	1112	1072	782	914	918	5620
Rice Residue	368	250	520	400	474	470	2482
Wood Residue	110	130	144	69	122	81	656
Other	46	195	92	138	78	162	711
<u>TOTALS</u>	<u>1346</u>	<u>1687</u>	<u>1828</u>	<u>1389</u>	<u>1588</u>	<u>1631</u>	<u>9469</u>

C. Contracting Arrangements (Project Verification and Audit)

As noted elsewhere, implementation of BST will be through a RSSA with the Tennessee Valley Authority. A major proportion of BST funds will therefore go to the TVA RSSA. In addition to the funds required for staff and associated expenses of TVA, additional monies will be obligated for use as BST project support via TVA

subcontracts, grants, and cooperating agreements with third parties having expertise and/or experience necessary for supplementing TVA support to BST.

The remainder of BST funds will be obligated directly to contracts and grants via PIO/Ts to other contractors and grantees through the A.I.D. contracts office.

All contracts, grants, and cooperative agreements, whether established directly between A.I.D. and contractors/grantees or whether established through TVA to contractors and grantees, will be executed in accordance with the verification and audit requirements of A.I.D.

#### B. Leveraging

In addition to the programmed money of BST, considerable leveraging is expected to result. For example, a prefeasibility study costing \$40-60,000 should result in a \$250,000 feasibility study funded either completely by the Trade and Development Program or 50-50 funding by TDP and the private company concerned. A recent project in rice husk power plant country potential assessment has resulted in a new design at smaller scale, engineered for developing country application at the expense of the U.S. company.

### IV. IMPLEMENTATION PLAN

#### A. A.I.D. 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 useful for the Agencywide policy and programming purposes. Project staff will report to the Director of S&T/EY.

#### B. Administrative Arrangements

Implementation of project activity will be accomplished through the work of core TVA staff, sub-contracts, and cooperative agreements. To implement this project the RSSA between A.I.D. and the Tennessee Valley Authority will be continued and extended for a period of two years.

Because of its own extensive experience with biomass and the experience gained over the past four years supporting BST, the TVA is uniquely qualified to supply expertise to assist in development of all technical aspects of the project and to assist in the implementation of biomass energy systems.

Given the wide range of issues, both technical, economic, environmental, etc., which arise during the planning of bioenergy systems as well as the specific expertise related to sugar cane

and rice processing systems, there will be need for expertise not available at TVA. In such instances, the RSSA personnel will advise A.I.D. technical staff in the missions, bureaus, and the Office of Energy as to the selection of qualified contractors. Since TVA is already involved in an extensive network of bioenergy as well as cane and rice experts, identification of best qualified contract personnel will not be difficult. Both contracts and cooperative agreements will be used by TVA to supplement the regular staff assigned to support BST.

The management of project operations will be the responsibility of a core TVA staff. The staff will consist of four full-time senior scientists, an administrative officer, 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 U.S. Government and other donor agencies.

## V. EVALUATION PLAN

The extension will provide funds to evaluate BST activities and will assess to what extent the project has met past objectives, what can be learned about implementing successful biomass energy conversion systems from project activities to date, and how well the private sector is integrated into design of field work. Indirect measures of project success include the extent to which the project has been able to leverage funds from other private and public organizations to serve BST project objectives and the opinion other organizations hold of the quality and influence of BST activities.

### A. Meeting Project Objectives

The formal evaluation of the BST Project will review original objectives, strategies and expected outcomes. Major subjects will include:

1. Appropriateness of Project activities
2. Effectiveness of assistance to USAID missions
3. Usefulness of studies and reports
4. Effectiveness of meetings and workshops
5. Effectiveness of Project activities in relating to other donor agencies
6. Consideration of sustainability of systems under development and environmental consequences

**B. Judgement in Modifying Project Mechanisms**

As the BST Project evolved, modifications were frequently needed to incorporate new information. The evaluation will examine project experiences and assess whether mechanisms selected for Project implementation were effective. The evaluation team will also make recommendations of other mechanisms that should be considered.

