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TERMS OF REFERENCE

PHASE IV

RENEWABLE ENERGY PROJECT

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SUMMARY PHASE IV TERMS OF REFERENCE

Phase IV is a six-month joint evaluation, herein referred to as the Project Assessment. As described within these Terms of Reference, the Project Assessment will attempt to measure the extent to which the project achieved the goals, purposes and outputs contemplated in the logical framework matrix, and the implications of such results for future RE programs in Mali and elsewhere, paying particular attention to the experience of Phase III and the village testing program.

The present Terms of Reference serve as a guideline to both the "lead-in" period from November 1984 to March 1985 and to the six-month period from April to September 1985 when Phase IV will actually be conducted.

Two sections of the present report--the CRITERIA FOR ASSESSMENT and the METHODOLOGY TO EVALUATE TECHNOLOGIES, combined with Appendix 'A'--provide those responsible for Phase IV with a comprehensive reference defining considerations for performing the assessment and an approach to the problem. The third principal section--the IMPLEMENTATION PLAN--provides a detailed definition of tasks to be accomplished, a schedule, manpower needs and the budget necessary to implement this phase. The remaining sections define the project objectives--immediate and longer term, the technologies available for assessment and provide the newcomer to the project with a general background for LESO, accomplishments within the RE Project, and principal areas of activity in applied research, field installations and monitoring programs.

The USAID Mali Program Office (Roger Simmons) and DEO (Zach Hahn) advise that USAID/Bamako will not participate directly in Phase IV, which will be conducted jointly by LESO personnel and independent consultants, preferably the energy scientist and social anthropologist who participated in the earlier phases of the project (cf. Project Paper Appendix 'L'). USAID also advises that the final report resulting from the Project Assessment may form the basis of a desk-top study to be performed internally within USAID upon completion of Phase IV and will serve as the USAID final Project Evaluation.

Phase IV of the project will be directed, managed and implemented by LESO with part-time input from two project advisors. Immediate management, logistical support, and coordination of the various implementation elements will be responsibility of the Phase IV coordinator. The chief of the scientific and technical section (SST) within LESO is proposed for this role and would report directly to the LESO director, be counterpart to the consultants, and work closely with the Intervention Group, Zone Controllers and Interviewers throughout the entire six-month phase. Additional input will be provided by members of the research groups, LESO management, administrative and manufacturing sections as defined in the manpower schedule.

Consultant assistance--an energy scientist and a social anthropologist--will be provided to Phase IV in two separate inputs one of seven weeks duration beginning 1 April, and the second consisting of six weeks, beginning mid-August 1985 and terminating with publication of the final report in late September. During each input period, consultants will be programmed as per the manpower and task schedules and will work alongside LESO personnel.

The consultants will make a preliminary assessment and analysis of project outputs, provide recommendations for last-minute data collection to supplement the initial assessment, review the final output, and guide LESO in the task of analyzing and preparing a final project report which will contain

1) a measure of the potential for RE technologies in Mali,

2) a measure of the institutional growth within LESO,

3) extensive recommendations for the future profile of LESO both in R&D production and commercialization and finally

4) recommendation of a long-term strategy.

Each of the tasks to be accomplished and a scope of work for each consultant within Phase IV are discussed extensively in the section "Implementation Plan."

The issue of "local" consultants, particularly to reinforce the social impact studies aspect of the Phase IV Assessment, has been discussed with LESO. The initial reaction is favorable and such a service deemed highly desirable, but time and resources available to prepare this document did not permit extensive review to be performed. It is thus recommended that LESO pursue this issue and initiate the action necessary to contract with another Malian public service or local private organization--either immediately, to reinforce the output from the lead-in period to Phase IV, or in April 1985 to guarantee provision of these services throughout the Assessment. The potential to draw more complete and extensive conclusions from the village installations progam will be enhanced if these measures are incorporated.

Several major issues are evident at this stage of the project:

1. The baseline energy survey has not produced the results anticipated, and does not offer the basis for comparison of energy consumption within the pilot villages before and after technology introduction.

2. The pilot project zones selected may have been appropriate for social impact studies, but they were not well-suited to field-testing and monitoring of RE technologies.

3. A restructuring within LESO to emphasize field installations and monitoring is needed to provide an adequate structure upon which to base the Phase IV Assessment (Cf. Appendix 'B').

4. LESO should define its requirements for, and if appropriate, contracts with local social scientific consultants deemed desirable to supplement the present social science research capacity within LESO. This will strengthen the village level technology assessment scheduled within Phase IV.

5. Technologies introduced into field applications, if donated to the user, may be attractive to those promoting RE technologies, but make assessment very difficult; consequently, there is a tendency to misrepresent the potential of that technology.

6. The institution-building within LESO has been remarkable, and can be evaluated readily. This rapid but effective institutional growth should be emphasized to demonstrate to other collaborators the capacity of LESO to accomplish a task presented to it.

7. LESO lacks provision to market its acquired expertise. This expertise, both in manpower capacity for consulting and manufacturing capacity for production, are key elements to the future success of the organization.

The issues cited above, and others, will be addressed in detail throughout Phase IV. Criticism and recommendations will be made. Much can be done to strengthen areas of weakness, rectify earlier errors, and build upon the present capacity, so that the assessment will be more complete, positive and constructive. As an interim measure and in preparation for Phase IV, we recommend that LESO:

1. review tasks accomplished and required project outputs

2. prepare a workplan for the remaining period of Phase III which will encompass the major elements identified above. The workplan should include:

-- the field installations and monitoring program
-- the social-impact studies
-- restructuring of LESO to provide maximum support to the above activities
-- a proposal for LESO to market its acquired expertise

3. review the Terms of Reference, which will provide a total understanding of how Phase IV will be performed, the aspects of the program to be assessed and the approach used to perform this assessment.

BACKGROUND

THE SOLAR ENERGY LABORATORY

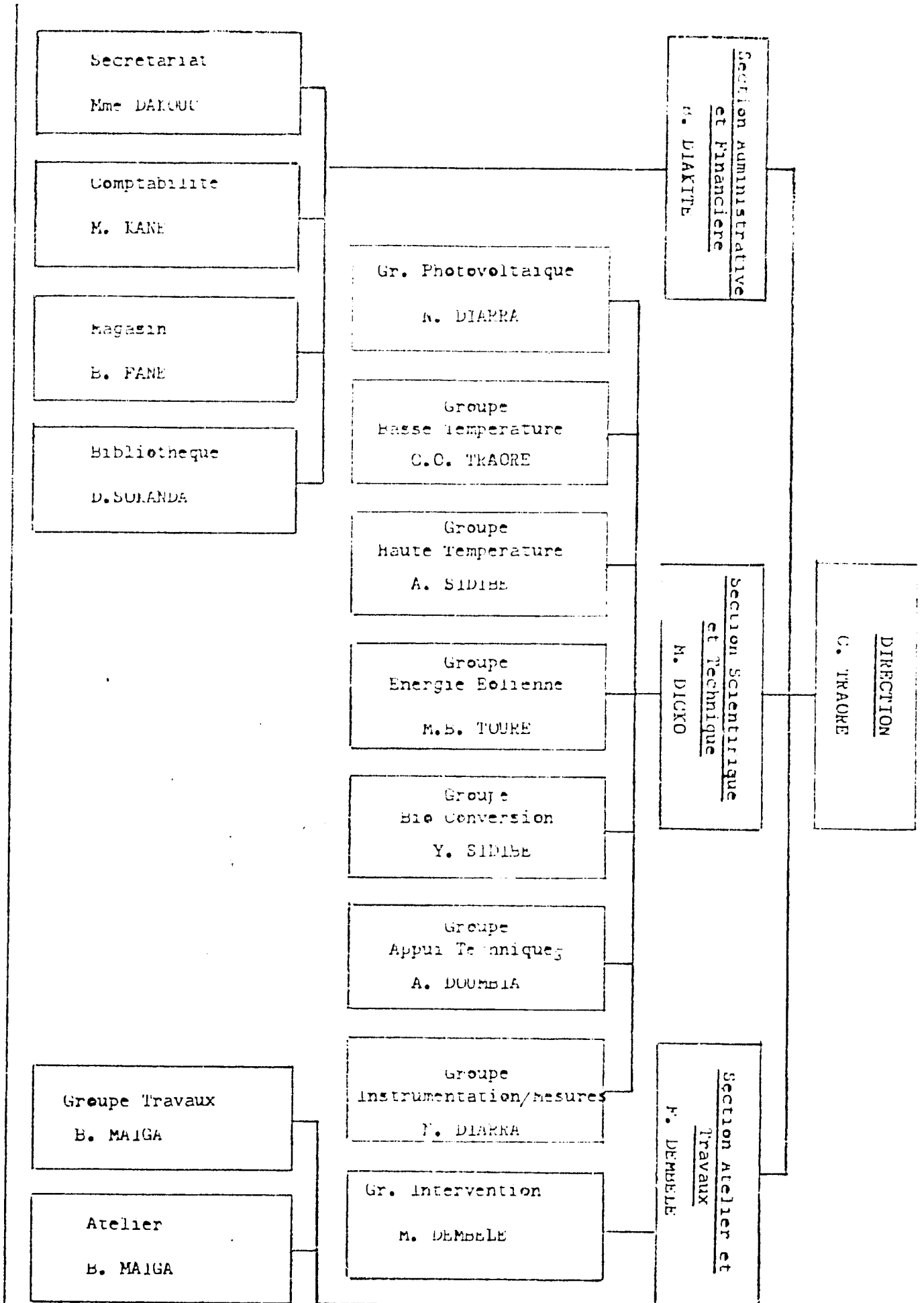
The LESO was created shortly before 1964. In spite of a difficult beginning, after which the laboratory was able gradually to organize, equip and define itself as an agency with the capacity to play a key role in the development of Mali. Its 80-member staff now includes 15 senior research engineers and approximately 20 specialized technicians.

The principal task of the LESO is Research and Development in Renewable Energies Technologies (RETs), but in addition to R&D, the laboratory performs more practical work such as the fabrication of solar water heaters and improved portable woodstoves, installation and maintenance of pumps, refrigerators, solar lighting systems, etc.

The laboratory is attached to the Department of Energy and Water Resources (Ministry of Equipment) and is divided into three sections (cf. organigram):

- the administrative and financial section
- the scientific and technical section, including five research groups plus a technical support group and an instrumentation and measures group
- the workshop, maintenance and field installations section which consists of three groups:
  - a workshop where prototypes are constructed for the applied research program and field installations
  - the maintenance department for the facility and fleet of vehicles
  - the Groupe Intervention, who supervise both the technical and social impact aspects of the field installations and monitoring program

The permanent staff of the LESO has increased from 45 in 1979 to 84 at present, with GRM financial support to the institute increasing annually. This is indicative of the contribution and effort the GRM is parpared to invest to alleviate dependence on imported energy, to encourage conservation, and to build the national capacity to establish decentralized energy autonomy.


DIRECTION
C. TRAORE
Section Administrative et Financiere
M. DIAKITE
Section Scientifique et Technique
M. DICKO
Section Atelier et Travaux
F. DEMBELE
Secretariat
Mme DAKOUO
Comptabilite
M. KANE
Magasin
B. FANE
Bibliotheque
D.SOKANDA
Gr. Photovoltaique
N. DIARRA
Groupe Basse Temperature
C.O. TRAORE
Groupe Haute Temperature
A. SIDIBE
Groupe Energie Eolienne
M.B. TOURE
Groupe Bio Conversion
Y. SIDIBE
Groupe Appui Techniques
A. DOUMBIA
Groupe Instrumentation/Mesures
Y. DIARRA
Gr. Intervention
M. DEMBELE
Groupe Travaux
B. MAIGA
Atelier
B. MAIGA

5a

S S T

M. DICKO

Groupe PHOTOVOLTAIQUE

CHEF : N'TO DIARRA

ING. : Mam. DIARRA
Ousmane SOUMAORO

TECHN. : Abd. TOUNKARA
Sidi DIAWARA

Groupe BIO CONVERSION

Chef : Yaya SIDIBE

ING. : Cheick SANOGO -
Mlle Fatoumata SIDIBE

Gr. BASSES TEMPERATURES

Chef : Cheick TRAORE

TECH. : Abc. DEMBELE

Ing. a tps partiel :
Ch.TRAORE-M.DICKO-Ah.DOUMBIA

Groupe APPUI TECHNIQUE

Chef ; Ah. DOUMBIA

TECH. : dessinateurs
- Illo DIALLO
- Attino MAIGA

Gr. HAUTES TEMPERATURES

Chef : Amadou SIDIBE

TECH. : Abd. OUATTARA

Gr. INSTRUMENTATION & MESURES

Chef : N'To DIARRA

ING. : Alh. MAIGA

TECH. : Mohmoud OUATARA
Alassane MAIGA

Groupe ENERGIE EOLIENNE

Chef : M.B. TOURE

ING. : KAMISSOKO

TECH. : Seydou DIARRA

S A T

Fat. DEMBELE

TRAVAUX

B. MAIGA

Tidiani DIARRA CM Electric.
Mamadou Yattassaye CM Menuisier
Amadou KOUREISSY CM Menuisier
Dramane COULIBALY CM Menuisier
Mamadou KEITA Macon
Bekaye SAMAKE Manoeuvre
Broulaye SIDIBE Manoeuvre
Nouhoum YANOGO Jardinier
Moussa SAMAKE Jardinier

