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MALI RENEWABLE ENERGY

A MID-PROJECT EVALUATION REPORT

FOR USAID, BAMAKO

MALI RENEWABLE ENERGY

A MID-PROJECT EVALUATION REPORT FOR USAID, BAMAKO

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I. Executive Summary

The first purpose of the project was to demonstrate that greater development of renewable energy--solar, wind, fire wood, and biogas--could reduce Mali's dependency on fossil fuels and human energies. The second purpose was to help Mali develop the capacity to carry out this development by strengthening Mali's Solar Energy Laboratory.

The project was designed by AID in 1978 and organized in four phases. Phase I would, by fast installation for four photovoltaic pumps, demonstrate a practical application of solar energy. During Phase I, the existing Malian Solar Energy Laboratory would be strengthened by construction of a new building, the purchase of new equipment, and the training of personnel so that the Lab would be able to test or to develop renewable energy products responsive to the needs identified in the energy survey of Phase II. In this second phase, a socio-economic survey would be conducted in 25 representative villages to determine energy needs and usage, local energy resources, and village level abilities to maintain and repair renewable energy apparatus that seemed likely to be given priority by the results of the survey. In Phase III, prototype apparatus would be placed in selected survey villages and records kept of its use and maintenance by villagers who had been trained in its operations and service. In Phase IV, analysis of field records would determine which technologies and products had the greatest potential for financial and economic benefits.

A favorable evaluation of phases I and II and of preliminary plans and budgets for phases III and IV was made a condition of proceeding to these latter phases. This is the report of the evaluation originally scheduled for June 1980, but because of project delays, concluded in April and May of 1982, 44 months after the project began. It includes recommendations for Phases III and IV.

The evaluation is favorable and project continuation is recommended, not because of entirely satisfactory performance in Phases I and II, but because the problems have largely been corrected and because there is clear promise of success in the next two phases. Indeed, in mid-1980 the project seemed doomed to failure. The early start pumps had not been installed, equipment had not been delivered, no plans had been made for Lab construction, coordination between Malian agencies and between AID and the Solar Energy Lab was strained and ineffective.

Then, largely because the hire of a broadly competent resident consulting engineer for the Lab helped its Director to lead others to better efforts, the project turned round. The work of the Lab is approaching--and in some areas has reached--the highest level to be found in the other national laboratories in the Sahel. The Lab has sought and apparently will be granted authority to become self-supporting to a significant degree. It has already been approached by potential clients in the resident international agencies and is seeking other consultant or product development work. Two or three of its products have commercial potential and, in three instances, local entrepreneurs are assessing the prospects for profit-making enterprises.

The socio-economic survey was well conducted in spite of the initial problems and its results should prove valuable in establishing priorities for future research and product development. Administration of the Lab has improved remarkably and the prospects for comparable improvement in project management by USAID/Mali appear excellent. Funds are available to proceed with the next two phases of the project about as planned. Project performance conforms to the criteria for continuation that were formally agreed to by representatives of the governments of Mali and of the United States in 1978 and meets, as well, the several criteria for successful project performance subsequently applied by USAID/Mali.

The project should, therefore, proceed to phases III and IV with formal amendment to the project agreement on the changes in goals and procedures as may be adopted after consideration of the recommendations that follow. The new Lab should be built and equipped.

II. PREFACE

The Mali Renewable Energy Project Paper requires that an evaluation of the project be carried out prior to the start of its third phase. An objective of the evaluation, as stated in the Project Paper is, "To determine whether the Solar Energy Laboratory is an effectively functioning organization capable of performing its role in the overall program."

The scope of work for the evaluation (shown in Annex C) gave emphasis to assessment of the technical capability of the Lab, including: the records of tests of prototypes; the cost and performance characteristics of these prototypes; an examination of equipment use and maintenance; examination of insolation and weather data; the quality of technical assistance provided to the Lab; the quality of Lab management; the level of socio-economic survey; commitment of the Lab to the socio-economic survey; and the relevance of the Lab's R&D program to rural needs as identified by preliminary Lab findings. The evaluation was to include assessment of the long-term viability of the Lab in relation to other donor activity (particularly the Centre Regionale d'Energie Solaire (CRES); its capacity to become self-supporting; and the structure to assure coordination with other on-going programs elsewhere in Mali and in West Africa.

In reviewing the draft Scope of Work for the evaluation, the Laboratory's Director suggested that the evaluation team examine the socio-economic survey in more detail (Bamako 1808). The evaluation covered some of the questions needed to assess the validity and accuracy of the Phase II village studies, a task which the Project Paper had assigned to a second evaluation to take place six months after the end of Phase II.

The Grant Agreement was signed in August of 1978, and the evaluation took place between roughly 12 April and 22 May of 1982, after 44 months of project activity.

The evaluation team reached agreement on most matters, and on only one issue, that of whether the Lab should give high priority to achieving a measure of self-support, are opposing views presented.

The basic question is to what degree the market place should effect the Lab's priorities for the development of technologies, products and services. The Renewable Energy Project design, it can be argued, gave emphasis to the judgement of experts in energy, economics, and sociology as their recommendations would guide the conduct and analysis of results of a socio-economic study in representative villages. Several of the reccommendations of this report are based upon the anticipated results of this study; specific priorities are recommended for the Lab's future research and product development. Another view is that these judgements should be tempered to greater degree by finding out - from a range of prospective clients - what people are ready to pay for and what the government and its donor agencies are willing to subsidize. The answer to this question seems critical to the future of the Laboratory for, unless other sources of income can be found during the next two years, the Lab seems likely to be in financial difficulty after USAID support ceases.

The evaluation team comprised:

Richard Graham	Management, Team Leader (VITA)
Papa Fall	Economist (ORGATEC)
Clarence Kooi	Energy (USAID/REDSO/WA)
Frances Stier	Anthropologist (USAID/REDSO/WA)

The team was guided by advice from the USAID/Mali evaluation office, headed by Robert Shoemaker. The staffs of the AID mission and of the Solar Energy Laboratory were extremely helpful. The team would especially like to thank M. Chieckna Traore, Director of the Lab; Jon Anderson, AID's Energy Project Director, and Terry and Carol Hart. The report of Jerry Cashion, USAID anthropologist, was of particular help. The broad rance competence and cheerful willingness of Maimouna Dienapo made the work a pleasure. The insights of several Peace Corps Volunteers and former Volunteers helped to place findings in perspective; namely David Benefal, Roy Speed, Gehart Behrens, Tom Mirbi, and especially, Craig Burke.

In response both to a request by the AID mission and to specified AID format, recommendations are presented in several ways and in several places; briefly in the executive summary, more fully in section V where they are grouped according to the category of recommendations, e.g. to the laboratory, to AID, etc. They are presented again in Section VI where they are grouped by priority of recommendation. In Appendix A, the section "Lessons Learned" presents certain recommendations in still another form.

III. INTRODUCTION: BACKGROUND OF THE PROJECT AND ITS EVALUATION

A. Purpose of the Evaluation

There were at least four perspectives for the evaluation:

1. The primary purpose of the mid-project evaluation, as defined in Section 5.2 (b) of the Project Agreement, was to determine whether to proceed to Phase III and IV of the project and to base this decision upon performance, under the terms of the agreement, in Phases I and II of the Project. Another purpose of the evaluation, as stated in the Project Agreement, was to develop recommendations for project modifications on which common accord can be reached for Phase III and IV, and from which preliminary plans can be drawn and cost estimates can be made. It is therefore a purpose of this evaluation to submit specific recommendations for project modifications and, in less binding ways, to make suggestions for project improvement.
2. The purpose of the evaluation, as specified in the Statement of Work was that of assessing the performance of the Solar energy Laboratory, the survey of village level energy needs, the energy plans of the Malian Government, and those of Sahelian energy organizations in order to decide whether to proceed, not only with Phase III of the project, but also with a major part of Phase II - the construction of a new solar energy Laboratory.
3. In interviews with the AID Mission Director and members of his staff, it was suggested that the evaluation team determine whether the project meets several other priority criteria of the mission.

   a) that the project will not overtax AID/Mali's administrative resources.
   b) That the project will increase the overall coherence of USAID/Mali's development assistance, that it would, for example, be of assistance with the energy needs of other USAID supported projects.
   c) that the Solar Energy Laboratory will become the agency having principal responsibility for renewable energy development in Mali.
   d) that the Laboratory management be capable, at the end of USAID's technical assistance, of carrying out its anticipated responsibilities.
   e) that there be reasonable likelihood after USAID support ceases that the Lab will be assured of sufficient funds to continue operation, whether from the revenues of the Malian government, from donor agencies, or from income produced by the Lab from consultant contracts, royalties from product development, or from other goods or services.
   f) that work of the Lab foster private sector enterprise development or at least not have inhibitory effect on same.

g) that the Lab will complement rather than duplicate or compete with the efforts of CRES, the Centre Regional d'Energie Solaire that will, according to present plans, be located at Bamako.
h) that the costs of Laboratory construction will not exceed current budgets.

4. AID's officer for renewable energy development in the Sahel asked that the cost and performance of the renewable energy products tested or developed by Mali's Lab be examined in light of their potential for use in other Sahelian countries.

B. Method of Evaluation

1. The evaluation team conducted interviews with:

   - most of USAID/Mali personnel
   - most of the personnel of the Solar Energy Laboratory
   - personnel at the Ministry of Industrial Development and Tourism
   - village leaders and other personnel involved with the socio-economic survey and product test in the San, Nioro, and Dilly regions.
   - four representatives of the Ecole Nationale des Ingenieurs, Ecole Normale Superieure, Institut d'Economie Rurale.
   - representatives of other organizations, including Machinisme Agricole, FED, Elf Solaire, Aqua Viva, ENDA, TAMS, Africare, Union Nationale des Femmes du Mali, CARE and the World Bank.

2. The team examined the performance of the Solar Energy Laboratory; its personnel, programs, equipment, and facilities were examined in detail. Field trips were made to examine installations in the San region, the Nioro region and at Dilly, Samaka and Moribabougou.
3. Technical reports, survey results, operational documents, and financial documents were examined. The operation of equipment in the field and in the Laboratory was observed.
4. The team leader assigned each section or subsection of the report to a team member. Since time was limited and some sections had not been edited when three team members left Mali, there are differences not only in style, but in the emphasis that each member of the team wanted to give to the section he or she authored. We have therefore noted the author of each section in the table of contents.
5. As noted in the preface, there was little disagreement among the members of the team, but on these three issues, there was a difference of view: 1) whether the Lab should give priority to producing income; 2) whether the new Laboratory buildings should be constructed without a brief review of the design; and 3) whether to take into account other criteria that members of the USAID/Mali Mission say will be applied in deciding the priority to be given to continuation of the project. An effort has been made to present both sides fairly and in a way that will lead to closer examination of issues that are likely to be debated in other USAID projects.

C. Project Goals and Purposes (quoted from the original Project Description)*: "The two basic purposes of this project are (a) to improve the quality of life in Mali, particularly in the rural areas, by energizing tasks that are now largely accomplished by human muscle power and; (b) to contribute to the alleviation of Malian dependence on increasingly costly fossil fuels and firewood with its negative economic and ecological consequences. A third purpose is to gain a better understanding, based on close observation of the social and economic consequences of introducing renewable energy technologies in rural Africa."

D. Project Strategy Summary (Quoted from the original Project Description): "To accomplish these goals, the project proposes a coordinated program--involving up to eight Malian agencies--of institutional support, applied research and development, village surveys, and field demonstrations in over twenty sites. In sum, the project aims to prepare Mali to introduce renewable energy technologies in rural areas on a wide scale.

"Two types of preparation are required. First of all, there must be a sustained effort to adapt proven applications to the Malian situation. The substitution of local for imported materials used in the fabrication of various devices will be as important as making design modifications that increase durability under Malian conditions. Secondly, while the hardware is being adapted, efforts must also be made to determine effective ways for village groups or family units to take over the ownership, operation and basic maintenance of the new devices. Both types of preparation will have to be successfully completed for each new technology before it will be possible to consider it for wide-scale distribution to villages, not only in Mali, but possibly elsewhere in the Sahel as well.

"The project consists of five distinct phases. An in-depth evaluation of research and development work accomplished by the Solar Energy Laboratory in Phase II will be required before the project proceeds to Phases III, IV, and V. **

"The first phase will have two parts. One will consist of material, technical and training support for the Solar Energy Laboratory, the primary recipient, and for the National School of Engineering, the Ecole Normale Supérieure, and the Central Veterinary Laboratory. The second part will involve the installation of four pumps powered by arrays of photovoltaic cells.

"These pumps will be placed in the ground at the beginning of the project for two reasons. One is to provide a demonstration effect, to show that the project has as one of its main purposes the production, from solar energy, of goods and services for use by the rural population. The second reason is to gain experience from the use of photovoltaic pumps under harsh climatic and physical conditions. The lessons learned in the realms of equipment durability, technical performance and social use would be applied in the more carefully prepared tests that follow in a later phase of the project. Since each proposed demonstration would take place under the aegis of an existing institutional program, risks regarding

* In the Paragraph cited here and in II. D. 1.
** Phase V was not funded in the REPPP, but was to be authorized separately.

supervision and maintenance would be minimized.

"In order to capture the informational lessons of these "early starts", technical and socio-economic data will be gathered at each site. This information will be of value in structuring the broader survey effort that is contemplated in Phase II. Three short-term specialists--an energy scientist, a social scientist, and an economist--will develop a scope of work and methodology, in consultation with the Malian agencies concerned for gathering "early start" data and making it available.

"The four early starts would have different uses. Two would be installed in the zone of the Mali Livestock II project, one at Kamodibo, near Dilly, and the other in the village of Demba Diawara, 15 km away, to provide water for villagers and their animals. A third pump would irrigate a portion of the fields of a market gardening cooperative in Mopti. The fourth would be installed at Samako, a village for the rehabilitation of lepers, 15 km from Bamako. It would be easily accessible to Lab personnel, School of engineering and École Normale Supérieure students and others for training and demonstration purposes.

"Support for the Solar Energy Laboratory in the first phase will consist of several elements. Most important is the establishment of a program of applied research aimed at perfecting the adaptation of certain energy technologies for use in Mali. The Lab would be assisted in the élaboration of its program by the assignment of an American renewable energy scientist for the first two years of the project. To allow the Lab to disengage from its partial, uncertain dependence on military space, the project would provide for the financing of new facilities, including offices and a workshop, at a site provided by the Malian government. It will also contribute equipment for the new facilities, particularly items needed for the conduct of the research program. U.S. training of selected members of the Lab's staff is also contemplated. Furthermore, during the early years of the program, financing for a portion of the Lab's expanded operating costs will be required.

"A tentative list of priorities for the Lab's research and development program, developed collaboratively between the PP team and the Lab's staff, includes (a) testing and improvement of solar water heaters for urban uses and rural institutions (dispensaries, schools, etc.), (b) testing and improvements on crop/fish dryers, (c) development of an efficient, wood-burning stove using readily available materials, and (d) development of an efficient photovoltaic battery charger, emphasizing reliability and ease of operation. Other priorities would be added to the list in the course of Phase II (village surveys) and as the Lab increases its capacity to take them on.

"The second phase, eighteen months in duration (including a preparatory period), would begin six months after the start of Phase I. It would involve coordinated activity directed by the Institut d'Economie Rurale with the participation of several other government agencies* (which have already established a project committee for this purpose) and the Peace Corps. During Phase II, meteorological and socio-economic studies would be undertaken at 25 villages determined (by the project committee) to have potential for experimentation with devices using alternative energy sources. Initiation of the studies would be preceded by a training program for enumerators (2 to each village) and for four mid-level supervisory teams, each of which would cover a geographic zone and periodically visit the village sites in its zone. These teams would consist of a Malian contrôleur and a Peace Corps Volunteer, both appropriately trained in survey techniques.

"In addition to the collection of data, a crucial aspect of Phase II would be the selection of village cadre who would later assume responsibility for the operation and maintenance of the device or devices to be installed. Selection of the cadre would be a function of village preferences, inter-action with the supervisory survey teams, and the characteristics of the devices to be introduced.

"The major output from Phase II would be village level reports indicating (a) socio-economic base-line data, (b) local availability of energy sources (wind, insolation, biomass, etc.), (c) village preferences as to tasks to be energized, and (d) potential village capacity to operate and maintain energy devices. At the end of Phase II, 20 of the most promising of the 25 villages surveyed would be selected by the project committee for the introduction of energy devices in Phase III.

"Prior to the initiation of the third phase, a rigorous review and evaluation of the research and development work of the lab would be conducted by a team of three energy scientists. The review would focus on whether the measuring, testing and modification work performed by the Lab was good enough to assure confidence that its renewable energy devices could be tested in the field.

"If the review were predominantly negative or mixed, Phase III would be delayed and Phases I and II extended while appropriate modifications were made and completed. The point is that village testing would not occur until the devices were considered to be ready for field application.

"In Phase III, which would last 2 ½ years, several different devices and applications would be tested in the villages selected. Villages would contribute part of the cost, with the remainder subsidized by the project. Performance would be watched with some care, and the social and economic changes that result from the introduction of the new technology would be observed and recorded. One of the Solar Energy Laboratory engineers would direct the project in this testing phase. The Lab itself would continue to make adjustments to the devices being tested as experience is gained during Phase III.

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*In addition to the Institute, participating agencies would include rural development "Operations", the Meteorological service, the functional literacy agency (DNAFLA), the Community development service (Animation Rurale) and the Cattle and Meat Board (OMBEVI).

"Operation and basic maintenance of the devices would be carried out by the village cadre. They would receive technical support from the Solar Energy Laboratory. Meanwhile, the data-gathering network would continue to function, with one enumerator observing and recording socio-economic data at each village site. The supervisory teams would continue to make periodic visits. This work would be reinforced by the continued guidance and consultant services being provided by IER, a consulting U.S. energy specialist, and the consulting social scientist.

"The fourth phase of about six months would be devoted to a detailed analysis and evaluation of the experiments. Base data collected during Phase II before the devices were introduced would be compared with data collected after more than two years of use of the new technology. The evaluation would attempt to determine whether the project had provided answers to the questions posed in the Project Identification Document:

1. Which technologies are most succeptible to local operation and maintenance and, in each case, how should local control be organized?

2. What will be the impact of the new technology on income levels, income distribution and social welfare in the community? Who benefits the most? the least? not at all?

3. Which devices perform and endure well in their physical setting?

4. How do the costs per unit of output compare with alternative sources of energy that could be used in the same setting?

5. Are the technologies culturally and socially acceptable to those who use them, or do they require changes in habits that are considered unacceptable?

"The evaluation would take place under the joint direction of the IER Evaluation Unit and the Solar Energy Lab's project director and would utilize consultants, supervisory personnel, DNAFLA, and such others as may be able to contribute in the light of the situation at the time. A six-month effort to compare the village sites before and after the tests, with full exploration of the performance of the devices, the villagers' adaptation to them, and the socio-economic changes induced, would be required. An evaluation report would be printed and distributed.

"As the results of the evaluation began to emerge, a fifth phase would be considered. Phase V would consist of transitional support to the Solar Energy Laboratory. The project would seek to collaborate with other donors in promoting proven devices for private sector production and distribution in both urban and rural areas. It would be desirable to set up licensing arrangements so that the Lab would receive royalties from the sale of these products and thereby finance further research and development activities. Phase V would be developed in greater detail during the later years of the project, and funding for its implementation would be added through a PP amendment during the fifth year."

1. The Socio-Economic Survey Strategy

The Mali Renewable Energy Project was designed to affect rural populations throughout the country. The project design included a socio-economic survey that was to gather information on the energy needs of rural populations and on current energy use. The survey was also intended to serve as a base line to assess, in the second phase of the project, the effects of renewable energy devices on the allocation of household labor, on household production and income, and on the social structure of the community.

The survey was meant to be designed and executed principally by Malian institutions. The interagency project committee comprising representatives from the Solar Energy Laboratory, National Meteorology, National Directorates of Functional Literacy and Applied Linguistics, Genie Rural, Energie du Mali, Training and Rural Action, Water and Forests, the Malian Board for Livestock and Meat, the Institute of Rural Economy, and USAID, chaired by the Director General of Hydrology and Energy, drew up the original list of survey areas (shown in Table I). Villages within the designated administrative districts were to be chosen on the basis of their suitability for adoption of devices under development at the Laboratory. The survey was to be designed by a staff member of the Evaluation Unit of the Institut d'Economie Rurale (IER), with the help of an engineer from the Solar Energy Laboratory and of a U.S. social scientist.

Malians with at least 9 years of formal education were to serve as village-level enquêteurs or enumerators, two to a village. Four contrôleur teams, each comprising a Peace Corps Volunteer (PCV) and a Malian who had completed the baccalauriat were to supervise the enquêteurs in each zone. The IER was to have responsibility for recruiting enquêteurs and contrôleurs and, assisted by the U.S. social scientist, in training them. The IER staff member in charge of the survey, and possibly some of the PCV contrôleurs, were to get short-term U.S. training in survey research techniques.

The content of the survey to be conducted in each site would depend on the device contemplated for that site and the survey was meant also to identify suitable local-level institutions and individuals to manage and maintain devices to be installed at the field sites during Phase III. The baseline data from the survey was to permit a comprehensive evaluation of the social and economic impacts of the device on the local population during Phase IV.

2. Laboratory/Prototypes

During Phase II the Laboratory was to develop prototypes of renewable energy devices such as improved stoves, windmills, food dryers, water pumps, and other devices. After the results of the survey were known, this development was to be directed to the specific devices indicated by the survey and these were to be installed in villages during Phase III. In reality, the Solar Energy Laboratory has already installed stoves, photovoltaic lights, and a photovoltaic refrigerator during Phase II.

Table I:

Survey Zones Designated in the Renewable Energy Project Plan

	Numbers of Communities in each Circle
Zone I - Nioro	
Cercle de Nioro	- 2
Cercle de Yélimane	- 2
OMBEVI pastoral zone	- 1
OMBEVI villages	- 1
Zone II - Bamako	
Cercle de Bamako	- 1
Cercle de Kolokani	- 1
Cercle de Kita	- 2
Cercle de Bougouni	- 1
Cercle de Yanfolila	- 1
Zone III - San	
M'Pessoba	- 1
Yankasso	- 1
Dogon area	- 2
Mopti Livestock Operation	- 1
Kona and Sendégué	- 2
Zone IV - Gao	
Menaka	- 1
Rharous II	- 1
Diebock	- 1
Cercle de Bourem	- 1
Cercle de Tombouctou	- 1

E. Intended Beneficiaries

The first direct beneficiaries of the project were to be the residents of the rural communities where the early-start solar pumps were to be installed: Peulh and Maure herders at Demba Diawara and Dilly, Bambara truck gardeners at Mopti, and the ex-lepers in residence near the training center at Samanko. The other direct beneficiaries of Phase I would be the Lab engineers who would receive U.S. training, who would gain greater work-space and equipment and who would learn from participation in a well-planned and focussed research and development program.

The direct beneficiaries during Phase II of the project would be the school-leavers and baccalaureates employed on the socio-economic survey. The major benefits for villagers would occur in Phase III, when most of the 25 communities studied in the survey would receive test devices: improved fish and crop driers, grinders, wood burning stoves, photovoltaic battery chargers, or wind or PV pumps, and rural institutions receive solar hot-water heaters and photovoltaic lighting and refrigeration devices. The major beneficiaries over the long-term, as renewable energy devices would gain acceptance, would be those who hew and gather wood, draw and haul water, and grind grain, principally women. The project paper anticipated that devices that reduce the time and human effort required in preparing grain, gathering fuel, and drawing water would allow women more time for child care and for increased agricultural and artisanal production, particularly if women themselves have control over the reallocation of their released time. The users of the rural institutions receiving solar powered devices would be expected to benefit from increased availability of vaccines, improved utility service, and lower institutional operating costs resulting from the devices' reliability and low recurrent costs.

F. Inputs and Outputs

The major inputs were to be funds for the design and construction of a new Laboratory, the provisions of Laboratory equipment and supplies, the provision of technical assistance for the Lab and the training of personnel for the Lab and for the survey teams. The major outputs were to be demonstration of the practicality of reduction in use of fossil fuels, in hard currency purchases, and in arduous human labor. These were to result from the introduction of renewable energy products that would be tested or developed by the Solar Energy Lab which, in the process, would increase its competence in renewable energy research and product development.

IV. RESULTS OF EVALUATION: ASSESSMENT OF PROJECT PERFORMANCE

A. Technical Performance of the Solar Energy Laboratory: Summary

Though little was accomplished in the first two years of the project, during the last one and a half years, commencing in the last quarter of 1980, the laboratory has shown surprising vitality and significant accomplishments in several technical areas. The shop and warehouse have been re-organized and up-graded, a library established, weather and insolation measurement systems put into operation, personnel trained, administration and management improved, and a sense of mission adopted. Although the design of individuals' research projects and their reports leave much to be desired, technical performance in use of equipment, data collection and analysis and prototype construction has shown remarkable improvement.

1. Early Start Photovoltaic Pumps

The Project had intended to demonstrate that it could quickly produce visible results. It would do this by installing four Guinard photvoltaic pumps which were the only off-the-shelf photovoltaic pumps available in 1978-79. Three were ordered and received in Bamako in January 1981. The fourth, for Samanko, is reported to have arrived about six months later.

The Mopti pump was installed as a demonstration at a temporary site in mid-1980. It is the only one of the four that came close to "early demonstration;" and its performance was unsatisfactory. After considerable delay required for conversion from horizontal to vertical axis equipment (the new well is 8 m. deep in the dry season, beyond the depth of the horizontal axis equipment) and for construction of a 160 cubic meter reservoir, the installation is now complete and the pump has been operating since March 11, 1982.

Contract negotiations for installation of the pump at Demba Diawara began in September 1980, though AID decided to become the disbursing agent in order to insure payment to the contractor and the contract was not let to Metal-Kouyaté, a a Malian Construction firm, until March 1981. The pump was installed in September 1981 but the storage reservoir, completed in March 1982, was found to leak and the contractor has advised that he will repair it his next trip to the site. Whether the delay of over a year between receipt of the pump and the letting of the contract for installation is the fault of AID or the Lab has not been thoroughly explained. The subsequent delays appear to be the Contractor's responsibility.

The contracting for installation of the pump at Camp Modibo was also let with Metal-Kouyaté but when they attempted to install the pump in September 1981 they found that the well diameter was less than that of the pump. They contacted Service Hydraulique who drilled a new well of the correct diameter

(but too shallow so it may run dry) and broke the solar panel supports while drilling. Metal-Kouyaté must now repair the pedestals before pump operation can begin.

The well at Samanko was drilled in September 1980 and site preparation was completed by the Laboratory in February 1981 when the pump was installed. It operated for two months until the well ran dry and ruined the shaft bearings, which are water lubricated. An argument over whether Guinard or AID should pay for the new bearings has been resolved (AID paid). The replacement parts cleared customs on May 3, 1982 but the Samanko well seems likely to run dry again and, if Guinard will not allow an automatic shutoff device to be attached to their pump on pain of voiding the warranty as Lab personnel believe, the pump may be moved since it appears that there is not enough water in the Samanko aquifer.

Although there have been delays associated with installation and start-up, the really significant delay occurred between the satisfaction of the conditions precedent in December 1978 and the letting of the installation contracts in March 1981, a period of over two years. The Guinard pumps are off-the-shelf items that were to be air-freighted to Bamako. If the order had been placed promptly and the contract for installation let promptly, installation could have started one and a half years earlier and the pumps might have accomplished their objective of "early demonstration". Whether USAID/Mali or Lab personnel were responsible seems of less concern than an apparent lack of communication between them and lack, as well, of any evidence that the parties to the agreement recognized that the objective of an early start demonstration was no longer possible and considered whether to cut their losses and, by amendment to the project agreement, reallocate funds and equipment to more useful purposes.

2. Technical Assistance and Training

a. From 1980 to 1982, nine expatriates were hired to assist the Solar Energy Laboratory. Their periods of service have varied from 8 days to 2 years and their functions have ranged from presenting and teaching a single technology to performance of an almost complete range of activities necessary for laboratory functioning. The laboratory considers some of the technical assistance to be of marginal value, but the major part of it to be of great value to the Laboratory and to the project.

Eric Brunet was hired by SERI in 1980 in anticipation of a long-term technical assistance assignment. Though he remained only three months, he prepared a list of equipment that has been and is being purchased. His limited effectiveness was due in part to lack of equipment and material with which to work and to poor support from SERI that included failure to provide his pay and per diem.

J.D. Walton, of Georgia Institute of Technology, stayed for 12 days. He assisted with solar motors (non-photovoltaic) and built two models of the Georgia Tech spiral solar concentrator. The Laboratory Director considers him to be of very high caliber but his stay was too short and his subject matter does not appear to be important for the Laboratory's future work.

Amir Mikhail and Jack Park, provided by SERI, spent eight days in Mali in order to plan wind power activities. Their contribution was not important, at least partly because of their short stay.

Alex Roqueta, from VITA, came to the Laboratory for three months from March to May, 1981 to develop the machine shop and warehouse. During his stay the shop building was completed and all machine tools on hand were installed and, when necessary, cleaned up and put in working condition. The warehouse was reorganized and an inventory system set up. He also furnished basic training on the sheet metal fabrication machines. The Laboratory Director considers him to have been the most valuable of any of the short-term assistants particularly with respect to training and inciting improved performance by laboratory personnel.

Alan Wyatt spent three months during June - August, 1981 working mainly on wind energy, solar hot water heaters and solar radiation measurements. He was contracted for from VITA for SERI. He worked hard and produced a good amount of work which he described in an extensive report submitted to the project. The Laboratory, however, considers that he was somewhat less effective in training Laboratory personnel.

Andre Longmire, sponsored by SERI for five months between January and May 1982, came to work on wood stoves. He was very systematic and productive, particularly in acquiring data from the field and installing woodstoves in the San region.

Michael Weitzenhoff came for 35 days in March - April, 1982 to build a Chinese-type biogas unit. He was exceptionally well organized and productive. The digester was built and put into operation in 30 days. He taught a course on bioconversion for one hour each day and he was very effective in motivating people. He accomplished all he came to do. His stay is considered to be very valuable.

Bill Wright from ITDG, furnished by SERI, spent 4 months, from February to May, 1982, designing and building an improved windmill which can be locally manufactured. His work was considered adequate but slow and his ability to transmit skills and knowledge to Laboratory personnel quite poor.

Richard Campbell, provided by SERI, is now doing his second stint as a technical assistant in the electronics and measurements area. He is making solid and valuable contributions particularly in the radiation measurement area where the Data Point systems have given a great deal of trouble and in calibrating the pyranometers and pyroheliometers.

Terence Hart, who was hired by SERI in the capacity of long-term technical assistant for the two year period from October 1980 through July 1982, has provided exceptionally strong guidance and assistance in formulating and accomplishing the technical program of the Laboratory. During his tenure most of the technical programs have moved to a state of promising activity and accomplishment, and he has made and is continuing to make major contributions to the financial and general management of the laboratory. He has assisted with coordination with the other organizations that are party to the project agreement and with other organizations, such as Machinisme Agricole, which do related work. A large part of the Laboratory's effectiveness in the conduct of the Survey is due to his initiative. He forms the major link to USAID. He motivates Laboratory personnel to better performance. Lastly, and most importantly, according to the Laboratory's Directory, he and the Laboratory direct work as a closely knit unit.

b. SERI (Solar Energy Research Institute, Golden, Colorado) was granted the contract to provide technical services to the project. Their initial performance was poor. They did not provide timely assistance or financial reports and they did not adequately support Eric Brunet in the field. They produced an R&D plan for the Laboratory that was little more than a collection of material selected from current publications and submitted it after the Laboratory had begun activities that were largely guided by the project documents.

However, in late 1980 SERI's performance improved and has been satisfactory since. SERI has provided a generally excellent group of short-term, and one long-term, technical assistants. It has arranged and facilitated the U.S. training of Laboratory personnel and it has provided assistance in other matters.

c. Training of Lab Personnel in the United States has included the following:

Modibo Dicko and Mahamane Bilal Touré attended Colorado State University and visited local solar energy sites for four months in late 1980. Dicko concentrated on thermal applications and Touré on wind and photovoltaics. They considered the training to be valuable but too short to absorb instruction in a broad range of technical subjects.

David Sokando, who attended a three week session in library science at VITA in October 1981, is in charge of the Lab's library. He considers his training valuable and that he made useful contacts with U.S. agencies (NTIS, the Library of Congress, the African Bibliographic Center, etc.).

N'To Diarra spent three months at Eric Faber's Solar Energy Center at Florida State University where training was oriented toward thermal and power applications of solar energy.

d. The laboratory technical assistance and training program of the project appears to have been good to excellent.

3. Insolation and Weather Measurements

The Laboratory has installed commercial Data Point 21 Systems at Bamako, Nioro, Gao, San and Bougouni. They measure total insolation, wind speed and direction, precipitation, dry bulb temperature, and humidity. Design and construction have been criticized. Batteries could not withstand temperatures above 40° C; malfunctions were frequent; and poor accuracy has been reported to necessitate large correction factors, although our inspection of equipment at the San Station showed that all channels were operating and that the operator was properly and efficiently recording the data. Nonetheless, the Laboratury reports that equipment is of limited use and is seeking remedy from the manufacturer.

More precise and reliable insolation measurements have been installed at the Laboratory. These consist of two Eppley pyranometers, one with a shadow band for measurement of diffuse insolation and the other for measurement of total insolation, and an Eppley pyroheliometer for measurement of direct insolation. These drive a Leeds and Northrop multipoint recorder to give continuous daily records of these three quantities. Records have been kept since the early months of 1982. Comparison to the Laboratory's new precision Eppley pyroheliometer (essentially a laboratory standard) yields correction factors for each instrument. Unfortunately, frequent city power failures mar the recordings so that, ultimately, a local (battery) power supply must be obtained. When this is done the Laboratory will be in a position, as planned, to put out good quality, reliable monthly reports on direct, diffuse, and total insolation.

4. Product Test and Development Summary

The quality of work by the low temperature group is mixed. Accomplishments are not yet great, but promising starts have been made on solar dryers, water heaters and distillers. Contributions to Phase III appear limited by the high cost/productivity ratio of these devices--though the hot water heater could be cost effective for urban use if problems of installation can be solved. Work in the low temperature group is unlikely to make substantial contributions to Phase III except for the work on dryers where some possibilities exist.

The Solar cookers have problems of user acceptance. Work on thermodynamic engines is, and will be for at least the duration of this project, beyond the capacities of the Solar Energy Laboratory. Neither of these projects is likely to contribute to Phase III.

The photovoltaic group has not received as much technical assistance as some of the other groups, though photovoltaics has promise for being one of the most important solar energy technologies for Mali. The quality of the Laboratory work is hard to judge at this time, but it appears to be good enough to satisfy Phase III requirements and, most of the Lab's capability building in this very important area still lies ahead.

The quality of work and the competence of the Laboratory in the biogas and wood stove areas are good, and the Laboratory appears capable of satisfying the requirements of Phase III.

a. Low Temperature Group

The low temperature group is developing solar dryers, solar water heaters and solar distillers and has tested a commercial zeolite refrigerator.

(1) Solar Dryers - Work on about five different types of dryers is proceeding. Good work has been done on drying mangoes, for example, in the Taos type dryer. Quantitative data are being obtained (see below). Attention is being given to the costs of the dryer and to its productivity. A number of other dried products of good quality have also been prepared. The work is adequate in some cases but is very amateurish in other cases. As an example, the down-draft dryer (séchoir combiné) was designed with extensive calculations, and built at considerable expense in order to find out that there was essentially no air circulation. An experienced engineer should have been able to make that determination before construction by examining a sketch of the dryer.

A large dryer is being built for fish drying in Mopti. Attention is being paid to productivity versus cost. It may be that thorough cost-productivity work on large dryers is one of the more important things that the Lab can do in this area.

(2) Hot Water Heaters - The residential hot water heater of the type built extensively during the past decade by the Laboratory is being studied, its performance determined, and modifications to improve performance and life are being considered. These are all positive developments, long over-due, and considering the potential importance of solar hot water heaters, may have a good pay-off. The engineering work is good but hampered by low quality shop work. Attention is being paid to costs--a positive development which needs to be carried much further.