**C. Integrating Private Sector into Project Activities**

Given the need to attract private investment in order to achieve impact, the evaluation team needs to examine relationships the BST project has developed with the private sector. The evaluation will determine if the project has established effective relationships and how activities have responded to private sector concerns. The evaluation team will also make recommendations to A.I.D. of how the BST project might more effectively interact with the private sector. These recommendations will be particularly important to design of the new project.

**D. Leveraging Funds from Outside A.I.D.**

The Project has leveraged considerable funding in support of BST objectives from other sources both within A.I.D. and from outside A.I.D. Outside sources include other donor agencies (both bi-lateral and multi-lateral), other U.S. Federal Agencies, and private sector organizations including businesses and trade associations. The evaluation will review project experience with leveraging funds.

**E. Evidence of Credibility and Leadership**

Important criteria of success to be scrutinized during the evaluation include the awareness of BST programs among the development community and the private sector and recognition by this audience of BST leadership in developing systems for biomass energy production.

**VI. PROJECT ANALYSIS**

Project analyses examine the feasibility and potential impacts of the substantive project activities themselves as well as the ability of A.I.D. and TVA to carry out those activities. The original project paper presents these analyses. This project paper supplement only treats project orientations that have changed since original project design.

**A. New Orientations**

The following project orientations differ sufficiently from the original project design to warrant analysis in this supplement: focus on existing agricultural plantations rather than on creation of new plantations; increased focus on private sector activities; and environmental impacts of cane and rice systems.

## 1. Focus on existing biomass feedstock

The new emphasis of BST projects on use of residue as the primary feedstock in successful biomass energy systems poses a different set of feasibility and impact questions than was the case under the original BST project design. The original project considered bioenergy feedstocks from plantations to be as worthy of attention as bioenergy feedstocks from existing residues.

Project experience has found that large plantations dedicated to biomass production require strong management capabilities often in short supply in rural areas of A.I.D.-assisted countries. Adding this burden to project development requires more resources than most governments are willing to allocate to relatively unproven systems. In addition, biomass plantations that have been developed have not achieved predicted yields and have been more costly than estimated. Producing crops for energy markets alone does not look financially attractive given current yields and the current value of energy products.

In the short term, development of biomass plantations to supply feedstock for producing energy products is unnecessary to demonstrate significant national energy impact from bioenergy projects. In the long term, research being carried out by other organizations in the U.S. may reduce the risks associated with plantation development, decrease the management attention needed, and improve the economics.

Activities to be carried out during the Project extension will emphasize reorganization within existing agricultural and forest industries to make better use of process wastes. These wastes often have a negative value because they present disposal problems. Importantly, technical skills and management ability are already present in these industries.

A second source of feedstock which will receive attention during the extension period is residues from agricultural or forestry operations currently left in the field or forest at harvest. Utilization of these residues can have major impact on rural economies by creating new jobs, new rural infrastructure, and increasing the value of products produced from a given land area.

For example, the recent BST study titled "Electric Power from Cane Residues in Thailand" projected a fuel cost of 235 Baht/ton for sugar cane tops and leaves delivered to a sugar mill to be used as feedstock for electricity production. Currently, a small percentage of these field residues is collected for animal feed at the time of harvest, but most of the available residue is burned after harvest. The report also estimates that under reasonable collection scenarios the annual field residue available for power generation is 6.5 million tons at 35% moisture or 5.9 million tons at 25% moisture. This means that the value of the otherwise unused feedstock ranges between 1386 million Baht and 1527 million Baht or between \$53 and \$59 million (at 26 Baht/USD) of new revenue for cane growers and harvesters.

Electricity demand has been growing steadily in Thailand. New capacity has been financed largely through foreign borrowing by the Royal Thai Government. The sugar industry may be able to produce between 270 and 715 MW of electric power depending on combustion equipment efficiency. If this addition to capacity is funded by the sugar industry, the government can save on the order of \$300 million.

The sugar industry in Hawaii began to sell large quantities of electricity in the late 1970's. The price they receive for electricity is related to the price of oil. At today's price of oil (\$16/bbl), revenues from electricity represent between 5 and 10 percent of total revenues. Representatives of the sugar industry claim at least several mills would be out of business without revenues from electricity sales.