Les chauffeurs

Groupe ATELIER

B. MAIGA

Yaya TRAORE c/maitre adjoint
Michel DIAKITE "
Demba KEITA "
Negueba DIARRA "
Souleymane TIEBAA Contre-Maitre
Oumar KANTE Ouvrier
Sidiki TRAORE Ouvrier
Notie TRAORE Ouvrier

Groupe INTERVENTION

M. DEMBELE
X. DEMBELE
B. SAMAKE, CM

* Tous agents des groupes Atelier et Travaux selon les travaux
* Controleurs et enqueteurs des zones

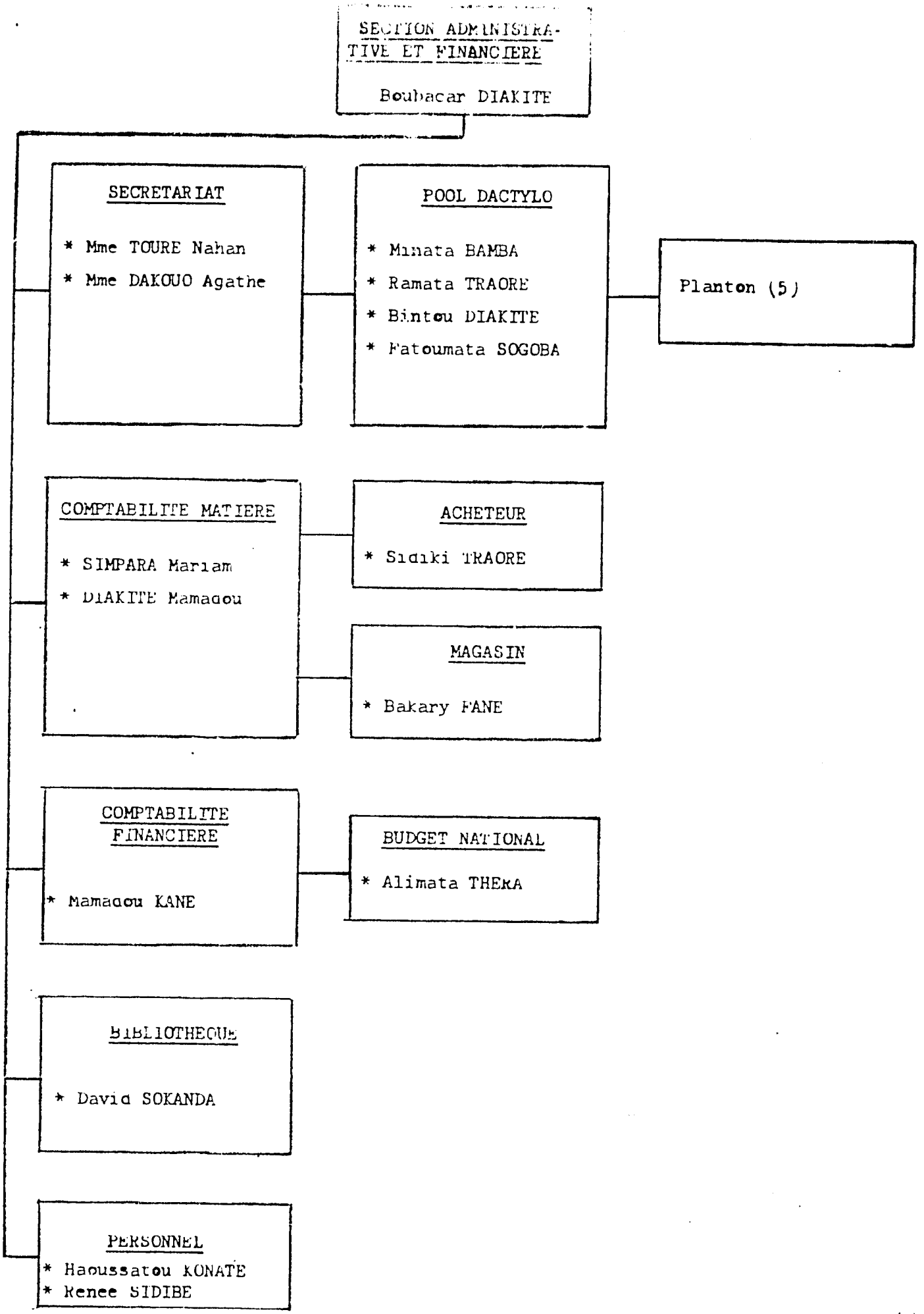
Attributions

Tous travaux de genie civil, d'entretien des locaux, du materiel technique.

Relation avec le garagiste : Tenue d'un cahier d'entretien par vehicule (y seront notees toutes les interventions).

Fabrication des prototypes. Reparation des appareils exposes au champ ou installes ailleurs (en atelier). Entretien du materiel technique de l'atelier.

Execution des taches pratiques sur le terrain (dans les zones et ailleurs) avec l'appui du G.A.T., des groupes de recherche concernes et de l'Atelier.


SECTION ADMINISTRATIVE ET FINANCIERE
Boubacar DIAKITE
SECRETARIAT
* Mme TOURE Nahan
* Mme DAKOUO Agathe
POOL DACTYLO
* Minata BAMBA
* Ramata TRAORE
* Bintou DIAKITE
* Fatoumata SOGOBA
Planton (5)
COMPTABILITE MATIERE
* SIMPARA Mariam
* DIAKITE Mamadou
ACHETEUR
* Sidiki TRAORE
MAGASIN
* Bakary FANE
COMPTABILITE FINANCIERE
* Mamadou KANE
BUDGET NATIONAL
* Alimata THERA
BIBLIOTHEQUE
* David SOKANDA
PERSONNEL
* Haoussatou KONATE
* Renee SIDIBE

5d

RENEWABLE ENERGY PROJECT PURPOSE

The purpose of the RE project is to increase the institutional capacity of the National Solar Energy Laboratory (LESO) sufficiently to establish a representative data base upon which to assess the potential of locally manufacturable and imported Renewable Energy Technologies (RETs) in rural Mali. Conclusions drawn from the assessment will provide guidelines for the Government of the Republic of Mali (GRM) to determine the role and level of emphasis on renewable technologies in future energy policy planning, and their impact on the rural population

ACTIVITIES AND PROGRESS TO DATE

A preliminary phase

1) equipped the LESO with workshop tooling necessary to manufacture prototype RETs,
2) imported commercialized western technologies,
3) procured instrumentation systems to monitor the performance and reliability of these locally manufactured and imported technologies

The project proceeded to concentrate on two principal tasks an energy survey to identify and quantify energy consumption in a representative sample of rural Mali, and a development and testing program of locally produced and imported technologies which could reduce the labor-intensive lifestyle, increase productivity, or improve health, educational and living standards of rural inhabitants

The energy survey and applied research program provided the basis upon which to plan and implement a subsequent 20-month field installation program of various technologies including wind and photovoltaic pumping systems, refrigeration, lighting, fish and crop dryers, distillation plants, improved woodstoves, and domestic hot water systems. The results of monitoring programs to determine the technical viability and economic base, and to measure social impact of these field-installed technologies, are forming the data base upon which the final phase of the project (Phase IV) will assess the potential for RETs in rural Mali

Project technical advisors to strengthen the management and research capacity of LESO and to assist in achieving project objectives were provided by the Solar Energy Research Institute (SERI) from September 1980 to July 1982 under a PASA agreement and by Sheladia Associates through an 8A contract from January 1983 to September 1984. Short-term consultant assistance will also be provided to the project to assist LESO in the final phase of assessment (Ref. Implementation Plan). The institutional capacity of the LESO has further been strengthened by 42 months of short-term practical-biased training programs in the US, Europe, and developing nations. The LESO now also conducts training programs for other national and regional centers.

APPLIED RESEARCH AND FIELD INSTALLATIONS PROGRAM

In keeping with its goal, LESO has from the beginning elaborated research programs oriented toward the development of Renewable Energy devices capable of satisfying the energy needs of the population. The program set forth in the RE Project is divided into two parts:

- testing and adaptation of imported materials--pumps, refrigerators, solar lighting systems, etc., and
- development of original devices (aeolians, dryers, etc.)

Research at LESO may be divided into five activity areas. Achievements within each area are summarized below.

1. <u>Photovoltaic Technologies</u>. After several years of research and experimentation on improved systems, coupled with a series of highly specialized training programs, the group now has an advanced understanding of the engineering applications of this technology. Currently the group (four engineers and two technicians) are involved in the development of:
   - a photovoltaic battery charger to recharge D and C cells commonly used in flashlights and radios at the Malian village level
   - a photovoltaic mill (2.5 KW peak) with a milling capacity of 300 kg of grain per day. The mill system, totally designed within LESO, is scheduled for installation in the fall of 1989. This will be the first mill of its kind in Mali
   - a series of photovoltaic refrigeration and lighting systems installed within village dispensaries and schools.
   - a 1.2 KW uninterruptible power supply to drive sensitive instrumentation within the laboratory facility, since the reliability of the national grid is inadequate
   - a project to design and manufacture low-powered charge regulators/controllers and DC fluorescent lamps (under review)

LESO has supervised site engineering of four PV pumping systems, installed 11 systems, and commissioned approximately 25. It regularly monitors the performance of four systems and has recently dimensioned four new generation systems which will be installed, monitored and maintained by the group. A free advisory service is provided to the private sector for PV technologies.

Activities in the PV group are supported by an extensively equipped and well-staffed instrumentation section, which provides instrumentation support to all research activities and maintenance support to all monitoring equipment.

2. Low Temperature Technologies. The group has produced a semi-industrial solar fish dryer used within a commercial fish plant in Mali. The system (capacity of 75 kg per day) has been selected as a pilot project and will be extended to meet the total drying needs of the production plant when the technology is perfected. A selection of village-level fish and vegetable dryers are also installed and are being monitored. The group has also perfected a locally manufacturable, relatively low-cost solar hot water heater, of which approximately 150 units are installed in urban institutional and domestic applications. A series of these hot water units is also installed in village dispensaries within different zones of Mali. Two versions of the technology are available, depending upon availability of a piped water supply. Maternity units have expressed considerable satisfaction with these low-cost thermal siphon water heaters.

Other activities include the design and installation, in a series of locations, of small solar distillation plants with a capacity of two liters per day, and the production of plaster of Paris from gypsum, which is mined in Mali. Transformation is achieved using a high efficiency flat plate collector process.

3. High Temperature Technologies. LESO has constructed and field-tested a series of molded parabolic cookers. The technology has encountered a series of user problems and its viability is being reassessed.

4. Wind Technologies. The group has designed and is currently field-testing a series of multi-bladed wind pumping systems. The LESO design is totally manufacturable in Mali and will utilize raw materials available on the local market. Plans to produce this wind pumping system in quantity are under review.

5. Bio-Conversion Technologies. There are two principal activities within this group: bio-digesters and improved woodstoves. The critical deforestation problem in Mali has necessitated a major emphasis on efforts to decrease wood consumption since approximately 93% of wood consumed in Mali is used for domestic cooking. An improved technology which will increase cooking efficiency could significantly assist conservation. LESO has, in collaboration with other national institutes throughout the Sahel, developed a series of high-efficiency, low-cost stoves for rural and urban applications. Several thousand are currently being tested and monitored throughout the country.

The anaerobic digesters, constructed from indigenous materials and adapted to local needs, are installed in a series of dispensaries and schools. These units provide lighting, energy for domestic cooking, and refrigeration. The principal restraint of this technology in Mali is the widespread shortage of water, an essential ingredient for anaerobic digestion. The group plans to study a semi-dry digestion process in 1985.

All applications research in renewable technologies necessitates a knowledge of the energy resource. The present energy resource data base in Mali is extremely limited, since the meteorological network, although established many years ago, is not well-equipped and does not provide a basis from which to perform sophisticated analysis. LESO has installed a series of remote monitoring weather stations throughout Mali which monitor global and indirect solar irradience, wind force and direction, ambient temperatures and precipitation. Data from these stations are periodically transmitted to LESO, analyzed and stored on micro-computer diskette.

SOCIAL IMPACT STUDIES.

All laboratory level research activities and field installations are supported by a group responsible for performing social impact studies and training equipment users in correct operation, simple maintenance and diagnostic procedures. As LESO's capacity expands, this group, formed in 1980, is assuming an increasingly important role in the installation and maintenance of a large selection of technologies in rural and urban applications.

The project paper for the Renewable Energy Project set forth a series of objectives to be realized by LESO with the assistance of a social anthropologist during Phase II. Basic goals were to determine "traditional" energy use by rural Malians across as broad an ecological and cultural spectrum as possible; such a baseline would guide LESO efforts to choose and implement early RETs deployment, and would establish a set of data against which change in energy use might be measured once LESO's RETs were installed. Villagers' needs would be identified, and solutions sought at LESO to meet them through innovative R&D in a series of renewable eneergy technologies. Four zones of action were chosen: San, Bougouni, Nioro and Gao. Three sorts of survey techniques were attempted (observations, questionnaires and "protocols") through 1981 and the first months of 1982. Malian interviewers living in the survey villages were used to collect data. Results were then processed in part by staff of the Institute for Rural Economy (IER), but mainly by project anthropologist Dolores Koenig, who was responsible for most of the statistical data; computer data sheets have been made available to LESO.