(3) Solar Distillers - Attempts are being made to increase production of distilled water by increasing the area of radiation absorption by putting charcoal in the water. Measurements of productivity have been made--an improvement over past work. However, we saw no cost figures and heard of no good application areas except for production of battery water. This appears to be an area of work that can be discontinued unless the survey shows a need for it.

(4) Zeolite Refrigerators - Three commercial solar powered zeolite refrigerators were tested and found to lack the capacity to refrigerate. The causes are suspected but not known. Disassembling and modifying one of the units would be a good learning experience.

b. High Temperature Group

The high temperature group is working on solar cookers and has made a review of the literature on solar thermodynamic engines.

(1) Solar Cookers - Three types of reflecting, concentrating cookers have been built and tested. The testing procedure and analysis of results is a good start toward quantification of cooker performance. However, the report on the work is unclear and difficult to unravel. The VITA and Georgia Tech cookers came out very poorly compared to the standard parabolic reflector type. Apparently, no attempts were made to solve the real problem of solar cookers (i.e., making them acceptable to the user).

(2) Solar Thermodynamic Engines - After a brief review of the literature in this field, it was decided not to undertake Laboratory work at this time.

c. Photovoltaic Group

(1) Lighting - Tests of commercial lighting systems have been carried out, and one system consisting of solar panels, controls, batteries, and two flourescent light tubes has been installed in Somo, a village near San. The lighting system in Somo is installed in a school so that evening classes can be held. It works well but there were hints from the villagers that it is not utilized to its full potential. The Laboratory tests appear to be reasonably well done, but the analysis, use, and reporting of results could be improved considerably.

(2) Refrigeration - Work on photovoltaic refrigeration was carried out in the same way as in the lighting program. A commercial unit (ARCO) was Laboratory tested and an identical unit installed in a partially completed dispensary in Torosso near San. Though it apparently works well and the nurses at the dispensary are keeping records of its operation, there is no schedule for completion of the dispensary, and, since the refrigerator is not in manual use--with frequent opening and closing of the door--the test results will be of little value. Data collecting of the Lab appears well done but, again, analysis and reporting of results need improvement.

(3) Battery Charger - A photovoltaic battery charger is being developed. This will be the first actual photovoltaic design and development carried out at the Laboratory. There are no results yet reported.

(4) Pumping - The Laboratory has participated in the installation of the four early start photovoltaic pumps. It has been the principal installer of the Samanko pump. This work is described in section IV. A.1. "Early Start Photovoltaic Pumps". The photovoltaic group has also installed a pump test stand using an SEI-250 watt photovoltaic pump. It has been determined that the pump is not operating up to its rated capacity, but nothing has been done about it. It would be, as with the zeolite refrigerator, a good learning experience to analyze, modify, and improve the pump. Apparently, there still remain traces of the lack of initiative so characteristic of the Laboratory of the pre-project days.

(5) Solar Radiation Measurements - This is discussed in section IV. A.3.

d. Product Test and Development - Wind Driven Apparatus

Review of Lab Records: The apparatus tested to date includes a Savonious rotor, constructed with help from students at the Ecole Nationale des Ingénieurs, and two Sahores wind driven units. The Sahores is designed to be built and serviced by villagers. It is designed for low wind speeds, low water delivery; for human needs, cattle, and small gardens. It is built of wood, hammered out corrugated roofing, inner tube parts, bamboo, and a minimum of machined fasteners. It has an ingenious, fast acting, blade feathering system to protect it from high winds.

One Sahores was tested by Alan Wyatt, a short-term consultant from VITA, who directed well-documented tests of performance (volume of water delivered at measured heads) at various wind speeds. A second Sahores unit, currently being tested by the Lab engineers provides data from which brake power at the rotor shaft can be calculated and, assuming some similarity between the two Sahores units, an estimate could be made of the losses in the apparatus power train and in the pump. The tests currently being conducted include:

(1) A modified Sahores unit. It has a three meter diameter rotor with 16 metal blades mounted on bamboo spars. The rotor drives a crank shaft supported by hardwood bearings or, in an alternative design, by purchased ball bearings. A connecting rod drives the shaft of a pump having a wood and leather piston in a P.V.C. cylinder.

(2) A larger Lab-constructed unit designed by consultant William Wright, is reminiscent of the Chicago Aeromator design but has a cam driven pump rod lifter to reduce speed and load on the delivery cycle; then a fast return. It is designed for Bamako level technology, that is, it is to be constructed from parts and materials available in Bamako, using locally available skills and locally available shop facilities. It has a six blade rotor, five meters in diameter, that will be mounted on an eight meter octahedron tower of locally available galvanized steel tubing. A piston pump using a polyvinyl chloride cylinder is designed to deliver 10 cubic meters per hour at 5 meters static head in a wind of 6 meters per second.

Costs and Performance Characteristics of Wind Apparatus

Cost estimates of the Wright designed apparatus were not available to the evaluation team but Gerhart Behrens, a Peace Corps Volunteer, recently completed a detailed analysis of the costs of labor and material for the Sahores device. His figure of about $450 for rotor, transmission, tower, and pump--but without storage tank or hand tools for maintenance--is consistent with the costs reported by the Catholic Mission in Segou. Over 20 of their units have been built at the Mission by villagers who were selected by their communities to come to the Mission for training, then to return to their village to install and maintain the apparatus.

As of May 1982, performance tests had not been completed on the Sahores unit nor had they begun on the Wright machine. An apparent advantage of the Sahores is that, because of a simple pump stroke adjustment, it is designed to deliver marginally useful quantities of water from shallow wells in southern Mali even at seasonally low wind speeds. Further, though its flimsy design leads to frequent breakdown, repairs can be made by villagers at low cost and in a matter of hours. The Wright design is sturdier and, though also intended for low wind speed locations, there are as yet no data to confirm its design specifications nor to confirm that useful quantities of water can be delivered at wind speeds less than 6 meters per second. Arrangements for production, for service, and for stocking of spare parts are anticipated after completion of successful tests of the Wright machine. (See Section IV.A.5.d. for comments on the sales potential for wind powered water pumping apparatus.)

e. Bioconversion Group

The bioconversion group is working on biogas production using both Indian and Chinese style fermentation units, and on improved woodstoves.

(1) Chinese biodigester - This digester was constructed in the spring of 1982 during the visit of technical assistant Weitzenhoff. It was constructed in about 30 days and put into operation immediately. It seems to be operating properly although good measurements of its output are not possible at the moment because the necessary measurement equipment has not yet arrived.

(2) Indian biodigester - This unit was built almost two years ago. It now operates properly although, as with the Chinese digester, good measurements of output cannot be made because of lack of equipment.

The gas from both digesters is being analyzed at the Ecole Nationale des Ingénieurs. Tests are underway on cooking and lighting applications. They also plan to run an internal combustion engine on the gas. No equipment exists nor were plans proposed for removing CO_2 and H_2S from the gas. The effluent is used to fertilize a vegetable garden.

The project is quite successful. The engineers appear to be well versed in construction, operation and analysis of the digestors. The reports, as usual, need improvement. The economics have been done but not correctly, and there are large differences between the economic input parameters for the two types of digesters.

f. Improved Wood Stoves

The Bioconversion group has constructed and tested a variety of wood stoves, and has gathered a considerable amount of quantitative data on temperatures during use and on thermal efficiencies. The efficiency measurements differ somewhat from measurements elsewhere. In particular, the calculations do not distinguish between the cooking period where the pot is increasing in temperature and the period where the pot is at constant temperature. Table IV.A.4.f.i. summarizes the efficiency results for two series of tests on fixed stove models and for several sorts of portable stoves, and compares each group to the thermal efficiency of three-stone hearths. It is clear that under Laboratory conditions it is possible to get significant increases in thermal efficiency.

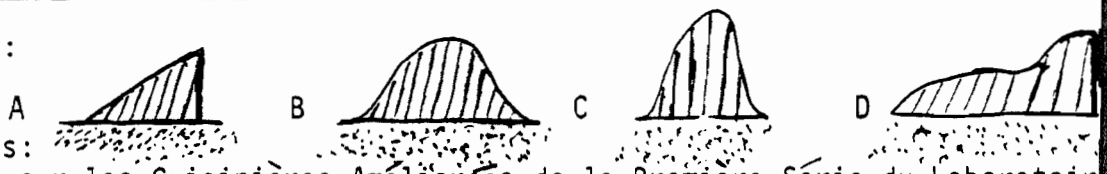
Lorena Hybred I and II stoves were installed in consenting survey households in the San zone during January and February of 1982. It was the Laboratory's first effort to field-test devices in a non-institutional rural setting, and, like most first tries, it encountered a great many problems. An unannounced inspection by SEL staff during 4 to 8 March 1982 showed that only about 39 per cent of stoves were in regular use (Hart 1982 ms. - breakdown by village is shown on table IV.A.4.f.ii).

Table IV.A.4.f.i

Thermal Efficiency of Stoves Tested in SEL in 1981 and 1982

	Stove Type	Monticule type (1)	Thermal efficiency (2)
A. Series I Stoves (efficiency calculations do not separate charcoal from wood as source of heat)	3 stones	-	10.2
	Lorena Hybred I	-	17.0
		B	12.0
		- (high chimney entrance)	15.0
		D	18.0
	Lorena Hybred II	A (2)	17.0
		D	20.0
		D (with higher chimney)	17.0
	Baked earth	C	17.0
		D	16.0
	Lorena Hybred II	D	17.0
		D (with lower chimney)	16.0
B: Series II Stoves-(efficiency calculations separate charcoal from wood)	Parallel type (LTP - 2)	-	15.1
	Guebre	-	16.8
	Lorena Hybred I	-	18.6
	Lorena Hybred II	-	21.7
C. Portable Stoves (charcoal not separated from wood)	3 stones		9.6
	1-Pot metallic stove		9.0
	2-Pot metallic stove		12.0
	Baked earth		12.6
	Improved baked earth		13.7

(1) Notes: Monticules:



(2) Average of 4 trials:
Sources: "Rapport sur les Cuisinières Améliorées de la Première Série du Laboratoir l'Energie Solaire" Hantafaye et al. 1981.
"Tests Comparatifs des Foyers Améliorés, 2ème Série", Hantafaye et al. 1982.
"Essais de Foyers Améliorés Portatifs",Hantafaye et al. 1981.

There were several sorts of problems that surfaced in the first inspection. The quality of the construction varied widely from builder to builder; the most common problem was in stoves with a rectangular mouth where the dalle, or stovetop, did not extend sufficiently over the bricks used to form the sides of the firebox. In many of these stoves, the dalle cracked or collapsed. Another problem was that the dimensions of the stoves were variable (and thus it was likely that thermal efficiency would also vary). Construction materials were also a problem in some villages: for example, the sand in some locations was too fine to make a durable banco. Another problem was that the Lorena Hybred models had been tested in Bamako, where many meals consisted of a relatively heavy meat sauce and to (millet or sorghum pâté). Since the smaller sauce pot needed considerable heat, the stove was designed with the small hole at the front of the stove. In San, where fish sauces needing less cooking are common, many stove users perferred to put the sauce pot at the back of the stove rather than at the front.

The placement of the stoves also caused difficulties. The Laboratory staff insisted that stoves be built inside a kitchen building wherever possible, because the hangers outside the buildings (where most dry-season cooking is done) do not provide complete protection from rain. However, many of the kitchen buildings were dark and hot, and in some cases the stoves were constructed with chimney outlets that faced the prevailing winds, and so the stoves smoked badly. Chimney caps made from tin cans helped in some instances, but not in all.

In spite of these difficulties, a preliminary examination of wood consumption in Kampogosso before and after the introduction of the stoves showed that total cooking time decreased by about 30 per cent, wood burnt per hour total cooking time increased by about 12 per cent, and total wood consumption for cooking decreased by about 20 per cent. (Hart ms. 1982). The wood consumed per person per meal decreased from about 1.27 kg. to about 1.0 kg. Wood consumption per person per meal in Laboratory conditions, however, was about 0.28 kg. Clearly, there was room for improvement.

When the evaluation team visited the survey zone in San, our arrival had been announced, although the exact times of our visits to each village were not known in advance. We took note of the proportion of stoves that were in use or were still perceptibly warm from use (as opposed to being warm from standing in the sun) at the time we visited the household. Table

III shows that we saw a considerably greater proportion of stoves in use than Hart had 6 weeks earlier. In some cases, this was probably because the enquêteurs knew we were coming and exhorted people to use the stoves. In many cases, however, the enquêteurs had been working with the survey households to repair the stoves, and, in some cases, to completely rebuild them to the users' specifications (e.g. with the larger pot-hole in front). Some enquêteurs had also constructed stoves for other families in the village who wanted them.

The most common kind of repair was crêpissage, or re-plastering: some stoves had been replastered four times or more since construction. This sometimes caused a problem, because each layer somewhat decreased the size of the pot-holes, so the pots sat higher in the stove and got less heat. Some enquêteurs were experimenting with new tempering materials for the banco - for example, termite nests.

A very vigorous stirring, necessary to make the to lump-free, put a heavy strain on the stove top, and users noted that bits of the banco were always falling out of the top, and that there were frequent cracks. Some users suggested either constructing the stoves completely of cement or using cement to strenghthen the plaster applied to the outside of the stove. One of the evaluation team members noted that metal stove-tops were very well accepted in Upper Volta, and that the Lab should consider a series of comparative Lab and field tests.

Another problem people noted was that the pot holes were sometimes too close to the chimney to allow the user to use a large diameter steamer for cous-cous. The stoves had to be custom-built for a given set of pots, and whenever the size of the group being cooked for changed, the cooks had to either use a three-stone hearth for a pot size that had not been allowed for in the stove, or else risk breaking the stove-top. This kind of difficulty was common where young men migrated for work during the dry season, or where parts of families spent part of the year in fishing camps, and later rejoined the rest of the family.

Enqueteurs had not always persuaded people to cover all pot holes not in use and to cover the pots themselves (which increases the stoves thermal efficiency), and some users were not cleaning out the chimney often enough.

The Laboratory's original aim in constructing the stoves had been to put out as uniform sample as possible, and Laboratory staff were not entirely happy about the modifications that had been made on many of the stoves after construction. However, it was clear that they also learned a good deal from the reaction to the first set of stoves. At the time of the project evaluation, the Laboratory crew was starting to build stoves in villages in the Nioro zone. The two models being tried were a parallel stove with two chimneys (which allowed the user to block one chimney and halt cooking in one of the pot-holes) and a series stove in which the second pot-hole was raised. The stove construction crew was trying to keep a much tighter control on the quality of construction, and was reinforcing the bridges over the firebox with scrap-metal.

5. Economics of Prototypes

The following economic analyses have been based on cost and performance data provided by the Lab. When these did not exist, no economic calculations were made. Where possible, comparisons have been made with conventional devices or sources of energy. Unless noted otherwise, costs are presented in Milian francs (MF or FM). The conversion rate at the time of this evaluation varied from about 595 to 615 MF to the dollar.

a) Low Temperature Group

(1) Water Distillation: These estimates of the costs of water distillation are based on data applying to the prototype developed in the Laboratory. Although the market for distilled water seems small, there appears to be a need for use in storage batteries.

Given that:

o production capacity	20,000 l/year
o construction cost/m^2	135,000 MF
o size of prototype	25 M^2
o life expectancy	10 years
o annual interest rate	15 percent
o amortization factor	0.199

o $\frac{i}{1-(1+i)^{-N}}$ i: interest rate
N: number of years

Cost per liter 104 MF
(annual cost production capacity)

Annual Costs

Capital amortization	672,500 MF
Operation and Maintenance	1,408,000 MF
TOTAL	2,080,500 MF

Itemized Costs

Construction cost		3,375,000
Amortization per year		672,500
Operation and Maintenance		
Labor	370,000	
Maintenance	270,000	
Other	768,000	1,408,000
TOTAL		5,455,500

Table IV.A.4.f.ii

Comparison Between Stoves in San Zone Villages
4-8/3/82 and 21-23/4/82

Villages	A. 4-8/3/81					B. 21-23/4/82				
	No. obs.	In use	(%)	Not in use	(%)	No. obs.	In use	(%)	Not in use	(%
Kompogosso	10	6	60	4	40	10	8	80	2	20
Belenichini	8	2	25	6	75	9	5	56	4	44
Somo	9	2	22	7	78	9	5	56	4	44
Tiediena	9	0	0	9	100	10	4	40	6	60
Dinso	10	8	80	2	20	9	7	78	2	22
Total	46	18	39	28	61	47	29	62	18	38

The price hereby calculated is much higher than that calculated in 1973 by the Laboratory. Since it is also higher than the price per liter of distilled water sold in Mali, the solar distiller appears to have no market unless its cost can be substantially reduced.

(2) Solar Hot Water Heater - The basic assumptions under which the Lab is conducting this product development and test are:

- Electrical hot water heaters and these solar hot water heaters, installed in Bamako will cost around the same: 400,000 Malian francs.
- The maintenance cost and the life expectancy in Bamako should be about ths same under normal use for electric and solar hot water heaters.
- The savings are realized in the costs of electricity.
- The collector is absorbing an average of 3.7 kwh that could heat 100 liters per day up to 65° from 25° . If this could be translated to savings in electricity at local rates (125 MF/kwh for the first level of power consumption):

  125 MF x 3.7 - 462.50 MF
  The annual savings will amount to 138,750 MF on the basis of 300 days usage, an indication that a solar hot water heater could be very competitive in comparison to an electrical hot water heater.

The solar water heater, from the foregoing analysis, appears to have a market in urban dwellings hospitals and hotels. The Lab and the Malian Government should encourage private entrepreneurs to produce such a heater provided the problems that have so far inhibited consumer acceptance can be overcome. (See appendix E and confirming recommendations in section V.D., Focus of Renewable Energy efforts, and comments in section V.D., the summary section on Project and Technologies Direction.)

b. Economic Analysis: Bioconversion Group

(1) Improved Cookstoves - Because fuelwood is a most important energy source in Mali, the Lab is working on more efficient cookstoves. Possible savings in fuelwood are estimated to be around 25 to 30%.

In rural areas stone materials, such as banco are readily available; but a Malian family without children available to gather the banco is apt to turn to local masons for the construction of the stoves. Cost analysis will, therefore, be made only

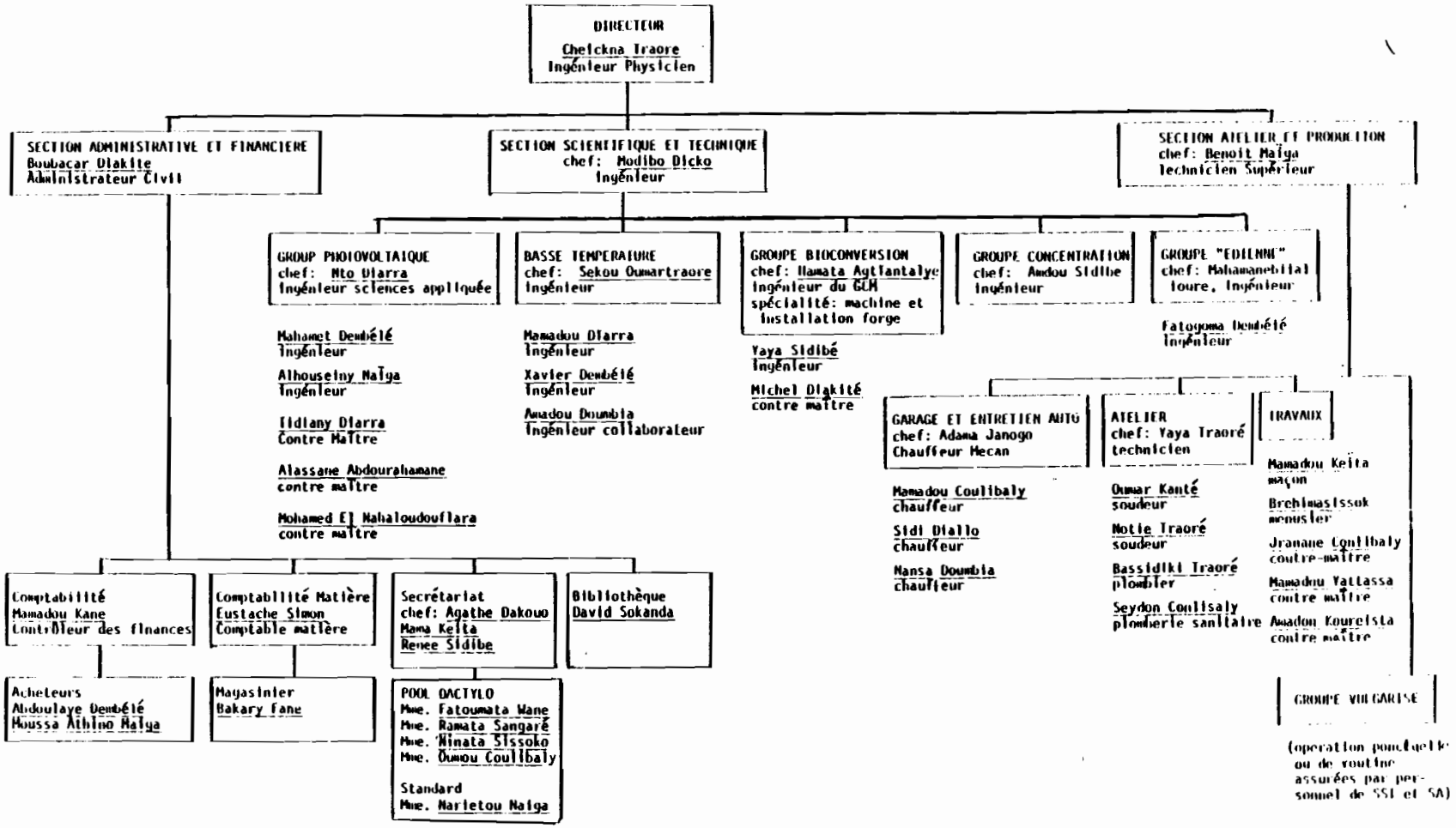


FIGURE IV. B.7. I ORGANIZATION CHART OF THE SOLAR ENERGY LABORATORY

for the suburban and urban areas where a stove might be bought and fuelwood is more frequently a purchased commodity. The construction cost of a stove is estimated to be around MF 15,000 according to the Laboratory mason.

Stove Cost

Total Construction Cost	MF 15,000
Amortization per year (15% interest)	2,500
Maintenance cost per year	4,500
Total annual cost	22,000

Fuelwood costs and savings

Family expenses for fuelwood per year	146,000
* Savings of fuelwood (at 25% reduction in consumption	36,000

Net Benefit

Savings in fuelwood	36,000
Minus cost of stove	22,000
	MF 14,000

If a family were to purchase firewood at 400MF/day and if the life expectancy of the cookstoves is only one year, and the interest rate is 15%, the savings in fuel cost per family is 164 percent of the total stove cost for one year, including amortization and maintenance costs. Thus the payback period of the stove is about eight months.

(2) Biodigestor - Two prototype biodigestors are being tested at the Lab to produce gas for cooking, lighting and prime moving of engines. A cost analysis attempt is made to determine the price of 1 kwh thermal equivalent of gas for the chinese type of biodigestor.

Cost per kwh
(annual cost - gas output) = 48.37 MF

Annual cost

Capital amortization	69,000 MF
Operation and Maintenance	316,000 MF
Total	385,000 MF

* A study of typical urban costs and consumption of fuelwood was not available but 400MF per day would appear to make cooking costs a high percentage of average per family income than is normal for most urban families.

Given that:

Gas output per year	1,206 M^3
Gas output per day	3.6 M^3
Days of output per year	335
Methane content of gas	60 percent
Gas output/yr. in kwh	1206M^3 = 7959 kwh thermal
Annual interest rate	15 percent
Amortization factor	.171 over 15 years
Cost per kwh (annual cost - gas output)	48.37 MF

Annual cost

Capital amortization	69,000 MF
Operation & Maintenance	316,000 MF
Total	385,000 MF

Itemized costs

Construction		404,000 MF
(materials	- 220,000)	
(transport	- 22,000)	
(labor	- 87,000)	
(handling & other	- 75,000)	
Operation - annual		316,000 MF
(manure	- 12,000)	
(water	- 4,000)	
(labor	- 300,000)	

The cost per kwh thermal is about 48.37 MF which is higher than the cost calculated by the Lab. The difference is explained by the poor choice of data and errors in calculation. Despite this, the cost per kwh thermal is competitive with the price per kwh of electricity in Bamako, taking into account that four units of thermal energy convert to about one unit of electrical energy. Electricity prices in Bamako decreases as consumption increases as follows:

First level of consumption	125 MF per kwh
Second level of consumption	96 MF per kwh
Third level of consumption	69 MF per kwh

The comparison of biogas with gasoline or kerosene shows roughly equal costs. 48.37 MF per kwh is about 0.0136 MF/kjoule. Considering that electricity will not soon be available in remote rural areas and that the price of gasoline in the black market is about 1000 MF per liter, biogas is very competitive in rural Malian areas. (See also comments in section V.D.)

c. Economics of Lab Prototypes: Photovoltaics Group

Because the early start pumps are not funtioning to full capacity, the economic data available are not sufficient for a cost analysis.

The Lab is also testing lighting and refrigeration powered by photovoltaics but, for these as well, there are insufficient data for cost analysis.

d. Economics of Lab Prototypes: Wind Group

The windmills being tested and developed by the Lab have not yet yielded cost and performance data that could be used as the basis of an economic analysis.

6. Research Project Design

The Lab's agenda has been determined largely by USAID's project paper written in 1978, and by the anticipated results of the socio-economic survey. Research projects are not guided by laboratory priorities that have been formally established nor by documented market analysis that could complement the socio-economic survey. Partially because of this, individual projects do not appear to have a clearly defined place in an overall research effort. They seldom have clearly defined purposes, or state why the Lab has decided to undertake the project of research or product evaluation rather than seek the information elsewhere. The review of literature tends to be fragmentary with little guidance from the conclusions and recommendation of previous research and product development. The research project hypotheses are seldom well drawn and, hence, the conclusions are seldom stated in terms of a specific hypothesis that is supported or rejected. Lacking such conclusions, the project report seldom recommends a precise course for further action; what additional research or project test is indicated, what course of product development or product distribution should be considered or, as would seem likely to be a frequent recommendation, whether to leave to someone else to pursue further research and product development. For example, in the preceeding sections on product test and development and economics of prototypes there is seldom indication of the decisions made by the Lab for further action or recommendations for action to be taken by others--e.g. to move the refrigerator field test from the uncompleted dispensory to a place where typical use could be observed, to conduct tests of a prefabricated cook stove for urban use and to seek data on costs and consumption of fuelwood in urban settings, to recommend what action should be taken following the "successful" tests of the bio-gas digestors, to request that the manufacturers of the SEI pump send a representative on analysis test data to determine why their pump has not performed to specifications, to follow up on the conclusion of section IV.A.4.a that large fish dryers offer promise by suggesting

what further investigation is indicated. Could a dryer of this kind be bought by a fish drying and marketing cooperative? If so, what could be learned from such efforts elsewhere? What would be the steps to take to determine whether a cooperative is feasible?

B. Administrative Performance of the Laboratory: Summary

The Lab recovered from a shaky start. It now appears to be well administered with decisions that are made quickly, are well understood and delegated, with informal but apparently effective lines of communication, with frequent assessment of work. Middle level employees appear to be confident that they can ask for help and get it. There are no signs of bureaucratic inertia. Indeed, the Lab seems remarkably free of external restraints and internal impediments. The Director and his associate directors appear to have the confidence of Lab employees and they in turn, with few exceptions, are well regarded by the Director. Policies for personnel selection, promotion, and separation are no more cumbersome than those of the U.S. Government and, in some ways, better administered; e.g. the procedures for selecting junior level engineers from among graduates of the Ecole Nationale des Ingénieurs and for promotion within the Lab seem more flexible than our own. The technical assistance provided by Terrence Hart on a sustaining basis and by almost all of the short-term consultants has been of high quality.

The Lab managed to compensate for some, but not all of the problems associated with the lack-luster performance of the Institut d'Economie Rurale in the conduct of the field survey. The Lab continues to address the problems that were identified in the design and upkeep of the improved wood stoves.

The physical equipment of the Lab has been well used and maintained in spite of unforseen problems associated with late delivery, crowded quarters, and concurrent training of personnel.

Problems remain: Purchasing, accounting, and sub-contracting procedures need improvement. Liaison and collaboration with Malian agencies, with USAID, with regional and international agencies, and with the private sector need great improvement. A regular process is needed for receiving outside advice from people competent to give it and willing to do so. Prospective clients and decision-makers are, for the most part, unaware of the Lab's accomplishments and the services it can render.

The Lab does not yet have a charter that includes a comprehensive declaration of purposes. It appears to have neither a short term research agenda nor a "five year plan" for development. Further, it does not appear to have agreed upon criteria or a procedure for establishing research and development priorities.

The causes of most of these problems are fathomable and, as recommended later, solutions should not be hard to come by. Indeed, USAID, in its project document, sent the Lab off in several directions and, then did little to help with mid-course corrections.

In sum, if AID's principal intent was to help in establishing a well administered national energy laboratory, the progress to date strongly supports the conclusion that AID has gotten its money's worth and will continue to do so in the rest of the project.

1. Potential for Self-Support of the Laboratory
It is agreed that there is an unexplained potential for considerable self-support of the laboratory; but disagreement on whether efforts to achieve it should be given high priority. The two views are presented below.

a. Self-Support Should Have Low Priority (by Clarence Kooi)

The laboratory has the potential to become self-supporting. However, its ability to do so has not been developed. This would require (1) a re-orientation in management from a development mentality to a strict business mentality; (2) development of an installation, sales, service, and parts division and (3) up-grading the abilities of the shop and manufacturing personnel who cannot now do work of sufficient quality nor do it rapidly enough to construct profit-making products. Furthermore, as in any small profitable business, all work in areas that cannot show a near-term profit would have to be stopped and all personnel not related directly to the profitable line of business would have to be laid-off or re-oriented toward the product line.

Since the solar hot water heater is the only possible near-term item with profit potential all other work would have to be stopped and the people and monies devoted to that work applied to setting up sales, installation, service and manufacturing divisions for hot water heaters. The Laboratory would then be a business, not a Laboratory, and it would not fulfill the needs of the project nor of the Malian people.

In pre-project days the Laboratory attempted some degree of self-support by selling solar hot water heaters (and it still does sell a few every year). Essentially no other work was done during this period (see project paper). Furthermore, the income was insignificant. It is entirely feasible that a very careful accounting of the time and materials extended in this effort would show a significant loss of money rather than a profit.

Similar solar hot water heater manufacturing, sales and installation efforts have been undertaken by other Sahelian laboratories such as CERER in Dakar and ONERSOL in Miamey. They were not successful efforts.

It is possible to break off a company, such as a solar hot water company, that would be set up separately as a profit making business. However, to expect it to make enough profit to support a Laboratory of the kind and size needed for this project and for Mali's needs is illusory. Only very large, profitable businesses have been able to do that and even they seek and obtain significant government contributions to their R&D programs. To ask a small inexperienced Laboratory in a developing country to fulfill the requirements of a major GOM/AID energy project and to be self-supporting is unrealistic and counter-productive.

b. Self-Support Should Have High Priority
(by Richard Graham)

o Neither USAID nor any other donor is interested in permanent support of an enterprise which, given a potential for self-support, instead causes a drain on Malian resources. The Lab will be seen as a better investment both for the Malian Government and for other donors if it is at least partially self-supporting. Indeed, the Lab must soon develop a plan of operation after completion of the USAID project.

o An effort to be at least partially self-supporting gives emphasis to client-orientation, to practical use of Lab-developed technologies and products, to assessment of costs and benefits from a purchaser's perspective, to problems of dissemination and of product maintenance.

o Client-orientation leads to a kind of low-cost needs assessment. While it does not provide the kinds of information nor the basis of understanding that are obtained from a village survey of the kind undertaken in this project, it does provide important information for deciding on an overall research and development strategy and helps establish the objectives and guide the designs of individual projects of research and product development.

o An effort to match income against expenses, at least partially, gives priority to control of expenses, to costs of personnel and vehicles, to the cost of non-productive research and the like.

o It encourages greater attention to the costs and benefits of alternative courses of action; e.g., whether to manufacture a prototype within the Lab, whether to put it out for bid by local job shops and whether to choose the former if outside bids and the benefits of Lab personnel-development so indicate.

o It leads to stronger liaison and collaboration

with potential clients and greater attention to the work of others engaged in similar research and product development. If knowledge can be gained at less cost from others, the Lab is less likely to undertake duplicative efforts, as in some instances has occured.

o The sources of income need not be from the manufacture and sale of products. Indeed, as noted above and in Appendix E, manufacture and sale of products by a government agency is not likely to be a money making proposition. As noted elsewhere in this report, net income can, however, be looked for from contracts with national and international donor agencies including other projects of USAID, from private non-profit organizations, from other national energy laboratories, from the Centre Regional Energie Solaire (CRES), and from either contracts or royalty agreements with private entrepreneurs.

2. Lab Management

The organization of the Lab and the duties of key personnel are described in Section IV.B.7: Laboratory Personnel.

Management appears business-like. There is a sense of commitment and pride in work. Direction appears neither lax nor rigid. Decisions seem clearly to be made by the Director after receiving advice from his associates. Lines of communication appear open and perceived as such by lab personnel.

The need for improvement in accounting, purchasing, and sub-contracting procedures is dealt with in Section IV.D.2 and IV.D.4. The need for improvement in research agendas and research design is dealt with in section IV.A.6.

The Lab appears ready to take on the additional responsibilities it will handle under the anticipated reorganization within the Ministry of Industry and Tourism.

3. Relationship to Organizations Party to the Project Agreement

The Solar Energy Laboratory has responsibility for managing the project including distribution of funds. It is responsible for contracting to other Malian organizations for services such as the installation of the "early start" pumps. It is responsible for coordinating the activities of the Ecole Normale Supérieure,

the Ecole Nationale des Ingénieurs, the Institut d'Economie Rurale, the Peace Corps, the Central Veterinary Laboratory, Génie Rural, OMBEVI, and the other organizations represented on the advisory board.

These relationships during the first two years appear to have been infrequent and ineffective. However, during the last year and a half, contracts for installation of the early start pumps have been let and frequent contracts with IER have been made in connection with the Survey. It has worked less closely with the Ecole Normale and the engineering school.

4. Relations to Other Organizations

Research and product development on new and renewable energies in Mali are conducted by several other organizations including the following:

a) the Division du Machinisme Agricole, attached to the Direction du Génie Rural, is conducting research on the production of biogas to be used in prime movers for agricultural equipment. Their work is not advanced and the biodigestor they built has not reached the level of performance achieved by the Laboratory. Coordination with the Lab is weak and it would seem advisable for the Lab's bioconversion group to carry on at least part of their program of research on Machinisme Agricole units instead of building comparable units.

b) The Direction Nationale de l'Elevage has established a Centre in Dilly to conduct tests on pasture management. The Centre benefitted to some degree from the "early start" solar pumps and, despite technical and contractual problems, the Center expects to achieve more collaboration with the Lab.

c) The Direction Nationale du Génie Rural is supervising the installation of the "early start" solar pumps at Camp Modibo and Demba Diawara. They expect further joint efforts when it becomes feasible to disseminate solar pumps nationwide.

5. Physical Equipment, Buildings, and Space of the Solar Energy Laboratory

The evaluation plan requires that the physical equipment of the Laboratory be examined to determine whether it is functioning properly, whether it is receiving proper care and maintenance, and whether it is being used properly and

effectively. According to the Project Paper (see Schedule on page 37) the equipment should have been received by the end of 1979. However, over two years later, a large part of the equipment has not yet been received. Therefore, this evaluation will be concerned with only existing equipment.

The temporary shop building has been constructed and the existing machines installed. The building was designed by Laboratory personnel and constructed for about $5,000. It contains about 165 square meters of floor space, about half of that needed to accommodate all equipment and to provide adequate work area. Existing machinery, including a lathe, sheet metal tools (roll, brake, shear, etc.) welding equipment, and other tools ahve been installed. This includes the large machinery which had been in crates outdoors for many years (see project paper). These were de-rusted and put back into working shape. The lathe, of Russian origin, is inadequate. Its clutch slips so that the depth of cut is limited. It is so worn that accuracy of work is low. Only a few cutting tools exist. Fortunately, a new lathe has been ordered.