Additional examples will be developed by activities carried out during the Project extension.

## 2. Increased private sector focus

The importance of working with the private sector expanded as the BST Project evolved and increasingly focused on using residues associated with processing industries. In addition, the original project was designed before private companies in the U.S. had developed many successful bioenergy facilities. During the Project extension, BST plans to continue work initiated with private firms that have been successful in the U.S. to make them aware of opportunities in A.I.D.-assisted countries and to work with them to identify conditions necessary to assure project success.

Because energy facilities generally require significant capital investments, one of the primary responsibilities of BST for the remainder of the Project is to adequately describe the economic and financial soundness of candidate bioenergy systems in order to attract private investment. The need to attract private investment shifts the primary emphasis of feasibility analyses away from issues of technology choice towards issues of economic viability. The degree of innovation that can be introduced into projects is tempered by the need to control risk to assure financial soundness.

BST hopes to complete development of a sound project framework during the Project extension and to identify key research which will support innovation. The focus of the proposed new project will be introduction of innovations into sound field projects.

The BST program is predicated on the belief that product diversification will strengthen the commodity sector. Energy markets offer excellent prospects for diversification as proven by U.S. experience. The sugar industry in Hawaii has over 185 MW of installed electric capacity funded with private capital. Rice mills in Louisiana and Arkansas are converting rice husks into

useful energy products. The wood products industry in the U.S. provides almost 90 percent of its energy needs from its waste. Energy systems being evaluated for both the cane and rice industry show pay-back periods under five years and make good economic sense for their parent industries. For example, the study of electricity from cane residues in Thailand shows that even for old cane mills under the worst case scenario, investment will be paid back in four years.

### 3. Environmental Analysis of Cane and Rice Systems

Bioenergy systems are classified as renewable energy but are only renewable if the systems developed are environmentally sustainable. Residues cannot be converted into energy products if they reduce productivity of the overall system. Consequently, examining the sustainability of systems which use biomass residues to produce energy products becomes an essential part of the cost-benefit analysis associated with cane, rice and wood energy systems. Investors will only invest in energy facilities based on biomass if they are assured of a fuel supply for the life of the investment.

Research under the project extension will continue examination of impacts of removing residues from fields after harvest and will establish a methodology for evaluating these impacts. Techniques developed will enhance the quality of future environmental analyses and reduce investment risks. Experience shows that in Hawaii, complete removal of biomass from cane fields over the past several decades has not decreased the ability of the land to produce cane.

Currently the massive amounts of unused or marginally used cane tops and leaves, bagasse and rice husk and straw pose an environmental problem. Under current practices in most countries, residues that accumulate at processing facilities or that are left in fields are burned. In the U.S., this practice was banned because of its negative impact on air quality. In fact, often the initial motivation for agricultural waste-to-energy work in the U.S. arose from the need to dispose safely and successfully of residues. Using residues to produce energy in controlled facilities reduces negative impacts on air quality.

#### Ability of A.I.D. and TVA to Carry Out the Project Extension

The objective of the original project was to build a "critical mass of basic knowledge and practical know-how" within the BST program. A.I.D. has established relationships through TVA with a wide range of private and public organizations.

TVA maintains broad capabilities in energy, natural resource management, and economic and community development. They are unique among federal agencies in the amount of experience they possess in planning, designing, building, and operating facilities which makes them particularly well qualified to examine issues

related to field project implementation. TVA's reputation for effective management of field activities often benefits A.I.D. project development.

TVA continues to support biomass research and development in the Biomass Branch of the Office of Agriculture and Chemical Development (OACD). Since A.I.D. signed the original RSSA with TVA in 1982, TVA's role in U.S. biomass development has increased. Staff of the Biomass Branch now manage the Department of Energy (DOE) Southeast Regional Biomass Program. DOE has rated TVA performance excellent in this program.

TVA is willing to continue to make available core staff that have been assigned to the Office of Energy under the existing RSSA. This core staff bring with them knowledge of BST project development work and represent the critical mass necessary to complete activities under the Project extension. Through this core staff, A.I.D. has been able to draw increasingly on other resources within TVA.