Koenig's trip reports and other memoranda, and her papers on energy use in the zones studies, form the Phase II baseline of LESO socio-economic research. These have been reviewed (at least those elements then available) by anthropologist Frances Stier in the July 1982 evaluation of the LESO/USAID program, and Phase III comments by Regis Maubrey and Brooke Schoepf in their regard are pertinent as well to a Phase IV wrap-up.

Phase III social research moved from a household (or, more precisely, a commensal-unit) based survey to one which focused upon the particular RETs deployed, or about to be deployed, by

LESO. Consultant Regis Maubrey was named Zone Liaison Advisor and worked with the Intervention Group (GI) of LESO to devise survey instruments to this effect. A goal was to retain to the degree possible the methods and survey structure composed by Koenig, so that enqueteurs would, with a minimum of re-training, be capable of implementing the research, and so that results from Phase III could be compared with data of Phase II. Maubrey also sought to integrate LESO efforts with those of other Malian and donor agencies.

By the time of Maubrey's departure, the need to alter Phase III methodology to produce the required results was evident. This is reflected in reports by Maubrey himself and by consultants Schoepf and Roberts. During the latter's visits, extensive revisions of questionnaires took place.

The main difficulties to date concern the demands made on "enqueteurs", who do not have the social science training or supervisory back-up to enable them to carry out the work required. For the remainder of Phase III, there will be less emphasis on questionnaires then hitherto. A pilot study to examine the need for other approaches was undertaken in Niror zone in October '84. It indicated that periods of fieldwork where Groupe Intervention members remain "on site" and work closely with zone teams would both help to motivate teams and improve the quality control on data collection.

The remaining technologies will therefore be examined using several approaches. Semi-structured interviews with users and "responsables", and observations of technology will compliment the often idealized responses elicited by questionnaires. These approaches will also aim to improve the understanding of LESO's interventions in the social contexts in which the technologies are used (village, institution, cooperative, etc.).

To assist in the analysis of Phase III data, Groupe Intervention team member M. Dembele received training in social science theory and data processing. The latter focused particularly on improved woodstoves, for which a large number of questionnaires exist.

PHASE IV RE PROJECT OUTPUTS

RESPONSE TO PID

The Project Implementation Documentation defined the five principal questions which must be answered during Phase IV in order to make a valid assessment for the potential of RE technologies. These five questions are as follows:

1) Which technologies are most susceptible 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 level, income distribution and social welfare in the community--who benefits the most, the least, not at all?

3) Which devices perform well 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 unacceptable changes in habits?

A principal objective of the terms of reference for Phase IV is to define the criteria and methodology necessary to respond to these five questions. In order to define more clearly the outputs required from Phase IV, each of the five questions is reviewed below.

1) Technology Management and Adaptability of Technologies to Local Managements and Maintenance

Technology management and maintenance are key factors in the successful introduction and acceptance of any technology. Without a local infrastructure to manage and maintain it, no installed technology can survive.

Rural Mali having had very little exposure to mechanical and electro-mechanical devices consequently has a very limited capacity for maintenance, and numerous examples of technically sound installations with no provision for maintenance and no local management infrastructure testify to the importance of this feature. The diversity of these technologies and their applications does not permit a single management or maintenance structure to cater for all installations. Neither do the complexity and diversity of needs permit easy identification of effective management and maintenance programs. In this context LESO has attempted to introduce different local management systems, frequently for different applications within the same technology in order to provide a basis for assessing the various

approaches. Likewise, since maintenance is frequently a function of the skills of villagers and the effectiveness of user training programs, it has to be assessed on a site-to-site and technology-by-technology basis. The Phase IV assessment will be required to determine which of the approaches introduced by LESO for technology maintenance and local management are effective and what can be done to improve upon experience to date.

2) Impact on Income Levels and Social Welfare

This parameter, which provides part of the economic basis upon which to assess the potential of any specific technology, is particularly difficult to evaluate in a rural milieu. Limited use of cash and reluctance to reveal information make data unreliable. In addition, impact on income levels and social welfare only becomes evident after an extended period. The technologies whose impact on income can be monitored most directly are solar dryers (used by fishermen or small-scale "truck" farmers), PV battery chargers and solar water distillers. In the latter two cases, income to those managing the chargers or distillers will complement income saved, presumably, by those using such improved services; but in both cases, quite small amounts of money are in question. Solar dryers and PV or wind-driven pumps (when used for irrigation, as in Mopti) may increase production and resultant profits. Such matters are to be investigated in late Phase III research, and evaluated in Phase IV.

The specific benefits in the field of social welfare provided by the each technoloegy will be evaluated in Phase IV. In the long term, for example, dryers should enable increased amounts of relatively vermin-free fish and dried vegetables to reach the consumer. Those technologies placed in healthcare facilities (PV lighting, water pumps and refrigerators, solar water heaters, possibly solar water distillers) will provide a variety of benefits. PV or wind-driven water pumps and PV-powered grain mills will assist with tasks at present carried out primarily by human power. It is often assumed that womens work, in particular fetching water and grinding grain, will be reduced, thus freeing them to undertake more "productive" activities. Data collected in Phases III and IV should enable this assumption to be evaluated empirically. The theoretical issue of what constitutes "productive" time and who defines it should also be examined. Difficulties in applying this concept are evident in another energy-related project (the Tangaye Solar Energy Demonstration, Burkina Fasso), and comparisons between the two projects should be considered in Phase IV.

The impact of improved woodstoves must be a major consideration during Phase IV. Are cooking times and firewood consumption reduced significantly enough to have an impact on womens' workloads? Are these benefits actually perceived? Does the use ofimproved woodstoves complement other efforts to preserve forestation in Mali? These and related issues may only be answered by longer-term research, including comparisons between

rural and urban stove use

Technology Performance and Reliability

Technology performance is probably the most easily measured parameter, given LESO experience and areas of expertise. Technology performance when monitored over a specific period provides quantitative indicators of reliability. Technology performance and reliability outputs for Phase IV can be assessed by reference to the systematic field monitoring results and reports available for varying periods of time for all technologies being field-tested. Based on these criteria a comparison between imported and locally manufactured technologies could well yield some startling results.

Cost and Cost comparison with conventional technologies

This output which is essentially an economic comparison between installed RE technologies and conventional technologies performing similar tasks is particularly difficult to quantify principally because any economic comparison for a technology is based upon technology performance and reliability. Throughout Mali very limited records exist to demonstrate either of these criteria with regard to conventional technologies. Within the framework of this and others RE projects (in particular Mali AquaVivar) the models available for economic comparison with conventional technologies are mostly based upon desk-type studies. An accurate assessment of this output will necessitate extensive research to establish a basis for comparison. A reference point may well be provided by a study outside of the framework of the RE project which will be conducted in late 89 by LESO to develop a methodology for comparing the technical and economic base of PV pumping systems.

Cultural and Social Acceptance

A major goal of LESO is to identify appropriate technologies among RETs. "Appropriate" must be seen to have two complementary senses, one technological, the other social. Any RET which only meets one of these two cannot be regarded as fully "appropriate". One important aim of LESO is therefore to determine "villagers' needs and which RETs they find appropriate, and therefore are willing to use regularly and maintain. Phase II baseline data provides information on a variety of aspects of rural life in Mali. Phase III will provide data on the patterns and scope of RET utilization, local organization among villagers to regulate access to and insure upkeep of RETs, etc. Comparisons between the two will provide an important contribution to an assessment of RETs in rural settings and to considerations of the deployment of LESO's resources in the future.

OTHER DONOR COLLABORATION & PRIVATE SECTOR INVOLVEMENT/INVESTMENT

The Project Paper identifies two further outputs not directly linked to the assessment of installed technologies: donor collaboration and private sector investment. The first--collaboration with other donors--is intended to provide longer-term support to LESO in all areas of its future activities. The second, private sector involvement/investment, permits a measure of financial independence for LESO and paves the way to widespread commercialization of renewable technologies.

Other Donor Collaboration

The conclusive phase of the RE Project is in reality a stepping-stone toward the future for both LESO and renewable energy technologies in Mali. In consequence, the Phase IV report should not only reflect the direct findings of the RE Project, but should emphasize the elements essential to attract future donor collaboration with LESO.

These elements, which vary from donor from donor, nevertheless have a common base:

-definition of a coherent in-house research and development program which builds upon the accomplishments of the past in order to identify and meet priority needs for the future.

-demonstration of the capacity of LESO to collaborate with other organizations and to play a major role in project implementation.

-definition of the role which LESO must perform to encourage commercialization and large-scale acceptance of renewable technologies. This will provide a measure of private sector involvement and commercial potential for imported and locally manufacturable technologies.

Considerable advances have already been made toward future donor collaboration. This issue should be addressed extensively in Phase IV, and potential donor audiences should be borne in mind when producing the Phase IV report.

Private Sector Involvement/Investment

Private sector involvement and investment is an issue which requires careful review. LESO has evolved and is moving closer towards changing its status within the GRM from a public service to a parastatal organization--a transformation which will permit private sector and commercial involvement.

Through the VITA-LESO Improved Woodstove Project, LESO will interact directly with the private sector to manufacture and promote portable improved woodstoves for urban use. The laboratory has also identified and is discussing possible licensing agreements to manufacture western techologies in Mali.

RENEWABLE ENERGY TECHNOLOGY INSTALLATIONS OPERATIONAL IN MALI

Renewable Energy Project

TECHNOLOGY	QUANTITY	SITE	LOCAL MGMT STRUCTURE	INSTALLATION DATE (YEAR)
GAO REGION				
Solar Water Heater	1	Gao	Maternity	83
Dryer (TENT)	1	Djidara	Fish Coop	83
Dryer (TAOS)	2	Djidara	Fish Coop	83
Solar Still	2	Gao (8)	Garage	84
PV Lighting	1	Gao (8)	Maternity	83
PV Lighting	1	Ansongo	Maternity	83
Improved Stoves	160	Surveyed Villages	Households	82/84
Remote Weather Station	1	Gao A/P	Control Tower	81
MOPTI REGION				
PV Pump	1	Mopti	Market Garden Coop	81
SAN REGION				
Water Heater	1	San	Maternity	82
Dryer (TENT)	2	Beleni-ticyni	Quartier Bozo	82
Dryer(TAOS)	2	Beleni-ticyni	Quartier Bozo Village Chief	82 82
Solar Still	1	San	Zone Controller	84
Solar Refri-gerator	1	N'torosso	Dispensary	82
PV Lighting	2	N'torosso Somo	Dispensary	82
Improved Stoves	270	Surveyed Villages	Households	81/84
Remote Weather Station	1	San Meteo	Meteo	81
DILLY REGION				
PV Pump	2	Demba-Diawara	OMBEVI	82
		Camp-Modibo		82

NIORO REGION

Solar Refrigerator	1	Nioro	Hospital	82
Solar Water Heater	1	Nioro	Maternity	83
PV Lighting	2	Nioro	Hospital	82
PV Lighting	1	Banire	Literacy Centre	82
Improved Stoves	300	Surveyed Villages	Households	81/84
Remote Weather Station	1	Nioro A/P	Meteo	81

BOUGOUNI REGION

Solar Water Heater	1	Tourokoro	Maternity	82
Solar Still	1	Bougouni	Meteo	83
Digester	1	Keleya	Dispensary/ School	84
Improved Stoves	150	Surveyed Villages	Households	83/84
Remote Weather Station	1	Bougouni	Meteo	81
Hand Mill	1	Tonfa	Interviever	84
PV Lighting	1	Zantia-bougou	Dispensary	83

BAMAKO REGION

Improved Stoves	200	Bamako	Households	83/84
Wind Pump	1	Titibougou	Landowner	84
Digester	1	Sotuba	Livestock Research Centre	84
Remote Weather Station	1	Bamako	LESO	81
PV Pump	1	Samanko	Post Cure Centre	81
PV Uninterrupt Power Supply	1	Bamako	LESO	84

Renewable Energy Project-Planned Installations

PV Mill	1	Tonfa	Village Council	84/85
PV Pump	1	Hamakoul-adgi(Gao)	Village Council	85
PV Pump	1	Tinaukert (Gao)	Village Council	85
PV Pump	1	Bema(Nioro)	ODIK	85
PV Pump	1	Kirane (Nioro)	Sahel Occidental	85
Wind Pump (LESO II)	2	San	-	85
Wind Pump (LESO II)	1	Bamako	-	85
PV Charger	2	San	-	85
PV Charger	2	Bougouni	-	85

Other LESO Installations

PV Refri-gerator	1	Ouelessebougou	Dispensary	84
PV Lighting	1	Kati	Minister	84
PV Lighting	1	Missa-bougou	LESO Engineer	84
PV Refri-gerator	1	Bamako	Missionary	83
Solar Dryer (Forced Air)	1	Mopti	Fish Coop	84
Improved Stoves	300	Bamako	Households	83/84

Other LESO Installations Planned

PV Refri-gerator	1	Koro	Health Centre	85
PV Refri-gerator	1	Douenza	-	85

Other LESO Installations Pending

Micro-Electrification of 2 Hospitals & 8 Dispensaries (Nioro region)

Electrification of Tombuctou Hospital

Non LESO Installations

A comprehensive listing of renewable energy technologies installed in Mali by organizations other than LESO is available for reference in the report, "Planification de l'Energie-Rapport Finale, Annex 4, Energie Nouvelle et Renouvelable".