Although all tools are now in good condition and are being well maintained, the shop personnel, with perhaps one exception, do not have the training and experience to fully utilize the equipment. Some training and instruction (much by example) has already been done. However, we strongly recommend that a comprehensive, long-rang, program be undertaken to up-grade the general abilities of the shop personnel. This will require an experienced shop man for at least a 12 month period. This should be done after all machine tools and equipment have been received.

The instrumentation laboratory is presently adequately housed. However, more space will be needed when the rest of the instrumentation arrives. The present equipment is not extensive. Most is in operation but some is not.

The proportion of non-operational equipment is not much different from that in U.S. laboratories so that one can say that it is in a normal range. Solar insolation and wind measurement equipment appears to be operating routinely. The Data Point systems (one at the lab and one in each of the four regions) are operating but, because of major design and construction problems) have given a good deal of trouble. The Laboratory is attempting to secure some remedy from the manufacturer.

Laboratory personnel are generally using the instrumentation properly, but they could benefit from greater association with engineers and scientists who are expert in instrumentation. Such associations during the past two years have been adequate and should be continued for at least another two years.

The Lab's outdoor testing area is rapidly filling up with test units and installations. It is adequate now, but will be too small within about a year. There is no indoor Laboratory area except the test instrument room and while the program has not yet run into any serious problem with this lack of space, further program development and installation of the scientific equipment that has not yet arrived will require a considerably larger indoor laboratory area equipped with utilities, electronic work benches, cabinets, etc.

The engineering and administrative offices are inadequate in number, size and appointments. They are too scattered about and there is no conveniently located conference room.

According to the project schedule, a new Laboratory should have been completed by January of 1980. The only progress so far is a commitment by GRM of land and preparation of plans for the new laboratory by the architect Baba Alpha Cissé. In order to accomplish Phase II objectives, the laboratory has up-graded its present facilities but they are far from sufficient (as shown in Chart IV.B.6); total enclosed area is 575 square meters compared to the 1,000 square meters needed.

The money stated in the Project Paper for construction of the new Laboratory was $350,000 plus an inflation allowance which brings it to $425,000 today. The architect's present estimate of the cost of construction according to his plans is 494,000,000 FM or $810,000 at the current conversion ratio of 610 FM/$. This is almost double the estimate of the Project Paper and corresponds to a cost per unit covered area of $840 per square meter or about $80 per square foot. This appears unjustifiably high and when contractor's bids come in, the cost may be found to be lower. If this does not happen, the most feasible alternative may be partial construction. Discussion with Laboratory personnel revealed that they would be willing to use their own personn to construct, for example, the atelier and the the "aménagement extérieur" so that the estimated

Chart IV.B.6

Areas of Present and Proposed Laboratories

Item	Present Laboratory (floor space in square meters)		New Laboratory (floor space in square meters)
Site area (total)	7,600		15,000
Office and conference room	100)		
Library	24)	252	340
Engineer's offices	98)		
Under construction	30)		
Workshop (M/C shop, sheet metal and welding, assembly, paintshop, electrical, carpenting)	165		285
Testing			
Fully exposed	1,700)		
Shaded	275)	2,000	1,200*
Covered	25)		
Storage			
Closed	55		45
Open	36		32
Tools	15		0
Field Instruments	27		48
Total covered area	575		964

*Architect's plans. However, adequate area exists for expansion to needed size.

cost of the remaining contracted construction would be about $450,000. The Laboratory has experience in such work, having already constructed the present atelier for only $5,000. Such an arrangement would be workable if part of the Phase I and II contingency and inflation funds ($342,000) were released for this purpose. The architect's cost estimates are given in Table IV.B.7. See also discussion in Section IV.G Draft Budget Phase III and on page A-9 of Appendix A.

6. Laboratory Personnel

The Laboratory is organized into three sections under the underall direction of Cheickna TRAORE.

- Administrative and Finance headed by Boubacar DIAKITE
- Science and Technology headed by Modibo DICKO
- Shot and Production headed by Benoit MAIGA.

The organization chart is shown as Figure IV.B.7 and a list of personnel in Table IV.B.7.

Since 1978, when the project began, the engineering staff has increased from eight to fourteen. The 1978 staff was composed of those engineers marked by an asterisk in Table IV.B.7 plus Mamadou TOURE and Mamadou SOW who are no longer on the staff. Most of the additions came from the Ecole Nationale des Ingénieurs (Bamako). They are a young and vigorous group which has already made significant contributions to the Laboratory. Progress in the bioconversion and photovoltaic groups, for example, is due in large measure to their efforts.

The heart of the Laboratory is its scientific and engineering staff. However, the supporting staff in all three sections is equally important. It has been improved and expanded under this project.

The Laboratory personnel can carry out the work necessary for Phase III but for about two years will need further training and technical assistance. This is particularly true for the shop personnel and the personnel concerned with instrumentation and measurement. We recommend that a skilled shop person such as Alex Roqueta be retained for a 12 month period to improve the skill level of the shop personnel. Continued contact with engineers, scientists and electronics and instrumentation people with hands-on capabilities is also recommended. The short-term assistance has fulfilled this need and should be continued.

Table IV.B.6

Architect's Estimated Costs by "Lot". The Costs are in FM at time of estimate and must be up-dated by an inflation factor of 1.21.

Lot no. 1	Poste transformer	4.604.190
Lot no. 2	Loge Gardien	7.995.540
Lot no. 3	Administration Aile gauche	98.804.785
Lot no. 4	Administration Aile droite	89.809.555
Lot no. 5	Bâtiment d'essai	11.042.060
Lot no. 6	Ateliers	65.904.330
Lot no. 7	Parking, Velos, Mobylettes	9.823.520
Lot no. 8	Toilettes Extérieures	7.174.320
Lot no. 9	Aménagement Extérieur 1	60.181.390
Lot no. 10	Amenagement Extérieur 2	53.021.565
	Prix Août 1980	408.361.255

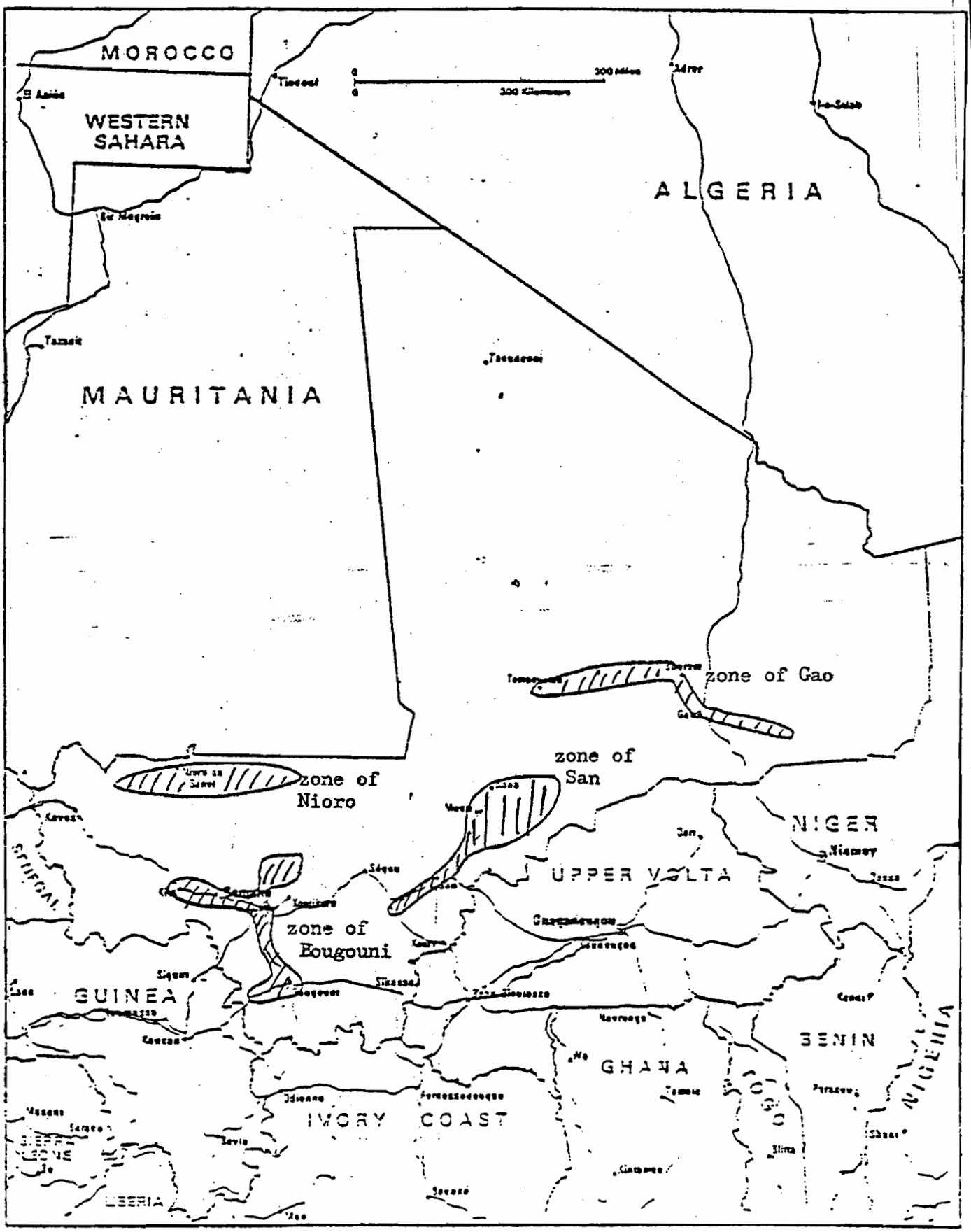
Actualisation (Inflation factor = 1.21)

408.361.255 x 1.21 = 494.117.119 FM

= $810,000 (1982 cost)

Figure IV.C.1. Survey zones identified in the PP

Mali



LOCATION OF POTENTIAL SITES

Railroad

Road

Table IV. B7 2: ENGINEERING STAFF OF THE SOLAR ENERGY LABORATORY

Names	Qualification	Experience
1. Cheickna Traoré *	Ingénieur Principal Thermo-physicien	Director of the Laboratory since 4/31/1969
2. Amadou Doumbia *	Diplôme d'Ingénieur des Sciences Appliquées Diplôme des "Hautes Etudes sur l'Energie Solaire"(Perpignan)	In service at LESO since 2/21/1974
3. N'To Diarra *	Ingénieur du 2è degré du Génie Civil et des Mines (spécialité électro-mécanique), diplômé de l'ENI - Bamako	In service at LESO since 1/22/1975
4. Modibo Dicko*	Ingénieur principal. Diplôme d'Ingénieur de l'Institut Polytechnique de Bielorussie (URSS)	In service at LESO since 10/20/1976
5. Mahamane Bilal Touré*	Ingénieur Principal. Diplôme d'ingénieur électro-mécanicien de l'Institut Energétique de Moscou. Spécialité "Machines et Appareils Electriques".	In service at LESO since 12/15/1977
6. Cheick Oumar Traoré	Ingénieur du 2è degré du Génie Civil et des Mines (spécialité: electro-mécanique), diplôme d'ingénieur de l'ENI	In service at LESO since 1/22/1979
7. Hamata Ag Hantafaye	Ingénieur du Génie Civil et des Mines Spécialité: Machines et Installations frigorifiques à compression).	In service at LESO since 11/24/1980

Table IV.B.7

Names	Qualification	Experience
8. Amadou Sidibé *	Ingénieur du 2è degré du GCM. Diplôme d'Ingénieur de l'ENI. Spécialité: électro-mécanique	In service at LESO since 12/15/1976
9. Mamadou Diarra	Ingénieur du 2ème degré du GCM. Spécialité: électro-mécanique) Diplôme d'Ingénieur de l'ENI	In service at LESO since 1/22/1979
10. Sékou Xavier Dembélé	Ingénieur du 2è degré du GCM. Spécialité: électro-mécanique Diplôme d'Ingénieur de l'ENI	
11. Fatogoma Dembélé	Ingénieur du 2è degré du GCM. Spécialité: Electro-mécanique. Diplôme d'Ingénieur de l'ENI/Bamako	In service at LESO since 8/15/1979
12. Yaya Sidibé	Ingénieur du 2è degré du GCM. Spécialité: électro-mécanique Diplôme d'Ingénieur de l'ENI	In service at LESO since 7/8/1981
13. Alhousseyni Maïga	Ingénieur du 2è degré du GCM. Spécialité: Electro-mécanique, Diplôme d'Ingénieur de l'ENI/Bamako	In service at LESO since 7/8/1981
14. Mahamet Dembélé	Ingénieur du 2è degré du GCM, Spécialité: électro-mécanique Diplôme d'Ingénieur de l'ENI	In service at LESO since 1/2/1979

IV. C. Assessment of Survey Design and Achievements

1. Assessment of Survey Design

As specified in the Project Paper, the project staff was to gather socio-economic data on the communities receiving the early start solar pumps during the first phase of the project. These preliminary sets of data would help guide the designers of the more extensive socio-economic study of communities in a broader range of zones that was planned for Phase II. The aims of the Phase II socio-economic studies were diverse: to identify the aspects of traditional technology that could be improved by devices developed by the Lab, to identify the traditional institutions best capable of managing and maintaining introduced devices, and to establish base-line data that would allow a very complete evaluation of the impact of introduced devices on labor productivity, on the allocation of labor, on household revenue, and on local social structure (particularly social stratification). In addition, the survey was to estimate average consumption of traditional and modern energy sources, to give data on prices and distribution channels, and to gather technical data needed for an assessment of the economic returns to improved technologies compared with traditional technologies. The lists of topics of study in the Project Paper were meant to be illustrative: the exact focus of the study was expected to vary from site to site, depending on the devices the laboratory intended to introduce.

The original choice of survey zones and administrative districts shown in table IV.C.1.a and figure IV.C.1 was to be made in the Interagency Project Committee, chaired by the Director General of Hydrology and Energy, and was to include a wide range of sites in some of the most isolated regions of Mali. The principal motivation for the choice of survey sites seems to have been to get as wide a range of ethnic groups and geographical zones as possible. The survey instruments were to be designed by the Evaluation Unit of the Institut d'Economie Rurale (IER), assisted by a liaison engineer from the Lab, and by a U.S. social scientist. Both the IER director of the survey and possibly some Peace Corps Volunteers were to get short-term training in survey methods. Two middle school leavers--students who had completed nine years of schooling and were not going to enter secondary schools--were to be based in each of the survey villages, and they were to be supervised by four teams of Peace Corps Volunteers and a Malian national at the baccalaureate level. The survey zones were supposed to be compact enough to permit the supervisors to visit each village about once every three weeks without requiring that the supervisors travel more than half of their working time.

During the course of the Phase II studies, the enquêteurs were to identify village cadres--either traditional institutions or individuals--who were able to manage and maintain renewable energy devices and who were to be given training at the start of Phase III when test models of devices were installed in village sites. The plan was intended to give all communities that wanted it a concrete return for their patience and cooperation but community members were to be expected to contribute at least part of the cost of such devices. Phase IV was to include an exhaustive evaluation of the impact of project interventions in each survey community.

The PP budget for the socio-economic surveys is shown in table IV.C.1.b. The table includes only items budgeted for the base-line socio-economic survey and consumption estimate and omits the costs solely attributable to field testing and evaluation in Phases III and IV. However, it does include the anthropologist's time and the costs of report preparation and translation,

Table IV.C.1.a: Survey Zones designated in REP PP
(numbers of communities in each circle)

Zone 1 - Nioro	
Cercle de Nioro	- 2
Cercle de Yélimané	- 2
OMBEVI pastoral zone	- 1
OMBEVI villages	- 1
Zone II - Bamako	
Cercle de Bamako	- 1
Cercle de Kolokani	- 1
Cercle de Kita	- 2
Cercle de Bougouni	- 1
Cercle de Yanfolila	- 1
Zone III - San	
M'Pessoba	- 1
Yankasso	- 1
Dogon area	- 2
Mopti Livestock Operation	- 1
Kona and Sendégué	- 2
Zone IV - Gao	
Menaka	- 1
Rharous II	- 1
Diebock	- 1
Cercle de Bourem	- 1
Cercle de Tombouctou	- 1

since it is assumed that these reports are in part reports of the base-line data. The budgeted cost of the base-line survey is roughly 10% of the total project budget. Several items, however, were missing from the PP budget for the survey. The short-term training in survey techniques was not budgeted for. More importantly, the PP made little provision for entering or analyzing the survey data: it did not budget for keypunching costs, programming costs, or computer time. The sums for interim reports and final report preparation seem mostly for typing, reproduction and translation. A common rule of thumb is that analysis and report writing take about the same amount of time as field work but no budget provision is made for anything near that amount of time. Another problem was that the PP did not make clear whether IER or the expatriate researchers had the bulk of responsibility for data analysis and for report writing.

To sum up: the socio-economic study designed in the PP covered a very wide range of topics and an extremely wide range of survey sites. The Evaluation Unit of the Institut d'Economie Rurale was to have most of the responsibility for survey design and execution, and the personnel and supervision of the data gathering are laid out in some detail. However, the PP gave little guidance on how the data were to be analyzed. IER has always tabulated and analyzed its survey data by hand; it has no experience in designing survey instruments to be analyzed by machine, it has no personnel with much programming experience; and it has no functioning computer facilities. To tabulate by hand a year's worth of data on 250 households in 4 survey zones would have been extremely difficult, and any kind of multivariate analysis would have been impossible. On the other hand if analysis was to be done by machine, it should have been evident that IER personnel were going to need considerable training, access to computer facilities, and long-term technical assistance to conduct and analyze the survey.

The original implementation schedule had called for recruitment of survey personnel by IER to begin in May 1979, for the survey to select field sites by April of 1979, and to begin by October 1979. However, the Participating Agency Service Agreement (PASA) between AID and the Department of Energy Solar Energy Research Institute (SERI) that provided for the services of the U.S. social scientists (as well as other technical assistance to the Lab) was not signed until June of 1979 and the Convention No. 0718 between the Institut d'Economie Rurale and the Lab was not signed until May of 1980.

The Convention negotiated between the IER and the Lab differed in several respects from what had been planned in the project paper. The Lab noted in its technical report of 1 November 1980 that it had hoped that IER would be able to assume full responsibility for the survey, including the management of funds for the field teams, but that IER had not wanted to assume responsibility for transferring money to the survey zones or accounting for expenses. The convention as it was signed gave IER an advisory role in designing the survey questionnaires and the major responsibility for recruitment, training, and supervision of the enquêteurs and contrôleurs.* IER was to participate in drafting twice-yearly progress reports and the final report. However, the nature of this participation was not detailed in the convention and the budget of the accord included no staff time for analysis or report writing.

*Note: Throughout this report the terms <u>contrôleur</u> and <u>controller</u> are used interchangeably.

Table IV.C.1.b: PP Budget for socio-economic studies-
Base-line data only

Phase I	
Short-term mission (energy scientist, economist, and social anthropologist)	26,000
Technical assistance - social anthropologist	29,000
	55,000
Phase II	
Survey vehicles (5)	60,000
In-country training for enumerators and controllers (65)	10,000
Enumerators' salaries	52,000
Village housing for enumerators	2,500
Housing allowance for contrôleurs	2,600
Contrôleurs' salaries	5,500
In-country travel	14,800
Vehicle operating expenses	24,000
Operating expenses, contracting agencies	25,000
Social anthropologist (3 mo.)	21,000
Office expenses for survey headquarters	15,000
	232,400
Phase III (does not include costs of field tests per se)	
Social anthropologist	47,000
Interim report preparation	10,000
Translation of interim report	7,000
	64,000
Phase IV	
Social Anthropologist (3 mo.)	19,000
Final report preparation	15,000
Translation of final report	10,000
	44,000
TOTAL.....	$395,400

The U.S. social scientist for the project, Dr. Koenig, first visited Mali to draw up pilot questionnaires in October 1979. She realized the logistical problems that the original choice of administrative districts would pose for the survey supervisors and wisely restricted the choice of survey areas to within 75 km. from the town where the supervisors were to be based. Koenig had hoped that IER would be able to begin pre-testing the questionnaires and selecting survey sites in November or December of 1979. The pretest did not begin, however, until June of 1980, and by then one of the PCVs recruited for the survey had already finished his tour and left. Indeed, at every juncture where there were significant delays in project implementation, personnel changes were also a problem.

The pre-tests in the survey zones began in June of 1980, and involved selecting a preliminary sample of 18 to 20 villages in each zone, gathering preliminary data on the preliminary sample of villages to select 5 survey villages, and, finally, testing the household questionnaires in villages outside the survey zone. The methods used to select villages and households will be discussed in Section IV.C.2.a.

The household questionnaires drew heavily two sets of sources (Koenig ms. 1979). The first set were energy surveys: The Peace Corps Energy Survey (developed by Jankura with the Overseas Development Council), Africa Energy Survey Methodology developed by Donovan, Hamester and Rattien, Inc., for AID, and the Base-Line Study for Socio-economic Evaluation of Tangaye Solar Installation developed by Hemmings for AID. The second set of sources were farming systems studies that draw on work by Norman and others at Ahmadu Bello University and that include work Koenig and others had done with Morris out of the Department of Agricultural Economics at Purdue.

Koenig returned to Bamako at the start of August 1980 to work with the supervisory teams, and with Y. Cissee, Gros, and Querbes of the IER in revising the forms and the coding directions. There were several groups of questionnaires in the final version of the survey:

1) No. 10 and 11, which enumerate the households within each compound (carré) and collect preliminary information on fuel use and water sources.

2) No. 13 through 17, which inventory the water vessels in each household, list the origin points for fuel and water for each household, inventory energy-using devices, and give conversions for local terms for the time of day and measures for weights and volumes. (filled out once a month except for the device inventory which was repeated each 6 months, and time weight and volume measures which was to be filled out once).

3) No. 21 through 28. Time use, economic activities, and household revenue and expenses. Asked of each survey household once each 8 days for the previous two days only.

4) No. 31 through 35, based on observation of each household once every 8 days, record time and/or money spent getting fuel and water, water consumed by household members present, fuel use, food preparation, and use of energy-using devices.

5) Protocols 41 through 59, open-ended questions that were at first intended to be filled out by controllers for all villages. These try to get information on basic ethnographic data for each village: Infrastructure, natural environment, history of settlement, decision-making, economic activities, traditional technology, artisanal work, energy needs assessment, fuel use, water use, nutrition, use of manure, markets, transport, local-level collectivities, and local values affecting adoption of energy devices.

6) No. 72. Price of fuels and water (to be filled out every two weeks).

Copies of the questionnaires can be found in annex D.

The basic unit of the observation for the survey was the household, defined as a cooking unit composed of relatives (Koenig 1979 ms.). Each enquêteur followed five households over an eight-day observation cycle: one day of questionin all five households on time-use and revenue and expenditures over the last two days, one day of observation in each of the five households (alternatively from 6 am to 1 pm, and during the next cycle from 1 pm to 8 pm) one day for general paperwork and the market forms, and protocols, and a final day of rest. The eight-day cycle insured that each household was observed during every day of the week.

The survey, as it was designed, was very close to the specifications in the Project Paper. Decisions influencing the survey design, though, were divided among different individuals who were not always in accord with what they wanted from the survey and what were the least costly ways to get what they wanted. Thus, the survey zones were chosen by the Interagency Project Committee to encompass a wide geographical range and a diverse set of ethnic groups. This environmental diversity is valuable in giving the SEL areas with different energy needs and different potentials; however, it has also made logistical support of the zones (discussed below) a grave problem and means that meeting service needs of test devices located in the most distant zones will be a heavy drain on the laboratory.

The sampling methods for villages and households, discussed below, were developed by the IER. They are quite complex, and, having arrived at a sample of villages, it is rather hard to say exactly what population the sample of villages represents. This could be a problem if the survey data were used for global economic estimates: for example, if a researcher wanted to use the field-test data on stoves to estimate the effect on the whole survey zone of large-scale production of improved stoves. Similarly, because the zones were purposely chosen, it is hard to use the survey data as estimates for rural Mali as a whole.

Part of the survey--the forms dealing with time allocation, economic activities, and consumption and revenue--were mostly meant to be used in evaluating the impact of devices introduced in Phase III. Designing forms and codes applicable to four geographic zones and thirteen ethnic groups is difficult. Some of the controlling teams felt that this part of the survey was not closely connected to the Laboratory's need for information. It might have been possible to carry out the survey in conjunction with on-going or completed farms systems studies, which would have allowed the enquêteurs and controllers to concentrate on the observational data, the protocols, and the "renseignements techniques" later contributed by the lab, and would also have given more accurate estimates of income, agricultural production, and labor productivity.

The Renewable Energy Project was designed when AID was directed to address itself principally to the rural poor majority, and so the survey zones are predominantly rural. Adapting and testing prototypes is slow work for the laboratory and the first devices it has been able to bring to the point of being ready to be field-tested have been improved stoves. However, some of the survey areas are relatively well-forested. Children gather much of the firewood and many families do not perceive a serious problem in fuelwood supply. The motivation to change to stove cooking is therefore relatively low. In most urban areas, however, firewood is costly and households may be more motivated to try new ways of reducing their fuelwood consumption. Controllers in the rural survey area where stoves were installed in sample households felt that the stoves would be more appreciated in towns and urban areas, and the costs of following the households where stoves were installed would be lower than for rural areas (since population is denser) (C. Burke, pers. comm.). However, we have no base-line data for urban areas.

Technical assistance to the Laboratory was not very effective before October of 1980 and the Lab was therefore unable to furnish much input to the original survey design. More recently, the Lab has been able to specify the information it needs on traditional technologies (in the "renseignements techniques") and the survey structure has been able to fill those needs. Laboratory personnel would have preferred that fuelwood used in cooking be measured to hundredths of a kg. rather than rounded to the nearest kg. but that was the only specific problem they noted.

A final question is whether parts of the survey were too complex for the enquêteurs level of education. All codes used in the survey are numeric, and the number of codes is large. In some cases, codes from one question on one form will be used in other questions or on other forms (e.g., fiche 33 uses the same codes as fiche 31 for wood types). In other cases, codes vary from question to question and form to form. It might have been possible to use self-coding forms where codes are on the questionnaires themselves (although forms would have been much more bulky and costly). Another possibility might have been to use alphabetical codes based on French, (which can be easier to remember and edit,) and to transform them to numeric codes, if need be, through the RECODE command in SPSS.*

* Statistical Package for the Social Sciences.

IV. C. Assessment of Survey Performance

2. a. Village and Household Selection

The methodology for choosing communities and households for inclusion in the survey was devised by IER. It was a fairly complicated way to have chosen a sample and I have been unable to find any preliminary reports that describe it completely (although instructions for the first stage are included in "Instructions aux contrôleurs sur le programme de travail de la pré-enquête" issued by IER in 1980). It seemed worthwhile, therefore, to describe it in some detail.

The first step began during the pre-test when the contrôleurs for each survey zone got in contact with local administrative authorities and obtained a list of arrondissements that were within two hours' drive of the chef-lieu de région where the contrôleurs were to be based. The controllers then listed all villages in accessible arrondissements in order of increasing population. They calculated a sampling proportion, which we'll call p, by dividing the total number of villages listed by 18 (the number of villages they were to retain in a preliminary sample), choosing a random number from 1 to p, starting on the village corresponding to the random number they had chosen, and then selecting each pth village on the list.

For each of the selected villages, the contrôleurs filled out a questionnaire that included information on the population, number of "familles", ethnic composition, major economic activities, artisanal activities, livestock holdings, estimated the amount of animal traction equipment, inventoried sources of water and fuel, inventoried government services available, and also inventoried vehicles and diesel engines in the village. The principal source of information for these questions was the chief and local notables.

Having filled out the village questionnaires, the contrôleurs were then to choose a village outside the sample population (that is, more than two hours away from the chef-lieu) that included a market and that had a government encadreur, and test the household forms with a literate family and an illiterate family.

After the pre-enquête, the village forms were tabulated, and the preliminary sample villages were classified by criteria that differed from zone to zone, as follows:

Bougouni
- ethnic groups
- accessibility (less than 1 hour or 1-2 hours from chef-lieu)
- major economic activities (agriculture, iron working)
- source of water (permanent or sporadically dry).

Gao
- ethnic groups
- presence or absence of market
- presence or absence of artisanal activity

Nioro	- ethnic group
	- accessibility
	- presence or lack of permanent water supply
	- degree of difficulty in obtaining firewood
San	- ethnic group
	- activity
	- accessibility

Since IER wanted all survey households to be unrelated, it excluded from consideration all villages with fewer than 10 "familles". The villages were then classified by size and a sample of 5 villages from each survey zone was selected that represented the final categories of the stratification criteria, and that also gave 25 per cent small villages, 50 per cent medium-sized, and 25 per cent large villages.

The second drawing was not random, the object being rather to choose a village from each category and have the desired distribution with respect to size. The problem, of course, was that classifying villages by these 5 criteria gives 48 possible final categories, and it was impossible to represent all categories in the final list of villages to be studied.

The method for choosing survey households used the same kinds of stratification: households were classified by size, type of occupation (farmer, herder, fisher), the use or non-use of modern fuels, and whether or not the household had a well within the compound. The categorizations for each survey zone were lumped, and a sample of 50 households was selected that had roughly the same proportions in each cell as the total population of households in the zone. These totals were then adjusted to divide the total sample into 10 households for each village.

The major problems with the sampling method for villages and households, however, come from its premises. The point of stratified random sampling is to incorporate knowledge you have about the variable you're interested in, by separating your population into relatively homogeneous classes. However, in a case where you start out without much knowledge of the variable you're interested in--energy use, here--it's very common to find out that the variables you thought would have important effects don't, and that the major effects on the variable you're interested in come from elsewhere. Thus, when you know very little about your survey topic, it's often best to draw a sample as simply as possible.

The other problem with the sampling method is the non-representativeness of the sample villages. Often one of the justifications for relatively costly surveys is that they will allow planners to make more accurate estimates of production and consumption and demand for the country as a whole, or for regions of the country, or for a project zone. However, with a sample of the kind chosen, it's hard to argue that the survey results will be accurate estimates for the population drawn from.

b. Personnel Selection and Training

Under its convention with the Lab, IER had responsibility for recruiting and training all village-level enquêteurs and Malian zone-level contrôleurs, and for training Peace Corps Volunteers acting as zone-level contrôleurs. The task was complicated by the delays in project implemenation and consequent turnover in personnel, among the Volunteers, among enquêteurs in the zones, and within IER itself.

Thus, of the IER staff members assigned to work in the survey in 1979, one had been transferred before the pre-test began and replaced by the present supervisor, Youssouf Cissé. The other staff member, Querbes, was transferred to other duties 6 months after the survey got under way. Turnover among the contrôleurs was even more rapid; of the four teams Koenig worked with in October 1979, only one team (at San) was intact at the pre-test of the forms in June and July of 1980, due to resignation of two Peace Corps Volunteers. Two other Volunteers (one original and one replacement) finished their tours while the enquête was still in progress. Since the Peace Corps could not rapidly recruit new volunteers, IER supplied Malian contrôleurs to substitute.

Most of the contrôleurs recruited were at the 2è Terminale level. All the original contrôleurs received a month of training from the IER before the start of the pre-enquête, and another training course from 3 to 11 November 1980. Although one of the Malian controleurs during the pre-enquête worked poorly, Koenig felt that the contrôleur teams at the start of the survey proper (May-June 1981) were conscientious and competent (Koenig trip report May 18-June 27,1981) The evaluation team was only able to visit two of the four survey sites: San, which had the strongest contrôleur team of any of survey sites, and Nioro, whose contrôleurs seemed competent. Gerald Cashion, AID Mission anthropologist, made a trip at the same time to evaluate work at Gao. He felt that the enquêteur from San who was promoted and transferred to Gao as a contrôleur was working well and had significantly improved the work of the other contrôleur.

The initial control teams included two women, a Peace Corps Volunteer and a Malienne. The replacement Volunteer was also female. However, all three had left by the end of the survey* and had been replaced by males. This was unfortunate, since most of the tasks the survey focussed on--cooking, grinding grain, and drawing water--were women's work, and it would have been helpful to have had better access to women's views on them.

The recruitment of enquêteurs by competitive examination did not begin until January 1981. Most candidates had a Certificat de Scolarité (attesting that they had completed 9 years of schooling but had failed the Diplôme d'Etudes Fondamentale a few had started at a lycée but had flunked out. The training lasted about 2 months and was based on the questionnaires and code books. The preliminary selection among trainees was based on their language skills (i.e., whether they spo the languages of the survey villages) and on written tests during training. All enquêteurs then did 2 to 4 week's field work on probation before a final selection was made.

*There were efforts to hire one Peace Corps Volunteer on a Personal Services Contract at the end of Peace Corps Service but interpersonal friction with IER made this impossible.

In her tour of survey sites in May and June 1981, Koenig noted that enquêteurs at Bougouni had not had many of the codes and questions explained to them well, and she spent considerable time retraining the enquêteurs. The worst training problems, however, were at Gao, and these were compounded by more rapid turnover in enquêteurs and supervisors (see below) than elsewhere. In some areas, it wasn't possible to recruit enquêteurs who spoke the local languages: thus, for example in San, enquêteurs for Bobo and Minianka villages had to do most interviews in Bambara.

c. Survey Supervision

There are two levels of supervision that have to be examined here: supervision of the zone controller teams from Bamako, and supervision of the enquêteurs in the field. This section will concentrate on the technical side of the supervision; the next section will discuss logistical support for the field crews.

The major problem the Chargé d'Etude had to cope with after the convention was signed was getting the controller teams into the field. This pre-enquête had ended in July and questionnaires had been revised in August 1980 but the teams did not get back to the field until late December to recruit and train enquêteurs, census the sample villages, and carry out preliminary village inventories. The delay is hard to explain. The Division des Etudes Techniques (DET) of IER felt that during this time it was taking on tasks not specified in the convention: managing the zone vehicles, the controllers salaries, and the funds not used in the pre-enquête. IER was also irked that USAID would not allow it to hire an additional controller to stand in reserve to replace any controller falling ill or finishing his or her tour. The problem did not seem to have been lack of funds; by 31/12/80 IER had received 6,181,225 MF in advances, of which it had justified 2,460,856 FM (IER memo to SEL 22/4/82, No. 00156).

The convention between IER and the Lab specified that technical supervision would include a visit during the pre-enquête of 7 to 10 on-site working days in each zone, participation in a seminar to rework the forms, one month in each survey zone to help in the training of enquêteurs, and then a visit every four months to each survey zone. The convention also specified that the supervisors were to submit written trip reports to the Lab for each visit.

However, the only reports the evaluation team was able to locate were two progress reports for the periods 1 June to 20 July 1980 and March 1981, and an undated technical report on changes to be made in Gao. The supervisor of the survey at IER said he was not allowed sufficient time between field trips to write trip reports, and that in most cases he debriefed the Lab informally. The only record we have of his trips is an undated, handwritten listing of trips from 1980 to the present, transcribed in Table IV.C.2.c.

According to the chart, Bougouni and San were visited at fairly regular intervals but Nioro had not been visited since October 1981 and Gao had not been visited since the survey got started in September 1981 (although Hart noted that Cissé has visited Gao in November 1981). Part of the problem has been delays in AID advances to the Lab and consequent delays in the Lab's advances to IER (discussed in the next section).

In principle, IER was to review and correct all forms before sending them to Koenig in the U.S. for keypunching; however, some batches (like the first set from Gao) were not checked adequately before being sent. Koenig's "Conseils Généraux aux Contrôleurs et aux Enquêteurs" note persistent problems like illegibility, failing to fill out activity forms corresponding to each task reported on the time-allocation form, and mistakes in coding.

Table IV.C.2.c: Supervisory Trips by Youssouf Cissé, IER

	Bougouni	Nioro	San	Gao
To choose sample villages	13/06/80	21/06/80	19/06/80	24/06/80
	4-6/07/80			
Supervisors visits to zones			24/12/80	
				20/01/81
				10/02/81
	28/03/81	02/04/81	09/03/81	
		28/05/81		
	07/05/81			
			03/06/81	07/06/81
				29/06/81
		26/10/81	22/11/81	
	10/12/81			
			04/03/82	
	19/04/82		23/04/82	

One problem for the IER supervisor was his lack of experience in analyzing survey results on the computer and his consequent reluctance to make changes in survey forms or codes. For example, Form 33 has two columns for a code "espèce de bois" and in the code book each survey zone was allotted an additional 10 codes for its most important species. San enquêteurs found people used more than 10 species of wood, and requested that they be allotted additional codes (out of the 59 possible codes not being used). The request was refused.