CRITERIA FOR THE ASSESSMENT OF TECHNOLOGIES

INTRODUCTION

The framework within which to assess the social and economic consequences of introducing renewable energy technologies in rural Mali is provided by the five criteria for their evaluation set out in the Project Implementation Document. These are

1) the extent to which the technology can be operated and maintained locally, the nature of local control and management

2) the impact on income levels, income distribution and social welfare in the community--who are the beneficiaries?

3) the performance and functioning of the technology in its setting

4) unit cost compared with other sources of energy usable in the same context

5) the cultural and social acceptability of the technology, resulting changes in village life/patterns of carrying out tasks

Although Criteria 3) and 4) involve primarily technical assessments, they also include a social component. For example, the characteristics of users, and the nature of the use made of a technology, will affect its performance. Similarly, cost comparisons with other technologies need to take account of the ability and willingness of users to pay both initial and recurrent costs.

The range of technologies installed under the REP, their functions, and the contexts in which they are being assessed vary widely. It is therefore important to establish differences in criteria and methods of assessment for each technology as well as a framework for an overall social evaluation.

Technologies can be divided into those where system management and maintenance are restricted to individuals or households (improved stoves and possibly Ni-Cad chargers in the future), and those where an institution or wider social organization--e.g., a cooperative, or a village, clan or kin-based group--is involved at some point in the process of energy use. This division is important when considering the practical aspects of assessment set out below. Technologies with an institutional element provide for slightly easier assessment, as there are "responsables" or organizational structures through which the technology operates. These provide potential sources of data and offer a means of supplementing information available from "end users".

Village surveys carried out in Phase II of the RE Project provided baseline data on energy use prior to the introduction of technologies. Subsequent monitoring in Phase III was to have provided a comparable picture once the technologies had been installed. In practice, the scope for matching "before" and "after" data is extremely limited: print-outs available from Phase II are not in a form which facilitates this type of analysis, nor is the impact of the new technologies measurable in the terms of the Phase II surveys. Because of difficulties associated with applying survey methodologies to a rural milieu in Mali, remaining stages of the survey, including the social assessment, are faced with three main difficulties:

1) the validity of statistical data collected to date;
2) the methods needed to obtain other types of data to meet the project's evaluation criteria (e.g., income data and user's--and potential users'--views on the technologies and their benefits have proved extremely difficult to establish satisfactorily);
3) the assessment of needs, which has to date been based largely on subjective judgments and expressed wants by certain villages (a more systematic assessment of needs is required).

These difficulties have in part determined the scope and methodology for assessment of technologies set out below. Issues that are technology-specific are reviewed, technology by technology, in Appendix 'A' of the guidelines and will provide the reader interested in detail on a specific technology with insight into the evolutionary technical or social parameters which led to the placement and utilization (and problems) of a specific technology within a particular environment.

GENERAL CRITERIA FOR ASSESSMENT OF SOCIAL ACCEPTANCE OF TECHNOLOGIES

1) Introduction of Technology
   - context in which operated
   - task performed and how carried out previously
   - siting
   - control and management of technology, responsibility for breakdowns
2) Use
   - numbers and characteristics of users
   - catchment areas (e.g., where installation is in a health care facility in town, % of users from town/villages)
   - estimates of potential use
   - if task done by technology is also still carried out by traditional or other means, proportion of population not making use of new technology and reasons--e.g., percentage of fishermen in Belenitveni not using dryers
   - users' views on technology ("responsables"/"end-users")
   - potential users' views and understanding of purpose of technology
   - nature of benefits resulting: different criteria for each technology

3) Breakdowns
- system for notifying breakdowns
- frequency
- nature and effect on functioning
- time needed for repair, whether carried out locally and by whom

4) Costs
- ideally, assessment of the potential for local individuals/organizations to invest in certain technologies--e.g., improved stoves, battery chargers dryers

This may not be feasible unless one can find examples of investment in other forms of technology. National organizations may be able to furnish examples (e.g., ODIK) of villages who organized payment for water pumps. Examples would at least provide indications of conditions where technologies may be sold commercially and where they will need to be introduced with subsidy

(One of the difficulties with this part of the assessment is that technologies installed for the RE Project at no cost to users will not provide information about willingness of potential users to pay for installation.)

5) Potential for future installations
- discussions with national agencies, ONGs, on scope
- information from census, other national data on potential for use and dissemination of technology. In part this will depend on other aspects of the assessment (e.g., some technologies may not be effective in their present form).

6) Scope for local manufacture

Although not a main criterion for assessment, the potential for certain technologies to be made locally should be included (e.g., improved woodstoves, distillation plants).

The details of how these assessment criteria are to be applied to individual technologies are examined further in the methods of assessment.

GENERAL CRITERIA FOR ASSESSMENT OF TECHNICAL EFFECTIVENESS OF TECHNOLOGIES

The general criteria consist of
- determining what constitutes a representative sample of use for each technology, to assess its potential market,
- the techno/economic parameters defined in the PID.

These two criteria are discussed below.

1. A representative sample can only be determined if the total potential market is assessed For renewable technologies, assessment of the potential market is a function of

-the resource

-the demand

-the availability of a technology providing a medium for transforming the energy resource to meet the demand.

The potential market should be determined as follows.

-Conduct a resource assessment of wind, solar, biomass energy potentials. Separate similar resource potentials by type and quantitatively Define the geographical zones for each type and quantitative group defined

-Estimate the nationwide energy need, again as a function of geographic zone and types and quantities of energy needed . To obtain this estimate it will be necessary to define rural, urban and industrial areas, determine population distribution, locate the presence of significant ethnic groups and identify GRM plans for conventional energy provision.

-Overlay the geographic zones identified for resource on the geographic zones identified for demand and determine the best match of resource tyupe with demand type on a nationwide basis.

-Determine the type and combination of systems needed to meet the total demand which can be satisfied by technologies which match resource to demand. This provides a measure of the potential market for a technology and its capacity to provide a satisfactory energy transformation between the resource and the demand.

Once this measure has been made, an assessment of the sample necessary to demonstrate that the resource demand interface is appropriate can be made. This sample, referred to as a representative sample, forms the pilot installation for each renewable energy technology to be field-tested

If the above method to determine a representative sample is not applied, a pilot project may serve only as a demonstration of the technology and not as a measure of its potential when introduced for large-scale diffusion This factor, which is frequently overlooked or misinterpreted, requires serious assessment within the context of Phase IV of this project

An important component of Phase III will be the identification of factors influencing the diffusion and acceptance of each technology It should nevertheless be recognized that testing to date cannot claim to be based systematically on samples which are representative according to the above definition. Survey villages were originally selected to represent a cross-section of

regional economic, social and ethnic differences in Mali. Resource constraints meant that it was subsequently impossible to place examples of each technology in each village for testing.

2. The criteria for assessment cited in the PID may be divided into two categories: those general criteria (discussed below) which may be applied to all technologies, and criteria specific to a technology or series of technologies (discussed in Appendix 'A').

Pilot Installations

Site selection The choice of site for pilot installations can have a major influence on the measured success or failure of a technology installed for field testing. Site selection must initially meet the series of criteria defining a representative sample for a technology type, which includes availability of an adequate resource and demand.

Additional issues which must be addressed in making any site selection include:

-the verification that the installed technology will not replace an already available and commercial technology. If the case exists, the provision should be made to avoid losses within the commercial sector which could harm entrepreneurs and cause negative public opinion toward the new technology. These interests invariably have an economic base.

-precaution not to discourage technology use through noise, or physical danger, which might result from installation of the technology in an inappropriate setting. These potential hazards could be electrical or mechanical, and can frequently be reduced or overcome by adequate user training, or protective measures.

-security: the installation should be provided with a local management structure which will assure security, both to the user of the technology and to the technology from misuse or inappropriate treatment (vandalism).

A key factor controlling misuse is adequate user training, and use should be limited to trained personnel. If the initial installation and commissioning of each system provides sufficient guidance to establish a local management structure which has the capacity to supervise operation, then physical danger to users and damage to the system by untrained operators should be avoided.

The risk of damage to the technology through access or operation by unauthorized users should be part of the initial engineering precautions incorporated at the time of installation.

The variation in the degree of training and sophistication of the training program will vary greatly, technology to technology, and user to user. The match which insures adequate training and sufficient understanding to operate any technology in an

efficient, correct manner and additionally allows users to attain some degree of understanding when the technology ceases to operate correctly, is an important criterion for assessment.

Technical Performance. Technical performance may be divided into two principal categories performance of imported or locally manufactured systems All imported systems should be procured with a clearly defined guarantee of the technical performance of the system by the manufacturer or supplier Technical performance in these cases is verified by the appropriate installation of measuring instruments and monitoring of system output according to a specified program A comparison of monitored performance with specified performance provides a measure of the technical performance of imported technologies

Locally manufactured technologies may be assessed by comparing the output with an alternative, usually conventional, technology which provides a similar product or service, or by comparison with the design specifications for the system.

In either case, system monitoring is necessary on an instantaneous or continuous basis, and where a direct comparison is to be made with a conventional technology, then provision must exist either to measure the performance of the technology or verify that its performance is comparable with manufacturer specifications

This criterion, although readily assessed, may require considerable time and effort to acquire and verify the parameters In the area of gasification, for example--a technology which has not been addressed within the context of the RE Project, experts consider eight months of regional monitoring of a field-installed system in Mali to be the minimum program upon which to make a comprehensive assessment of technical performance of one example of this technology

A measure of reliability of the technology or series of a technology type (representative sample) can only be assessed after the technology is operational for a determined period of time, or has undergone accelerated life testing

Since reliability is linked to user competence, maintenance capacity and quality, operating environment, system design, and intended life cycle, all of these parameters must be considered when conducting a reliability assessment

Specific parameters to track include down-time and frequency, spare parts availability, maintenance levels, local or specialized maintenance, impact of user, economic consequence.

User Training and Comprehension This is a key element which must be conducted according to the type and sophistication of the technology and the ability of the operator/user to understand the technical/operational aspects of the installation This element should be built into a pilot project as part of the procedure to

set the technology in place commission it and transfer operational responsibility to the client (user or producer). The variation in the degree of training and sophistication of the training program will vary greatly, technology to technology and user to user. The match which insures adequate training and sufficient understanding to operate any technology in an efficient, correct manner, and additionally allows users to attain some degree of understanding when the technology ceases to operate correctly, is an important criterion for assessment.

Quality of Service Provided to User. The quality of service is directly linked to the appropriateness and capacity of the technology to satisfy a need and the system put in place to transfer the output of the technology to the user, particularly when the operator of the technology is not necessarily the user. If the user is satisfied with the quality of the service or product provided by the technology (and this satisfaction can be a function of quality, quantity, reliability, cost or convenience), then the successful introduction and acceptance of the technology becomes principally performance-related. An assessment of user satisfaction will permit an analysis of technical performance to be distinguished from other parameters controlling effective utilisation.

Adaptability of the Technology. This is principally an issue to be addressed in defining a representative sample of a technology type, since if the system offered for a particular application is not adapted to the need, a poor match was made between the resource and demand. Other factors which require review include the aspect of competition to established habits, customs or alternative methods of satisfying a specific demand.

If, in spite of its good record (performance, reliability, economic base), a technology appears not to be well adapted to user-needs, then social acceptance criteria must be reviewed.

Follow-up and Maintenance. If one looks historically at failed technologies, conventional or renewable, the greatest single cause for failure is lack of provision for follow-up and maintenance. This is particularly true in Mali, where the capacity for local maintenance is frequently limited and access is difficult and expensive. Provision at the time of technology introduction for follow-up and maintenance is an absolutely key element.

The level and frequency of both routine and unscheduled maintenance varies enormously from technology to technology and application to application. These factors must, however, be explored thoroughly, even in the conceptual stages of any proposed pilot project installation. A clearly defined schedule for follow-up should be established for the initial period of operation, with long-term provision for reduced-level support for the estimated system life. Additionally, [illegible] of parts, and where possible maintenance expertise, should be made available.

Frequently a key element to long- term provision of parts and skilled repair capacity is the establishment of a local management structure which insures that the technology "earns" enough income to permit the services to be bought Experience has shown that with this type of local management structure in place, incentives exist to insure that routine maintenance is conducted, repairs are performed and parts are provided The assessment of any installation must carefully review these criteria

CRITERIA SPECIFIC TO COMMERCIALIZED TECHNOLOGIES

The cost of pilot installations is commonly used to determine the economic viability of a technology--e g , the PV mill at Tangaye. Although certain cost elements can be determined from any pilot installation and used to provide economic indicators, a real economic evaluation and comparison with the economics of other tehnologies can only be conducted once the technology is commercialized

An economic evalaution of RE tehnologies in Mali is thus limited to imported products, with the exception of improved woodstoves (metallic), since no other RE technology is presently commercialized and realistic figures of production costs, installation and operational costs are not available One possible exception which should be considered is the Sahores wind-pumping system manufactured in Segou, which although in question from an engineering standpoint, has been produced for long enough and in sufficient numbers to permit an analysis of its manufacturing and installation costs (if not recurrent costs stemming primarily from maintenance).