The Peace Corps Volunteers we talked to felt that IER supervisors were conscientious in doing the parts of their jobs they understood well but that they had difficulty dealing with new situations. They felt that the overall quality of supervision from IER was erratic and that in some cases IER's insistence on going through channels had made technical collaboration between Lab personnel and the field teams difficult.

The quality of supervision given to the enquêteurs by controllers has also varied from zone to zone. Each controller is supposed to keep a listing of each enquêteur's observations to make sure he's following the right schedule of observations and is making observations for each day of work. There was considerable variation, however, in the volume of observations. For example, in San (the best zupervised zone), tabulation of the number of forms each enquêteur filled out during the first three months of data showed that the number of water-use and fuel-use forms per enquêteur varied from 24 to 47. In Gao, the zone that experienced the worst problems, an evaluation in March 1981 showed that 3 months were missing out of 6 months total survey time.

The number of visits received by each set of enquêteurs varied from about 4 per month to 2 or less per month in Gao before March 1982. However, by early May 1982, Cashion reported that the controllers in Gao were making 3 visits per month to more distant villages and two visits a week to nearer villages. In Nioro, controllers said they tried to visit each site one or twice a week when gas was available but enqueteurs in one village thought they were visited every one or two weeks when gas was available and noted there had been two periods of a month to six weeks when the controllers were unable to make rounds.

d. Survey Logistics

The major difficulties for field teams in all zones involved the availability of funds, difficulties in getting and maintaining equipment, and difficulty in getting blank forms from IER. The funding problem was the most frequent and widespread.

When the convention was negotiated, IER did not want to have financial responsibility for the survey zones. Advances to cover the salaries, living, and travel expenses of the controllers and enquêteurs, as well as zone operating expenses, are advanced by the Lab from its operating expense advance. There have often been problems in allowing sufficient time to get requests for advances approved and to get checks issued by USAID. Another problem has been that receipts to justify sums expended in the field zones take a long time to get back to the Lab in Bamako, and it has, consequently, had difficulty convincing USAID that funds have been spent (see below).

The procedure for getting money to the field is that the Lab writes out a check for operating expenses to the Cellule Administrative et Financière of the Ministère de l'Intérieur, who (given 24 hours' notice) gives cash to the IER supervisor or to the Lab liaison engineer who carries the money to the Registrar of each administrative cercle to give out to the controllers against receipts for expenditures. The receipts are collected from the Registrars every 3 months (in principle) by the IER supervisor or by the Lab liaison, but it can take longer; for example, the Lab financial report to AID for January 1982 included salary receipts from the previous June.

San has been the only survey site that has managed to carry on the survey continuously, despite, for example, two month delays in paying salary. At times, carrying on has meant using mobylettes for making trips to survey villages because there was no money for gas for the car. Nioro had three periods without funds: June to the end of September 1981, October through December 1981, and January through March 1982. During the first period, the enquêteurs were unable to pay their lodging and board, and were forced to gather in Nioro and wait for funds. Other times they have been able to get credit from local suppliers to tide them over. Gao had the most severe problems with funds because living costs are higher there than elsewhere. Work stopped from 15 January to 2 March 1981, and from 20-24 August 1981. At the time of the evaluation (25 April 1982) Bougouni had reportedly received no funds since February.

Equipment and vehicles also posed major problems. Survey equipment that had been requested in October 1979 had not been ordered by January 1981 and had to be bought locally. Some items, e.g., pedometers, never arrived for some sites. The watches the Nioro enquêteurs were issued were not durable and enquêteurs had to repair them or replace them at their own expense. Enquêteurs in the more remote areas had problems finding pencils that had hard enough leads not to smear.

Vehicles were also a problem. The gas-engine Toyota Land Cruisers ordered for the project used large amounts of fuel, and controllers in San felt that a bacher would be able to manage the roads and would cost less to run and maintain. The vehicle at Gao never got proper sand tires and had problems with tires and with the fuel system: Koenig estimated that the controllers had been immobilized half the time between January and June 1981 by lack of funds or a working vehicle or both, (Koenig report in manuscript, 1981).

Lack of blank forms was the third major problem for most zones. San controllers reported that although they requested forms two months in advance, they twice ran out of forms (once for more than a month) and had to rule blank sheets by hand. Gao had run out of forms from 14 October to 11 November 1981, from 16 January to 11 February, and from 16 March to 3 April 1982. Nioro was the only zone for which we had information that had never run out of forms: the controllers were able to get forms sent in on the ODIK planes that came in from Bamako each week.

e: Survey Coordination

During the early parts of the project, administrative and technical coordination among USAID, the Lab and IER posed considerable problems. During the time when Koenig drafted the original household questionnaires (October 1979 to June 1980) and when she and the IER revised them in August 1980, the Lab was unable to furnish technical input to the questionnaires. (The REDSO/WA energy advisor, however, was able to give some advice.) When the Lab began to compile its data needs, in early 1981, and asked that the survey forms be re-drafted, IER was reluctant to revise the forms, claiming that the forms had already been reproduced and that revising and reproducing them again would be prohibitively costly. The Lab dispatched a list of the questions it needed answered to Koenig, and she discussed two possible channels for the interchange of information in her trip to Bamako during May and June of 1981.

The first possible channel involved Lab's contacting the researchers at IER, jointly drafting questions to be answered, IER's transmitting these questions to the controllers, the controllers discussing the questions with the enquêteurs and in terms of village problems, and drafting short reports in reply to the questions. These reports were to be transmitted to the Chargé d'Etude at IER, and the IER was to send them to the Lab. The second possible channel was for the liaison engineer of the Lab to compile the questions his colleagues needed answered before leaving on field trips and then to discuss these questions directly with the field controllers and villagers. In this case, the liaison engineer would draft a short report on his return to Bamako, and send a copy to IER.

The official channel proved to be very slow. The Renseignements Techniques that the Lab wanted were transmitted to IER early in 1981 and sat in the IER until Koenig's visit in May 1981, in spite of her having approved their distribution before her arrival. The controllers in San drafted a report that was sent to IER in July 1981. IER wanted to type and edit it before passing it to the Lab, and it was still in IER in January 1982 (Koenig memo to Anderson, Hart, and the Evaluation Team 8/4/82). It was apparently lost in the IER some time during early 1982. The IER did, however, transmit reports from Gao and Nioro to the Lab in late April 1982.

Administrative coordination between IER and the Lab was almost equally difficult in the beginning. The section on logistics covered some of the consequent delays in funding and in procuring equipment. However, starting in early 1981, the Lab liaison engineer began to take a more active role in coordinating support for the survey among IER, the Lab, and the USAID. He began making regular trips to the survey zones, in part to install and monitor the data-point systems, in part to help with survey logistics, to get funds out into the zones, and to collect receipts for expenditures. The Lab also negotiated a personal services contract between SERI and one of the Peace Corps Volunteer controllers of the survey in order to continue the controller's service at the expiration of his contract with the Peace Corps. It thus became possible to communicate without having to go through the IER. However, communication with the IER is still sometimes difficult. A recent example was when the IER brought the Gao field vehicle to Bamako for repairs, but failed to notify the SEL, who were to have arranged for and paid for the repairs.

A memo from Koenig to Anderson, Hart, and the Evaluation team examines the coordination problems between IER and the Lab in some detail in order to assess what IER's role should be in Phase III of the project, when the Lab begins to put in place prototype energy devices. She felt that although the IER had supervised the structures part of the Phase II socio-economic survey competently, IER had considerable trouble with less structured inquiries like the protocols and the Renseignements Techniques. She felt that this difficulty in carrying out unstructured inquiries, IER's inflexibility in revising structures inquiries, and its repeated difficulties in communicating with the Lab would continue to create problems if (as planned in the Project Document) the IER continued to supervise field studies in Phase III of the project. She suggested that the Lab instead hire the more capable controllers and enquêteurs directly. That is, indeed, what the Lab has now done in the San zone, where a reduced force of controllers and several enquêteurs monitor household use of the 50 improved stoves that had been installed in survey households. The evaluation team concurs in Koenig's recommendation.

f. Cost of Survey

Because the socio-economic survey was ambitious in scope, it seemed worthwhile to get a rough idea of what the cost of survey had been, or, at least, what the cost in terms of USAID projects funds had been. Costs borne by the Peace Corps and by the Malian Government are not included in these estimates.

Table IV.C.2.f.i shows the local-currency costs that were reported and justified to AID by the Lab by March 1982. These figures were transcribed from the monthly financial reports submitted to AID. During the first months of reporting, expenses for the survey were sometimes lumped with similar costs for the laboratory; the figures asterisked are therefore approximations. Some of the field equipment for the survey team was bought at the last minute by the Lab - it is listed under miscellaneous.

Table IV.C.2.f.ii shows the total advances made to the zones to date and the total advances to be made to the zones for the rest of the survey. Funds were separately advanced to the IER for supervision costs from Bamako - the amount justified of these funds is 318,882 FM more than advances, and the amount to be advanced during the rest of the survey is 4,406,000 FM.

Inquiries to SERI from the evaluation team elicited a prompt estimate of the amounts spent to furnish the U.S. social scientist, the Peace Corps Volunteer-controller later hired by SERI on a personal services contact, and then travel and support costs, and the amount reserved for a final TDY in Bamako for the U.S. social scientist at the end of the survey. The cost of survey vehicles was budgeted at $60,000. Table IV.C.2.f.iii gives an idea of the total cost paid by USAID funds.

If we convert the local currency part of the cost to dollars, the total cost is roughly $278,000 at current rates. However, since the dollar has risen recently in value, the dollar cost of local-currency expenditures was somewhat higher. Still, it is clear that the costs incurred and the costs expected for the survey over the next few months come very close indeed to what was budgeted for the survey and the social scientist over phases I and II. The cost to the project of data gathering was about $348 per household per month.

Koenig noted in August 1980 that the Project Plan made no provision for data entry and data processing costs. She estimated the costs of entering and processing the data in the U.S. would include about $20,000 for keypunching and about $3,000 for air-freight; however, SER/OM has been able to take on keypunching. If we assume that the analysis and report writing will take about 12 person-months, that inflation since 1980 is roughly 15%, and that a programmer will be able to do about half the work, programmer costs would be about $10,000 and consultant costs would be about $19,000. There would be additional costs for supplies and computer time.

The Project Paper budget for Phase III includes $47,000 for social science services in the program of prototype testing and for analysis and report writing. The evaluation team recommends that the REP update estimates of the cost of data entry, analysis, and reporting, and earmark Phase III funds to cover the cost. The project should then contract for an analyst's services through the agency that succeeds SERI or with a consulting firm or U.S. University. Dr. Koenig's knowledge of the survey and experience make her a strong first choice for the principal analyst.

	28/12/79-3/3/80	30/3/80-30/6/80	30/3/80-30/6/80 & 30/6/80-15/10/80	14/10/80-30/11/80	12/80	1/81	2/81	3/81	4/81	5/81	6/81
a_1. Fixed costs and operating expenses, IER	-	-	-	-	-	-	1,806,220	-	28,945	245,170	77,120
a_2. Fixed costs and operating expenses, survey zones	-	-	-	-	-	-	-	232,200	-	23,745	187,500
e. Salary, primes, and lodging, enumerators and controllers	-	-	2,372,180	-	-	-	-	-	2,597,275	558,870	5,354,580
f. Laboratory travel to survey zones	-	-	62,500*	84,450*	-	-	-	-	-	458,500	-
f_2. IER and zone travel	-	-	-	-	220,565	-	15,370	-	-	646,940	2,006,060
g_2. IER vehicles (fuel & repairs)	-	-	-	-	756,176	-	1,144,734	-	-	717,438	-
g_3. Zone vehicles (fuel & repairs)	-	-	392,250	144,090	-	-	-	-	1,273,430	506,250	705,650
Misc. (preparation for departure of teams)	681,691	887,421	-	141,720	-	-	-	-	-	-	-
TOTAL	681,691	887,421	2,826,930	370,260	976,741	-	2,966,324	232,200	3,899,650	3,156,913	8,330,910

TABLE IV.C.2.f.i: SURVEY COSTS REPORTED BY SEL, DECEMBER 1979 THROUGH JANUARY 1982 (FM)

	9/81	10/81	11/81	12/81	1/82	2/82	3/82	Totals	% of Total
a_1. Fixed costs and operating expenses, IER	-	-	-	-	55,975	-	98,830	2,312,260	4.8
a_2. Fixed costs and operating expenses, survey zones	17,755	-	29,650	7,200	61,140	-	-	559,190	1.2
e. Salary, primes, and lodging, enumerators and controllers	1,787,385	-	3,862,325	1,105,380	-	-	210,000	17,847,995	36.9
f. Laboratory travel to survey zones	119,150	100,420	168,200	517,245	4,537,840	136,000	75,000	6,259,305	13.0
f_2. IER and zone travel.	-	-	11,000	-	522,540	-	420,000	3,842,475	8.0
g_2. IER vehicles (fuel & repairs)	-	-	-	-	262,435	-	1,488,115	4,368,898	9.0
g_3. Zone vehicles (fuel & repairs)	1,047,500	-	1,917,765	1,613,790	3,232,450	569,875	-	11,403,050	23.6
Misc. (preparation for departure of teams)	-	-	-	-	-	-	-	1,710,832	3.5
TOTAL	2,971,790	100,420	5,988,940	3,243,615	8,672,380	705,875	2,291,945	48,304,005	100.0

TABLE IV.C.2.f.i: SURVEY COSTS REPORTED BY SEL, DECEMBER 1979 THROUGH JANUARY 1982 (FM) Continued

Table C.2.f.ii: ADVANCES MADE AND TO BE MADE TO SURVEY ZONES, APRIL 1982 (FM)

	Made before 11/5/82 (1)	(2)	(3)	(4)	(5)	(6)	To be made after 11/5/82 (7)	(8)	Total (9)
San	2,643,500	2,870,000	3,536,490	3,536,490	3,536,490	1,016,110	3,285,765		20,424,845
Gao	2,643,500	2,870,000	3,599,490	3,599,090	3,599,490	3,348,785	3,599,490	1,047,630	24,307,875
Nio o	2,900,000	3,126,000	647,150	3,883,040	3,883,040	3,883,040	3,883,040	1,589,690	23,795,000
Bougouni	2,755,000	2,870,000	1,272,740	3,818,040	3,818,040	3,568,440	3,818,040	1,160,200	23,080,500
Sub-total (Not including leave)	10,942,000	11,736,000	9,055,8	14,837,060	14,837,060	11,816,575	14,586,335	3,797,520	91,608,220
Leave									2,960,000
TOTAL									94,568,220

Table IV.C.2.f.iii: ROUGH BREAKDOWN OF SURVEY COSTS

		MF	$
1.	Local currency costs justified by March 1982 by SEL (includes IER supervision)	48,303,655	
2.	Zone advances not yet justified	24,920,710	
3.	Money to be advanced to zones to July 1982 (includes leave monies)	21,343,855	
4.	Advances to be made to IER	4,406,000	
5.	Expenditures to date on SERI PASA technical assistance to survey		48,500
6.	Reserved for Koenig TDY, Bamako		7,800
7.	Cost of vehicle purchase		60,000
	Total	98,974,220 (approx. $162,253)	116,300
	Total expected cost for survey:	Approximately $278,553	

3. Assessment of Survey Usefulness

a-i Quantitative Data

When people have been working on the same piece of research for several years, the question of the accuracy of the data is very much in their minds. The concensus among the people we spoke to and the reports we read indicated that San had been the best-supervised and most carefully controlled, that Bougouni and Nioro had more problems, but none insurmountable. Gao had very serious difficulties, including the distance from Bamako and consequent logistical problems, harsh living and environmental conditions, repeated vehicle breakdowns, and health problems among the two original controllers.

This section is based principally on talks with enquêteurs and controllers, on reports and on a very preliminary analysis of one section of the data in the reports. It will cover some of the general problems of accuracy in socio-economic data on rural communities, some of the specific problems noted by enquêteurs and controllers, and the special problems with the data from Gao.

To start with the most general problem, many Malian rural communities have bad memories of government efforts to attain socialism during the 1960's through local-level institutions like the ton, and efforts to identify local institutions to finance, manage, and maintain energy-conserving devices can awaken some of those memories. Even now, farm communities have to fulfill quotas for grain deliveries to OPAM, the government's marketing organization. These quotas are based on estimates of the grain harvest and numbers of workers aged 14-60. Thus, when the survey began enquêteurs in Nioro found that some individuals were very apprehensive that the data would be used to increase their tax liability.

Similarly, the GRM has several times made efforts to control trade in some commodities, and most enquêteurs and controllers felt that respondents understated "revenue" on farm for Revenue and Consumption (form 28), but thought that purchases were reported more accurately.

In many of the farms there were difficulties whenever there was the need to estimate quantities for activities that were not observed by the enquêteurs. These included quantities (and types) of agricultural inputs, amounts harvested (form 23), numbers of livestock (especially, as in San, where many animals are in the care of Peul who keep the herds outside the village for much of the year (form 24), amounts of fish caught (form 25) and amounts of fish smoked or dried away from the village (form 26). The fishing data were especially hard to get because members of many fishing households spent part of the year in temporary camps away from the village and often sold the catch before returning home.

A problem with the agricultural data was the difficulty in checking data for internal consistency. A farm system survey would, for example, measure fields, measure harvest per unit area, and also try to measure total quantity harvested, and thus be able to cross-check observations. Here, that wasn't possible.

Controllers in San felt that fuel use in artisanal activities like beer making and karite processing was sometimes hard to measure because of sheer size of the logs involved (too heavy for the scales).

There had been some initial problems with some of the observation forms (30-34). These problems were fewer than those with the forms on economic activities, in part, because the forms didn't have to encompass the same diversity. As above, problems sometimes arose in estimating quantities for activities taking place outside the compound; for example, the amount of wood stacked outside, or quantities of water used to wash clothes or give water to livestock. During the first months of the survey, no one distinguished between preliminary grain grinding (to remove the bran) and the actual transforming of grain into flour.*

However, the very number of concerns of the controllers and the number of detailed concerns in the "Conseils aux Contrôleurs" attests to their concern that the data be accurate. It is clear that even if the sample is not strictly representative, the estimates of fuel and water use and estimates of food preparation time will be based on a larger number of more careful observations than most available estimates, and will add greatly to our knowledge of time allocation and energy use.

Gao had by far the most serious problem in completing the pre-enquête, in part because of the illness of one of the controllers, in part because of the intrinsic difficulties of working in the zone, in part because of the distances to villages and the amount of earlier survey work that had occured in villages nearest to Gao. The survey proper did not begin until 2 September 1981 (three months after Nioro and Bougouni) and the survey was halted at several points due to lack of funds, forms and a vehicle. While the IER supervisor visited Gao several times during the pre-enquête, he said he did not visit the zone while the survey was in progress

The first installment of forms from Gao were not checked carefully by IER, and Koenig felt that the minute amount of work done (an average of 6 weeks of observations per village) and the number of serious mistakes she found on the forms made the data useless, and recommended in December 1981 that the zone be closed. IER, however, asked for and was given a three-month extension, and agreed to reduce the scope of the survey by eliminating the forms dealing with time allocation and revenue (forms 21-28) and to reduce the duration of the survey by ending it in June 1982, when Nioro and Bougouni would end.

One of the enquêteurs from San, Barry, was chosen to replace the Peace Corps Volunteer Controller who had been med-evacked in August, and the Volunteer controller from San, Burke, accompanied him to the field site to evaluate the situation. Burke visited all survey villages to look at recent data and to retrain the contrôleurs and enquêteurs. He found many problems with the forms 21-28, and felt that the observation forms (31-35) to date were completely worthless (Burke report, March 1982).

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*Mechanical grinding is thougnt to be a substitute for the second grinding, but not for the first without changing the taste of the flour. Other countries, however, do only a single grinding.

Since the data from the forms on food preparation and cooking were most central to estimating energy use, he reviewed them in considerable detail. Problems included not recording use of dung, very improbable amounts of fuel and cooking times, and problems keeping track of how many persons were present. However, after reviewing the observation methods with the enquêteurs he noted considerably more plausible observations.

Cashion was asked to visit Gao some 6 weeks later to see if there had been a durable improvement. He reported several encouraging developments: the new controller was working well and seemed to be helping the other controller perform better, the car was working, and another project had agreed to take on repair work for the survey vehicle, controllers were visiting the villages more regularly, and the enquêteurs seemed to be filling in the forms more correctly. However, the controllers had run out of forms, and many enquêteurs had missed work-days due to illness, lack of forms or absence of households. Cashion was also troubled by the data on cooking that he had transcribed. Burke had thought there should be a correlation between cooking time and fuel use. Cashion had calculated cooking time per kg. of fuel and had found few consistent trends, a finding that worried him considerably.

In a meeting to discuss Cashion's findings, we discussed the problem of whether or not one should expect to find a close correlation between total cooking time and quantity of wood consumed. We agreed that it would also be necessary to take into account the number of persons who would consume the meal (a proxy for the quantity being cooked). Stier volunteered to run multiple regressions of total cooking time and number of persons consuming the meal on quantities of fuel use for San, which was considered to have the best data of all the zones, and for Gao both before Burke's trip and after it to see if improvements could be discerned.

The estimated regression models from San are shown in table IV.C.3.a.i. In all cases, the estimated constant (which represents the hypothetical amount of fuel in kg. a fire would use that cooked for zero hours for zero people) is positive and between 1.9 and 4. The coefficient for X, total cooking time, which represents the extra fuel used (in kg.) per hour of cooking, is positive in all cases and between 0.60 and 1.83. The partial regression coefficient for X_2, number of consumers for the meal, is positive in all cases but one, and is considerably smaller than the regression coefficient for X_1. The coefficient represents the extra fuel used in kg. per additional consumer for the meal, and ranges from 0-13 to 0.49.

The multiple correlation coefficient, R^2, denotes the proportion of observed variability in the dependent variable (Y, fuel consumed in kg) is accounted for by the model, and ranges from zero to 1 (i.e., the model predicts all observed variation). It fluctuates in all the groups of models, and seems no higher, on the whole, for the San data than for Gao.

The estimated regression models from four villages in Gao before Burke's visit and after Cashion's visit are shown in table IV.C.3.a.ii. Although it would have been interesting to compare the results immediately after Burke's control with those just before Cashion's control, the samples were too small (with 4 to 7 observations per site and per enquêteur) to estimate a regression with two independent variables. It would also be interesting to have the standard errors of the regression coefficients, but the canned program and

TABLE IV.C.3.a.ii: ESTIMATED REGRESSION MODELS FROM GAO BEFORE AND AFTER CONTROL

Village	Enquêteur	Period	Model	R^2	df
Tassiga	4	Before CB	$-104.02 + 113.57X_1 + 1.13X_2 = \hat{Y}$	.344	10
	8	Before CB	$17.79 - 3.96X_1 - .016X_2 = \hat{Y}$	.130	7
	4	2/24 to 3/3 3/11 to 3/18	$2.21 - 0.85X_1 + .34X_2 = \hat{Y}$	.27	18
	11	2/24 to 3/1 3/11 to 3/18	$5.93 + 4.06X_1 + .36X_2 = \hat{Y}$	.24	15
Tabango (11)	1	14/12 to 16/1	$3.14 + 0.56X_1 - 0.129X_2 = \hat{Y}$	.24	6
	8	14/12 to 5/1	$.58 + .59X_1 - 0.08X_2 = \hat{Y}$	.26	13
	1	3/6 to 3/13 3/22 to 3/29	$2.66 - 0.24X_1 + .32X_2 = \hat{Y}$	.50	9
	8	3/6 to 3/13 3/22 to 3/29	$-0.10 + 1.56X_1 - 0.004X_2 = \hat{Y}$	.77	7
Lellehoye (12)	6	14/12 to 17/1	$-2.89 + 5.24X_1 - 0.06X_2 = \hat{Y}$	.40	9
	13	14/12 to 7/1 (Before CB)	$2.25 - 0.69X_1 + 0.23X_2 = \hat{Y}$	.26	9
	6	3/5 to 3/26	$1.26 + 1.15X_1 + .22X_2 = \hat{Y}$	.80	8
	13	3/5 to 3/26	$3.43 + 0.90X_1 + .05X_2 = \hat{Y}$	.09	17
Djidara (14)	9	17/11 to 11/12	$-.436 + 2.72X_1 + 0.265X_2 = \hat{Y}$	.20	10
	10	17/11 to 9/12	$13{,}854.63 - 900.71X_1 - 2139.38X_2 = \hat{Y}$	.418	7
	9	3/10 to 3/15 3/26 to 3/31	$6.26 - 0.64X_1 - 0.06X_2 = \hat{Y}$	.052	12
	10	3/10 to 3/15 3/26 to 3/31	$1.18 + .22X_1 + 0.006X_2 = \hat{Y}$	.04	17

TABLE IV.C.3.a.i: ESTIMATED REGRESSION MODELS FROM SAN

Village	Enqueteur	Period	Model	R^2	df
21	21 & 23	24/12/81-5/1/82	$4.01 + 0.91X_1 - 0.13X_2 = \hat{Y}$	.07	15
22	23 & 24	8/12/81-20/12/81	$2.39 + 1.65X_1 + 0.47X_2 = \hat{Y}$	.65	16
23	26 & 32	7/12/81-18/12/81	$2.77 + 1.83X_1 + 0.04X_2 = \hat{Y}$	.47	16
24	27 & 28	9/12/81-25/12/81	$3.55 + 0.60X_1 + 0.08X_2 = \hat{Y}$	.26	16
25	29 & 30	12/12/81-23/12/81	$1.94 + 1.21X_1 + 0.10X_2 = \hat{Y}$	.72	17

Note: X_1 = Total cooking time (in hours)

X_2 = Number of persons consuming the meal

Y = Quantity of fuel used (in kg.)

Since we're assuming the San data had relatively small errors attributable to the measurer, observations for the two enqueteurs in each village were lumped.

the TI-59 calculator used to calculate the models do not provide them. However, SPSS runs on larger sets of observations will furnish the standard errors at a later date.

There are clear differences between the models of Gao observations before Burke's visit, and the models from San. The Gao regression constants before the control range from -104.02 to 13,854.63. The regression coefficient for X_1 (total cooking time) range from -900.71 to 113.57, and three out of eight of them are negative, implying that fuel consumption decreased (all other factors being equal) as cooking time increased. The regression coefficients for X_2 (number of consumers) were also much more variable for the Gao data before control than for the San data, and they are negative in four cases out of eight.

The models from data gotten during Cashion's visit resemble the San models considerably more than do the models from before Burke's visit. All but one regression constant is positive and between -0.10 and 6.26; the regression coefficient for X_1 is between -0.85 and 4.06 and is positive in three out of eight cases, while the regression coefficient for X_2 is also within a more reasonable range. However, several factors which are not allowed for in the models may also be influencing total fuel consumption per meal, including the type of fuel, wind conditions, and the type of dish being prepared. The numbers of observations are still relatively small, and more complete runs should be performed when data have been entered.

Their preliminary analysis shows that recent data from Gao are far more reasonable looking than earlier Gao data and suggests that Gao may indeed be making some progress. The evaluation team concurs with Cashion's recommendation that the survey in Gao be continued until its planned termination in June with the other zones. However, maintaining and monitoring prototype devices in Gao is likely to continue to remain difficult and the evaluation team recommends that Gao not be used as a site for testing prototypes during Phase III unless technical requirements mean that high-priority devices cannot function elsewhere--for example, if wind speeds in more southerly sites are insufficient to make wind driven apparatus reasonable power sources.

a-ii. Open-ended Protocols

The quality of answers to the protocols varied. Although originally the protocols were to be written by the Controllers, in most cases the enquêteurs filled them in for each village and the role of the contrôleurs was mainly to explain the questions and to eventually compile the results for each village. The only zone for which the whole set of protocols was examined was San, but a significant part of the Nioro protocols were read, and Gerald Cashion, a sociologist at the AID Mission, made detailed notes on the protocols he read in Gao.

The quality and substance of the answers varied widely from question to question and varied among enquêteurs. On one hand, there are replies like the village history for Somo, which read like a close translation of a very detailed oral account. Some questions elicited little detail from most enquêteurs; these often included more detailed questions on social structure. For example, in reply to a question "Est-ce qu'il y a des conflits entre familles?", there were the following replies from San:

(Village 21): account of a fight over payment of a belier to be paid to the Government.

(Village 22): "Il n'y a jamais eu de désaccord entre les villageois."

(VIllage 23): "Depuis la fin des luttes entre les chefferies, il n'y a plus eu de conflit entre familles."

(Village 24): "Quelques rares fois il y a des conflits entre familles. Les conflits viennent surtout du fait que chaque famille se propose la chefferie."

(Village 25): "Il n'y a pas de conflits notables entre familles."

It might have been possible to get more information in an interview where it was possible to press somewhat more for an answer, and where oral replies could be taped and transcribed, rather than written out in longhand by the enquêteur. Even in San, not all enquêteurs seemed to write easily in French. In Gao, many replies consisted only of the question turned into a declarative statement. Concrete questions, especially that concerned energy use directly, got more detailed answers than relatively abstract ones, and on some questions there were very complete answers by the controllers (for example, food transformation in San).

Protocol no. 50 deals with needs assessment in fuel and water, and will probably interest the Laboratory. Many of the protocols on charcoal, water, and manure use cover the same topics as the Renseignements Techniques. It would be useful if the Lab were able to type up the protocol answers as they come in, and perhaps reproduce and circulate extracts.

b. Quality of the Data Analysis

There has been extremely little analysis of the quantitative data to date. The only tabulations that have reached Bamako are compiled frequencies of all variables on a couple of months of the data from San. The formats had been mis-specified in one printout (water consumption), and hence many of the data were unintelligible. Koenig provided a guide to the reading of the printouts. It would be very useful if there was more use made of value labels and variable labels on the printouts, to give the English and French labels on all codes and variables. It might also be helpful to make sure the Lab gets copies of the SPSS Handbook (in French if possible, as well as English) to give them fuller explanations of what all the printout items mean, and to give them a better idea of the kinds of analyses that are possible.

c. Lab Commitment and Use of Survey Data

The protocols and the Renseignements Techniques are only now reaching Bamako though much of the material on the needs assessment has already been discussed by Koenig, the project manager, and the Lab. In the course of its building the field prototypes of improved cook-stoves and checking on their use, the Lab personnel have learned a good deal from the enquête, the enquêteurs, and the villagers about cooking habits, dietary patterns and fluctuation in family size over time, and about how these factors have to be taken into account in field testing if the prototypes are to continue to be used. As the enquêtes in other zones end and as some enquêteurs and controllers become direct employees of the Lab, communication should become easier. The Lab has made considerable efforts to get information from the survey that directly bears on its R&D program and they have committed significant amounts of time and effort to overcome logistical problems in the survey zones. It seems likely that as data become available, the Lab will continue to think through their implications for field testing and for charting future work.

D. Administrative and Financial Performance

Summary: Though AID's administration was faulty during Phases I and II of the project, the causes are understandable and correctable. While many corrections have already been made and others have begun, solutions to some fundamental problems have not yet been agreed upon. There is still no clearly defined process for drawing upon the within-AID/Bamako competencies in administrative matters and knowledge of the energy needs of other USAID/ Bamako projects.

1. Project Chronology

Project implementation is behind schedule by more than two and one half years. Some reasons for the delays are:

- The non-functioning of the Interagency Project Committee chaired by the Director General of Hydrology and Energy and consisting of representatives from 12 different GRM administrations and organizations, and USAID. Had the Committee functioned, pressure could have been applied to USAID to speed up its procedures and to Malian agencies - e.g., customs and IER - to speed up theirs.

- Delay in installation of the early-start pumps was due to the inexperience of the Lab in contracting and supervision and to the failure of AID to recognize these problems and help solve them.

- Orders for equipment for the lab met substantial delays due to procedures for procurement, customs clearance, and other administrative functions. See Section IV.D.4.

- No decision has been made on when construction of the new Lab will begin. Architectural designs have been completed on schedule, but the architect's cost estimates of about 50,000,000 MF greatly exceed the amounts budgeted. USAID has yet to process the necessary waivers for open bidding and for purchase of non-U.S., non-Malian materials.

The following tables compare the schedule of the project plan with the dates of achievement.

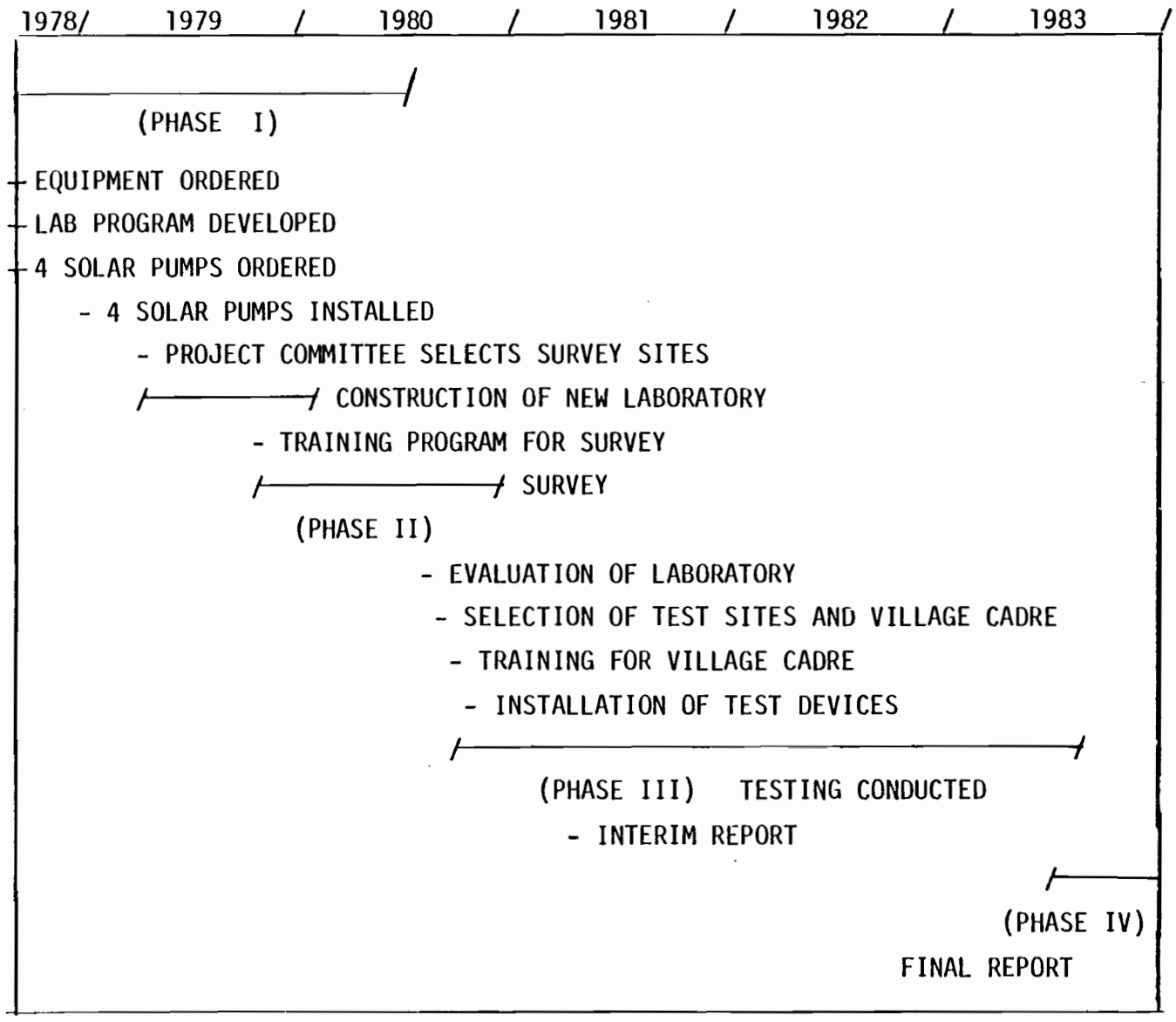
IMPLEMENTATION SCHEDULE - AS ORIGINALLY PLANNED

Event No.	Item	Date
1	Authorization	July 1978
2	Notice requesting expressions of interest for technical services contract issued	August 1978
3	Project Agreement signed	August 1978
4	Conditions Precedent for disbursement met	October 1978
5	Initial order of machine tools, scientific equipment and vehicles (8)	October 1978
6	"Early start" solar pumps ordered	October 1978
7	RFP issued to "short list" for technical services contract	October 1978
8	Recruitment of Peace Corps Volunteers initiated	October 1978
9	Technical services contract awarded by GRM	January 1979
10	"Early start" solar pumps installed	January 1979
11	Short-term economist/anthropologist/energy scientist mission established procedures for monitoring early starts	January 1979
12	Energy scientist arrives in Mali	February 1979
13	Contract for construction of new Solar Energy Lab awarded by GRM	March 1979
14	Recruitment of Phase II survey personnel initiated by I.E.R.	March 1979
15	Project Committee completes selection of survey sites	April 1979
16	Construction of Laboratory begins	April 1979
17	Equipment and vehicle (1) for new Lab ordered	April 1979
18	Training program for survey personnel	September 1979
19	Phase II village surveys begin	October 1979
20	Laboratory equipment arrives	November 1979
21	Laboratory construction completed	January 1980
22	Laboratory evaluation conducted and determination made on whether to proceed into Phase III	June 1980
23	Imported material for village tests ordered	July 1980
24	Project Committee selects final sites	July 1980
25	Village cadre and Phase III enumerators selected	August 1980
26	Training program for village cadre and Phase III enumerators	September 1980

Implementation schedule con't.

Event No.	Item	Date
27	Village surveys end	October 1980
28	Test devices installed in villages	October/November
29	Interim Report issued	April 1981
30	Progress reports submitted by Solar Energy Lab, social anthropologist and energy scientist*	October 1981
31	Phase III ends	April 1983
32	Phase IV evaluation begins	April 1983
33	Phase V begins	July 1983
34	Final Report issued	October 1983
35	Project ends	October 1983

*Also in April and October 1982.



RENEWABLE ENERGY PROJECT - MALI PLANNED SCHEDULE

IMPLEMENTATION SCHEDULE - AS CARRIED OUT

1978

Jan.	PID written
Feb.	
March	
April	
May	
June	PP written, approved
July	
August	26 - Grant Agreement signed
Sept.	
Oct.	
Nov.	3 - Impl. Letter No. 1 re. PCVs, ESSP, Project Committee
Dec.	29 - Impl. Letter No. 2 re CPs

1979

Jan.	20	- Meeting GRM/USAID/SERI
	21	- Drs Mackie, Goldberg (SERI) start week visit
Feb.	9	- Implementation Letter No. 3 - First CP met
	15	- Implementation Letter No. 4 - Technical Assistance CP met
March		
April		
May	14	- Implementation Letter No. 5 - Financial Procedures and First Year Budget
	31	- AID/W signs PASA
June	19	- DOE signs PASA
July	14	- GRM letter selects 4 A&E firms to be consulted
August		- SERI reps. visit Mali A&E contract signed 4 Peace Corps Volunteers (survey) arrive for two year tours
Sept.	17	- Contract between BEAU and Lab for A&E services signed
Oct.		- C.V.s of T.A. candidates studied
Nov.		
Dec.		- Higgins (equipment) two week consultancy
	13	- Contract signed between SERI and Brunet

1980

Jan. Eric Brunet arrives for 3 months, develops list of equipment which is ordered.

Feb.

March

April 16 Dr. Terence Murphy visit for 3 days (writes report).

May 9 Convention between IER and Lab signed.

June

July

August 7 - Dr. Koenig (survey) begins 3 week visit (assists evaluation).

10 - Dr. Kooi arrives for brief evaluation - writes report.

14 - New PCV replacement arrives - Dicko and Toure (wind and solar) leave for U.S. training.

14 - Dr. Malik arrives for brief visit (assists evaluation).

16 - Longmire quits survey.

Sept. 19 - Contract signed between SERI and Hart.

Oct. 20 - First long-term T.A. arrives; Hart.

Nov.

Dec.

1981

Jan.		
Feb.		- Dr. Ellis visits Dr. Walton TDY at Lab
March		Start of survey in SAN
April	1	- Roqueta (workshop) starts 3 month consultancy at Lab
	16	- Impl. Letter No. 7 CPs for construction Met.
May	21	- AID/W (Simmons) requests Financial reports from SERI
	23	- Park and Mikhail (wind) start week long consultancy
June	1	- Dr. Koenig (survey) starts 5 week visit
	5	- Wyatt (wind solar) starts 3 month consultancy
	6	- Flood (SERI backstop) starts week visit
		- Effective start of survey in Bougouni and Nioro
July	2-3	- Howe (SERI) two day visit
	8	- PASA increased by $201,142 extended to April 15, 1982 despite lack of financial reports from SERI
August	27	- Diarra to States for non-Project Univ. of Florida training
Sept.	13	- USAID/M receives SERI R&D program
Oct.	5-23	- Sokanda (Library) trained on project funds at VITA
Nov.	12	- Ward (AFR/DR/SDP) starts 4 day visit
Dec.	21	- Dr. Koenig (survey) arrives for four week visit

1982

Jan. 19 - SERI request $20,000 but provides no budget or justifications of past expenses.

Feb. 4 - PASA extended to July 30, 1982.

- Wright, Wietzenhoff begin consultancy.

March 3 - SERI request $31,020 amendment.

18 - PIO/T processed signed for $31,020 despite lack of financial reports from SERI.

April

May - USAID receives first financial reporting from SERI.

June

July

August

Sept.

Oct.

Nov.

Dec.

2. Contractual Performances: A Summary of Performance Under Project Contracts.

a. The Contract with SERI.

Within the framework of the project agreement, AID signed a contract with the Solar Energy Research Institute (SERI), of the U.S. Department of Energy to provide technical assistance to develop a research plan, provide publications and library materials, specify laboratory equipment and instruments, and establish technical and scientific contacts in the field of renewable energy.

In the last half of 1978, in 1979, and in part of 1980, SERI did not provide the required administrative and financial reports. Their liaison with USAID/Mali was not up to standard and the project suffered subsequently. Since mid-1980, thanks in large part ot the efforts of Richard Flood as SERI project manager, the situation has improved measurably. During this period SERI has assisted in providing technical specifications for the instrumentation, procuring of equipment, and providing the necessary liaison with USAID/ Washington.

The U.S. Department of Energy has abolished SERI's International Division and the SERI contract will not be renewed after its completion in July 1982. In view of the additional technical assistance needed by the Lab, it is recommended that an American organization replace SERI.

b. The Contract with the Architect.

A contract for the design of the new Lab building was signed with Malian architect, Baba Alpha Cissé, on September 1979. Though specific terms of reference were issued, the contract did not specify the cost of the building to be drawn up. The architect produced a design, the cost of which was estimated at 408,361,000 MF in August 1980 and, with subsequent inflation, the cost is expected to be as high as 500,000,000 MF in mid-1982, considerably higher than the amounts budgeted.

Performance of the architect was judged up-to-standard and the design was approved by USAID, by the Director de l'Habitat, and by the Lab although a cost of $80 per sq. ft. seems unnecessarily high (See section IV.B.7).

The serivces of the architect were contracted at a cost of about 20,000,000 francs to be paid in several installments. Sixty-nine percent of the total contract cost had been paid as of June, 1982.

The current rate of increase in building construction costs in Mali urges all parties concerned with project to release the bidding documents for the construction of the new Lab. With the intent of reducing these costs, it is recommended that wide participation of small local contractors be encouraged and that they be permitted to bid for lots of less than 100,000,000 MF. Fortunately the bidding documents prepared by the architect divide the construction into 10 lots of small sizes.

c. The Contract for Construction of Water Storage Facilities.

Métal Kouyaté, a Malian small contractor was given a contract to build storage tanks and watering troughs for the four solar pumps and to do so under both the supervision of the Lab and the Direction du Genie Rural. The job performed by the contractor has not been satisfactory. The tanks and troughs, particularly in Dilly, are leaking badly. The contract terms have not been met and, since installation of these pumps was supposed to demonstrate fast and efficient performance, the contractor should be urged to promptly repair the leaks so the pumps can be put in operation. It is our understanding that the contractor is prepared to repair the leaks but not to do so until other sizeable work in the Dilly area will minimize travel and other repair costs.

3. Financial Management

The Grant Agreement signed on August 26, 1978 specified that $2,176,000 be disbursed during phases I and II as follows:

	Phase I	Phase II	Total
	US $1000	US $1000	US $1000
Commodities	493	144	637
Technical Assistance	413	44	457
Training	16	10	26
Construction	350	--	350
R&D	38	50	88
Operating Exp.	124	152	276
Inflation & Contingency	262	80	342
Emergencies	--	--	--
	1696	480	2176

Two amendments to the grant agreement were signed, one on May 15, and another on August 30, 1981 in the amounts of $300,000 and $630,000 to increase fund to a total of $3,104,000.

During project implementation, disbursement and accounting procedures were governed by USAID rules and regulations. The newness of the rules and regulations to the Lab, the inexperience of its accountant, and the difficulty in dealing with two different accounting procedures created serious delays in processing the necessary documents to satisfy USAID requirements for fund disbursements. This has been a cause of misunderstanding between USAID and the Lab. After discussion between the two parties a new understanding was established. This requires that a three month budget be presented by the Lab and reviewed and approved by USAID before funds are disbursed. The process usually takes six to eight weeks from the submission of the budget to the disbursement of funds.

The justification of funds spent by IER in the survey zones has been a serious problem since the Lab has little control over the presentation of the justification. The enquêteurs and their controllers must send their receipts to their central accountant at IER in Bamako who forwards them to USAID through the Lab after approval. Each zone spends about 1,000,000 MF a month. This means that every three months approximately 12 million in Malian francs is floating around without justification and since USAID bases its disbursements on justified expenditures, the Lab budget could be short in an amount of about 12 million. The new accounting procedures have improved matters to the satisfaction of USAID and the Lab. The USAID controller's office has also organized a seminar on accounting procedures for all project accountants to improve financial management.

4. Procurement.

There have been substantial delays in procurement, particularly procurement of laboratory equipment, shop hand-tools, library documents, and publications. Though procurement is difficult in all USAID projects in Mali, there were unnecessary delays at four levels of procurement - in ordering of items, in carrying out purchasing procedures, in transport and transit, and in customs clearances in Bamako.

According to USAID procurement procedures for this project, a purchase order has to be issued and signed by both the USAID project manager and project director after a formal request is made by the Lab and funds are committed by the controller's office. Though it should not take more than a week for USAID to clear and sign a purchase order, past experience indicates that delays occured because of lack of communication between the parties.

Most of the items to be ordered are scientific instruments, laboratory equipment, and other specialized items which require carefully worded specifications. Seldom are these items available in Mali or neighboring countries and even if they were, waivers would be needed to purchase them locally. The use of the Afro American Purchasing Center in New York for the purchase of some items has not expedited matters; on the contrary, it has slowed down the process. It would have been better to ask SERI or some other technical contractor to handle directly the purchase of the scientific equipment. During the last year, SERI was able to procure items faster than the Afro American Purchasing Center.

Because Dakar offers good facilities, USAID/Mali is using it as port of entry. SIDICO, a small freight forwarder based in Dakar and represented in Bamako by Dosolo Freres, has been contracted by USAID/Mali to handle all their freight transport. SIDICO seems to provide good services to USAID though the goods ordered by the Lab must compete with other goods entering Mali, particularly cereals which have priority. The transport and transit times from New York to Dakar and Bamako are difficult to compress. Use of air freight instead of sea freight, whenever feasible, could reduce the time required for transport and transit.

In principle, goods ordered for this project are imported free of taxes and should clear customs quickly. Nevertheless, there are substantial delays in getting the necessary clearances from customs in Bamako. Such delays are not particular to this project. In some neighboring countries, the exoneration documents are stamped by project officials in accordance with appropriate customs procedures, a procedure that hastens customs clearance and one which might have applications in Mali.

5. Project Coordination

a. Collaboration Between AID and Other Malian Agencies Participating

Coordination was intended to be provided by an Interagency Project Committee chaired by the Director General Hydrology and Energy and consisting of representatives from the Solar Energy Laboratory, National Meteorology, National Directorates of Functional Literacy and Linguistics (DNAFLA), Génie Rural, Energie du Mali, Training and Rural Action, Water and Forest Department, the Malian Board of Livestock and Meat (OMBEVI), the Institute of Rural Economy (IER), USAID and such other organizations as the chairman believed would contribute to the work of the Committee. The anticipated importance of the Committee was indicated by requiring its setting up as a condition precedent to fund disbursements.

The Arrêté Ministériel no. 3643/CAB/MDIT dated November 25, 1978 created the committee and entrusted it with:

- the overall planning of new and renewable energy activities in Mali;
- the overall assessment of the technical and socio-economic conditions to which the energy activities of Mali would be addressed;
- the planning, coordination and conduct of all actions to be undertaken within the framework of the Solar Energy Laboratory project.

The committee has met no more than twice during the last two years. Because of its very nature and composition, it is too cumbersome to be effective; the work it could perform is too general to be useful. At least, part of the functions of the committee may soon be performed by the administrative organization to be set up within the Ministry of Industrial Development and Tourism.

Unless strong assurance can be given that the existing committee will be reorganized so as to perform its intended functions, it should be disbanded in favor of a more effective and presumably less formal means of coordination. (See Appendix F.)

b. Project Coordination Within AID and Between AID and the Lab

i. Coordination Within AID There does not appear to have been an effective procedure for analysis and correction of problems that went beyond the responsibilities of the project officer or for internal examination of project performance and mid-project correction. There was no committee--comparable to those for other AID projects--of USAID/Mali personnel having interest in Mali's energy problems as these are reflected in the energy needs of the other AID projects. The Lab had no means to present to AID personnel a report on its accomplishments and its potential for assistance with the energy needs of other AID projects. AID appeared aware of unanswered official correspondence and there seemed to be no system to log in such correspondence and assure its reply. There was little evidence that the project delays occasioned by AID procedures or administration of them were treated seriously.

Coordination between AID and the Lab was inadequate but the difficulties appear understandable and correctable. Early in the project an AID consultant recommended that the project be terminated unless there was a change in the administration of the Lab. When the project officer attempted to respond to a mission decision to this effect, and when his assistant was suspected of fomenting disloyalty among Lab personnel, the project officer's ability to work collaboratively with the Lab was severely impaired.

Apparently, as a result of this, official letters from the Malian Government went unanswered and requests of the Lab Director to meet with AID personnel were not acted on. Project changes, tacitly agreed to by AID and the Lab, though in contravention of the intent of the project agreement, were never made a matter of record. Changes in the Project Agreement were made by AID without notification to the Lab or to other agencies of the Malian Government. Although critical of the Lab's administrative procedures, USAID missed opportunities to help the Lab improve its methods of accounting, purchasing, customs clearance, and sub-contracting. Recently, however, coordination has improved substantially and the Mission is now providing this kind of assistance.

For this project at least, USAID does not appear to have established a procedure for examining whether there have been departures from the terms of the project agreement and for determining whether project amendments should be adopted. For example, AID was aware that the Lab's advisory committee was not functioning as spelled out in the Project Agreement but did not inform the Lab of non-compliance nor recommend alternative means for obtaining the kind of surveillance and advice that had been intended. Similarly, when the Lab formally notified AID that it was not in compliance with the terms of the agreement to construct the Laboratory, AID took no steps to reach accord on an amendment.

V. CONSLUSIONS AND RECOMMENDATIONS FOR PHASE III

A. General Summary

The evaluation team finds that the Renewable Energy Project is satisfactorily achieving the objectives set forth in the Project Document and that, having met the criteria established in Section 5.2(b) of the Project Agreement for evaluating performance in Phases I and II, the team recommends that the project proceed to phases III and IV.

The principal conclusion of the evaluation team was that, although the management and technical performance of the Lab were inadequate to accomplish the goals of the project during the first two years of implementation, management performance has improved markedly during the past year and a half, and the Lab is now performing well enough to satisfy the requirements of the project. Implementation of the project has been slow, particularly in securing long-term technical assistance for the Lab and in commodity procurement. Better management principally by the Lab, but also by the USAID/Mali and by the Solar Energy Research Institute (SERI) could have lessened the delays, The Afro-American Purchasing Company (AAPC) was not an effective procurement agent for the USAID, and the resulting delays significantly harmed overall project performance. Another continuing problem has been the lack of communication, cooperation and collaboration between the management of the Lab and the USAID/Mali project officer. The project is too large and complex to be supervised by a single officer, and there has been no group within the USAID to counsel and support the project officer.

Installation of the early start pumps at Dilly, Samanko, and Mopti was delayed for about one and a half years due to inattention on the part of the Lab and USAID/Mali. The pumps have thus begun to perform their intended demonstration purpose only recently. The Committee that was set up to coordinate the Lab activities with other GRM agencies has met only once during project implementation, and has thus been ineffective. There is no reason to think it will function better in the future. The National School of Engineering (ENI), the École Normale Supérieure (ENSUP), and the Central Veterinary Laboratory (CVL) have also done almost no project work to date, although the ENI has supplied eight new engineers to the Lab since the start of the project. However, ENI and ENSUP are now preparing their research programs, and will soon start their work.

The Project Paper survey design was extremely ambitious in terms of the number of zones and number of communities to be covered. It was oriented toward providing baseline data for an exhaustive impact evaluation of prototypes, rather than toward meeting the immediate information needs. Early in the project, the Lab was unable to help draft the survey questionnaires, and later in the project the role of the Institute d'Economie Rurale (ER) as field supervisor for the survey teams hampered communications between the Lab and the field. There were significant delays in selecting sample communities and in beginning the socio-economic survey, and turnover in personnel was a continuing problem. The IER was not able to give the survey teams adequate logistic support, and was also unable to collaborate technically with the Lab. The quality of field supervision in the zones varied from excellent to poor-but-improving.

In spite of these difficulties, the survey has furnished a valuable characterization of rural energy use, and will give estimates of energy use, time allocation and consumption patterns based on year-long observation of a large sample of households. The anthropologist who drafted the questionnaires was able to reduce the survey specifications to a more manageable scale and to design questionnaires and coding schemes that were comprehensive and comprehensible to enquêteurs with relatively little schooling. The Lab has begun to draw on the controllers' and enquêteurs' knowledge of rural energy use patterns and has sought to actively incorporate this knowledge into its program of field testing. It has furnished logistical support to the survey teams and has committed considerable amounts of staff time to coordination with the field teams and with the Lab.

Despite delays in implementation, the project is well within its budget, and the financial management of the project is to be commended. The facilities now available to the Lab are not adequate to allow it to carry out its work in the remaining phases of the project. Despite the increased technical capability of the Lab personnel, continued technical assistance will be necessary over the next two years. Shop capabilities are not yet adequate, and need up-grading through technical assistance. Fortunately, the present project budget will suffice to cover construction of the new laboratory building as well as technical assistance.

The incentive bonus system at the Lab, designed to reward good work, has been successful. We estimate that the laboratory will have developed sufficient administrative and technical capabilities in two years to carry on with reduced levels of technical assistance.

Prototype development by the Lab is promising, but should be re-directed by preliminary survey results and by technical and economic analysis. Preliminary assessments of rural needs give highest priority to pumping water, grinding grain, and farm labor. In order to satisfy these primary needs, the Lab should concentrate on the following technologies (in order of priority): (1) photovoltaic, (2) wind, (3) stoves, (4) biogas, and (5) dryers.

The Renewable Energy Project has thus far contributed little to other AID-financed projects (or other donor-financed projects), but could be a valuable technical resource for projects involving water pumping, grain grinding, and other energy-consuming functions. The evaluation team believes that establishing the Centre Regional de l'Energie Solaire in Bamako will assist the Lab in performing its functions, particularly with library and information services, technical and scientific exchange, cooperation and coordination within Africa and outside it, and interchange of laboratory and shop facilities. R&D will also be enhanced by cross-fertilizing ideas.

The member of the evaluation team responsible for analysis of management believes not only that the project is achieving, and seems likely to improve not only in achieving the objectives specified in the Project Agreement but also in satisfying in large measure the six other criteria for assigning priority to this project that have been adopted by USAID/Mali, mostly informally.
These include:

1. The lab has the ability, and will have government of Mali authorization, to become partially self-supporting. The lab has a list of prospective clients and, based upon the document already approved by Mali's Council of Ministers, will have authority to receive and disperse funds.

2. The Lab will have prominence in Mali's energy efforts. A reorganization within the Ministry of Industry and Tourism has been approved by the Council of Ministers. This increased stature should enhance coordination within the Ministry and with other agencies.

3. Phases III and IV of the project, including construction of the new lab, can be carried out without an increase in budget.

4. The project can become complementary to other USAID/Mali projects. It can help to achieve overall AID programming coherence, and, given the expected resolution of internal problems, should place less demand on USAID/Mali administration.

5. The Lab will complement the activities of the Centre Régional de l'Energie Solaires (CRES) rather than duplicate or compete with its functions.

6. The Lab should require little administrative and technical consultant assistance after completion of the USAID project and Lab administration should be more than adequate for the increased responsibilities it may be asked to assume in the reorganized Ministry.

B. Laboratory
(See also Section VI where these recommendations are listed according to priority):

1. Buildings and Facilities: The evaluation team recommends that the new Laboratory be promptly constructed and occupied. Although construction costs are higher than estimated in the Project Paper (even including inflation) there is sufficient money in the Phase I and II inflation and contingency funds to build the Laboratory, provided the Laboratory personnel do some of the construction themselves as they did with the shop at the present site (see Section IV.B.5).

2. Laboratory and Shop Equipment: We recommend that the current equipment list be revised and that additional equipment, as needed for Phase III, be ordered as soon as decisions, following from the survey results, are made on the future course of the R&D work and on the devices to be installed in the villages.

3. Library: We recommend that the French language component of the library be augmented through purchase of French language periodicals, books and reports. Contact with the "Energy Center" in Paris would be useful.

4. Personnel: Lab personnel (the responsibility of the Malian Government) should be maintained, in number and in competence, at a level sufficient to satisfy the needs of Phase III. The training and technical assistance recommendations are designed to help accomplish this. Furthermore, we recommend continuation of the Incentive Bonus system funded by the Project since it has proven to be quite effective.

5. Training: We recommend training be continued as planned and budgeted during Phase III (see Section IV. A.2).

6. Vehicles: We recommend that the Project sell, exchange, buy, and re-assign vehicles as necessary in order to reduce costs and to accommodate to changing conditions and field assignments.

C. Technical Assistance

1. Long-term R & D

We recommend that Terence Hart be retained as technical assistant to the project for two years. We believe that in two years a full-time technical assistant will no longer be necessary. The momentum gained during the past 1½ years could be lost if he were to leave at the end of his present contract (July 1982). Furthermore, we specifically recommend extension of Hart's contract because of his outstanding performance during the first 1½ years, his close working relationship with the laboratory personnel, and his intimate knowledge of all aspects of the project. This is our strongest recommendation concerning technical assistance.

We recommend that an experienced general shop manager with design experience and with the ability to train and motivate people be retained for a one year period in order to raise the level of shop capability. The shop personnel, in general, are not capable of doing many necessary tasks and the quality of work is too low. Alex Roqueta is an ideal candidate for this job.

2. Short-term R & D

The short-term technical assistance program which has been very effective and useful should be continued as the budget allows. One technical area that has been relatively neglected with respect to technical assistance is photovoltaics. We recommend that this deficiency be remedied. Assistance can perhaps be obtained from NASA Lewis Research Center, which has highly qualified and experienced people, at no cost to the project since they have an assistance contract from AID (ST/EY).

We also recommend that short-term assistance be continued in the electronic and instrumentation area. It is especially needed in order to unravel some particularly knotty problems due to improper instrument procurement during the early stages of the project.

3. Programming and Research Design

Further training of Lab administrators and engineers should be provided in research planning, research project design and report writing whether by short-term technical assistance, by thorough training of someone at the Lab who can train others, or by other means. See also Section V.D., Project and Technologies Direction: Summary.

D. Project and Technology Directions: An Analysis by Clarence Kooi

The Project Paper set certain project directions and recommended that development work be carried out on a number of renewable energy technologies. Now, four years later, it is time to reconsider these project and technology directions in the light of new information and new conditions.

Information from the field and from the energy survey has become available. Technologies have developed and changed considerably in four years. General and specific knowledge of rural energy needs has improved. The people working on the project have developed a more mature viewpoint concerning renewable energies as needed in the rural Malian milieu. Therefore, it is time to emphasize some technological directions and to de-emphasize others.

There are also external factors which have changed; for example, CRES (the Centre Regionale de l'Energie Solaire) will soon come into being. New and continuing AID projects have energy needs and aspects not formerly apparent or considered. Other donor agencies, government agencies, and educational institutions have become involved in energy work related to that of this Project. It is time to re-examine the Project direction in light of these developments.

1. Focus of Renewable Energy Efforts:

Human Energy in Rural Mali

Solar energy is essentially the sole source of energy in rural Mali. Via photosynthesis it produces food, fiber and fuel. Via natural physical processes it lifts water from the oceans for human consumption. In favorable circumstances people would have little more to do than accept and consume these gifts of nature. However, in the inhospitable environments of rural Mali it is necessary to facilitate or subsidize these natural processes. Thus agriculture is practiced, wells are dug, cattle are tended, and houses are constructed. These activities require a source or sources of energy controlled by humans. This energy has been called by Slesser 1/ "Energy Subsidy". In rural Mali the Energy consists primarily of human energy.

That the Energy Subsidy in rural Mali is primarily energy produced by human muscle was recognized by Dolores Koenig as a result of her work with the project's energy survey. She states "It is clear that we have overlooked an even more important source of energy... That source is human

1/ M. Slesser, C. Lewis, and W. Edwardson, Food Policy, p. 123 (May 1977).

labor power, and human energy was in fact the most common source of energy for all tasks..."2/. She also noted that the rural people were particularly concerned with the labor they expended in producing and preparing food and in obtaining water. She states "Over and over, people complained of the amount of time necessary to do certain tasks, particularly to get water. What they wanted was relief from their daily work load. The most common innovations that interested villagers were pumps (to relieve the work in getting water), mills (to relieve the work in pounding grain) and more agricultural equipment (to relieve the work in hoe farming)". These observations are in accord with observations of the evaluation team both in connection with this project in Mali and in other countries of West Africa.

If the Energy Subsidy is limited to human labor not only do people find the drudgery disagreeable but, as we shall see in the next section, their productivity and incomes (and standard of living) are limited. Furthermore, there is little time left from the daily cycle of drudgery (especially for women) in which to pursue work that takes advantage of skill and intelligence, with which humans are far better endowed than with the muscle power. It is evident that something needs to be done about the rural Malians near total dependence on human labor.

b. Productivity and Energy Subsidy

Many studies have established that food productivity increases as the energy subsidy is increased.3/ The energy subsidy consists of all energies (for land preparation, planting, tilling, fertilizing, irrigating, chemicals, etc.) under human control that go into the food production process. In the case of Malian villagers it consists almost entirely of human work. A relationship between productivity and energy subsidy is shown in Figure 1:4/ It is evident that, if all other conditions (soil, climate, etc.) are the same, agriculture that is restricted to human labor inputs has a ceiling on productivity. It is true that very intelligent use of the human labor input can increase productivity and the curve of Figure 1 would be raised somewhat. However, the really significant productivity increases require increased energy subsidy.

The effects of increased energy subsidy on output per person (rather than hectare) are even more pronounced. A Malian farmer can perhaps produce one ton of maize per year. An Iowa farmer can produce over 1,000 tons per year. If the Iowa farmer were limited to a human energy subsidy only he would be hard pressed, even with all technical, soil, and climatic advantages, to produce more than 5 tons per year (and his farm income would be not much higher than that of a Malian farmer).

Since the Malian farmer's (farm) income is proportioned to his or her annual production he or she must always remain poor if limited to an energy

2/ Dolores Koenig, "Reflections on the Design of Energy Projects for Developing Countries". Report submitted to USAID, undated.
3/ References are not available but will be supplied upon Dr. Kooi's return to Abidjan.
4/ There exists a wide variety of similar Productivity-Energy curves for many food systems and for other productive enterprises.

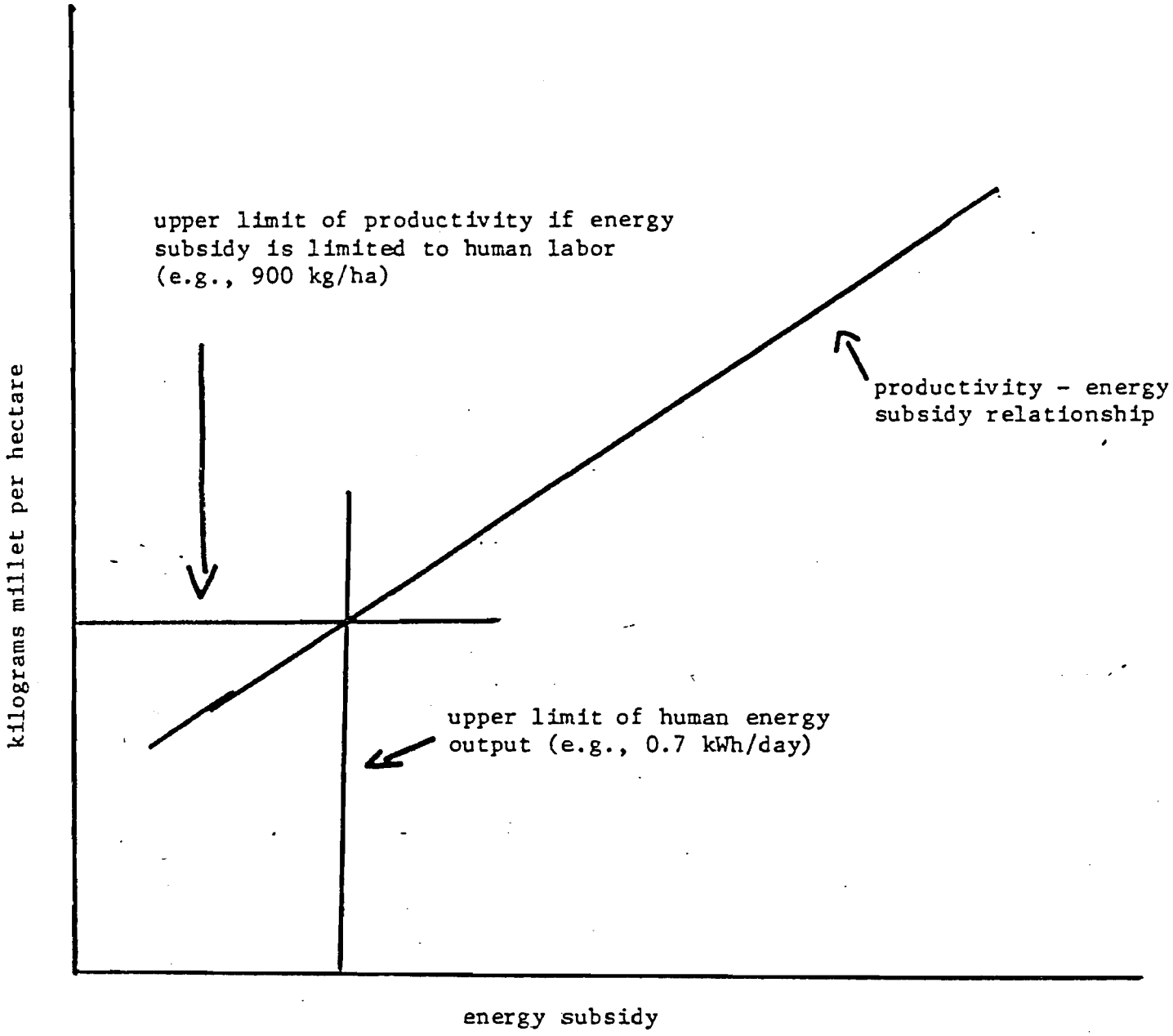


Figure 1: Relationship between productivity and energy subsidy showing limited nature of human energy.

subsidy consisting entirely of his or her labor. At 25¢ per kilogram for cereal grain the annual (farm) income would be about $250. The farmer must either acquire means to increase the energy subsidy or obtain a non-farm source of income if he or she is to emerge from poverty.

As a consequence of this line of reasoning and taking into account information from the field and preliminary survey results, we arrive at the principal objective of renewable energy technology development for rural Mali.

Objective of Renewable Energy Technology Development for Rural Mali

To increase, and render more effective, the energy subsidy to the food and water production processes in rural Mali so as to reduce human labor and increase production of food and water.

How to Accomplish the Objective

It is convenient to break down the approaches to increased (or more effective use of) energy subsidies into four categories. These are:

(1) More effective use of human labor through better hand tools and human powered machines (e.g., hand grinders) and through development of better techniques for applying human labor.

(2) Use of animal power.

(3) Use of fossil fuels (e.g., diesel engines, tractors, industrial fertilizers).

(4) Use of renewable energies.

This project, as developed in the Project Paper, deals exclusively with number (4). The team which wrote the Project Paper decided that inclusion of numbers (1), (2) and (3) would simply spread resources too thinly and that it would be better to do one thing well rather than dabble in many things. Furthermore, there are many animal traction, hand pump and farm tool projects in West Africa. For example, USAID in Upper Volta has a $12,000,000 well-digging and hand pump project and USAID in Mali has at least eight projects that deal with animal power.

Human Powered Devices

However, the evaluation team recommends that human powered devices be given some attention. Hand-powered grinders should be evaluated. Work on human-powered pumps is not recommended since that is such a well-worked area (with a low success rate) that an additional effort by the project is not likely to add much. Furthermore, the problem with hand pumps is primarily one of setting up financing, installation, sales, service and spare parts businesses, all of which lie somewhat outside laboratory abilities.

The first step in introduction of human-powered grinders is to determine if they really are more efficient than the mortar and pestle. They must increase production of flour and/or reduce labor sufficiently to justify

their initial and maintenance costs. Then they should be introduced into villages to test customer acceptability and to determine maintenance and parts requirements and also useful life of the equipment.

This same procedure should be followed for introduction of other human-powered equipment. An essential part, almost universally ignored, is the initial testing to see if the device actually has a ghiher for a given human labor input. This should be one of the first tests of any new human-powered device.

Renewable Energies

Heretofore, the laboratory has felt obligated to work on all of the renewable energy technologies listed in the Project Paper. However, in order to more effectively attain the objective stated above it is time to re-direct and to focus the efforts of the laboratory. The technologies that promise to fulfill the objective should be emphasized, those that do not should be de-emphasized. In making recommendations to this end we shall consider broad areas only since specific decisions should be left to the project and laboratory personnel who are better qualified than the evaluation team to make such decisions. Furthermore, many decisions concerning emphasis or de-emphasis of technology areas or specific technologies should await the final results of the survey*.

Renewable Energy "Prime Mover" Development

The high priority needs--water pumping, grain grinding, and agricultural work--require mechanical and/or electrical power. "Prime movers", that is devices which produce such power, are required. These are, for example, internal combustion engines (running on biogas, ethanol, methanol, vegetable oils or wood), photovoltaics, solar thermodynamic engines, wind machines, water turbines, etc. A few of these show promise in the rural Malian context. These should be emphasized. The laboratory is currently working on wind, photovoltaics and biogas and is considering work on solar-powered thermodynamic engines. It is a question of which should be emphasized. This question can only be answered by continued and thorough analysis, tests, and trials. At present it appears that photovoltaics has great promise but costs must be reduced; wind has promise but only in northerly parts of Mali where wind speeds are adequate; biogas-driven motors have limited potential due to a combination of cost, operational requirements, and lack of easily collectible feedstock; and solar thermodynamic engines are either too expensive or not yet sufficiently developed**. Therefore, we recommend that the laboratory put a primary emphasis on photovoltaics, a secondary emphasis on wind and biogas power and drop work on solar thermodynamic engines.

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* It may turn out that installation of improved stoves in some of the villages in the San region is a mistake that could have been avoided if the information from the field and from the survey has been available. Preliminary information indicates that the villagers in the San region are more concerned with energy inputs to agriculture and water pumping than to cooking.

** Thermodynamic engine development at the laboratory is well beyond the capabilities of the laboratory for the next few years at least.