Pilot projects likewise cannot offer the complete picture for system reliability This to some extent is frequently associated with the marginal or inadequate sample size of the technology being field-tested, but on the whole is a factor which can only be accurately assessed when the commercialized version of the technology is operated within a regular environment for a defined period or percentage of its estimated life cycle

Because of the relatively premature state of commercialized RE technologies in Mali, an assessment of the economics of technologies is not possible except for those imported, but economic indicators of locally manufactured or manufacturable technologies can be determined

The economics of any technology must invariably be based upon a comparison with alternatives The economics of convention technologies appears to be poorly documented and not well understood. An important responsibility within this assessment will be to establish a base for comparison between RETs and conventional technologies

METHODOLOGY FOR EVALUATION

The general methodology will consist of the following principal elements:

a) a collection of information and test results available for each technology within the Research Group and the Groupe Intervention at LESO
b) interviews with Research Group personnel and members of the Groupe Intervention to supplement the information acquired in point a)
c) interviews with the controllers and interviewers in each of the four rural zones where technologies are installed and a baseline survey has been conducted
d) interviews with technology users
e) direct measurements performed at sites where technologies are installed and comparison with results available from tests performed by LESO personnel and, in the case of imported equipment, from manufacturers' specifications
f) a technical and economic analysis of the data acquired through reports, interviews, site visits, etc.
g) cross-reference with other projects and other technologies, both renewable and conventional
h) assessment of the social impact on users of installed technologies

Specific to the Applied Social Science Research Program

The report should begin with a rapid summary of the assumptions for research and the hypotheses based thereon, from the project paper, Koenig's various overviews, Stier's mid-term evaluation, and related documents. Detail drawn from these latter need not be extensive. Consideration should be given to including copies of key documents as appendices to the Phase IV report (perhaps in a looseleaf binder), so that eventual readers will have them for reference and detail as desired: all too often with such reports, reference is made to key sources of information that are next to impossible to locate once one is removed from the project in time or space.

As post-mid-term contributions, reports by Maubrey and by Schoepf should be given more thorough review in the Phase IV report. The evolution of thought regarding Phase III research should be documented. Fleise's work with the GI is to be considered here, giving special attention to initiatives taken or suggested by M. Dembele, Y. Dembele and others who have modified and implemented these suggested methods. It is the evaluation and input of these latter which will shape future social-impact research by LESO. Either in the background section, or in a conclusion to the social research portion of the Phase IV report, an assessment must be made as to how "appropriate" may be the sort of survey research LESO staff and consultants have conducted (in comparison to other methodologies available--e.g., long-term fieldwork by a small team of Malian and ex-patriate anthropologists).

From these beginnings, Phase IV evaluators will turn to the results of Phase III, wherein the effectiveness of each installation is determined. To the degree possible, this will result from comparison between Phase II and Phase III baseline data, when use and management of RETs were studied. As noted above, LESO has already encountered difficulties in comparing Phase II with Phase III socio-economic data, and as of this writing, efforts are still being made to correct both survey instruments and research strategy--notably to include greater time for fieldwork at particular sites by the GI team.

The following comments on methodology for evaluation, then, will serve a dual purpose: to record ideas discussed during the present TOR preparation concerning research in the last months of Phase III, and to provide Phase IV staff with a starting point for their evaluation of the social impact of each RET developed and deployed by LESO.

Specific to the Techno-Economic Assessment

A review of the technical reports and mission reports combined with input from the Research Group will provide an understanding of the methodology used throughout the project to 1) conceive laboratory tests, install and monitor technologies of local origin, and 2) select laboratory tests and install imported technologies. These methodologies have evolved throughout the life of the project and do not necessarily demonstrate the optimum approach for creating a data-base for the asssessment. The Phase IV report should recommend a procedure within LESO to determine methodologies appropriate for future programs.

Cited in the mid-term project evaluation, one of the notable early weaknesses within the project was the absence of a precise plan, both for research and field monitoring of technologies. This situation stemmed from inadequate guidance to the project in the preparatory phases, primarily in the absence of technical assistance and also because of inadequate experience within LESO to prepare for implementation of this type of project.

The social science research program design, pre-test, and introduction clearly demonstrate a lack of understanding as to how to generate a coherent program planned to meet a specific set of technical and social objectives. Not having been provided with guidance from the technical assistance program, LESO based its early work on technologies cited within the Project Paper. Intended in this context as a guideline, the Project Paper did not specify a methodology by which to achieve project objectives (other than division of the project into four principal phases and identification of the major outputs from each phase). There was no attempt to define a methodology for the evolution of a technology from the initial stage of identifying a rural need and energy resource (which can be satisfied by providing an appropriate technology as an interface) to the evaluation of a

field installation or representative technology sample There was thus no guidance on the importance of interim findings for the planning of subsequent stages of the project nor was there preparation of GI members on user training and the need for regular follow-up after the initial introduction of a technology.

This task, principally a planning activity should have been coordinated closely with the design of the social science research program and should have constituted the first phase of the project Technologies cited in the Project Paper were initially introduced into the R&D program in an attempt to design, optimize, and verify, in most cases the technical performance There was no active consideration to determine the quality of interface the technology could provide between the resource and the demand the level of the demand, nor the magnitude of the sample of the technology needed to field-test the product, nor was there consideration for the data-base to be generated which would provide the key element upon which to base the Phase IV assessment

As the project evolved, particularly at the R&D level within Phase II and subsequently when technologies were introduced into the field during Phase III, awareness increased, and remedial efforts were made to create an adequate data-base for Phase IV It is this data-base which must now be used to conduct a techno-economic assessment

IMPLEMENTATION PLAN

The tasks necessary to implement Phase IV are divided into 11 specific but interrelated activities. An outline of each task, the schedule and manpower input is discussed below. The descriptive paragraph for each task is to be read in conjunction with the manpower/transport schedule (Table No.1) and task schedules (Table No.2).

A Coordinator will be designated to manage the complex logistical support program necessary to implement these tasks. It is proposed that the Chief of the R&D Section (Section Scientifique et Technique) assume this responsibility and that the consultant Renewable Energy scientist assume the role of his immediate counterpart for the portions of Phase IV where consultant assistance is programmed.

Task No. 1: Phase IV Briefing and Terms of Reference Review
-Schedule: April 1 - 8, 1985
-Manpower Input: Intervention Group, Zone Controllers, research group representatives, Project Consultants (RE scientist and anthropologist), LESO management and administrative sections (partial).

This one-week briefing for project consultants and refresher for LESO personnel will consist of structured sessions organized by the Coordinator to define the technologies for assessment, criteria for assessment and the methodology by which to evaluate the technologies. The briefing will

1) review the RE project objectives, LESO as an applied research organization, the Phase II survey and applied research program, and the Phase III field installation and monitoring program

2) discuss in depth the five questions posed in the Project Implementation Document (PID)

3) identify the audience potentially responsive to the results of the project, and specifically the Phase IV evaluation

4) review the implementation plan, its tasks, schedules, and manpower needs, and demonstrate how the various elements are organized to provide a structure in which to introduce the criteria and methodologies for the assessment

5) treat the key elements (criteria for assessment and methodology by which to evaluate technologies) and establish a common interpretation of the approach and factors upon which the Phase IV assessment will be based

6) define the approach necessary to determine the institutional growth within LESO throughout the life of the project and emphasize the importance of the need to specify a future profile for LESO to include

- the R&D program
- field installation and monitoring programs, including social impact studies
- production, commercialization and marketing goals.

Task No. 2: Site Visit to the Four Project Zones

-Schedule: April 8 - May 15

-Manpower Input: Intervention Group, selected research group participation, Zone Controllers, Project Consultants, Phase IV Coordinator and Section Leader for the Field Installations Program.

Time restraints and the complexity of the logistics require that site visits be conducted by two teams. Each team, with scientific and social impact expertise drawn from LESO and complemented by a project consultant, will be responsible for two zones plus the peripheral sites. They will function independently to assess all field installations for the project, selected RE field installations from other projects, and certain conventional technologies which can be used for comparative purposes.

The principal objectives of these thorough and extensive field missions are to make an up-to-date assessment of all field-installed technologies and to apply the criteria and evaluation methodologies in order to establish a base for assessment. This mission will also serve as a further familiarization session for project consultants.

A complete listing of the technologies installed within the framework of this project and other projects by LESO and by other organizations is provided in the section "Technologies for Assessment". These listings are presented as a function of location and technology type in order to facilitate easy comparison and simplify planning of site visits, which are at the discretion of the Phase IV Coordinator and field installation assessment teams.

Task No. 3: Review Outputs from Task 2 and Specification of Additional Information Needs

-Schedule: May 15 - 22

-Manpower Input: Phase IV Coordinator, LESO management and administration (partial), Section Leader of Field Installations Intervention Group, research group representation (partial), Project Consultants

The review is intended specifically

- to test the criteria and the methodology defined in the terms of reference by making a preliminary assessment based upon the findings from the site visits defined in Task 2

- to evaluate the outputs

- to specify the need for supplementary information.

The outputs, including both technical and social impact parameters for each technology, will be reviewed with the research group personnel responsible and a basis of comparison will be established for non-project RETs and conventional technologies. Supplementary information necessary to establish an adequate data base for technology assessment will be defined along with the complementary or modified criteria and methodologies necessary to acquire this supplementary information.

Results of the preliminary assessment, which will encompass all technologies and technology samples evaluated in Task No. 2, will form the basis upon which to

- define a representative sample for each technology type (a "representative sample" and its role in the selection of pilot projects is defined in the section" Criteria for Assessment".

- identify those factors not adequately covered by the sample used during project monitoring and considered necessary for an effective assessment of the potential application of individual technologies.

In the event that an expanded sample of a technology is deemed essential to facilitate a valid assessment, further examples of specific technologies will be installed and a monitoring program established where practical, taking into consideration financial and time restraints. A complete analysis and assessment of "representative samples" available and essential to evaluate technologies will provide guidelines for further installations within the life of the project, and longer-term recommendations to build upon the experience/findings of the present project.

<u>Task No. 4</u>. Introduction of Continuation Field Program and Supplementary Data Acquisition

-Schedule May 23 - 22 June

-Manpower Input. Intervention Group, Zone Controllers, and Zone Interviewers. The Phase IV Coordinator will provide logistical support.

This component provides LESO the last opportunity to revise data acquisition procedures, information being retrieved, or methodology for data retrieval. In addition it provides the capacity to expand the representative sample of certain technologies, subject to availability of the technology at LESO or the capacity of LESO to manufacture further technologies for field installation within the limited time-frame.

The continuation program will be implemented using two independent field teams as in Task No. 2. Team leaders will re-visit the same zones visited in Phase II to optimize continuity of input. Team A will visit the zone of San followed by Nioro, team B will visit Gao followed by Bougouni.

The Groupe Intervention will have completed the preliminary assessment described in Task 3 and will specify at the beginning of this mission additional needs for information, the methodology necessary to acquire this information, and hardware required to expand the sample size of certain technologies if necessary. To provide this information and indicate the extent of supplementary needs for this continuation program will be one of the principal outputs of Task 3 and will be obtained in collaboration with the project consultants at the end of their initial seven-week involvement in Phase IV.

The Groupe Intervention, together with the Zone Controllers who participated in the Phase IV briefing, will introduce these supplementary needs to the interviewers in each zone and work closely with them to ascertain that a complete understanding exists and that the information requested can be acquired within the remaining 8 - 10 weeks of the zone operation.

<u>Task No. 5</u>: Final Phase of Information Input from Survey Zones
- -Schedule: May 23 - August 15, zones of San and Gao
  June 8 - August 15, zones of Bougouni and Nioro
- -Manpower Input: Zone Controllers, Zone Interviewers

The objective of this 8 - 10 week period of data collection is to supplement and attempt to complete the data base necessary to conduct each technology assessment. The session will begin by a period of information transfer from the Groupe Intervention to the Zone Controllers and Interviewers as defined in Task 4.

The responsibility to acquire the supplementary information and to make a preliminary assessment of the validity of this information will be placed upon the Zone Controllers. The LESO Intervention team will visit each zone for approximately two weeks, activities being strictly limited to introducing the additional needs and initiating the process of acquisition. During this final data collection period and subject to the results of Task 3 and the analysis conducted on representative samples of technologies, possible supplementary responsibilities for system installation may be necessary.

Completion of data acquisition and zone closeout will occur by 15 August in collaboration with a final visit to each zone by the Groupe Intervention and LESO administration. Zone Controllers are responsible not only for data acquisition throughout this period, but the logistics of zone closeout in collaboration with the representative of the LESO administration.