These "prime movers" do not furnish the mobile power needed for agricultural field work and transportation. This would require engines using liquid, gaseous or solid fuels of renewable origins (ethanol, methanol, vegetable oils, wood, etc.). Mali does not, at first glance, appear to be well endowed with the potential for producing such fuels. However, we suggest that the laboratory do some thinking along these lines because of the great importance of mobile power in agriculture.

At present mobile power for agricultural work is furnished primarily by humans and animals. Since other Malian agencies and other AID projects work in these areas we recommend that the laboratory not get involved in them. It should be noted that production of stationary power for pumping and grinding, for example, releases human workers for mobile field work, thus contributing indirectly to solution of that problem.

Even though major decisions should await the final survey results we feel that enough is already known to make some fairly firm recommendations concerning work on renewable "prime movers".

Photovoltaics: Up to now the laboratory has worked primarily on testing commercial units. It is time to start development work. Perhaps the most important areas are photovoltaic pumps, grinders and general power systems. The pumps available on the market are quite expensive, primarily because the balance of systems (BOS) costs are high. The BOS costs are all costs except for the solar panels themselves. In a 1,000 watt pump selling for $30,000 one can estimate that only 1/3 of the cost is due to the photovoltaic panels, After installation costs are added it may be only 1/4. Therefore, real savings should be possible by attacking the BOS and installation cost area. This can be done by buying the parts and designing, assembling and installing the pump with laboratory personnel. Much of the material could be purchased locally. The laboratory already has shown that it can install a photovoltaic pump (Samanko) more economically than a contractor can (Demba Diawara, Camp Modibo, Mopti). It's time to follow it up with design and assembly. Similar efforts should be made on grinders and later on general photovoltaic power systems.

Windmills: The laboratory is already heavily involved in windmill development. We recommend that it continue along present lines. One of the most important of these lines appears to be the development of a locally made windmill, with locally available materials, which has more reliable performance than the Sahores windmill*. This is an attempt to arrive at the optimum middle ground between higher performance equipment which is more reliable and more expensive and lower performance equipment which is less reliable and less expensive. The laboratory has the beginnings of a first-rate effort along these lines and it should be strengthened.

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* From Peace Corps record books on the VITA sponsored Sahores windmills (records kept from Oct. 20, 1981 to February 15, 1982) there were fifty-one instances of repair and malfunction. Only one of the pumps, Sama no. 2, appeared to be working well by February 15. Therefore, attempts to ameliorate the quality of these windmills appear to be needed.

It appears that there is another very important piece of work in the wind area that the laboratory can do. Wind speeds decrease as one goes further south. Therefore, the cost of wind-pumped water increases as one goes south. Technical-economic work should be undertaken to determine what this geographical-cost relationship is. There is also some folklore which says that winds along the river are stronger than those some distance from the river. This should be verified. This work is of considerable importance since the wind speeds in Mali are low and it may turn out that wind-pumped water is simply more expensive than that pumped by other means in large areas of Mali.

Biogas: We recommend that engines be tested on gas from the laboratory digester so that if suitable locations can be found for installation (which is yet to be done) the laboratory will be prepared to do so. The engine would drive a grain grinder.

Solar Thermodynamic Engines: We recommend that this area of work be discontinued because the laboratory does not have the capability to do useful work in it. It would take a first-rate machine shop and engineering experience which does not now exist at the laboratory.

Non-"Prime Mover" Renewable Energy Technologies

Improved Stoves: The laboratory has a good program in this area. It should be continued and respond to feed-back from the field. As with windmills the program should search for the optimum between high performance, long life, high cost and lower performance, shorter life, lower cost.

Solar Dryers: Future work should respond to the results of the survey. If need cannot be demonstrated and the cost/benefit ratio remains high the work should be de-emphasized.

Solar Distiller: Unless a need for expensive water can be demonstrated this program should be discontinued.

Solar Hot Water Heater: This effort will probably not contribute to the project since the need for such relatively expensive hot water in a village will probably not emerge from the survey. However, solar hot water heaters have good prospects in cities where they compete with electric hot water heaters. We recommend that the quality and life of the heaters be improved, that they be made more automatic so that misuse can be reduced, and that after-sale service be improved.

Biogas: We recommend that present work be continued. When survey results are available a decision on field installation should be made.

Solar Cooker: Unless new ideas emerge this work should be discontinued.

2. Support of AID Projects

There are energy inputs and energy components in all AID projects. Agricultural projects require numerous energy inputs--field work done by people, animals or tractors, water pumping done by diesel pumps, people, or solar pumps, etc. Health projects use refrigerators for vaccines (which could be solar regrigerators). All projects need lighting, communications, and transportation--all energy consuming. In fact, the Renewable Energy Project is a small part of the total AID energy project in Mali.

The Renewable Energy Project should assist the other projects. Renewable Energy pumps can be operated alongside diesel pumps in order to compare technical and economical aspects of operation. Lighting, communication, and refrigeration can be powered by sun or wind. Even transportation and agricultural field work can be done with renewable energies (gasohol, gazogene engines).

Therefore, we recommend that the Renewable Energy Project personnel examine the AID energy projects in Mali to determine where the project can contribute, coordinate, or advise. Discussions with project leaders should be held and joint efforts initiated where indicated. An example is the proposed installation of several solar pumps in the Action Blé project in order to compare their performance to diesel and animal pumps.

More specifically, the Evaluation Team's management person recommends that:

o USAID/Mali Project Directors and Project Officers be asked to inventory their energy needs and submit them to the Lab for consideration.

o On a regular schedule, the Lab make presentations to Project Directors and Project Officers on Lab work that bears on USAID/Mali project needs.

o Lab representatives visit those USAID/Mali projects in which specific renewable energy needs are identified and that a report be submitted to the AID Project Director identifying which, if any, energy problems the Lab can be of help.

o Where practical, the Lab be awarded a USAID/Mali sub-contract to do energy research or product development addressed to USAID/Mali project needs.

3. Support of Other Malian Projects

There is a great deal of energy work going on in Mali. Machinisme Agricole is building biodigesters; Mali Aqua Viva is installing photovoltaic pumps; the Segou Catholic Mission is manufacturing and installing windmills. The Project should (and is) coordinating and assisting in two of these projects. We recommend that this be continued and expanded as the laboratory decides. It should be recognized that this takes time,

effort, and money. Such cooperative efforts should be limited to a level which does not detract from the laboratory's main programs.

4. Relations With Regional Solar Energy Center (CRES)

Mali is part of a regional organization of the West African Economic Community (CEAO) headquartered in Ouagadougou (Upper Volta). Among other communal regional activities, CEAO is establishing a regional center for solar energy (CRES). The capital of Mali has been selected for the site of the center. According to its terms of reference, CRES will mostly perform coordination in research and development, production, and financing of solar energy devices undertaken by the existing national centers.

There are now three existing centers in the member countries of CEAO: Laboratoire d'Energie Solaire (Bamako), Energie Solaire (Niamey), and Centre d'Etude et de Recherche pour les Energies Renouvelables (Dakar). Ivory Coast, Upper Volta, and Mauritania are also making efforts to set up national laboratories and research centers, and CRES will help them in this work. CRES will primarily be staffed by scientific, academic, and administrative people from member countries; technical assistance will be provided by the world scientific and academic community.

The establishment of the Regional Center in Bamako will make the Malian capital the renewable energy center of the sub-region. It will provide an opportunity to build relations with other international scientific organizations and provide a flow of scientific information to CRES member countries. Because of proximity, the Solar Energy Laboratory will be able to draw on these resources and the establishment of the CRES in Bamako will thus help the the Lab to perform more effectively.

E. Field Work and Survey: Summary

1. Survey Design, Sampling Strategy, and Survey Implementation

The Project Paper survey design was extremely ambitious in terms of the zones to be covered. It was oriented toward providing base-line data for an exhaustive impact evaluation of prototypes to be placed in rural communities rather than toward meeting the immediate information needs of the Lab. Early in the project, the Solar Energy Laboratory (Lab) was unable to make input to the drafting of the survey documents, and, when it began to request information, the role of the IER as field supervisor for the survey teams hampered communication.

In spite of these difficulties, the survey has furnished a valuable characterization of rural energy use, and will give estimates based on year-long observation of a large sample of households for energy use, time allocation, and consumption patterns. The anthropologist who drafted the

survey instruments with the help of the IER was able to reduce the survey specifications to a more manageable scale and to design questionnaires and coding schemes that were comprehenisve, amenable to analysis, and, for the most part, comprehensible for use by enqueteurs with relatively little schooling.

The Lab has begun to draw on the controllers' and enquêteurs' knowledge of rural energy use patterns and has sought to actively incorporate this knowledge in its program of field testing. It has already demonstrated a commitment to keeping the survey going in terms of logistical support and in terms of staff time spent in coordination. The evaluation team recommends that the Lab take on responsibility for supervising and coordinating, monitoring and evaluation of prototypes in field testing, as it has already begun to do in San, rather than continuing to contract with the IER for Supervision.

2. Analysis of Present Data (See Section IV. C. 3. b.)

Material that is now reaching Bamako from the survey zones, as answers to the protocols and to the Lab's requests for Reseignements Techniques, should be circulated and discussed within the Laboratory and in the field survey zones where trials of prototypes are beginning. The bulk of the quantitative data will not be accessible, however, until it has been entered, tabulated, and aggregated. Nevertheless, special hand-tabulations, like those done to illustrate the data problems at Gao, can be very useful and can provisionally answer questions like: "What was daily wood consumption in Nioro villages before the introduction of the stoves?"; "What have been the effects since the introduction of the stoves?"

The evaluation team recommends that the project make all possible efforts to assure that the survey data from Phase II be analyzed rapidly and that the results be made available to the Lab. This means updating the 1980 estimates of the cost of data entry and analysis and earmarking sufficient Phase III funds to cover data entry costs, programmer time, computer time, supplies, and for contracting for the services of an analyst experienced in West African energy surveys, preferably Dr. Koenig.

3. Reporting Findings

In addition to preparing reports on the survey findings, the analyst should have responsibility for discussing the results in detail with the Lab, for synthesizing the results, and for working with the Lab to clarify the survey results' implications for the Laboratory's R&D priorities.

4. Phase III Activities

a. Needs Analysis

From answers to the protocols dealing with needs assessment for the survey communities and from her own discussions with villages in the course of the survey, Koenig reached some preliminary conclusions about the sorts of devices people said they needed. Rural communities used very few non-renewable energy sources and, in many cases, did not perceive scarcity of renewable energy sources as a major problem. What they were most aware of was the amount of labor it took them to get water, to prepare grain, and to farm, and what they were most interested in were affordable innovations that would lessen the human power required for these tasks.

Many such devices fall to the lot of projects in "appropriate technology" rather than projects in "energy" per se. Some sorts of development are probably not tasks that the Lab should involve inself in; for example, developing and improving animal traction equipment for agriculture. Other institutions and other projects have more resources and experience in some of these fields than the Lab. However, the Lab can take account of these priorities by concentrating its R&D efforts on the prime movers with the most potential to carry out the tasks that were seen as most important: raising water (for human, livestock, and agriculture) and grinding grain.

Urban populations were probably more aware of the cost of fuel and its increasing scarcity because of having to pay cash for it, and innovations that improved efficiency in the use of renewable resources, like improved stoves, would probably be more attractive to city and town dwellers than to rural denizens. Service institutions in both rural and urban areas that consume non-renewable energies would also find increasing use of renewable sources of energy attractive.

b. Personnel and Consultants

Under the Project Plan, Phase III is to concentrate on field tests of energy innovations, and the socio-economic inquiry is to be narrowed to concentrate on the variables most closely bearing on evaluation of the prototypes being field tested. The Lab will need technical assistance in designing the monitoring and evaluation for the field prototypes providing technical oversight for the monitoring and evaluation effort, and in analyzing the data as they are gathereed. The evaluation team recommends that the Lab contract for the services of an economist and/or social scientist to design and oversee monitoring and evaluation of devices, and that supervision and logistical support of the field teams be undertaken by the Lab itself. The individual contracted for the analysis of Phase II data could very appropriately take on these Phase III tasks.

c. Prototype Evaluation

The evaluation team recommends that the Lab consider sites outside the survey zones for some field-testing. Supporting field-work in Gao proved during phase II to require enormous efforts and the potential for using the sorts of devices the laboratory is developing seemed generally poor (Burke trip report 1982). For example, with respect to wind devices, survey villages are located at a distance from the rivers, the villages are too dispersed to all draw water from a single pump, and seasonal migrations would make it difficult to maintain devices. The evaluation team recommends that the Lab seek out a test site for wind devices that is more accessible than Gao. Similarly, there would be advantages to testing wood stoves in cities and towns rather than exclusively in rural areas.

The sorts of background data needed to develop useable devices are probably better furnished by requests for information like the Reseignments Techniques and limited series of observations rather than comprehensive, quantitative questinnaires of the survey as originally designed. The evaluation team recommends that enquêteurs and controllers be transferred as necessary to new sites to get background information and to implement monitoring and evaluation of prototype devices.

F. Financial Analysis Summary

In spite of two and a half years delay, the project is well within the budget as shown in Table no. XII. About $1,096,000 remains for the completion of Phases I and II and, with the exception of Lab construction, Phases I and II are all but completed.

It is therefore recommended that the unused funds of Phase I and II, along with the contingency funds of Phase III, be used to finance the construction of the Lab building, extension of technical assistance, the shop facilities, the processing and analysis of the survey data, and the overhead costs of SERI replacement.

The estimates of these costs are:

Building Cost	$800,000
Technical Assistance	
R&D	$300,000
Shop Facilities	$150,000
Survey Processing	$ 50,000
Overhead cost of SERI replacement	$ 80,000
TOTAL	$1,380,000

The sources of funds could be:

Unearmarked Phase I and II	$1,096,000
* Phase III budget reductions	200,000
Contingencies/Inflation	350,000
TOTAL	$1,646,000

Lab personnel could reduce building costs by supervising or providing certain aspects of new construction (e.g., the "amenagements" or the shop facilities) and by reducing or eliminating other elements in the architect's design (e.g., the guard house and outdoor latrines) for a saving of about $200,000.

G. Proposed Budget for FY 83 and Phase III: By Papa Fall

Phase III of the project is expected to last 2½ years. In view of the delays already encountered and the possible extension of the project completion date, it will be advisable to keep the USAID budgeting request as planned, provided some re-allocations are made. The project comprehensive pipeline shows that as of March 31, 1982. the obligated, unearmarked funds from previous fiscal year were about $1,000,000. In addition, the obligation of FY 1982 is about $470,000 and obligations for FY 1983 have been estimated at $700,000. Total obligations through FY '83 would thus be about $2.2 million. This amount is likely to be spent by December 1983. However, it is also probable that delay in commitment and expenditure, as well as the limited absorptive capacity of the Lab, will require less obligation in FY 83. Our estimate is that a maximum of $2.0 million will carry the Lab operations through FY 1983. We therefore recommend that the budget for FY 1983 be in the amount of $530,000.*

* Note by the team's management person: USAID/Mali personnel have advised that the mission must reduce the overall mission budget by about one million dollars but that the evaluation team would be consistent with the procedure followed in other projects if the best possible defense is made for what the team believes to be justifiable project costs.

RENEWABLE ENERGY PROJECT

Financial Situation as of March 31, 1982

	Obligated/ Earmarked	Committed	Expended	Unexpended
1. Technical Assistance	912,600.00	730,787.00	730,787.00	181,813.00
unearmarked	181,813.00	-0-	-0-	181,813.00
2. Training	47,400.00	32,388.00	27,418.00	19,982.00
unearmarked	15,012.00	-0-	-0-	15,012.00
3. Commodities:	934,600.00	931,397.67	806,441.10	128,158.90
unearmarked	3,202.33	-0-	-0-	3,202.33
4. Other Expenses	1,307,900.00	343,318.51	291,776.21	746,123.79
unearmarked	724,851.49	-0-	-0-	724,851.49
5. Contingencies:	171,500.00	-0-	-0-	171,500.00
unearmarked	171,500.00	-0-	-0-	171,500.00
TOTAL	3,104,000.00	2,007,883.18	1,856,422.31	1,247,577.00
of which unearmarked	1,096,108.82	-0-	-0-	1,096,108.00

The expenses to be incurred during phase III have been estimated to be as follows:

Phase III

Test devices-cost of fabrication and importation	$587,000
Training program for village cadre	10,000
Enumerators' salaries: 45,000 MF x 30 mos x 20	60,000
Contrôleurs' salaries: 55,000 MF x 30 mos x 4	15,000
Shipment and installation of devices at village sites	100,000
In-country travel expenses:	
Lab project director: 7,000 MF x 20 days	3,100
Supervisor teams: 4,000 MF x 30 days	26,100
Vehicle operating expenses: 100 FM/km x 300,000 km	65,000
Operating expenses, co-operating agencies	75,000
Maintenance and repair of devices	70,000
Enumerator housing repairs: $50 x 20	1,000
Building Cost (See above discussion of possible cost reductions)	800,000
Technical Assistance R&D	300,000
Technical Assistance shop facilities	150,000
Survey Processing	50,000
Housing allowance for contrôleurs: 25,000 MF x 30 mos x 4	6,500
Social anthropologist: 6 mos., 6 trips	47,000
Energy scientists: 6 mos., 6 trips	50,000
Office expenses related to field testing	10,000
Participant training: energy policy (Hydraulique)	51,000
other	20,000
Recurrent costs, Lab, 3 years each $20,000	60,000
Interim report preparation	10,000
Translation of interim report	7,000
Total	2,573,700
* Funds carried over from Phases I and II	1,096.000

* Note: Two amendments to the original project agreement provided $930,000 in additional funds for phases I and II. As of March 31, 1982, the unearmarked balance of phases I and II is about $1,096,000.

H. AID Administration

The project officer was assigned a highly sensitive task that might, in retrospect, have been handled, if at all, by other means, probably at higher levels in USAID/Mali's administration. When the project officer's standing with his Malian colleagues was thereby compromised to the detriment of project coordination, efforts to remedy matters were apparently inadequate.

Though the Lab is addressing the kind of energy problems that are found in other AID projects, there has been no process for informing USAID/Mali Program Directors and Project Officers of the Lab's potential for assistance with product tests or development.

There does not appear to be a well functioning system to make regular assessments of project progress for the purpose of recommending mid-course corrections or for amending the project agreement. There has not been a system for coordination with other AID projects, for reassessing the Lab's research and development priorities, for planning for project continuity after USAID funding ceases, etc.

The Evaluation Team therefore recommends:

A within-USAID/Mali Renewable Energy Project Committee should be established. Its functions and composition should be specified in writing--along with procedures for selection and replacement of members for non-performance. Its schedule of meetings, its processes for assessing project performance and for recommending changes in the project agreement, and the content and frequency of its reports to the Mission Director should be specified. Given the emphasis in Phases III and IV of the project on building construction and planning for future activities, the committee membership might include:

- The Project Officer
- A Representative of the Planning Officer, e.g., Richard Day.
- A Representative of the Engineering Office, e.g., Susan Buchanan.

These standing members would have responsibility for bringing to committee meetings, as appropriate, representatives of other USAID/Mali offices (The Mission Director or Deputy Director, the Controller, the Design and Evaluation officer, etc.) as well as representatives of other AID projects, of agencies of the Malian Government, or of international agencies who are willing and able to give advice.

The first responsibility of the Comittee might be to review the recommendations of the Evaluation Team and recommend a procedure for drafting a new course of action, for revision of project documents, etc., all of which would, if approved by the Project Officer, be submitted to the Mission Director for concurrence.

I. Recommendations (Listed by the priority assigned by vote of the members of the team. These recommendations are grouped by category in Sections V.B. through V.H.)

First Priority: Urgent and Important

1. The project should proceed to Phase III and IV, the project completion date should be extended, and the project agreement should be formally revised to effect this extension.

2. The new laboratory should be build promptly. Increased costs of building the new laboratory, above those estimated in the Project Paper, should be taken from the inflation and contingency fund for Phases I and II. Laboratory personnel should do certain parts of the construction and aménagement extérieur in order to hold costs down.

3. Terrence Hart should be retained as technical and management assistant for another two years. A technical and management assistant should be retained for one year for up-grading shop and device production capabilities. Short-term technical assistance in electronic, instrumentation and photovoltaics should be continued.

4. A private American contractor should be retained to replace SERI.

5. Sufficient Phase III funds should be earmarked to cover data entry costs and programmer and data analysis costs of Phase II data, in addition to funds allocated in the PP for designing, overseeing, entering, and analyzing Phase III data.

6. Funding for the preceding items should be provided from appropriate funds as given in the Project Plan, unspent from Phases I and II, and from the Phase III inflation and contingency fund. Funds scheduled for the Central Veterinary Laboratory should be redirected to the construction of the lab building.

7. Device development and R&D programs in the laboratory should begin to be redirected according to preliminary information from the survey and from the field workers, and from technical and economic analyses of the Laboratory. Final decisions on reorientation should await reception of final, analyzed survey results. Following preliminary field results, the Laboratory should concentrate on satisfying village needs of first priority: (1) water pumping, (2) grain grinding: and (3) farm labor, and as secondary priority: (1) fuel wood supply; (2) lighting; (3) refrigeration; and (4) drying.

8. As a consequence of this priority schedule, as supported by advice derived from recommendations, the laboratory should assign preliminary priorities to their present programs in the following manner: (1) photovoltaics; (2) wind; (3) stoves; (4) biogas; and (5) dryers.

load of the lab accountant. AID should review with the lab the kinds of technical assistance AID can provide (e.g., the training, recently recommended by Jenkins, in accounting practices and perhaps in contracting and sub-contracting procedures).

8. Because the performance of the AAPC to order and deliver the scientific equipment has been poor, USAID should consider assigning this function to the U.S. organization that will replace SERI.

9. IER's covenant with the lab for supervision of socio-economic studies should not be renewed at the start of Phase III, but the SEL should move forward on its plan to hire selected enquêteurs and controleurs directly so as to continue selected parts of the socio-economic survey that most closely bear on impact evaluation of the prototypes to be field-tested.

10. The laboratory should consider sites outside the survey zones for some field-testing. In particular, improved stoves should be tested in cities and towns where wood prices are relatively high, and wind devices should be tested in sites that have adequate average wind speeds and are more accessible than Gao. The lab should contract for the services of an economist and/or social scientist to design and oversee monitoring and evaluation of devices, and supervision, and technical and logistical support should be undertaken by the Laboratory engineer. Enquêteurs and contrôleurs should be transferred as necessary to implement monitoring and evaluation of prototype performance and impact.

11. Data gathering should continue at Gao until the termination date of the other zones in June 1982.

12. AID should review the recent analysis, made by AID/Washington on the CRES proposal, add its own recommendations and satisfy themselves--as the evaluation team is satisfied--that the CRES proposal and the proposed Lab organization and activities are complementary.

Third Priority: Less Important and Less Urgent

1. The lab, in its annual report, should identify:

   a. its research, development, and dissemination agenda for the following year along with an analysis of its criteria for establishing priorities;

   b. its general research and development plan for 5 years ahead;

   c. its expected one-year budget should show sources of income from consultation, product development, sub-contracts from AID, other ministries, international organizations, CRES, etc.; and

   d. its plan for public affairs: brochures, open house, seminars, etc.

2. The lab, as part of its short-term technical assistance, should provide further training to its personnel in research, project design, market research, and cost/benefit analysis.

9. AID should review its files of correspondence to be sure that appropriate replies have been given to all official correspondence from the Malian Government and to other unofficial documents of importance.

Second Priority: Important but Less Urgent

1. USAID/Bamako should not direct technical work at the project in any way directly or indirectly. This is the function of the survey and the appropriate project and assistance personnel.

2. The laboratory should design, assemble and install photovoltaic systems such as pumps, rather than import off-the-shelf systems, in order to adapt systems to Malian conditions and to reduce BOS costs. Wind systems should be developed which seek to find the optimum trade-off between cost, reliability and performance. Cost of wind-pumped water as a function of latitude (or average wind speed) should be determined. Work on biogas and stoves should continue but emphasis determined by results of survey and of prototype monitoring. Work on solar thermodynamic engines, solar distillers, and solar cookers should be de-emphasized or discontinued. Solar hot water heater and solar dryer work should continue, and means to manufacture, sell and service them so as to assist in financing the laboratory should be investigated. This should include private sector involvement where possible and a search for small business financing.

3. As a guide to its overall research program priorities and for its individual research and product development projects, the lab should develop a proposal for client-oriented advice and other coordination of the kind that was anticipated from the non-functioning committee called for in the project agreement.

4. The incentive bonus system at the laboratory should continue.

5. USAID/Bamako should establish a Renewable Energy Project Committee. AID should specify committee purposes, membership, meetings and agenda schedules, and committee performance review. The committee should report to the Mission Director on need for project amendment or mid-course correction by other means, on-going project performance in light of AID's interest in private sector development, AID project mutual assistance, etc.

6. The Mission Director, or his designee, should examine the proposed organizational and administrative plans of the Malian Government for their renewable energy activities and consider whether their proposal addresses the concerns that (a) the lab has a sufficiently prominent role in Mali's efforts; and (b) that the policies under which the lab operates do not preclude private sector involvement (as client or sub-contractor) nor prevent the lab from receiving payment for goods or services.

7. Simplification of the accounting procedures being undertaken by the USAID controller's office should be speeded up to alleviate the work-

3. A memo of understanding should be initiated by AID and the lab on the reasons for proceeding with lab construction without provision for use of renewable energy technologies in the offices and labs themselves (e.g., water-heating electrical generation, etc.).

4. The American Mission in Mali should demonstrate its commitment to energy conservation by installing solar hot water heaters where possible.

VI. ANNEXES

A. Project Evaluation Summary

Summary. The project is at midpoint, awaiting the results of this evaluation before continuing to its third and fourth phases. It is behind schedule by almost two years. Initially, it was beset with problems: "early start" demonstrations did not get started, equipment was poorly specified or not delivered, specified collaboration between Malian project officials and AID personnel were strained almost to the breaking point. From the Malian perspective, AID was not keeping to a key part of the project agreement--construction of a new laboratory building which was intended to strengthen Mali's ability to carry out its part of the agreement.

The project now appears in order and capable of achieving its objectives. Thanks in large part to a complementary relationship between the Lab's Director and the resident consulting engineer who joined the project in late 1980, the Lab has demonstrated extraordinary progress in administrative and technical competence. The survey of village energy needs has been reasonably well carried out and should help provide guidance for the Laboratory's research and product development agenda. Lab personnel have been well trained in certain aspects of their work and practical arrangements are being made to continue this training. Funds are available for construction of the new laboratory and the need for it has been reaffirmed.

Problems remain for the Lab in research project design and, for AID, in project supervision and review. Recommendations have been submitted in both areas.

Evaluation Methodology: A favorable midpoint evaluation was required by Project Agreement (Appendix A) as a condition of proceeding to the third and fourth phases of the project. Preliminary plans and cost estimates for these final project phases were to be agreed to and recommendations for project modification were to be submitted. The Project Agreement, a statement of work for the evaluation (Appendix B), a report outline suggested by the USAID/Mali's Design and Evaluation Officer, and suggestions by the Mission Director and by technical and administrative personnel in AID Washington guided our work.

Information was gathered from site visits to more than a dozen villages and towns where equipment was in use, from key officials in the Malian agencies presently or potentially involved, from representatives of international agencies having both a common interest and an outside perspective on project performance, from other potential clients for renewable energy technologies and products, from the Peace Corps, and from USAID personnel. Records were checked; the choice of equipment and the quality of maintenance were examined. Each member of the evaluation team had particular responsibility for data gathering and analysis in the field of his or her expertise. The priority given to the ensuing recommendations was established by vote of the members of the evaluation team.

External Factors. Since 1978, when the project began, several changes have affected or ought to affect project design, implementation and priority. They include:

- Realization that the development and adoption of renewable energy technologies and products is a long-term, uncertain proposition with few examples anywhere of widespread, unsubsidized purchase and maintenance. Nevertheless, the potential importance of renewable energy has generally been confirmed.

- A reorganization within the Ministry of Industry and Tourism, approved by the Council of Ministers but not yet in effect, will enhance the status of the energy Lab and its role in Malian energy development.

- AID priority has increased for at least partially self-supporting projects, for projects with potential for increasing private sector enterprise, for projects that produce goods and services that can demonstrate their cost-effectiveness in the market place, and for projects that complement others in the AID Mission portfolio in ways that give coherence to the Mission's overall objectives.

In light of these changes the project has no less validity than when it began and probably more.

Inputs: After solution of the early problems, the present and projected inputs now appear appropriate in quality and quantity. No significant change is indicated.

Outputs: The project appears now to be on target although outputs are difficult to quantify. Training has been good. Management and technical ability of the Lab has markedly improved. Research and product development projects are for the most part well conducted though not particularly well conceived. Data from the survey of energy needs have not yet been analyzed but appear to be of good quality and seem likely to make a useful contribution not only to this project but to others as well. No great change in outputs is recommended.

Purpose. The purpose of the project is (1) to demonstrate the practical use of renewable energies and (2) help Mali develop the institutional capacity to plan, execute, and evaluate programs of alternative energy development and use. Sub-purposes were to (a) conduct a survey of energy needs and sources at the village level and to use this information to guide the research and product development activities of Mali's Solar Energy Laboratory and (b) to strengthen the Laboratory's capacity to carry out this work by building and equipping a new Lab and training its personnel.

Project Performance. Convincing demonstrations of the practicability of renewable energy are not yet to be found from this project. The photovoltaic powered pump systems are almost operational though storage and delivery systems still present problems. Systems for self-supported maintenance and repair have not been worked out nor have alternative means of delivering water when these units break down. Design modifications are still in the concept

stage for reducing costs of enclosures to protect photovoltaic panels from damage by animals and humans, to shut down pumps when they run dry, and to find a less expensive, more durable pump preferably of American manufacture. The improved wood stoves demonstrate savings in fuel but not with sufficient conviction for users to maintain them by themselves nor, with perhaps one exception, to buy or build them. Similarly with biogas digestors and other products, the "demonstrations" to date show that the devices work to some degree, but not that they are worth the cost. Practical demonstrations of new or modified wind power devices are about to begin and, for these products, there may be a market sufficient to interest entrepreneurs in their manufacture, sale and service--provided that the apparatus performs to design specifications, can be produced at projected costs, and is as reliable as anticipated.

The survey of energy needs is all but complete. The Lab's capabilities have greatly progressed and will be further strengthened by construction of the new facilities. The End of Project Status (EOPS) should show a well-equipped Lab with competent personnel and good administration, the capacity-building that was the second purpose of the project. In two years' time there could be at least one market-tested demonstration of the profitability of renewable energy, enough to satisfy the first project purpose.

Goals and Sub-goals. The project goal was to reduce Mali's dependency on fossil fuels and traditional--mostly human--sources of energy. A subgoal was to reduce Mali's balance of payments deficit through energy devices that could be made from locally produced materials. There was to date been no measurable progress towards either of these goals. The improved wood stoves would measurably reduce firewood consumption--if they were to catch on. It apparently will be a slow and uncertain process. The wind powered pumping apparatus should have significant effect on both goals if design specifications are met. Photovoltaic powered illumination and refrigeration is nearing commercial practicability in special circumstances and the same will probably apply later on to photovoltaic powered water pumping. While this could reduce dependency on fossil fuels, it would for the forseeable future merely substitute one imported product for another.

Beneficiaries. The principal beneficiaries of the later phases of the project were to be villagers whose energy needs are mostly provided by themselves in fire wood gathering, grain grinding, and water hauling--or by animal power. Their quality of life was to be improved, especially for women, by making water and fuel supply less arduous. The intended beneficiaries of the first project phases were to be the Lab engineers who would receive U.S. and on-site training and the Malian personnel employed in the socio-economic survey. They have benefitted as intended.

The technical data produced by the projects on fuel savings that can be realized from improved wood stoves are apt to be attended to by other developing countries as will the problems of adoption and maintenance that will be reported in the later phases of the project. The project's work on photovoltaics adds to the very extensive work in this field by other organizations in Mali and elsewhere throughout the world. The project's work on wind powered apparatus appears in some ways unique and the prospects of a substantial, financially sound contribution to the intended beneficiaries seem reasonably good. But, to date, the principal intended beneficiaries, the villagers, have not measurably benefitted.

Unplanned Effects. The project has had no unexpected results or impacts that would require change in the project design or execution.

Lessons Learned

• Increase Host Country Participation in the Project Design: Neither agency involved in the survey of village energy needs--IER which was to carry it out and the Lab which was to be guided by its results--felt that it had participated sufficiently in the survey design.

• Require Ongoing Project Revision--A more effective process is needed whereby both parties to a project agreement have an opportunity--without jeopardy because of exposure of problems--to reexamine project purposes, procedures, and planned activities; to revise schedules as events have dictated, to adjust line items in the budget; and to propose amendments to the project agreement. There should be a specific obligation to state at regular intervals that no such changes are desirable, should this be the case.

• Require Market Place Analysis. AID should require that at least a few representatives of the local business community be asked whether there will be buyers for a product if it meets design specifications for performance and cost. This information would seldom be the determining factor in calculating goals and priorities in programs for health, population control, and the like--but it should be taken into account in research and product development projects and in establsihing within-project priorities. Indeed, when an estimate of market potential cannot be obtained, the reasons for proceeding without it should be noted.

• Establish Broader Based Advisory Groups. Seldom are advisory bodies for government agencies composed of members whose personal interests are associated with having an enterprise becoming self-supporting or, failing in this, to go out of business. While these need not be dominant views, they have a place in the advice heard by any program manager.

• Goals and Objectives: Changes Recommended. The project should be directed to energy needs throughout Mali, not exclusively to rural areas.

• The Lab should develop particular competencies in a few areas of renewable energy, leaving it to others in the Sahel and elsewhere to do product evaluation and development on products for which no near-term, unsubsidized market is likely.

• The socio-economic survey objectives should be qualified by making its results a most important but not exclusive guide to priorities for further product development and field testing. In establishing priorities among research and development projects and in the justification for undertaking each individual project, not only should survey results be cited but the findings of other market analysis and other social or economic studies should be taken into account.

Overall Validity of Project Design. A National Lab for Renewable Energy might not have been the best means to help Mali find ways to meet its energy needs but, because the Lab appears near to finding some partial solutions, it can be concluded that there was validity in the project design. (See Appendix E for further discussion of project design.)

Feasibility of Continuation

a) Administrative. The Lab is now well administered. The changes necessary to improve USAID/Mali administration of this project seem feasible without risk of overtaxing AID management resources.

b) Technical. Several weaknesses have been mentioned: research planning and research project design, photovoltaic technology, shop management, etc. But all seem readily correctable and means to do so have been recommended.

c) Sociological. The problems of adopting promising renewable energy devices by the intended beneficiaries of the project have not been resolved. The project has given some but perhaps not enough priority to products that could in large measure be self adopting--as were transistor radios. Improved cook stoves appear to have greater promise for self-adoption in urban areas; wind pumps and photovoltaic lighting may have promise for private sector pursuasion of usefulness.

d) Construction of New Laboratory Buildings. Several factors were taken into account in concluding that the Lab should be built immediately and without change in the present design. The arguments in favor were:

- The design cost to date is $35,000 and much of this would be lost, the cost of redesign is unknown.

- Redesign involves at least a brief delay with vulnerability to other delays of unpredictable origin and duration, perhaps even to reversal of the decision to build.

- Partial construction is feasible and savings can be realized if Lab personnel do part of the construction using lower cost methods. (See Section IV. B. 5. and IV. G.)

The arguments that were advanced by the teams management person for at least partial redesign were:

- The estimated cost of $80 per square foot seems indefensible at Bamako labor rates.

- The present design appears pedestrian and is absent of any example of the renewable energy technologies that the Lab will be encouraging.

- The proposal for holding to the present design but cutting costs of landscaping could result in a drab inauguration and quite possibly--given likely operating budgets--a drab character for some time.

•Formal guarantees might be secured that a brief delay to improve design and cut costs would not jeopardize construction. Indeed, there might be a formal ground breaking--then a brief hiatus for review of design.

Financial Feasibility of Continuation. There is money enough in the budget for construction and project support as planned if building costs can be reduced as suggested above.