Task No. 6: Data Reduction
-Schedule: June 22-July 21
-Manpower input: 50% effort by Intervention Group, 50% input by LESO volunteer familiar with micro-computer technology, 5% input by LESO micro-computer specialist

This four-week period will be used to complete analysis of the data collected throughout Phase III of the project. It should be noted that while data collection sheets and the baseline survey conducted in Phase II use selected households as the focal point for the assessment, this approach was later modified to focus on installed technologies in Phase III. Consequently data sheets were revised to be technology-based rather than household-based. Experience in the use of these sheets throughout the phase necessitated a series of modifications to the format and data acquisition. The level of effort defined in Task 6 will be used to analyze data available from these technology-based data sheets and will complement the findings of the initial field missions conducted in Task 2.

Task No. 7: Final On-site Review and Zone Closeout
-Schedule: July 22 - August 25
-Manpower Input: LESO Intervention Group, administration, Zone Controllers and Interviewers

This final field mission will be conducted using two field teams programmed as in Tasks 2 and 4 of the Phase. The principal responsibilities of this final mission will be 1) to review and collect the final data sheets and observations of the Zone Interviewers, in particular the results of the additional information specified within Task 4, and 2) to close out project involvement in each of the four pilot zones and transfer techology responsibility to local management.

Essential tasks to be achieved within each zone throughout this field mission include finalization of the zone accounting system with the registrar responsible for financial management within each zone, and removal of inoperative technologies from sites. Contracts with the Interviewers will terminate August 15, and all administrative formalities should be finalized. The Controllers from each zone will return to Bamako to participate in Task No. 8, the output assessment.

Task No. 8: Final Output Assessment

-Schedule: August 15 - 31

-Manpower Input: Management (partial), Intervention Group, Phase IV Coordinator, Project Consultants, Zone Controllers and partial representation from LESO research groups and the Chief of the Section responsible for the Intervention Group

This final 15-day assessment conducted in collaboration with the consultant anthropologist and Renewable Energy scientist will provide the output upon which the project final report will be based. The assessment of the potential of each technology is based upon the definitions provided in the section "Project Outputs" and on the sample size as defined in the section "representative sample".

Much of the input for this task will have been provided in the analyses of Phase III data sheets and in the review performed as Task 3 of the final phase of the project.

Task No. 9: Assessment of the Institutional Growth of LESO and recommendations for a Future Profile

-Schedule: September 1 - 15

-Manpower Input: Section Leader R&D, group leader Intervention Group, Project Consultants, LESO management and administration (partial), research group representation (partial)

An assessment of the institutional growth of LESO is of secondary importance, but an essential step in the process of determining a future profile, which should encompass three sectors:

1) R&D program
2) field installation and monitoring programs including social impact studies and
3) production, commercialization and marketing goals.

These are key elements upon which to base arguments for support of new work to be undertaken by LESO.

The conclusions drawn from the RE Project which will demonstrate the potential viability of various RETs are only valid if a future profile is defined for LESO. This profile must insure a natural progression from the institutional growth and experience of the RE Project to the introduction, acceptance and wide-scale diffusion of RETs in Mali (to the extent that a positive measurable impact is evident).

Assessment of the LESO's institutional growth is readily determined by reviewing progress throughout the life of the RE Project. Many of these aspects are integral to the tasks accomplished in the earlier part of Phase IV and will only require limited supplementary input.

Specific issues to address include:

- -review of RE Project reports, consultant training, technical evaluation and contractor-related documents
- -review of training programs
- -visit of the facility
- -discussion with LESO management and technical personnel
- -review of the respective phases of the RE project
- -review of the field installations and monitoring program
- -review of the energy survey and social impact studies
- -discussions with GRM officials and review of the level of GRM support to the institute
- -discussions with project collaborators (USAID, IDRC, AGECCO and CRES).

1) R&D Program: The R&D program conducted within the framework of the RE Project has been strictly limited to rural applications of RETs as defined within the Project Paper. Technological development over recent years is making it increasingly clear, however, that many of the promising applications (i.e. those which offer economic competition to alternative technologies or real potential for production) do not necessarily lie in remote rural areas, but also lend themselves well to decentralized energy sources. This issue should be re-addressed thoroughly when defining a future R&D plan.

CRES has proposed an RE equipment plan for Mali and other CEAO/CILSS nations. The plan, although not finalized, provides the basis upon which to judge future emphasis for technology installations in Mali. The LESO R&D plan should offer support to this national plan and be designed to complement efforts of CRES and other regional national centers. In this context, close collaboration with CRES is essential.

2) Field Installation and Monitoring Program: The reputation for field-installed technologies in Mali and throughout the Sahel is not particularly good, although in recent years, for certain technologies, the reputation is improving. A principal reason for this questionable track record is inadequate monitoring of installations and inadequate provision for system maintenance.

On the one hand, LESO, as the national renewable energy research center, is acutely aware of the shortcomings of many earlier projects and feels an immediate responsibility to the priority of maintenance support to all field installations, as well as systematic monitoring of new technologies or technologies which are not totally proven (either from a technical viewpoint or the consequences of social impact).

On the other hand, the laboratory is obliged to acknowledge its limits as an applied research organization, which by definition does not have the capacity to provide maintenance support for all installations. It does, however, have the scientific and engineering expertise to monitor unproven or partially proven technologies without having specific commercial interests, -- and it does have the capacity to serve as a central clearing house for new field installations to insure adequate provision for maintenance and local management structures.

By assuming these two major roles, LESO will automatically build upon the learning experience of the RE Project, complement its own R&D program, and provide technology manufacturers and the GRM with a service unique throughout the Sahel--thus making a major step in the direction of technology acceptance through increased reliability and performance monitoring.

LESO is currently reviewing the possibility of marketing its expertise, either in the form of consultant services or through the production of technologies. If LESO assumes the responsibility to establish an infrastructure for maintenance and monitoring of field installations, this marketable activity could expand upon LESO's other intentions in this respect.

3) Production, Commercialization and Marketing Goals: A bone of contention which has become progressively more and more evident as the RE project evolves is that off-the-shelf western-designed and manufactured technologies are all too frequently not well-adapted to needs in Mali or to most other developing country applications. In this context and with the growing expertise of LESO, increasing consideration is being given to local manufacture or component importation. Such an orientation will permit the nation to reduce its dependence on Western technologies, increase its learning and economic base by promoting local manufacture or sub-system assembly, and, by extension, build the national expertise to perform maintenance and provide replacement components for field-installed technologies.

This aspect of the assessment requires detailed review with LESO management and other GRM officials, with CRES to establish a coherent program between the national center and CRES's interest in production, and finally with the private industrial sector, where the capacity to manufacture and market is probably greatest, provided scientific and technical guidance is available from LESO as an applied research organization with extensive experience in field monitoring and social impact studies.

Task No. 10: Strategy to Optimize LESO Role in National and Regional Plans for Widespread Acceptance and Utilization of RETs

-Schedule: September 5 - 15

-Manpower Input: Section Leader R&D, Group Leader Intervention Group, Project Consultants, LESO management and administration (partial)

As the only public service with prime responsibility in the domain of RE technologies, LESO is by definition a key element in the GRM's growing effort to promote renewable energy (or any energy conservation) in order to decrease energy dependence and improve rural lifestyle. Several other branches of the government structure have been assigned responsibilities for specific technologies--particularly in agriculture, but the national and regional role of LESO remains unique and crucial: to guide the GRM in the selection and adoption of a policy which will permit renewable technologies to have the desired impact.

This consideration has made it imperative for the RE Project to define a sound strategy for LESO-- not only to provide channels of continuation from the RE project, but through LESO to guide the GRM toward a policy capable of creating a national energy plan which can alleviate hardship in the rural sector, promote local industrial growth, and reduce energy dependence by establishing de-centralized energy sources--the latter now considered in many industrialized nations to be one of the few long-term solutions for sustained existence.

Task No. 11: Final Assessment Report

-Schedule: September 4 - 22

-Manpower Input: LESO management/section leaders (partial), group leader Intervention Group, Project Consultants

The final report synthesizes the experience/findings of the project, establishes an up-to-date picture of the potential for RE technologies in rural Mali, offers specific guidelines for the future profile of LESO in R&D, monitoring and commercialization; and, finally, recommends to the GRM the basis of a strategy for the role of RETs in Mali.

In addition to serving as a point of reference for LESO, this document will provide a future profile to the GRM in policy-making and, equally important, to potential project collaborators, who will see in it a) the potential for respective RE technologies in Mali, b) the potential of LESO, as an applied research organization, to contribute to further advancement of technology acceptance and diffusion, and c) the boundaries of production, commercialization and marketing.

The report will be prepared with these factors specifically in mind, and distribution of the report together with presentations to the GRM, AID and other key donors will be made prior to the departure of the project consultants and termination of the RE project on September 30, 1985.

SCOPE OF WORK: CONSULTANTS

The scope of work for the two outside consultants scheduled to participate in Phase IV has been defined in the Project Paper. These consultants, a renewable energy scientist and a cultural anthropologist or sociologist, would be those who had participated in the earlier phases of the project. The scope of work outlined below expands upon the initial job description for each consultant so that if either consultant is not available to participate in Phase IV, a comprehensive definition of the scope of work is available upon which the recruitment of new consultants can be based.

SCOPE OF WORK: SOCIAL ASSESSOR

Principal Tasks

The social scientist consultant will have two principal tasks in evaluating the project:

i) Assessing the extent to which individual technologies proved appropriate in their settings, according to the criteria and methods set out elsewhere in the Terms of Reference. Together with findings from the technical evaluation, an assessment of the numbers and characteristics of Malian users likely to benefit from a widespread introduction of each technology should be attempted, as one input to LESO's future resource allocations.

ii) Assessing the appropriateness of the project's organization and methods in achieving its aims. Although this might be regarded as a secondary task of the social evaluation, it has important implications for the future use of AID funds and for the benefits accruing to the Malian organizations and personnel involved in the project.

Issues for examination in considering appropriateness of project's organization and methods:

a) Did project outputs justify the social survey methods used and the attempts to achieve a nationally representative sample, given the resources available and logistical problems in Mali?

To what extent, for example, did findings permit conclusions to be drawn on a nationally or regionally representative basis? To what extent were comparisons between the baseline survey and data collected after the introduction of technologies possible, and what light was shed on village energy use before and after the introduction of technologies?

Consideration of resources available and logistical problems should include examination of the capacity for supervision and support of zone teams by the group responsible within LESO (GI), and the support of enqueteurs by zone controllers. What were the benefits and disadvantages for the conduct of the survey and for

the participating villages of the zone team organization? Comparisons could be made with the training, supervision and communications available in conducting a survey of similar complexity in a developed country, as well as with other social impact studies which made use of different methodologies (e.g., Roberts's study of a solar mill in Tangaye, Burkina Fasso).

b) What benefits accrued to LESO as a result of the methods of social enquiry adopted? For example, did the system of consultant support provide LESO with a capacity to carry out future social impact studies independently? What sort of training was provided in social enquiry techniques to the GI and to zone teams? Are social enquiry techniques and their appropriateness in different settings understood by GI and applicable by them in the future? For example, in what circumstances to adopt anthropological observation techniques as opposed to social survey approaches; the different requirements of urban and rural enquiries, and the limitataions of questionnaires among the majority of social groups in Mali. How should the Groupe Intervention be organized in the future? Is there scope for a Malian social scientist to be based in the group, or will links with other agencies such as the Institut des Sciences Humaines, or AMRAD (an NGO), provide adequate specialist output?

As well as evaluations based on the documentation available, the above issues should be examined by means of interviews with GI members and zone teams, and with the technical groups within LESO--the latter to examine their understanding of and views on the role of the Groupe Intervention.

Method

Both the technical consultant and the social asessor will spend two periods in Mali during Phase IV: seven weeks in April - May 1985, and six weeks in August-September. The individual tasks to be achieved during those periods are set out in detail in the section, "Implementation Plan". Within the framework of this plan, the social assessor should in the first week in Bamako have familiarized him/herself with the documentation available and made a preliminary identification of any major gaps in documentation for each technology (based on the criteria of social acceptability set out elsewhere).

During the field visit (April 8-May 15) the social assessor should concentrate on:

-observations of technologies in use
-discussions with responsables, local representatives of relevant agencies (and users?), focussing particularly on aspects where documentation has been identified as inadequate, and on the potential for expanding the use of technologies.

It is during the second period of consultancy (August-September '85) that the social assessor will provide input on the appropriateness of the project's organization and methods (see above) in achieving its aims and in helping to determine the future directions of LESO.

The education, experience, and qualifications of the social assessor are those defined in the job description, Appendix 'M' of the Project Paper.

SCOPE OF WORK: TECHNICAL CONSULTANT

Principal Tasks

1) Assess the extent to which individual technologies provided a data base upon which to respond to the five questions posed in the PID--specifically the management, performance, reliability, and economic aspects of the technologies.

2) Utilize the criteria and methodologies defined within these Terms of Reference to assess the potential of technologies installed within the framework of the project. A comparison with other installed renewable and conventional technologies will be essential.

3) Recommend a future role for LESO--specifically, its R&D program, production and commercialization, objectives, together with a stategy for the integration of LESO into the national energy plan.