The key question is whether the enterprise will prosper after AID pulls out. It seems possible, particularly if the establishment of funding sources is given high priority over the next two years. The Lab has made a start on producing income, will have authority and apparently encouragement from the Government of Mali in doing so. Representatives of several international organizations have expressed their interest in turning to the Lab for help. A new large Canadian project in photovoltaic powered pumps could draw upon the Lab as a consultant or contractor. CRES seems likely to use the Lab for product development and quite possibly for the Sahel's "Good Housekeeping" seal of approval for products in one or more fields of renewable energy. And, given most of the above, the Lab would stand out among Malian development projects as one on its way to self sufficiency, one that could become an attractive investment for other donors.

Suggestions for Project Evaluation. Evaluation methodology could be improved by the issuance of written directions--or suggestions--to members of an evaluation team on:

•resolution of differences that may exist in the emphases given to certain aspects of evaluation as defined by a) the project document and (b) the scope of work for the evaluation.

•a suggested procedure for assigning priority to recommendations developed by individual members of an evaluation team.

•definition of the editorial and coordination responsibilities of the evaluation team leader; a guide for presenting dissenting views, etc.

Special Comments or Remarks. A basic unresolved issue in this project is to what degree the market place should establish priorities in the development of new technologies and products. The project design, it can be argued, gave emphasis to the judgment of experts in energy, economics, and sociology as their expertise would guide the gathering of evidence and its analysis. The project could not have had better qualified people in these fields, both in its development and its evaluation. Several recommendations are based upon this basis of analysis: specific recommendations are given for the course to be followed in research and development. The other view is that these judgements should be tempered to greater degree by finding out--from a range of prospective clients--what people are ready to buy.

PROJECT GRANT AGREEMENT

between

THE REPUBLIC OF MALI

and the

UNITED STATES OF AMERICA

for

MALI RENEWABLE ENERGY

Appropriation: 72-11X1012

Allotment : 812-52-688-00-69-81

Date : AUG 2 6 1978

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PROJECT GRANT AGREEMENT

BETWEEN

The Government of the Republic of Mali "Grantee"

AND

The United States of America, acting through the Agency for International Development (A.I.D.)

1 : The Agreement

The purpose of this Agreement is to set out the understanding of the parties named above (Parties) with respect to the undertaking by the Grantee of the project described herein, and with respect to the financing of the project by the Parties.

2 : The Project

SECTION 2.1. Definition of Project. The Project, which is further described in Annex 1, will consist of the provision of technical assistance, training, and goods and services required: (1) to assist in the conduct of a five-year test designed to show whether new or improved small-scale renewable energy technologies can provide affordable and reliable alternatives to fossil-fuel or traditional energy technologies and (2) to assist in the development of Malian institutional capacity to plan, implement and evaluate alternative energy technologies. Within the limits of the above definition of the Project, elements of the amplified description stated in Annex 1 may be changed by written agreement of the authorized representatives of the Parties named in Section 8.2, without formal amendment of this Agreement.

SECTION 2.2. Incremental Nature of Project.

(a) A.I.D.'s contribution to the project will be provided in increments, the initial one being made available in accordance with Section 3.1 of this Agreement. Subsequent increments will be subject to availability of funds to A.I.D. for this purpose, and to the mutual agreement of the Parties, at the time of a subsequent increment, to proceed.

(b) Within the overall Project Assistance Completion Date stated in this Agreement, A.I.D. based upon consultation with the Grantee, may specify in Project Implementation Letters appropriate time periods for the utilization of funds granted by A.I.D. under an individual increment of assistance.

3 : Financing

SECTION 3.1. The Grant. To assist the Grantee to meet the costs of carrying out the project, A.I.D., pursuant to the Foreign Assistance Act of 1961, as amended, agrees to grant the Grantee under the terms of this Agreement not to exceed TWO MILLION ONE HUNDRED SEVENTY FOUR THOUSAND ("U.S.") Dollars ($2,174,000) ("Grant").

The Grant may be used to finance foreign exchange costs, as defined in Section 6.1, and the local currency costs, as defined in Section 6.2, of goods and services required for the project.

SECTION 3.2. Grantee Resources for the Project.

(a) The Grantee agrees to provide or cause to be provided for the project all funds, in addition to the Grant, and all other resources required to carry out the project effectively and in a timely manner.

(b) The resources provided by the Grantee for the project will be not less than the equivalent of NINE HUNDRED FORTY-EIGHT THOUSAND US Dollars ($948,000) in FY 1978 and ONE MILLION TWO HUNDRED SEVENTY-TWO THOUSAND US Dollars ($1,272,000) over the life of the project, including costs borne on an "in-kind" basis.

SECTION 3.3. Project Assistance Completion Date.

(a) The "Project Assistance Completion Date" (PACD), which is September 30, 1983, or such other date as the Parties may agree to in writing, is the date by which the Parties estimate that all services under the Grant will have been furnished for the project as contemplated in this Agreement.

(b) Except as A.I.D. may otherwise agree in writing, A.I.D. will not issue or approve documentation which would authorize disbursement of the Grant for services performed subsequent to the PACD or for goods furnished for the project, as contemplated in this Agreement, subsequent to the PACD.

(c) Requests for disbursement, accompanied by necessary supporting documentation prescribed in Project Implementation Letters, are to be received by A.I.D. or any bank described in Section 7.1 no later than nine (9) months following the PACD, or such other period as A.I.D. agrees to in writing. A.I.D., giving notice in writing to the Grantee, may at any time reduce the amount of the Grant by all or any part thereof for which requests for disbursement, accompanied by necessary supporting documentation prescribed in Project Implementation Letters, were not received before the expiration of said period.

4 : Conditions Precedent to Disbursement

SECTION 4.1. First Disbursement. Prior to the first disbursement of funds under the Grant, or to the issuance of commitment documents with respect thereto, the Grantee shall furnish to A.I.D., in form and substance satisfactory to A.I.D., documentary evidence of the establishment of an Interagency Project Committee chaired by the Director General of Hydrology and Energy and consisting of representatives from the Solar Energy Laboratory, National Meteorology, the National Directorates of Functional Literacy and Applied Linguistics (DNAFLA), Génie Rural, Energie du Mali, Training and Rural Action (DNFAR), and Water and Forests, the Malian Board for Livestock and Meat (OMBEVI), the Institute of Rural Economy (IER), USAID, and such other organizations as the chairman believes will contribute to the work of the committee. The Project Committee shall have the authority to coordinate the various aspects of the project.

SECTION 4.2. Disbursement of Funds for Technical Services. Prior to the disbursement of funds under the Grant for technical services other than architectural and engineering services for the Solar Energy Laboratory, or to the issuance of commitment documents with respect thereto, the Grantee shall furnish to A.I.D. the following in form and substance satisfactory to A.I.D.

(a) A request for proposals to provide such technical services; and

(b) An executed contract with a firm acceptable to A.I.D. for the furnishing of such services.

SECTION 4.3. Disbursement of Funds for Architectural and Engineering Services. Prior to the disbursement of funds for architectural and engineering services for the design of the Solar Energy Laboratory, or to the issuance of commitment documents with respect thereto, the Grantee shall furnish the following to A.I.D., in form and substance satisfactory to A.I.D.:

(a) Documentary evidence of the availability of a new permanent site satisfactory to A.I.D. for the Solar Energy Laboratory; and

(b) An executed contract with a firm acceptable to A.I.D. for such services.

SECTION 4.4. Disbursement of Funds for Construction. Prior to the disbursement of funds under the Grant for construction services for the solar energy laboratory facility, the Grantee shall furnish to A.I.D. the following, in form and substance satisfactory to A.I.D.:

(a) Detailed plans, specifications and bid documents for such construction; and

(b) An executed contract with a firm acceptable to A.I.D. for the provision of such construction services.

SECTION 4.5. Notification. When A.I.D. has determined that the conditions precedent specified in Sections 4.1, 4.2, 4.3, and 4.4 have been met, it will promptly notify the Grantee.

SECTION 4.6. Terminal Dates for Conditions Precedent. If the condition specified in Section 4.1 has not been met within 90 days from the date of this Agreement, or such later date as A.I.D. may agree to in writing, A.I.D., at its option, may terminate this Agreement by written notice to the Grantee.

5 : Special Covenants

SECTION 5.1. Project Evaluation. The Parties agree to establish an evaluation program as part of the project. Except as the Parties may otherwise agree in writing, a joint evaluation of project implementation shall take place every 6 months. It will: (a) evaluate progress toward attainment of the objectives of the project; (b) identify and evaluate problems or constraints which may inhibit such attainment; (c) assess means of helping overcome such problems; and (d) evaluate, to the degree feasible, the overall development impact of the project.

SECTION 5.2. Other Covenants. It is mutually agreed that:

(a) The Grantee shall ensure that the solar energy laboratory, and other agencies of the cooperating country participating in the project, are provided with suitably qualified personnel, and budgetary resources, in addition to the amount of this grant, required for the effective implementation of this project.

(b) Prior to the obligation of funds by A.I.D. to finance goods and services for phases III and IV of the project, the Grantee and A.I.D., through an independent contractor, shall conduct an evaluation of phases I and II of the project, agree to modifications of the project that may be appropriate as a result of such evaluation, and, provided the evaluation results are satisfactory, develop mutually agreeable preliminary plans and cost estimates for phases III and IV of the project. If the evaluation results are unfavorable, the project will not proceed to phase III or beyond unless and until corrective action is taken.

6 : Procurement Source

SECTION 6.1. Foreign Exchange Costs. Disbursements pursuant to Section 7.1 will be used exclusively to finance the costs of goods and services required for the project having their source and origin in the United States, except as A.I.D. may otherwise agree in writing, and except as provided in the Project Grant Standard Provisions Annex, Section V.1(b) with respect to marine insurance.

SECTION 6.2. Local Currency Costs. Disbursements pursuant to Section 7.2 will be used exclusively to finance the costs of goods and services required for the project having their source and, except as A.I.D. may otherwise agree in writing, their origin in the Republic of Mali. To the extent provided for under this Agreement, "Local Currency" may also include the provisions of local currency resources required for the project.

7 : Disbursement

SECTION 7.1. Disbursement for Foreign Exchange Costs.

(a) After satisfaction of the condition precedent to first disbursement (Section 4.1.), the Grantee may obtain disbursement of funds under the Grant for the Foreign Exchange Costs of goods and services required for the Project in accordance with the terms of this Agreement, by such of the following methods as may be mutually agreed upon:

(1) by submitting to A.I.D. with necessary supporting documentation as prescribed in Project Implementation Letters, (A) requests for reimbursement for such goods or services, or, (B) requests for A.I.D. to procure commodities or services in the Grantee's behalf for the Project; or,

(2) by requesting A.I.D. to issue Letters of Commitment for specified amounts (A) to one or more U.S. banks, satisfactory to A.I.D., committing A.I.D. to reimburse such bank or banks for payments made by them to contractors or suppliers, under Letters of Credit or otherwise, for such goods or services, or (B) directly to one or more contractors or suppliers committing A.I.D. to pay such contractors or suppliers for such goods or services.

(b) Banking charges incurred by the Grantee in connection with Letters of Commitment and Letters of Credit will be financed under the Grant unless the Grantee instructs A.I.D. to the contrary. Such other charges as the Parties may agree to may also be financed under the Grant.

SECTION 7.2. Disbursement for Local Currency Costs.

(a) After satisfaction of the condition precedent to first disbursement (Section 4.1), the Grantee may obtain disbursements of funds under the Grant for local currency costs required for the project in accordance with the terms of this Agreement, by submitting to A.I.D., with necessary supporting documentation as prescribed in Project Implementation Letters, requests to finance such costs.

(b) The local currency needed for such disbursements may be obtained:

(1) by acquisition by A.I.D. with U.S. Dollars by purchase or (2) by A.I.D. (A) requesting the Grantee to make available the local currency for such costs, and (B) thereafter making available to the Grantee, through the opening or amendment by A.I.D. of Special Letters of Credit in favor of the Grantee or its designee, an amount of U.S. Dollars equivalent to the amount of local currency made available by the Grantee, which dollars will be utilized for procurement from the United States under appropriate procedures described in Project Implementation Letters.

The U.S. dollar equivalent of the local currency made available hereunder shall be, in the case of subsection (b)(1) above, the amount of U.S. dollars required by A.I.D. to obtain the local currency, and in the case of subsection (b)(2) above, an amount calculated at the rate of exchange specified in the applicable Special

Letter of Credit Implementation Memorandum hereunder as of the date of the opening or amendment of the applicable Special Letter of Credit.

SECTION 7.3. Other Forms of Disbursements. Disbursements of the Grant may also be made through such other means as the Parties may agree in writing.

SECTION 7.4. Rate of Exchange. If funds provided under the Grant are introduced into the Republic of Mali by A.I.D. or any other public or private agency for purposes of carrying out obligations of A.I.D. hereunder, the Grantee will make such arrangements as may be necessary so that such funds may be converted into currency of the Republic of Mali at the highest rate of exchange which, at the time the conversion is made, is not unlawful in the Republic of Mali.

8 : Miscellaneous

SECTION 8.1. Communications. Any notice, request, document, or other communication submitted by either Party to the other under this Agreement will be in writing or by telegram or cable, and will be deemed duly given or sent when delivered to such Party at the following addresses:

To the Grantee: Ministry of Industrial Development and Tourism
Bamako, Mali

To A.I.D. : USAID, American Embassy
B.P. 34
Bamako, Mali

Alternative address for cables: USAID, AMEMBASSY, Bamako. Any such communications may be in English or in French. If A.I.D. communicates with the Grantee in both English and French, the English text is the controlling language. Other addresses may be substituted for the above upon the giving of notices.

SECTION 8.2. Representatives. For all purposes relevant to this Agreement, the Grantee will be represented by the individual holding or acting in the office of the Minister of Industrial Development and Tourism and A.I.D. will be represented by the individual holding or acting in the office of the U.S.A.I.D. Mission Director in Mali, each of whom, by written notice, may designate additional representatives for all purposes other than exercising the powers under Section 2.1. to revise elements of the amplified description in Annex 1. The names of the representatives of the Grantee with specimen signatures, will be provided to A.I.D., which may accept as duly authorized any instrument signed by such representatives in implementation of this Agreement, until receipt of written notice of revocation of their author

SECTION 8.3. Controlling Language. This Agreement is signed in both English and French. In all matters of interpretation concerning this Agreement, the English text will be the controlling language.

SECTION 8.4. Standard Provisions Annex. A Standard Provisions Annex (Annex 2) is attached to and forms part of this Agreement.

IN WITNESS WHEREOF the Governments of the Republic of Mali and the United States of America, each acting through its duly authorized representatives, have caused this Agreement to be signed in their names and delivered as of the date and year first above written.

GOVERNMENT OF THE REPUBLIC OF MALI

By: [signature]

Title: Minister of Foreign Affairs

THE UNITED STATES OF AMERICA

By: [signature]

Title: Ambassador of the United States of America

By: [signature]

Title: Acting Director, USAID

THIS IS A TRUE COPY OF THE SIGNED ORIGINAL

Annex 1
Project 688-0217

PROJECT DESCRIPTION

The goal of the project is to adapt renewable energy technologies in order to improve the material conditions of life in rural Mali. More specifically, the project will attempt to (a) apply sources of renewable energy to tasks now largely accomplished by human muscle power, (b) help alleviate Mali's dependence on costly fossil fuels and firewood (with its negative economic and ecological consequences), and (c) gain a better understanding, based on scientific observation, of the technical, social and economic consequences of introducing renewable energy technologies in rural Africa.

There are two purposes in this project: to select appropriate sources and applications of renewable energy and develop processes for introducing renewable energy technologies in rural Africa.

There are two purposes in this project: to select appropriate sources and applications of renewable energy and develop processes for introducing them in rural Malian communities, and to develop the capacity of Mali's Solar Energy Laboratory to undertake continuing research and development that adapts renewable energy technologies for local use. Toward these ends, the project plans a coordinated program of institutional support, applied research and development, surveys of village resources and needs, and the launching of field demonstrations at two dozen sites. In short, it aims to prepare Mali for the introduction of alternative energy technologies in rural areas on a wide scale.

Two types of preparation will be required. There must be first of all a sustained effort to adapt proven technologies to the Malian situation. The substitution of local for imported materials in the fabrication of various devices will be as important as making design modifications that increase durability under Malian conditions. Secondly, efforts must be made to determine effective ways for village groups or individual village households to take over the ownership, operation and basic maintenance of the new devices. Both types of preparation will have to be successfully completed for each new technology before it can be distributed to villages, not only in Mali but possibly elsewhere in the Sahel.

The Malian organization responsible for the technical phase of the program is the Solar Energy Laboratory, a Division of the Directorate General for Hydrology and Energy, Ministry of Industrial Development and Tourism. However, this project requires the coordination of several Malian agencies which must act in concert for the achievement of the project's objectives. To ensure proper communication and coordination, a Project Committee will be officially established under the chairmanship

of the Director General of Hydrology and Energy. The Project Committee (with a single representative from each agency, including USAID) will meet from time to time as is necessary to review the project and resolve any inter-agency coordination issues. The committee will be the mechanism for making important project decisions, such as the selection of the 20 test villages. It will also serve to insure the effective allocation of project resources and the various technical inputs needed at design and implementation stages.

The members of the Project Committee will designate senior members of their respective services to serve as day-to-day points of contact on project matters or to assume special roles set forth in the project design. The Institute of Rural Economy (IER) will designate a senior member of its Evaluation Unit to participate in the design of the base-line studies and the socio-economic studies contemplated in Phase II (see below). Similarly, the Meteorological service will assign a staff member to participate in the design and evaluation of the village climatic studies.

The project is comprised of four phases: phase I(Institutional Support and Early Starts), phase II (Village Level Surveys), phase III (Village Level Testing), and phase IV (Evaluation). It is understood and agreed that, prior to the initiation of phase III, an evaluation will be conducted by a team of energy scientists and that a decision to proceed to phase III will be subject to the mutual agreement of both parties that the project is ready to proceed to phase III.

PHASE I

(a) Early Starts

In order to provide a momentum and demonstration effect for the program, and to gather valuable information for its subsequent phases, four early starts are contemplated. Each will consist of small pumps powered by arrays of photovoltaic cells. Two will be installed in the Dilly area (Camp Modibo and Demba Diawara) under the auspices of OMBEVI, one in Mopti, under the auspices of Genie Rural, and a fourth at the leper rehabilitation center at Samanko. In addition to operating and maintaining these devices, the sponsoring institution will also be responsible for gathering technical and socio-economic data in accordance with arrangements to be worked out between the Parties to this Agreement.

(b) Institutional Support

This element of phase I will consist of major support to the Solar Energy Laboratory for its applied research and development program. In addition, complementary assistance will be provided to the National School of Engineering, the Ecole Normale Superieure, and the Central Veterinary Laboratory in accordance with the provisions and funding noted in the Project Agreement budget.

Support for the equipment and facilities of the Solar Energy Laboratory, as noted in the budget, is aimed at initiating a program of applied research for perfecting the adaptation of certain alternative energy technologies for use in Mali. This program will be started immediately upon satisfaction of the Conditions Precedent to First Disbursement of this Project Agreement and priority will be given to the procurement of the initial order of machine tools and scientific equipment, the early start solar pumps (I(a) above), and vehicles.

Initial priorities for the laboratory's research and development program, as worked out in pre-project discussions, include (a) testing and improvement of solar water heaters for urban uses and rural institutions (dispensaries, schools, etc.), (b) testing and improvements on crop and fish dryers, (c) development of an efficient, wood-burning stove using readily available materials, and (d) development of an efficient photovoltaic battery charger, emphasizing reliability and ease of operation. Other priorities may be added to the list in the course of phase II, as the laboratory has the absorptive capacity to take them on.

PHASE II

The second phase, of one year to eighteen months in duration (including a preparatory period), will begin six months from the initiation of phase I and will involve a coordinated activity planned by the Institute of Rural Economy with participation by other government agencies represented on the Project Committee. During phase II, meteorological and socio-economic studies will be undertaken at 25 villages determined (by the Project Committee) to have potential for experimentation with various devices using alternative energy sources. The studies will be planned by the IER, an American social scientist (provided by the project), and an engineer designated by the laboratory who will be its liaison for the field studies. Initiation of the studies will be preceded by a training program for the enumerators (two to each village) and for the four mid-level supervisory teams, each of which will cover a specific geographic zone and periodically visit six or so designated villages in its zone. These teams will include a Malian supervisor and a Peace Corps volunteer (or U.S. researcher), both appropriately trained in survey techniques.

In addition to the collection of data, a crucial aspect of phase II will be the selection of village cadres who will later assume the responsibility for the operation and maintenance of the device or devices that are planned for introduction. Selection of the cadre will depend upon village preferences, inter-action with the supervisory survey teams, and the characteristics of the devices to be introduced.

If, before the end of phases I and II, one or more devices should be developed that are ready for field testing, in the judgment of the

Project Committee, they may be installed and tested in the field provided the Project Committee is persuaded that a suitable site or sites have been found, that adequate operational and supervisoty staff are available to monitor the devices and that the Solar Energy Laboratory or another appropriate GRM organization can provide the necessary technical support.

The major outputs from phase II will be village-level reports indicating (a) basic socio-economic base line data, (b) local energy sources available (wind, solar, biomass, etc.), (c) village preferences on tasks for which alternative energy will be used, (d) present or potential village capacity to operate and maintain energy devices, and (e) selection of village cadres. At the end of phase II, 20 of the most promising of the 25 villages surveyed will be selected by the Project Committee for the introduction of energy devices (phase III).

Prior to the initiation of phase III, a rigorous independent review and evaluation of the applications and development work of the laboratory will be held by a team of three energy scientists. The review will focus on whether the measuring, testing, and modification work at the laboratory on the priority energy devices has reached a point to assure confidence, that the devices developed can be tested effectively in the field and that the technical support for field testing will be adequate.

If the review is predominantly negative or mixed, the project will not proceed further until appropriate modifications are made and completed.

PHASE III

During phase III, which will last up to three years, several different devices and applications will be tested in the selected villages. Performance will be watched with some care, and the social and economic changes that result from the introduction of the new technology will be observed and recorded. The Solar Energy Laboratory, which will have devoted itself in the second phase to preparing devices for village testing, will continue to make adjustments in the light of experience gained during phase III.

Implementation of phase III will be carried out by the village cadres selected during phase II and backstopped technically by the Solar Energy Laboratory. In addition, the data-gathering network, established during phase II, will also continue to function, including the observation and recording of socio-economic data at the village level, and continued periodic visits by the supervisory teams. This work will be reinforced by the continued guidance and consultant services provided by the IER, a U.S. energy consultant and the social scientist consultant.

PHASE IV

The fourth phase of about six months will be devoted to a detailed analysis and evaluation of the experiments. Base-line data collected during phase II before the devices were introduced will be compared with data collected after more than two years of use of the new technology. The evaluation will attempt to determine whether the project has provided answers to the following questions:

1. Which technologies are most suitable for local operation and maintenance and, in each case, how should local control be organized?

2. What will be the impact of the new technology on income levels, income distribution and social welfare in the community? Who benefits the most? the least? not at all?

3. Which devices perform and endure well in their physical setting?

4. How do the costs per unit of output compare with other sources of energy that could be used in the same setting?

5. Are the technologies culturally and socially acceptable to those who use them or do they require changes in habits that are considered unacceptable?

The evaluation will take place under the joint direction of the IER, the Solar Energy Laboratory and USAID and will include the outside consultants who had been involved since the beginning, the IER evaluation unit, supervisory personnel, DNAFLA, and such others as may be useful in the light of the situation at the time. A six-month effort to compare the village sites before and after the tests, with full exploration of the performance of the devices, the villagers' adaptation to them, and the socio-economic changes induced, will be required. An evaluation report will be printed and distributed.

Annex 1
Attachment 1

MALI RENEWABLE ENERGY PROJECT

Illustrative Project Financial Plan
(U.S. Dollars)

INPUTS	FY 1978 Funding AID	FY 1978 Funding GRM	Future Year Funding AID	Future Year Funding GRM	Total Funding AID	Total Funding GRM
I. Technical Assistance						
A. Energy scientist (2 yrs)	250,000	-	-		250,000	-
B. Short-term consultants	100,000	-	105,000	-	205,000	-
C. Evaluation	105,000		82,000	-	187,000	-
Sub-Total	455,000		187,000		642,000	
II. Training						
A. U.S.	16,000	-	71,000	-	87,000	-
B. In-country	10,000	-	10,000	-	20,000	-
Sub-Total	26,000		81,000		107,000	
III. Commodities						
A. Vehicles	102,000	-	-	-	102,000	-
B. Energy equipment	534,860	778,000 1/	687,000	-	1,221,860	778,000
Sub-Total	636,860	778,000	687,000		1,323,860	778,000
IV. Other Costs						
A. Construction	350,000	89,000 2/	-	-	350,000	89,000
B. Operating expenses	363,900	81,000	591,000	324,000	954,900	405,000
C. Contingencies	342,240	-	380,000	-	722,240	-
Sub-Total	1,056,140	170,000	971,000	324,000	2,027,140	494,000
TOTAL	2,174,000	948,000	1,926,000	324,000	4,100,000	1,272,000

1/ Equipment existing at Solar Energy Laboratory
[illegible] Energy Laboratory

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ANNEX 2

STANDARD PROVISIONS

Definitions: As used in this Annex, the "Agreement" refers to the Project Grant Agreement to which this Annex is attached and of which this Annex forms a part. Terms used in this Annex have the same meaning or reference as in the Agreement.

Article A: Project Implementation Letters

To assist Grantee in the implementation of the Project, A.I.D., from time to time, will issue Project Implementation Letters that will furnish additional information about matters stated in this Agreement. The parties may also use jointly agreed-upon Project Implementation Letters to confirm and record their mutual understanding on aspects of the implementation of this Agreement. Project Implementation Letters will not be used to amend the text of the Agreement, but can be used to record revisions or exceptions which are permitted by the Agreement, including the revision of elements of the amplified description of the Project in Annex 1.

Article B: General Covenants

SECTION B.1. Consultation. The Parties will cooperate to assure that the purpose of this Agreement will be accomplished. To this end, the Parties, at the request of either, will exchange views on the progress of the Project, the performance of obligations under this Agreement, the performance of any consultants, contractors, or suppliers engaged on the Project, and other matters relating to the Project.

SECTION B.2. Execution of Project. The Grantee will:

(a) carry out the Project or cause it to be carried out with due diligence and efficiency, in conformity with sound technical, financial, and management practices, and in conformity with those documents, plans, specifications, contracts, schedules or other arrangements, and with any modifications therein, approved by A.I.D. pursuant to this Agreement; and

(b) provide qualified and experienced management for, and train such staff as may be appropriate for the maintenance and operation of the Project, and, as applicable for continuing activities, cause the Project to be operated and maintained in such manner as to assure the continuing and successful achievement of the purposes of the Project.

Article B: General Covenants (Continued)

SECTION B.3. Utilization of Goods and Services.

(a) Any resources financed under the Grant will, unless otherwise agreed in writing by A.I.D., be devoted to the Project until the completion of the Project, and thereafter will be used so as to further the objectives sought in carrying out the Project.

(b) Goods or services financed under the Grant, except as A.I.D. may otherwise agree in writing, will not be used to promote or assist a foreign aid project or activity associated with or financed by a country not included in Code 935 of the A.I.D. Geographic Code Book as in effect at the time of such use.

SECTION B.4. Taxation.

(a) This Agreement and the Grant will be free from any taxation or fees imposed under laws in effect in the territory of the Grantee.

(b) To the extent that (1) any contractor, including any consulting firm, any personnel of such contractor financed under the Grant, and any property or transaction relating to such contracts and (2) any commodity procurement transaction financed under the Grant, are not exempt from identifiable taxes, tariffs, duties or other levies imposed under laws in effect in the territory of the Grantee, the Grantee will, as and to the extent provided in and pursuant to Project Implementation Letters, pay or reimburse the same with funds other than those provided under the Grant.

SECTION B.5. Reports, Records, Inspections, Audit. The Grantee will:

(a) furnish A.I.D. such information and reports relating to the Project and to this Agreement as A.I.D. may reasonably request;

(b) maintain or cause to be maintained, in accordance with generally accepted accounting principles and practices consistently applied, books and records relating to the Project and to this Agreement, adequate to show, without limitation, the receipt and use of goods and services acquired under the Grant. Such books and records will be audited regularly, in accordance with generally accepted auditing standards, and maintained for three years after the date of last disbursement by A.I.D.; such books and records will also be adequate to show the nature and extent of solicitations of prospective suppliers of goods and services acquired, the basis of award of contracts and orders, and the overall progress of the Project toward completion; and

Article B: General Covenants (Continued)

(c) afford authorized representatives of a Party the opportunity at all reasonable times to inspect the Project, the utilization of goods and services financed by such Party, and books, records, and other documents relating to the Project and the Grant.

SECTION B.6. Completeness of Information. The Grantee confirms:

(a) that the facts and circumstances of which it has informed A.I.D., or cause A.I.D. to be informed, in the course of reaching agreement with A.I.D. on the Grant, are accurate and complete, and include all facts and circumstances that might materially affect the Project and the discharge of responsibilities under this Agreement;

(b) that it will inform A.I.D. in timely fashion of any subsequent facts and circumstances that might materially affect, or that it is reasonable to believe might so affect, the Project or the discharge of responsibilities under this Agreement.

SECTION B.7. Other Payments. Grantee affirms that no payments have been or will be received by any official of the Grantee in connection with the procurement of goods or services financed under the Grant, except fees, taxes, or similar payments legally established in the country of the Grantee.

SECTION B.8. Information and Marking. The Grantee will give appropriate publicity to the Grant and the Project as a program to which the United States has contributed, identify the Project site, and mark goods financed by A.I.D., as described in Project Implementation Letters.

Article C: Procurement Provisions

SECTION C.1. Special Rules.

(a) The source and origin of ocean and air shipping will be deemed to be the ocean vessel's or aircraft's country of registry at the time of shipment.

(b) Premiums for marine insurance placed in the territory of the Grantee will be deemed an eligible Foreign Exchange Cost, if otherwise eligible under Section C.7(a).

(c) Any motor vehicles financed under the Grant will be of United States manufacture, except as A.I.D. may otherwise agree in writing.

Article C: Procurement Provisions (Continued)

(d) Transportation by air, financed under the Grant, of property or persons, will be on carriers holding United States certification, to the extent service by such carriers is available. Details on this requirement will be described in a Project Implementation Letter.

SECTION C.2. Eligibility Date. No goods or services may be financed under the Grant which are procured pursuant to orders or contracts firmly placed or entered into prior to the date of this Agreement, except as the Parties may otherwise agree in writing.

SECTION C.3. Plans, Specifications, and Contracts. In order for there to be mutual agreement on the following matters, and except as the Parties may otherwise agree in writing:

(a) The Grantee will furnish to A.I.D. upon preparation,

(1) any plans, specifications, procurement or construction schedules, contracts, or other documentation relating to goods or services to be financed under the Grant, including documentation relating to the prequalification and selection of contractors and to the solicitation of bids and proposals. Material modifications in such documentation will likewise by furnished A.I.D. on preparation;

(2) such documentation will also be furnished to A.I.D., upon preparation, relating to any goods or services, which, though not financed under the Grant, are deemed by A.I.D. to be of major importance to the Project. Aspects of the Project involving matters under this subsection (a)(2) will be identified in Project Implementation Letters;

(b) Documents related to the prequalification of contractors, and to the solicitation of bids or proposals for goods and services financed under the Grant will be approved by A.I.D. in writing prior to their issuance, and their terms will include United States standards and measurements;

(c) Contracts and contractors financed under the Grant for engineering and other professional services, for construction services, and for such other services, equipment or materials as may be specified in Project Implementation Letters, will be approved by A.I.D. in writing prior to execution of the contract. Material modifications in such contracts will also be approved in writing by A.I.D. prior to execution; and

Article C: Procurement Provisions (Continued)

(d) Consulting firms used by the Grantee for the Project but not financed under the Grant, the scope of their services and such of their personnel assigned to the Project as A.I.D. may specify, and construction contractors used by the Grantee for the Project but not financed under the Grant, shall be acceptable to A.I.D.

SECTION C.4. Reasonable Price. No more than reasonable prices will be paid for any goods or services financed, in whole or in part, under the Grant. Such items will be procured on a fair and, to the maximum extent practicable, on a competitive basis.

SECTION C.5. Notification to Potential Suppliers. To permit all United States firms to have the opportunity to participate in furnishing goods and services to be financed under the Grant, the Grantee will furnish A.I.D. such information with regard thereto, and at such times, as A.I.D. may request in Project Implementation Letters.

SECTION C.6. Shipping.

(a) Goods which are to be transported to the territory of the Grantee may not be financed under the Grant if transported either: (1) on an ocean vessel or aircraft under the flag of a country which is not included in A.I.D. Geographic Code 935 as in effect at the time of shipment, or (2) on an ocean vessel which A.I.D., by written notice to the Grantee has designated as ineligible; or (3) under an ocean or air charter which has not received prior A.I.D. approval.

(b) Costs of ocean or air transportation (of goods or persons) and related delivery services may not be financed under the Grant, if such goods or persons are carried: (1) on an ocean vessel under the flag of a country not, at the time of shipment, identified under the paragraph of the Agreement entitled "Procurement Source: Foreign Exchange Costs," without prior written A.I.D. approval; or (2) on an ocean vessel which A.I.D., by written notice to the Grantee, has designated as ineligible; or (3) under an ocean vessel or air charter which has not received prior A.I.D. approval.

(c) Unless A.I.D. determines that privately owned United States-flag commercial ocean vessels are not available at fair and reasonable rates for such vessels, (1) at least fifty percent (50%) of the gross tonnage of all goods (computed separately for dry bulk carriers, dry cargo liners and tankers) financed by A.I.D. which may be transported on ocean vessels will be transported on

Article C: Procurement Provisions (Continued)

privately owned United States-flag commercial vessels, and (2) at least fifty percent (50%) of the gross freight revenue generated by all shipments financed by A.I.D. and transported to the territory of the Grantee on dry cargo liners shall be paid to or for the benefit of privately owned United States-flag commercial vessels. Compliance with the requirements of (1) and (2) of this subsection must be achieved with respect to both any cargo transported from U.S. ports and any cargo transported from non-U.S. ports, computed separately.

SECTION C.7. Insurance.

(a) Marine insurance on goods financed by A.I.D. which are to be transported to the territory of the Grantee may be financed as a Foreign Exchange Cost under this Agreement provided (1) such insurance is placed at the lowest available competitive rate, and (2) claims thereunder are payable in the currency in which such goods were financed or in any freely convertible currency. If the Grantee (or government of Grantee), by statute, decree, rule, regulation, or practice discriminates with respect to A.I.D.-financed procurement against any marine insurance company authorized to do business in any State of the United States, then all goods shipped to the territory of the Grantee financed by A.I.D. hereunder will be insured against marine risks and such insurance will be placed in the United States with a company or companies authorized to do a marine insurance business in a State of the United States.

(b) Except as A.I.D. may otherwise agree in writing, the Grantee will insure, or cause to be insured, goods financed under the Grant imported for the Project against risks incident to their transit to the point of their use in the Project; such insurance will be issued on terms and conditions consistent with sound commercial practice and will insure the full value of the goods. Any indemnification received by the Grantee under such insurance will be used to replace or repair any material damage or any loss of the goods insured or will be used to reimburse the Grantee for the replacement or repair of such goods, Any such replacements will be of source and origin of countries listed in A.I.D. Geographic Code 935 as in effect at the time of replacement, and, except as the Parties may agree in writing, will be otherwise subject to the provisions of the Agreement.

SECTION C.8. U.S. Government-Owned Excess Property. The Grantee agrees that wherever practicable, United States Government-Owned excess personal property, in lieu of new items financed under the Grant, should be utilized. Funds under the Grant may be used to finance the costs of obtaining such property for the Project.

Article D: Termination; Remedies

SECTION D.1. Termination. Either Party may terminate this Agreement by giving the other Party 30 days written notice. Termination of this Agreement will terminate any obligations of the Parties to provide financial or other resources to the Project pursuant to this Agreement, except for payment which they are committed to make pursuant to noncancellable commitments entered into with third parties prior to the termination of this Agreement. In addition, upon such termination A.I.D. may, at A.I.D.'s expense, direct that title to goods financed under the Grant be transferred to A.I.D. if the goods are from a source outside Grantee's country, are in a deliverable state and have not been offloaded in ports of entry of Grantee's country.

SECTION D.2. Refunds.

(a) In the case of any disbursement which is not supported by valid documentation in accordance with this Agreement, or which is not made or used in accordance with this Agreement, or which was for goods or services not used in accordance with this Agreement, A.I.D., notwithstanding the availability or exercise of any other remedies under this Agreement, may require the Grantee to refund the amount of such disbursement in U.S. Dollars to A.I.D. within sixty (60) days after receipt of a request therefor.

(b) If the failure of Grantee to comply with any of its obligations under this Agreement has the result that goods or services financed under the Grant are not used effectively in accordance with this Agreement, A.I.D. may require the Grantee to refund all or any part of the amount of the disbursements under this Agreement for such goods or services in U.S. Dollars to A.I.D. within sixty days after receipt of a request therefor.

(c) The right under subsection (a) or (b) to require a refund of a disbursement will continue, notwithstanding any other provision of this Agreement, for three years from the date of the last disbursement under this Agreement.

(d) (1) Any refund under subsection (a) or (b), or (2) any refund to A.I.D. from a contractor, supplier, bank or other third party with respect to goods or services financed under the Grant, which refund relates to an unreasonable price for or erroneous invoicing of goods or services, or to goods that did not conform to specifications, or to services that were inadequate, will (A) be made available first for the cost of goods and services required for the Project, to the extent justified, and (B) the remainder, if any, will be applied to reduce the amount of the Grant.

Article D: Termination; Remedies (Continued)

(e) Any interest or other earnings on Grant funds disbursed by A.I.D. to the Grantee under this Agreement prior to the authorized use of such funds for the Project will be returned to A.I.D. in U.S. Dollars by the Grantee.

SECTION D.3. Nonwaiver of Remedies. No delay in exercising any right or remedy accruing to a Party in connection with its financing under this Agreement will be construed as a waiver of such right or remedy.

SECTION D.4. Assignment. The Grantee agrees to execute in writing, upon request, an assignment to A.I.D. of any cause of action in connection with or arising out of the contractual performance or breach of performance by one Party or another to a contract financed in whole or in part in U.S. Dollars by A.I.D. under this Agreement.

STATEMENT OF WORK

A. OBJECTIVE

1. The contractor will provide an energy management expert who will serve as leader of a team which will evaluate the Mali Renewable Energy Development project (688-0217). The other team members are:

U.S. Energy Specialist (REDSO/WA)
U.S. Social Scientist (REDSO/WA)
African Energy Expert

2. In examining experience with this project to date, the team will, where possible, make (1) observations, (2) draw conclusions, and (3) guidance, which may be applicable elsewhere for improving program performance, sharpening AID's approach and selecting the most promising technologies that hold potential for widespread replication and maximum development impact.

B. SCOPE OF WORK

1. The evaluation will be primarily an in-depth assessment of the technical work of the Solar Energy Laboratory in developing, testing and modifying for village use the technologies which are to be deployed for field testing. The evaluation will include:

a. a careful review of records kept by the lab on tests it will have performed on each device;

b. the device's cost and performance characteristics under given conditions;

c. input and output records;

d. an examination of the physical equipment to assess whether it is functioning properly, whether it is receiving proper care and maintenance, whether it is being used in a cost effective manner, i.e., the amount of use that justifies the investment and whether lab personnel understand its operation and are effectively using it.

e. an assessment of whether the results of tests, insolation and weather data are (a) being properly recorded, (b) reduced and analyzed and (c) compared to theoretical models;

f. an examination of the (a) effectiveness of the technical assistance supplied to the lab and (b) an assessment of the lab personnel's ability to carry on the work without a visiting engineer/scientist in residence;

g. an examination of the effectiveness of the lab management (a) in the technical program, (b) in outlining goals and paths to reach them, (c) in communication with lab personnel, (d) in utilizing personnel and (e) in collaborating and coordinating with other organizations working on renewable energy and with the survey organization;

h. an examination of the lab's (a) commitment to the survey, (b) liaison with the survey organization, (c) technical contribution to the survey and (d) its use of the survey data;

i. given available survey data, assess the relevance of the lab R&D work to the rural village needs.

2. When assessing the technical program, the evaluation team should consider the degree to which the Phase I tasks have been accomplished. These include.

a. installation and operation of (1) insolation, (2) temperature and (3) wind measuring equipment;

b. performed quantitative performance tests on the lab's present hot water heater;

c. improvement of the construction of the hot water heater;

d. performed quantitative performance tests on the lab's prototype crop/fish dryer;

e. improvement of the construction of the crop/fish dryer;

f. development of an efficient wood-burning stove using readily available materials;

g. development of a photovoltaic battery charger, emphasizing reliability and ease of operation;

h. installation of the early start solar pumps;

i. training of two engineers in the U.S., and

j. construction of about 12 prototypes for installation in villages.

3. The evaluation team, especially the management expert, will also be called upon to assess:

a. the long term viability of the lab in relation to CEAO/CRES and other donor activity;

b. the ability or potential for the lab to become partially or wholly economically and financially self supporting; and

c. the structures and organizations that have been created to assure coordination, collaboration and planning.

C. REQUIRED REPORTS

The team leader will coordinate the reports of other team members and, based upon his own management report and those of the others, prepare the overall evaluation, summary and report.

A draft report will be submitted in English in 3 copies to USAID/Mali by May 14, 1982 with 2 copies submitted to AFR/DR/SDP/W shortly thereafter.

A final report will be submitted in English and French (25 copies each) to USAID/Mali (15 copies) and AFR/DR/AID/W (10 copies by June 11, 1982).

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UBJ: MALI RENEWABLE ENERGY PROJECT (688-0217) EVALUATION

EF: BAMAKO 0602

. THE FOLLOWING ADDITIONS SHOULD BE EVALUATION WILL BE TO
ETERMINE IF THE PROJECT'S ENERGY AND SOCIO-ECONOMIC SURVEY
S ACHIEVING OR HAS ACHIEVED ITS OBJECTIVES AND TO ASSESS THE
URVEY'S CONTRIBUTION TO THE OVERALL PROJECT. THIS WILL INCLUDE:
Q) AN ASSESSMENT OF THE SURVEY DESIGN AND ITS APPLICATION
ITHIN THE SCOPE OF THE PROJECT.
II) AN ASSESSMENT OF THE EFFECTIVENESS OF THE SURVEY SUPERVI-
OR AND INTERVIEW TRAINING PROGRAMS.
III) AN ASSESSMENT OF THE VILLAGE AND HOUSEHOLD SELECTION
ROCESS.
IV) A REVIEW OF SUPERVISORY PROCESSURE AND EFFECTIVENESS
N THE SURVEY ZONES.
V) AN ASSESSMENT OF THE ACCURACY OF DATA COLLECTED AND
HE CORRECTIVE PROCEDURES AT THE ZONE LEVEL.
VI) A REVIEW OF THE VURVEY DATA ANALYSIS PROCEDURES AND
CHEDULE.
VII) AN ASSESSMENT OF THE SURVEY DATA CONTRIBUTION TO THE
EL RESEARCH AND DEVELOPMENT PROGRAM.
VIII) A REVIEW OF THE TRAINING FOR AND OPERATION OF THE
IELD WEATHER STATIONS.
IX) A REVIEW OF THE EFFECTIVENESS OF THE TRAINING PROGRAM
SSOCIATED WITH THESFECTIVENESS OF THE TRAINING PROGRAM
SSOCIATED WITH THE CONSTRUCTION, MAINTENANCE AND STUDY OF
HE TYPES PLACED IN THE ZONES.
. AS IS THE CASE OF ANY EVALUATION THE EVALUATION TEAM
ILL ASSESS THE MANAGEMENT PROCEDURES OF INVOLVED ORGANIZATIONS
NCLUDEING THE SEL, SERI AND USAID. SUCH AN ASSESSMENT WILL
EVIEW, AMONG OTHER ASPECTS, FINANCIAL MANAGEMENT, PROCUREMENT
ROCEDURE PROCEDURES AND COORDINATION AND COLLABORATION ISSUES
HICH AFFECT PROJECT IMPLEMENTASTION.
. THE EVALUATION TEAM WILL MAKE RECOMMENDATIONS ON ON THE
PECIFIC FOCUS, FORM AND SCOPE OF FUTURE PROJECT ACTIVITIES.
F THE NEED FOR CONTINUING TECHNICAL ASSISTANCE IS AFFIRMED
HE TEAM WILL MAKE RECOMMENDATIONS ON THE SCOPE, FOCUS AND
ONTRACTING MODALITIES FOR THIS TECHNICAL ASSISTANCE.
. THE EVALUATION TEAM WILL ASSESS AS A MATTER OF COURSE WHE-

UNCLAS BAMAKO 1808

THER THE FACILITIES AND EQUIPMENT AVAILABLE TO THE SEL ARE ADEQUATE FOR ACEIEVEMENT OF PROJECT GOALS ESPECIALLY IN REGARD TO PLANNED ACTIVITIES AS REFLECTED IN THE PP.
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BEST AVAILABLE DOCUMENT

Annex D

Questionnaire Forms for Socio-Economic Survey

Questionnaire No.10. Recensement du carrée

Centre | Village | Jour | Mois | Année | Carrée | Premier ménage | premier ménage | Enquêteur

Chef du Carrée ____________ Total - Ménages

Nº	Nom	No. du ménage	Présent/Absent	Si Absent: Durée de Migration	Lieu de Migration	Motif de Migration	Lien de Parenté	Actif Economique	Statut	Sexe	Statut de mariage	Nombre de femmes	Rang (femmes)	Année de naissance	Groupe Ethnique	Niveau Formation	Activité Principale	Cod

Questionnaire No 10. Recensement du carré

Centre	village	Enquêteur	Jour	Mois	Année	Carré	Premier Ménage	Dernier Ménage

Chef du Carré _____ Nombre Total des Ménages

	Nom	Activité Secondaire	Code	Activités Artisanales

Questionnaire No. 7 : Recensement du Carré (suite)
(une fiche pour chaque ménage).

Centre	Village	Enquêteur	Jour	Mois	Année	Carré	Ménage

Chef du Ménage _____ ID : _____

Est-ce que les membres de votre ménage emploient les combustibles suivants ?

Combustible	Utilisation		
	toujours	De temps en temps	Jamais
Bois			
Charbon de bois			
Fumier			
Déchets Agricoles			
Herbes sauvages			
Bougies			
Piles			
Pétrole			
Gaz			
Essence			

Est-ce que les membres de votre ménage achètent les combustibles suivants ?

Combustible	Achat		
	toujours	De temps en temps	Jamais
Charbon de Bois			
Fumier			
Déchets Agricoles			
Herbes sauvages			

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Questionnaire No.11 (suite)

Centre	Village	Ménage

Où est-ce que votre famille obtient-elle de l'eau en saison de pluie ?

	Saison de Pluie		
	Toujours	De temps en temps	Jamais
Fleuve			
Marigot			
Puits dans concess.			
Puits hors concess.			
Puisards			
Collecte de Pluie			

Est-ce que vous trouvez de l'eau dans un autre endroit pendant la saison de pluie ? Si oui, où ?

Où est-ce que votre famille obtient-elle de l'eau en saison sèche ?

	Saison Sèche		
	Toujours	De temps en temps	Jamais
Fleuve			
Marigot			
Puits dans concession			
Puits hors concession			
Puisards			
Collecte de Pluie			

Est-ce que vous trouvez de l'eau dans un autre endroit pendant la saison sèche ? Si oui, où ?

Inventaire No.13. Récipients d'eau

Centre	Village	Enquêteur	Jours Mois Années	Ménage

Chef du Ménage_____

Numéro d'identif	Récipient	Quantité de l'eau en litres	Date debut de l'emploi	Date fin de

Numéro d'identif	Récipient	Quantité de l'eau en litres	Date début de l'emploi	Date fin de l'emploi.

Questionnaire N°14. Origine d'eau et des combustibles

centre	village	Enquêteur	Jour	Mois	Année	Ménage	chef du ménage	Point d'eau dans la maison : 0, Ailleurs : mesurer

Type d'eau ou de Combustible		Origine		Distance (km)	Est-ce que le point d'eau ou le point de recherche/achat de combustibles est utilisé pendant le mois de :												Pour les puits, profondeur (niveau de l'eau)											
	cod		cod		Jan.	Févr.	Mars	Av.	Mai	Juin	Juil.	Août	Sept.	Oct.	Nov.	Déc.	Jan.	Févr.	Mars	Av.	Mai	Juin	Juil.	Août	Sept.	Oct.	Nov.	Déc.

Inventaire NA 15 = Inventaire des appareils d'Energie (tous les 6 mois)

Centre | Village | Enquêteur | Jour | Mois | Année | Ménage | Chef du Ménage

Appareil	Code	Propriétaire	Comment Acquis	Code	Prix (en FM)	Age de l'Appareil	Etat de l'Appareil

Fiche No. 16 Conversions - Unités Locales (Heures)

Centre Village Enquêteur Jour Mois Annee

Mot Français	Mot Local	Heure Approximative

Par exemple l'aube = "mot local" = 6:00

Fiche No. 17 Conversion - Poids et Volume

Centre | Village | Enquêteur | Jour Mois Année | Ménage

Chef du Ménage _____

Unités Locales	Code	Denrée et Sa Forme	Equivalent en kgs, litres ou M^3						
			1	2	3	4	5	Moyen	Unité

ionnaire Na 2 1 (1 2) Emploi du Temps

4 5 Village — 6 7 8 Enquêteur — 9 10 11 12 13 14 Jour Mois Année — 15 16 17 Ménage — Chef du Ménage _____

18 19 20 21 22 23 Jour Mois Année

Statut	Age	Fadjiri				Wadaba				Selifana			Lazara			Fitiri			Safo							Observations
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	
28	32	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	

Questionnaire No. 22 (1 2) Activités Economiques - Agriculture (A remplir s'il y a des activités agricoles sur No. 21)

Centre (3) Village (4 5) Enquêteur (6 7 8) Jour (9 10) Mois (11 12) Année (13 14)

Ménage (15 16 17) Chef du Ménage _____ Date (18 19 Jour, 20 21 Mois, 22 23 Année)

Ligne (24 25)	Statut (27)	Age (29)	Champ (31)	Culture Principale (32)	Operation (34)	Outil (37)	Temps Passé: Heures de Prières	Temps Passé: Heures (39)	Type de Paiement (40)

Si on a emprunté ou loué de l'équipment ou des animaux, remplissez le suivant:

Propriétaire du Champ (41 42 43)	Statut (44)	Age (46)	Culture Principale (48)	Outil/Animal (50)	Propriétaire d'Outil (52)	Type de Paiement (53)

stionnaire No. [2 3] (1 2) Activités Economiques - Agriculture - Inputs et Sorties

(A remplir s'il y a des activités agricoles sur No. 21)

[ ] (4 5) Village [ ] (6 7 8) Enquêteur [ ] (9 10 11 12 13 14) Jour Mois Année

[ ] (17) ge Chef du Ménage _____ Date [ ] (18 19 20 21 22 23) Jour Mois Année

n a mis des inputs
- les champs,
lissez le suivant:

Propriétaire du Champ (24 25)	Statut (27)	Age (29)	Culture Principale (31)	Type d'Input (33)	Quantité: Unités Locales	Quantité: Kg ou Litres: Quantité (35 37)	Quantité: Kg ou Litres: Unité (39)

i on a recolté
quelque chose,
plissez le suivant:

Propriétaire du Champ (40 42)	Statut (43)	Age (45)	Produit Recolté (47)	Quantité: Unités Locales	Quantité: Kg ou Litres: Quantité (49 51)	Quantité: Kg ou Litres: Unité (53)

Questionnaire No. 2 4 (1 2) Activités Economiques - Elevage

(A remplir s'il y a des activités d'elevage sur Ho 21

3 Centre | 4 5 Village | 6 7 8 Enquêteur | 9 10 Jour | 11 12 Mois | 13 14 Année

15 16 17 Ménage

Chef du Ménage _____

Date 18 19 Jour | 20 21 Mois | 22 23 Année

Personne 24 26	Statut 27	Age 29	Operation Effectuée 31	Outil 33	Espèce Elevée ou Exploitée 35	Appartenance du troupeau 36	Temps Passé: Heures de Prières	Temps Passé: Heures 38	Type de Paiement 40

uestionnaire No. [2 5] (1 2) Activités Economiques - Pêche

(A remplir s'il y a des activités de la pêche sur No. 21)

tre (1 2 3) Village (4 5) Enquêteur (6 7 8) Jour (9 10) Mois (11 12) Année (13 14)

16 17 énage Chef du Ménage _____ Date (18 19) Jour (20 21) Mois (22 23) Année

Personne (26)	Statut (27)	Age (29)	Operation Effectuée (31)	Outils/ Instruments (33)	Lieu (35)	Temps Passé: Heures de Prières	Temps Passé: Heures (36)	Quantité: Unités Locales	Quantité: Kg ou Litres: Quantité (38 40)	Quantité: Kg ou Litres: Unité (42)	Conservé/ Transformé (43)	Pourcentage du Poisson Destinée à la Vente (44)

Questionnaire No. [2 6] (1 2) Activites Economiques - Peche - Transformation et Conservation

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Titre [ ] Village [ ] (4 5) Enquêteur [ ] (6 7 8) Jour Mois Année [ ] (9 10 11 12 13 14) Ménage [ ] (15 16 17) Chef du Ménage _____

Date [ ] (18 19 Jour, 20 21 Mois, 22 23 Année)

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Si le poisson est conservé ou transformé, remplissez le suivant :

Personne (26)	Statut (27)	Age (29)	Technique de Conservation/Transformation (31)	Operation (32)	Outil (34)	Temps Passé: Heure de Prières	Temps Passé: Heures (36)	Quantité (Fin) du Poisson: Unité Locales	Quantité (Fin) du Poisson: Kg ou Litres: Quantité (38 40)	Quantité (Fin) du Poisson: Kg ou Litres: Unité (42)	Combustible Utilisé: Type (43)	Combustible Utilisé: Quantité: Unités Locales	Combustible Utilisé: Quantité: Kg ou Litres: Quantité (45 47)

uestionnaire No. 2 7 (1 2) Activités Economiques - L'Artisanat (A remplir s'il y a des activités artisanales sur No.21)

Village (4 5) Enquêteur (6 7 8) Jour (9 10) Mois (11 12) Année (13 14)

ménage (16 17) Chef du Ménage _____ Date (18 19 Jour, 20 21 Mois, 22 23 Année)

Personne (26)	Statut (27)	Age (29)	Categorie d'Artisan (31)	Fabrication/Reparation (33)	Objet (34)	Temps Passé: Heures de Prières	Temps Passé: Heures (36)	Combustible Utilisée: Type (37)	Quantité: Unités Locales	Quantité: Kg ou Litres ou M³: Quantité (40 42)	Quantité: Kg ou Litres ou M³: Unité (44)	Destination (45)

-99/-

Questionnaire No. 28 Entrées, Sorties du Ménage (Revenus / Dépenses) D-17

Centre (3) Village (4 5) Enquêteur (6 7 8) Jour (9 10) Mois (11 12) Année (13 14) Ménage (15 16 17) Chef du Ménage _____

Date (18 19 Jour, 20 21 Mois, 22 23 Année)

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Personne (24 26)	Statut (27)	Age (29)	Sorties (Donné) Type Donné (31)	Quantité: Unités Locales	Quantité: Kg ou Litres ou M³ Quantité (33 35)	Quantité: Kg ou Litres ou M³ Unité (37)	Valeur (en FM) (38 40 42)	Entrées (Reçu) Type Reçu (44)	Quantité: Unités Locales	Quantité: Kg ou Litres ou M³ Quantité (46 48)	Quantité: Kg ou Litres ou M³ Unité (50)	Valeur (en FM) (51 53 55)

Fiche d'Observation No. 3 1 (1 2) Recherche, Achat des Combustibles et de l'Eau

D-18

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3	4 5	6 7 8	9 10 11 12 13 14	15 16 17
Centre	Village	Enquêteur	Jour Mois Année	Ménage

Chef du Ménage _____ Heure d'Arrivée (18 19 20 21) Heure de Départ (22 23 24 25)

Personne (26 28)	Statut (29)	Age (31)	Type (33)	Origine (35)	Distance en Kms. (37 39)	Quantité: Unités Locales	Quantité: Kg ou litres ou M³ — Quantité (40 42)	Quantité: Kg ou litres ou M³ — Unité (44)	Prix Total (46 48 50)

1 2

D-19

3	4 5	6 7 8	9 10 11 12	13 14	15 16 17
Centre	Village	Enquêteur	Jour	Mois	Année	Ménage

Chef du Ménage _____

Heure d'Arrivée [18 19] Heure [20 21] Minute

Heure de Départ [22 23] Heure [24 25] Minute

Total Présent au Ménage [26 27 28]

Eau	Quantité	
	Unités Locales	Litres
Quantité à l'Arrivée d'Enq.		
Quantité(s) ajoutée(s) pendant la période d'observation		
Somme A + B		
Quantité qui reste au départ d'Enq.		
Total Utilisé C-D		[33 34 35]

% Adults Présents [29 30]

Activité du Chef [31 32]

Estimez la quantité de l'eau utilisée dans les fonctions suivantes:	Quantité		Vu par l'enq.?
	Unités Locales	Litres	
La Cuisine		[37 38 39]	[40]
Pour se Laver		[42 43 44]	[45]
Pour Boire		[47 48 49]	[50]

Utilisation	Quantité		Vu par l'Enq.?
	Unités Locales	Litres	
La lessive		[52 53 54]	[55]
Abreuver les Animaux		[57 58 59]	[60]
Fabrication de boissons locales		[62 63 64]	[65]
Arrosage		[67 68 69]	[70]
Irrigation		[72 73 74]	[75]
Artisanat		[77 78 79]	[80]
Autres (précisez)		[82 83 84]	[85]

d'Observation No. [3][3] (1 2) Utilisation des Combustibles New.

D-20

[ ][ ] (4 5) Village [ ][ ][ ] (6 7 8) Enquêteur [ ][ ] (9 10) Jour [ ][ ] (11 12) Mois [ ][ ] (13 14) Année [ ][ ][ ] (15 16 17) Ménage Chef du Ménage _____

e d'Arrivée [ ][ ][ ][ ] (18 19 20 21) Heure de Départ [ ][ ][ ][ ] (22 23 24 25) Total Present au Ménage [ ][ ][ ] (26 27 28)

Adultes Present [ ][ ] (29 30) Activité du Chef [ ][ ] (31 32) Pour les autres utilisations du bois et les autres combustibles, remplissez le suivant:

Pour le bois de cuisine, donnez les informations suivantes:	Quantité		
	Unités Locales	Kg ou M3 Quantité	Unité
Quantité à l'Arrivée			
Quantité(s) ajoutée(s) pendant la période d'observation			
Somme A+B			
Quantité qui reste au depart			
Total Utilisé C-D		[ ][ ][ ] (33 35)	[ ][ ] (37)

Espèces de Bois de Cuisine	Espèce	Quantité (Kg ou M3)	Unité
plus important	[ ][ ] (39)	[ ][ ][ ] (41 43)	[ ][ ] (45)
deuxième en importance	[ ][ ] (47)	[ ][ ][ ] (49 51)	[ ][ ] (53)

Type de Combustible (pour bois, espèce) (65)	Fonction (57)	Quantité: Unités Locales	Quantité: Kg, litres ou M3 Quantité (59 61)	Quantité: Unité (63)	Heures d'Utilisat. (65 67)

170

1 2

3 entre | 4 5 Village | 6 7 8 Enqueteur | 9 10 Jour | 11 12 Mois | 13 14 Année | 15 16 17 Ménage | Chef du Ménage _____

Heure d'Arrivée 18 19 20 21 | Heure de Départ 22 23 24 25 | Quel Repas? 26 27 | Quel Plat? 28 29

Plat? (Ecrivez) _____

La Cuisson

Activités	Temps pour piler 30 32 Heures Totales Preparation de Grain 34 36
Personnes	
Ustensiles ou Outils	
Heure Début	Heure Fin
Heures Totales: 38 40	
Nombre de	

Activités	
Personnes	
Ingredients Principaux (y compris quantités)	
Ustensiles	
Heure début	Heure Fin:
Heures Totales: 44 46	
Cuisson de Grain Temps: 48	Cuisson de Sauce Heures: 50
L'eau de Cuisine Heures: 52	

Feuille d'Observation No. [ ][ ] (1 2) Emploi des Appareils

[ ] (1) [ ][ ] (4 5) Village [ ][ ][ ] (6 7 8) Enquêteur [ ][ ][ ][ ][ ][ ] (9 10 11 12 13 14) Jour Mois Année [ ][ ][ ] (15 16 17) Ménage Chef du Ménage _____

Heure d'Arrivée [ ][ ][ ][ ] (18 19 20 21) Heure de Départ [ ][ ][ ][ ] (22 23 24 25)

Personne (initiales) 28	Statut 31	Age 31	Propriétaire de l'Appareil 33	Appareil 35	Heures: Début	Heures: Fin	Heures: Total 37 39	Distance: Destination	Distance: Kms. 41 43

Questionnaire No. 72 Prix des Combustibles et de l'Eau

centre	Village	Enquêteur	Jour	Mois	Année

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Produit	Echantillon No. 1				Echantillon No. 2				Echantillon No. 3				Prix moyen
	Unités locales		Kg. litres ou M3	Prix en FM	Unités locales		Kg. litres ou M3	Prix en FM	Unités locales		Kg. litres ou M3	Prix en FM.	par KG., M3, litres
cod		cod				cod				cod			

Renewable Energy Product Development
A Comparison of Government and Private Enterprise Procedures

The principal purpose of the midpoint evaluation of Mali's renewable energy project was to determine whether the objectives of the first two phases of the project has been achieved as called for in the project design. Except for the sections "Lessons Learned" and "Overall Validity of Project Design" in Appendix A, there was little emphasis on evaluating the project design, on assessing, in retrospect, whether the project's means are well suited to the project's end, and if not, to recommend changes in the project design.

The purposes of the Mali Renewable Energy Project were to improve village life by substituting renewable energy for human energy and to reduce Mali's dependancy on fossil fuels along with the consequent drain on hard currency. The principal means was to build and equip a national laboratory for renewable energy that would develop and test products responsive to villagers' perceptions of their energy needs.

In the four years since the project was designed, there has been some rethinking world-wide about the prospects for renewable energy in developing countries, the best means to foster it and the likelihood of a slower pace of its adoption. Some of these changes, noted below, could raise questions about the wisdom of promoting renewable energy, principally by means of a national laboratory.

Some recent conclusions about renewable energy in developing countries:

- The introduction of renewable energy in developing countries should be preceded by successful research, development and demonstration in industrial countries.[1] (See the references and notes' section at the end of this appendix.)

- The economic attractiveness of renewables has not yet been proven on a large scale by the practical test of market acceptance.[1] The emphasis on supply has not been matched by creation of demand.

- Improved woodstoves, for example, only marginally get at the problem of deforestation. Also needed is creation of incentives for reduced consumption and increased supply.[2] The commercialization of firewood is creating an incentive , and market projections, a program of loan guarantee or subsidy and help with enterprise development might increase the rate at which entrepreneurs invest in wood lots near cities and towns.

- It is not primitive villages that offer the best potential for renewable energy use but rather the sectors of an economy already in transition from subsistance to income production;[3] the sector that has begun to consume and pay for kerosene, gasoline or diesel fuel; where there is some mechanized agriculture, water pumping, food processing, workshop enterprises and services; and where servings are looked for.

- The pace of adoption of renewable energies is likely to be slower than anticipated; a slower rate of reduction than predicted in the cost of photovoltaic cells would be one cause. Hence, the return on an investment in a national laboratory for renewable energy will be delayed, and the time that a lab will constitute a drain on a nation's economy will be prolonged.

Given the above, the renewable energy project design might be changed so that the Malian government would give greater emphasis to the following:

1. Use the Lab, perhaps in collaboration with another agency of the Ministry of Industry and Tourism, to encourage and support the development of Malian enterprises in the field of renewable energy. With USAID support over the next two years, provide good officers to entrepreneurs in securing assistance from private, national and international assistance agencies for capital formation, product design and manufacturing business management, and market development.

2. Over the next two years, take steps to reduce the net cost to to the Malian government of operating the Lab. This would include greater emphasis on creating income and, as noted below, on reduction of operating costs and on research and product development for which there is a new term market.

3. Develop criteria for the Lab's research and project development agenda that include the following:

   - concrete evidence of a market for the product if it performs to design specifications and can be offered to the user at the anticipated price. This criterion would complement rather than substitute for the project's original criterion for establishing the Lab's research and development priorities.[4]

   - reason to believe that manufacture, distribution and field maintenance will be self-supporting, perhaps after a brief period of subsidization.

   - assurance that comparable research and development work has not been carried out nor is being conducted elsewhere.

   - or, if the above criteria cannot be met, the Lab might still undertake the project if it receives a contract that provides compensation for its work or if, for other good reasons, the Lab's director waives the criteria suggested above.

In the analysis that follows, a comparison is made of typical procedures for the development of renewable energy products by a government agency and by a private enterprise. The purpose of this comparison is not to disparage what has been done; Mali's Lab should soon be functioning as intended. Rather, the comparison is intended to give support to the argument that the Lab, in the second half of the project, should become a means for enterprise development, not a substitute for it.

The argument is limited to small enterprises. It does not consider national benefits that may derive from government participation--as in Japan--to reduce the risks of large-scale, long-term investment in high tech development e.g., aircraft or computer manufacture.

Renewable Energy Product Development.
A comparison of government and Private Enterprise Procedures.

GOVERNMENTAL PROCEDURE	ENTREPRENEURIAL PROCEDURE
MOTIVATION	
To serve a need, national or local	To make a profit for personal gain
STARTING STIMULUS	
Economic urgency (balance of payments, etc.), altruistic obligations, or political pressures	Seeing an opportunity to sell something at a profit
KEY PERSON(S)	
A minister, sub-minister, or appointee	A private individual, a small group of friends or business associates
FIRST STEPS	
Issue a directive or pass legislalation	Design the product (improve existing designs where possible) with expectation of later refinement as tests and manufacturing methods indicate.
Provide capital for anticipated needs by government appropriation or through negotiation of a grant from a national, international or private donor agency. If the latter, develop a project plan consistent with the current priorities and procedures of the donor agency	Estimate initial and long term sales; costs and methods of manufacture, distribution, and promotion; capital needs
Form a board of directors generally from other government agencies	Look for sources of manufacture, farming out as much as possible except for processes that require little capital investment - e.g. assembly.
Hire director with political connections or agency experience	Look for sources of capital
Provide offices, furniture and fixtures, typewriters, copy machines, etc. of appropriate prestige.	Form a company of the kind necessary to get capital
Hire administrative personnel (generally from within government agencies or political appointees); hire secretaries, clerks, drivers, etc.	Pass inspection by the lending or investing agency or individuals: judgment that the concept is sound, the product has potential, the principals are competent

Order vehicles having an appropriate level of prestige

Publish administrative procedures

NEXT STEPS

Design a field survey to assess perceived needs; prepare interview forms to determine present energy consumption, product preferences, maintenance capabilities, etc.

Make arrangements with other government agencies to conduct the survey and analyze data

Design and construct an energy laboratory. Order manufacturing and test equipment: machine tools, data collecting and recording apparatus, etc.

Arrange for training of personnel on site and abroad

Hire consultants

Install and become familiar with test apparatus and manufacturing equipment

Begin design and test of apparatus expected to be given higher renewable energy priority by the field survey

Begin field test of initial apparatus

Begin cost analyses of products under test or development

Begin analysis of field survey data

Make preliminary cost-benefit analyses, both financial (to the user) and economic (to the nation)

Establish priorities for product development on the basis of the field survey needs analyses and the cost-benefit analyses

Narrow the variety of products under test or development

Rent cheap office space, assembly and storage space

Start manufacture

Buy used desks and a typewriter, pay secretarial help by the hour, get copying work done outside, get expert help - engineering, accounting, etc. part time, generally from moon-lighter (people with other jobs who will work at night)

Set up a sales and service organizatio generally through manufacturers' agent or distributors who handle similar products

Train and attempt to motivate the sales agents. Provide sales aids and, when a priate, as much advertising as can be afforded

Make design changes as indicated by a) field experience: breakdowns, maintenance problems, customer and dist butor reactions and b) a cost reduction program

Expand facilities, order manufacturing equipment as it becomes more economical to manufacture in-house than to farm ou

Hire some skilled workers; train others on the job

Hire a secretary, buy a decent typewriter, maybe a copy machine

Replace sales agents and distributors who are not producing

Plow profits back into the company, continue to expand sales, develop other products, increase salaries or go out of business

Maybe buy a company car

Manufacture enough prototypes for field test

Install (generally with the help of other government agencies) the prototypes in sites which, from the field survey, have need and interest

Monitor field performance; report on use, maintenance, and user reactions.

Modify product design based upon field experience

Estimate what people will pay for initial purchase and maintenance

With the help of other agencies, develop a plan for distribution and maintenance

Apply for another appropriation or grant

Note: The above analysis draws upon personal experience in starting small companies and from observations of government procedures in the U.S. and abroad. It does not deal with the most common problems with each procedure. Private firms go out of business because they price too low, their product doesn't work well or costs too much, their customers pay slowly or not at all, and for other kinds of bad management.

Government operations seldom work as intended. Advisory boards seldom meet and are rarely useful. Bickering develops between rival agencies, equipment purchases are excessive or inappropriate to manufacturing needs, vehicles break down and work stops.

Vehicles point up the basic difference in thinking. Example: A Government agency conducted survey of renewable energy needs and usage stopped for several months in a remote town because the agency's four-wheel drive Land Rover broke down and there were no local parts or repair facilities. Salaries accrued. The overhead continued but not the survey. Yet each day people went to and from the town by Peugot bush taxi, inconveniently and perhaps a day or two late in the rainy season, but not months late. In a government agency it was understandable. In a private enterprise the person would get there or be out of a job.

There is, in the foregoing comparison of government and private sector procedures, no indication of a time frame but, after four years, a government program, on which this analysis is partially based, is about two thirds through the process and is awaiting extension of the grant. Most small private enterprises, after two or three years, would be at least breaking even or would have folded.

REFERENCES AND NOTES:

[1] G. Foley, "The Future of Renewable Energy in Developing Countries," AMBIO 10 (5), 1981.

[2] G. De Lepeleire, et.al, "A Woodstove Compendium," (Report for Technical Panel on Fuel Wood and Charcoal of U.N. Conference on New and Renewable Energy Sources) FAO Rome, 1981.

[3] A.D. Dyer, "History Today," 25, 1976, p. 598.

[4] The original project design called for setting research and developmen priorities based upon a socio-economic survey of energy consumption and need in representative villages. The Lab was to test or develop products that addressed these needs, place them in some of the villages, and report on their performance and maintenance as a guide to further research or development. The market place method, by contrast, says guide research and product development by what people will presently buy and maintain at their own cost. The two methods can lead to differing conclusions as can be illustrated by the examples of solar water heaters and bio-gas digesters.

The Lab's studies on both products confirm the findings of tests made elsewhere that the cost per unit of energy generated compares favorably with more conventional means. The renewable energy project evaluation report, therefore, recommended further development of solar water heaters for urban use and that work on bio-digesters proceed.

But there does not appear to be an existing market for either product. The Lab produced some 250 hot water heaters, about half of which are still on hand three years later. There is a mix of reasons, one of which is that the city water pressure in Bamako is frequently too low to deliver water to a solar unit on the roof but enough to get it to an electric heater on the ground floor. The evaluation report also recommends that after-sale service of solar water heaters be improved but gives neither justification for assigning this priority nor indication of where funds would come from.

Similarly for bio-digesters, the feasibility analysis based on Lab data does not take into account the cost of distribution of energy in bio-gas form. While analyses of this kind can be improved, a quick survey of the market place is likely to help in avoiding some misguided efforts and in calling attention to the possibility of long term costs of subsidy for products that people are not ready to buy. This is not to say that a government will not make such decisions--particularly in the fields of health, water supply, communications or illumination--but only to say that the costs of such decisions should be estimated as soon as is possible.