Method

1) Familiarization with the documentation available

2) Preliminary field visit to assess the techno-economic elements of the field installations as cited in the PID

3) Based upon the preliminary assessment defined in point 2 above, define the supplementary needs in order to permit a more total measure of the technology potentials.

4) In collaboration with the consultant anthropologiest and LESO personnel, analyze project outputs and draw conclusions for technology potential, using the data base generated within the RE Project and other comparative sources available.

5) Recommend a future profile and strategy for LESO through contact with LESO management and other GRM officials responsible for elaboration of the national energy plan.

The education, experience, and qualifications of the technical consultant are those defined in the job description, Appendix 'M' of the Project Paper.

BUDGET

SUMMARY

-LESO DIRECT COSTS	CFA 8,579,000
-PROJECT CONSULTANTS	$ 63,600
-PHASE IV MANUFACTURING	$ 8,000
-ZONE OPERATING COSTS	CFA 7,019,500
-FINAL REPORT	CFA 3,437,500
TOTAL COST (CFA converted at 400/1)	$ 119,190

The budget for Phase IV is separated into five major components:

1. The direct costs of LESO participation, principally in the forms of displacement costs for LESO personnel and contact employees (controllers), transportation and mniscellaneous costs associated with data reduction, questionnaire, and report preparation.

2. The direct costs of project consultants. The level of effort is programmed at two consultancies of 1.75 months anmd 1.25 months respectively for a social anthropologist and energy scientist. Total 180 consultant days of effort.

3. The manufacturing costs of supplementary RE technologies introduced into the field as a result of the review (Task 3) conducted after the first series of site visits (Task No. 2). For budgetary purposes a global figure is estimated since the actual types and quantities of technologies cannot be defined until Task No. 3 is performed.

4. The costs of maintaining 24 interviewers and four controllers in the zones from April 1, 1984, to August 15, 1984 (4.5 months).

5. The cost of preparing a final project report, including translation, typing, editing, publication and distribution.

A detailed estimate of costs for each component follows:

1. LESO DIRECT COSTS

. LINE ITEM	COST CFA
TASK NO. 1 - BRIEFING - 7 DAYS	
-controllers to Bamako - travel	40,000
-controllers in Bamako - per diem	150,000
-local transport & maintenance contingency	100,000
-materials for lectures (copying, etc.)	80,000
SUB-TOTAL TASK NO. 1	370,000
TASK NO. 2 - SITE VISITS - 30 DAYS	
-transport Team 'A' (3,800 km)	200,000
-transport Team 'B' (5,300 km)	300,000
-per diem Team 'A' x 7 (35 days)	750,000
-per diem Team 'B' x 7 (35 days)	750,000
-vehicle preparation/maintenance (25%/vehicle)	250,000
-zone controllers displacement allowance 10 days/cont/zone	150,000
SUB-TOTAL TASK NO. 2	2,500,000
TASK NO. 3 - REVIEW - 7 DAYS	
-local transport/maintenance contingency	100,000
-copying report materials	50,000
-copying materials to define supplementary needs in zones	150,000
SUB-TOTAL TASK NO. 3	300,000
TASK NO. 4 - SITE VISITS TO INTRODUCE SUPPLEMENTARY NEEDS (30 DAYS)	
-transport Team 'A' (3800 km)	200,000
-transport Team 'B' (5300 km)	300,000
-per diem Team 'A' x 5 (30 days)	500,000
-per diem Team 'B' x 5 (30 days)	500,000
-vehicle preparation/maintenance (25% operating cost/vehicle)	250,000
-zone controllers displacement allowance 7 days/cont/zone	100,000
SUB-TOTAL TASK NO. 4	1,850,000

TASK NO. 5 - CONTROLLER/INTERVIEWER INPUT (10 WEEKS)

Cost included in mornal zone operating budget, included as separate line item for duration of Phase IV until zone close-out

TASK NO. 6 - DATA REDUCTION (4 WEEKS)

No supplementary cost to normal LESO operating budget

TASK NO. 7 - SITE VISIT - FINAL REVIEW AND ZONE CLOSE-OUT (21 DAYS)

-transport Team 'A' (3200 km)	170,000
-transport Team 'B' (4800 km)	270,000
-per diem Team 'A' x 5 (21 days)	375,000
-per diem Team 'B' x 5 (21 days)	375,000
-vehicle preparation/maintenance (25% vehicle)	220,000
-zones vehicles to Bamako (2400 km)	150,000
SUB-TOTAL TASK NO. 7	1,560,000

TASKS NO. 8, 9, 10, 11 - ASSESSMENTS AND REPORT PREPARATION (5 WEEKS)

-copying (other than final report)	200,000
-local transport (5 weeks)	250,000
-transport maintenance/contingency (25%)	60,000
-presentation of assessment	400,000
SUB-TOTAL TASKS No. 8, 9, 10	910,000

TOTAL LESO DIRECT COSTS	7,460,000
PLUS CONTINGENCY 15%	1,119,000
	8,579,000

2. PROJECT CONSULTANTS

ENERGY SCIENTIST

Salary - 90 days at $200/day	$ 18,000
Per diem 1st visit	
-5 weeks rural Mali (5,500 CFA/day)	192,500 CFA
-2 weeks Bamako ($82/day)	1,148
Per diem 2nd visit	
-5 weeks Bamako ($82/day)	2,870

Travel - international (2 round-trips US/BKO @ $2250/trip) 4,500

-local (provided by LESO)

Allowance
1st visit
-day.1 - 43 (zero)
-day 44 -49 (25% daily rate) 250
2nd visit (none).

Visas, permits, passports, etc.	150
Excess baggage, transit, airport tax, etc.	300
SUB-TOTAL	27,645
CONTINGENCY 15%	4,146
TOTAL	$31,800

SOCIAL ANTHROPOLOGIST
Budget Identical to that of ENERGY SCIENTIST
TOTAL $31,800

3. MANUFACTURING COSTS OF TECHNOLOGIES INTRODUCED THROUGHOUT PHASE IV

No detailed budget can be prepared since the complete definition of technologies to be installed will not be available until TASK NO. 3 of Phase IV is complete. Based upon the known manufacturing capacity of LESO and the period available, a global figure is budgeted.

TOTAL $8,000

4. CONTROLLER AND INTERVIEWER COSTS

Controllers x 4
Bamako - 2 weeks
Zones - 4.5 months

-salary	103,880	TOTAL/MON
-per diem	50,000	TOTAL/MON

Interviewers x 24
Zones - 4.5 months

-salary	310,080	TOTAL/MON
-per diem	135,000	TOTAL/MON

Operating Costs

-San/Bougouni	520,475	CFA/TRI/ZONE
-Gao/Nioro	565,475	CFA/TRI/ZONE

TOTAL 7,019,500 CFA

5. PREPARATION AND PUBLICATION OF FINAL REPORT

-typing draft (750CFA/page)	300,000	CFA
-typing (English version)	150,000	
-edit (English version @ 1250CFA/page)	250,000	

-translation	900,000
-typing (French)	150,000
-edit (French version)	250,000
-copying (draft/1000 pages)	50,000
-copying (final:50 reports @50CFA/page)	500,000
-binding	100,000
-distribution	100,000
SUB-TOTAL	2,750,000
CONTINGENCY 25%	687,500
TOTAL	3,437,500

APPENDIX 'A'

CRITERIA AND METHODOLOGY FOR ASSESSMENT-TECHNOLOGY BY TECHNOLOGY

Solar Dryers

Solar drying of fish, vegetables and fruits in Mali would, to all appearances, be an ideal technology to satisfy a rural need through use of an abundant solar resource. This technology easily demonstrates that products can be dried hygienically in less time than that required by traditional open-air sun-drying techniques and that a superior dried product is frequently produced. However, many solar drying projects at the village level have been attempted throughout the Sahel with disappointing results, and the acceptance and widespread use of dryers is far from evident.

In order to analyze the apparent lack of success of this technology, the Phase IV assessment must review the methodology used to develop and introduce it. The factors could be purely economic, in the sense that the advantages visible to the user do not justify investment in the device. However, in the case of the Renewable Energy Project, where dryers are donated, even this should not be a parameter influencing successful introduction of the technology. Efforts must be made to determine not only why satisfactory results are not evident, but what has to be done to ameliorate problems with the technology, the approach to introducing it, or user sensitivity.

Dryers are deployed in several different settings, each requiring its own criteria of assessment. In San Zone, river villages of Bozo fishermen have been chosen. A meeting was held with the village chief and other individuals, and it was decided in whose care the dryer was to be placed.

User data needed to determine the impact of the technology would include a reckoning of how many such Bozo fishing villages there may be, and whether, as fishermen go to various fishing camps during the year, the same people stay together or form different groupings. This, in turn, implies the need for social-organization data, in order to know who fishes with whom, and who would be prepared to use a dryer with whom. It is likely that such cooperation follows kinship lines, but there may be cross-cutting associations based on clan or age or other criteria, which allow people to pool their various labors associated with catching and preparing fish for market.

Such information (some of which may be available in earlier documents; Phase III and Phase IV researchers must make a careful gleaning and organization of any such data) is necessary to decide what the potential "market" for dryers among Bozo fishermen may be, and how many deployed as pilots is a representative sample.

Phase II baseline data is scant concerning the economic importance of fish drying. Koenig's write-up from San is based on a very small sample, and that from Gao is inconclusive. The print-out from protocole 26, on fish-drying practices, is missing and presumably was not received at LESO. For all intents and purposes, we are starting from scratch with regard to the impact fish dryers might have.

A close review should be made to tease from the various baseline documents whatever information we might have about fish-catching and preparation and the social organization leading to cooperation among fishermen. Contact should be renewed or established with the staff of agencies working in the same domain, both to gain access to relevant documents, and to integrate efforts.

A field study should be made of how fishermen do use dryers in situ, paying attention to who does and who does not have access to, or choose to use, the dryer; and to whether there is a perceptible difference in ability to sell solar-dried versus traditionally prepared fish (i.e. What can we establish as to increased profit resulting from dryer use?). Using samples of fish dried in rural areas, statements should be sought from public health officials in the rural areas where the dryers are in use, as well as in Bamako, regarding the condition of solar-dried fish with respect to vermin or other health related criteria.

On-site field observation by a GI team should include interviews and the recording of discussions with parties concerned--both those using and those who may not use a dryer in a given community, as well as those living in other similar fishing villages where no dryer has been placed. We need informants' exegeses as to these processes and their place in people's lives, to complement whatever statistical information exists from previous questionnaires. Only fieldwork over a period of 10 days to two weeks as a minimum, and in one place, can provide such substantive data.

As mentioned in Section IV, careful mapping of fishermen's movement among camps, and the manner in which people do or do not stay together as they move from one camp to the next, must be undertaken to determine where non-portable dryers can best be located, and to begin an estimate of how many dryers a given community would need to maximize their contribution to the fish drying and marketing processes. In Phase IV, projections should be made as to what further research may be necessary in this field, as well as to the future evolution of any project deploying significant numbers of dryers among fishermen.

In Gao zone and at Mopti, fishing co-ops have received solar dryers. The organization of these (who is a member? how are decisions made?), their numbers, markets, and related factors should be determined, as well as the more particular questions (to be explored for the Bozo fishermen as well) of how access to and maintenance of the dryers are organized.

To the degree possible, study of the potential of vegetable dryers should be integrated both with the above fieldwork (Can periodically un-used or under-used fish dryers be used for vegetables?) and with fieldwork in agricultural areas such as those around Mopti, where other RETs--e.g., PV pumping systems, can be studied at the same time. Can we combine vegetable drying installations with our efforts to provide PV pumps to market gardeners? Can the organization which gardeners have established to share access to PV-pumped water be exploited to manage vegetable dryers and eventual marketing of dried produce?

Data available from drying experiences within the RE project can be supplemented by references to the work conducted in Senegal by CERER through ITA. The Senegalese experience included diffusion of a dozen or so tent-dryers within fishing villages and the manufacture at CERER of a series of lightweight portable dryers.

Although it is a simple technology, solar drying for rural applications is faced with a series of engineering difficulties. The principal limitation which applies to most flat-plate collector-type technologies is in the definition of an adequate glazing that is not prohibitively expensive, is reasonably efficient, not fragile and does not deteriorate with exposure to ultra-violet. Experience in Mali, which has ranged from low-cost tent-dryers clad in polyethylene film (which must be replaced periodically, according to quality) to long-life forced ventilation systems. Each version of the technology is prone to engineering difficulties stemming from the unavailability of U-V resistant polyethylene film in Mali. Tests on locally produced film show a life of 6 - 12 weeks in direct sunlight.

Assessment will review the pros and cons of the various approaches and should attempt to supplement the RE project experience with information from other similar ventures. The quality and associated health hazards related to traditional sun-drying techniques, particularly for fish, should be carefully reviewed when performing comparative studies with solar methods.

Water-heaters

Solar water-heaters have been placed in rural health care facilities and, in one case, in a village. Data about their use is very sketchy: it is not clear how often they are used, by whom, and for what. Use for "soins medicaux," as one enqueteur reported, tells us nothing. We need data about the particular uses--in a similar maternity or dispensary without a solar water-heater--to which heated water is put. We need to determine the hygienic advantages of having warm water available in such facilities.

Dr. Peter Knebel of USAID has suggested that there may be no medical-hygienic purposes served in the use of warm water, other than comfort for the person bathing, and that in his estimation, the installation of solar water-heaters in health cre facilities should be a low priority. A wider spectrum of opinion on this matter should be obtained, from rural people (midwives both attached to maternity clinics and ones simply living in villages and operating there; staff of dispensaries or othe rhealth care facilities) and those attached to health agencies in Bamako.

Terry Hart suggests that the data at hand do not adequately reflect the consistent use of water-heaters he has observed. Better documentation is clearly needed. This is the case for the water-heater placed in a village setting, as well. This latter must be filled with a bucket, and it appears that it is not used often, if at all. This may be a local management problem in which it is not clear to villageers whose responsibility it is to fill the heater, or it may be a simple matter of preference: if fires are started in the compound to prepare food, the short amount of time to warm water for morning bathing as described in baseline documents may make heating water within the compound preferable to fetching it from the solar water-heater.

We need more information about use of the RET in the village where one is installed, if we are to determine the appropriateness of deploying others in future for similar use. If it should prove true that villagers are not sufficiently interested in the provision of warm water to want to keep the heater filled, then this may be a case of a RET that is technically, but not socially, appropriate for village use.
Enqueteurs should understand the need for more detailed responses to the existing questionnaire about users and uses; it should be explained to them that broad responses such as "soins medicaux" tell us nothing. Open-ended interviews by GI . staff with staff and patients at facilities using solar water heaters should include questions about perceived hygienic benefits. If it appears that the raison d'etre of the heaters is increased comfort for newborns and their mothers, it should not be inferred from the discussion in Section IV.B that such represents spurious use of the RET, nor that this should not be a goal of LESO interventions. If, however, bathing proves the abiding use of the solar water heaters, then this should be considered when prioritizing LESO's future program of RET deployment.

As with other RET installations in rural health care facilities, we need information concerning the nature and extent of the area served by the dispensary or maternity clinic--that is, its catchment area. Medical equipment is never used by everyone in the community, but it is (or should be) available for use by those in need of it. If heated water is deemed hygienically useful, or if the provision of solar water-heaters is considered a part of a wood conservation program (along with improved woodstoves), then it is as important to know how many people it could serve (catchment) as it is to know how many it does serve.

LESO has manufactured a solar water heater model for several years. Approximately 150 units are installed around Bamako, on private dwellings, or in several cases, in institutional settings. In consequence, much is known about the engineering aspects of the system. The problems of corrosion, costs, collector glazing, construction materials and water supply have been reviewed extensively within LESO for several years.

Technical reports are available which discuss these issues and demonstrate efforts made to improve the system design. Work is incomplete, but a series of improvements has been incorporated. The units installed rurally within the framework of the RE project are similar to, and in most cases, identical, to the units installed around Bamako. Features which have been added to the rural units include mesh protections for the collectors and protective fences, in some cases around the total system, or around the hot water outlet to control use. Local management of these systems requires review.

The LESO model is currently manufacturable from locally available materials and does not require sophisticated equipment for manufacture. In contrast, the other DHW system manufactured regionally at ONERSOL in Niger is a more advanced technology approach and has been extensively promoted for several years. The ONERSOL experience would be very appropriate for comparison.

Biodigesters

The implementation of biodigesters began in April 1984, with a unit placed in Keleya next to a maternity clinic and dispensary, approximately 100 meters from a school. Lighting for the school and maternity clinic, water-heating, and cooking facilities for the matron of the maternity clinic are provided through use of gas produced by the system, which runs primarily through the decomposition of cow manure.

Management problems of this project have already surfaced. During the installation, villagers apparently had little participation, there were few discussions with them about the system, and the GI team was only present a short while and never demonstrated the system.

An Elf-Mali PV pump exists in the village already, and the management committee for that RET decided that school children would be responsible for gathering cow manure for the biodigester. In return, lighting would be provided to the school, and the students would receive compost from the system to use on school gardens.

There is no cultural problem related to handling or using cow manure, as it is a substance with several important uses in the community, as, for example, in house construction. But, as a GI team member noted, it seems difficult for villagers to see what they as individuals will receive as profit from the system; and so cooperation in its upkeep has been minimal. Cow manure must be sought from a distance of 700 meters or more, and the cattle are only kept in the immediate area of the system for three to four months out of the year. No single villager possesses sufficient cattle to produce the manure necessary to keep the biodigester running. Students assigned the duty of gathering manure are sometimes not in class, and during their long vacation, no alternative labor organization appears to have been formed to keep the system supplied with manure.

There appear to be niggling technical problems with the system, as well, concerning such things as lamp mantles, and whether or not Petromax or other fairly readily available parts can be used. In short, the GI staff have reservations as to whether the biodigester, at this stage, is an appropriate RET.

Criteria for assessment of this system must include further study of the particular villages where biodigesters are to be placed, in order to determine the availability of manure. That is, how are cattle kept? Are there transhumance patterns which mean that manure will be available seasonally only? If so, are there alternative ways to keep the digester functioning? How can maintenance be best assured: what co-ops or other management groups must be created or reinforced? Data must be gathered in order to decide what extension work and sensitization in the first stages of implementation are necessary, to insure village enthusiasm and long-term participation.

Technical difficulties are minimal with low technology digesters of the types constructed at LESO and the Chinese type installed in the field. An adaptation is required to optimize use of locally available materials, particularly in the case of the Chinese digester, where bricks, clay, lime and cement are essential ingredients. Some of the problems encountered are user-based and can perhaps be reduced by careful selection of technologies driven by the methane.

In Keleya, for example, motivation to feed the digester so that it will provide gas for domestic cooking is low because wood is a readily available alternative. Refrigeration, however, if powered by the methane digester, would provide a valuable technology to

the village dispensary, which could only be replaced by a kerosene-powered alternative. Sufficient data exists on fuel consumption of kerosene refrigeration to determine that this is not an attractive alternative to the methane system unless the refrigerator is used for income earning activities as is the case in small-town boutiques where soft drinks offer an attractive reward to the investment necessary to keep the kerosene refrigerator operational.

One further issue must be addressed when assessing bio-digesters in Mali. In addition to the limited availability or irregular supply of manure, water supply presents a major problem for digester operation in many rural locations. LESO is aware of this restraining factor and in consequence is investigating semi-dry fermentation techniques.

It is said that Maubrey and a French anthropologist named Antonioni (?) studied the Keleya village system, but their report, if written up, cannot be found. An effort must be made to locate this, if it does exist, and other documentation from baseline surveys which might, for instance, explain cattle-holding and transhumance in villages of this sort. Fieldwork at Keleya must be conducted in late Phase III, during which GI researchers remain in the village to study factors such as transhumance, local management of the system, and user patterns. To what extent are services made available by the system, and who then takes advantage of this? At present there seems to be little or no data available to respond to such basic questions.

Water Distillers

Fewer than eight months ago--i.e., around March 1984, water distillers were deployed, one to each zone with two at Gao. The Zone Controller is responsible for maintaining the system and distributes the distilled water gratis, while sensitizing the potential audience of transporters, garage personnel, health care staff and others interested in a source of distilled water for vehicle batteries.

Since the use of non-distilled water in batteries radically decreases their lifespan, it is assumed that this RET will improve vehicle upkeep and eventually those services dependent upon the vehicles. Tests are being conducted to see if this same water is potable and could be used for other applications, principally in health care and hygiene.

Should tests prove the water potable, and should LESO then consider deploying more of the distiller systems for health applications, health care experts in Bamako and at the field sites should be contacted to gain a sense of how much potable distilled water is needed in an average dispensary or provincial hospital. This input could then be coordinated with the other existing LESO research at health care facilities--e.g., PV devices and water heaters.

Data collection has just begun, and only a single sheet has been received. More precision is needed as to the identity of users, so that we can gain a sense of the distribution of benefits. Until now, networks (word-of-mouth) have been the only means of publicizing the availability of distilled water from the systems; a better means of advertising is necessary.

Existing data sheets should be used in late Phase III, but with the instruction that precise information about the identity of users should be sought as possible (name of driver, company/agency represented, location of business, itinerary of vehicle). Combined with data from the sheets on the amount of distilled water produced and distributed, this information will be able to determine the radius of use. Questions should be asked as to whether anyone uses car batteries to power other appliances--e.g. radios, which might also need a source of dependable water. LESO should consider the creation of signs or other advertising to inform truckers and others that distilled water for batteries is available.

Distillation plants of this type suffer from several inherent technical problems. Distilled water, although marketable, is of very limited value, and a still can produce only 3-4 liters/square meter/day. Thus to make the technology economically attractive, the initial cost of the plant per square meter must be low or the reliability and system life particularly high. The susceptibility of glass to failure from stray stones or other forms of misuse, combined with the problem of corrosion which is inherent in most systems containing residual water and high humidity, does not contribute to the required long life of such a still.

The present model selected by LESO after a series of laboratory tests is low-cost, but has questionable market potential. Regardless of this limitation, the technology should be assessed from the viewpoint of providing high-grade water for specific applications, medical and otherwise, where no alternative source is available. In addition, the long-term influence on automotive battery life should be considered as an economic parameter when evaluating distillation plants.

PV Lighting

PV-powered lighting systems have been placed in schools or literacy centers, maternity clinics, and night nurses' rooms (salles de garde) at dispensaries or hospitals. User data is scant or non-existent. Systems placed in literacy centers, with the exception of that at Bandere, are not in villages where regular data collection is performed. The data we do have from schools is vague: at Somo village, for instance, it is reported that exactly 17 students of a 6e class spent exactly two and one-half hours using the light of the system, 13 different times in

April 1984. All one can deduce from such a report is that be students have used the system regularly, perhaps on the dates recorded; but whether or not there were always 17 of them who always spent two and one-half hours is anyone's guess.

What is needed is observation by GI team members, with interviews of schoolmasters and students (and anyone else in the village who might wish to use the illuminated classrooms when others are not there). Literacy classes are apparently informal, led by individuals who are not paid for their services, or at least in any systematic manner. Is this so? Can lists of those attending be acquired or compiled, so that we can gain an idea of how many may be profiting from the system? Through scrutiny of the lists that have been kept, or through interviews with those teaching, we might determine whether PV lighting has made it possible for more persons to attend literacy classes is available.

In addition, GI teams should interview and observe those destined to use the lighting systems. Can evening activities be programmed through a concerted effort of local school officials? Would this best be done by contacting Ministry of Education staff (or other agencies that may have educational outreach programs) to inform them of where PV lighting systems have been placed, so that these schools receive special attention in terms of distribution of written materials or other supplies useful for literacy courses or other teaching?

This RET, like all others, requires efforts to integrate LESO inputs (hardware, explanation of use, study of use patterns, upkeep) with other programs in order to achieve the maximum potential for system exploitation. GI staff should consider ways to inform agencies which may have extension activities in the area (agriculture, forestry, woodstove research health care, etc.) that lighting is available at these facilities for use lecture or meeting halls, distribution points, or other activities perhaps best done in the evening after villagers' daytime chores have been accomplished. Enqueteurs must be encouraged to give more precise data as to use. GI staff should incorporate these PV systems in their series of planned long-term fieldwork bouts, to observe use and interview those acquainted with the system and those who might wish to do so.

One should determine when lights should be lit all night long. Does this vary from night to night, or is there constant need? Why are lights needed for such along duration? How does this improve health care services? Is the improvement in services reflected in the number of patients seeking help, distance from which people are willing to come at night, or other data? Are night activities at the facilities programmed into the staffing and salary schedules?

Are officials at other levels of the hierarchy (lower levels, such as in dispensary versus town hospital; higher levels, such as regional officials who might include these services in their reckoning of staffing, medicine distribution, etc.) aware of the RET's potential for improving health care? GI staff should interview such individuals (including others in parallel institutions without PV systems) both to gain and to give information

At those health care facilities where PV lighting has been installed, the log of patients who have come for consultation, or of emergency cases treated during the evening, should be consulted to determine whether lights have improved services by encouraging more persons to seek assistance at night. (Staff will already have impressions of change.) We must determine the outreach of such facilities, to determine how mamy may benefit, at least potentially (obviously, not everyone falls ill, and those who do do not necessarily do so in such a way requiring night service).

The case of the PV lighting system at Nioro town hospital is more particular. Staff want the system to allow lighting all night long, whereas it is sized to provide a limited number of hours of illumination. Apparently, batteries were run down below the critical depth of discharge, and a new explanation was offered by the GI team, who corrected the situation. More information is needed about the sort of application given to particular PV lighting systems. If a nurses' night station must retain lights on throughout the night, then LESO should consider sizing the system accordingly.

Early systems installed consisted of off-the-shelf US-imported products, principally from ARCO SOLAR and SOLAREX. These systems, which in one case consisted of rechargeable portable lamps and 8-watt fixed neons, suit the kind of installation. Numerous technical defects identified have proved difficult to rectify in Mali. Lamps provided were special, and neither replacement parts nor schematic diagrams were readily available. For electrical battery storage, the portable lamps provided used gel-cell type batteries, which are not well adapted to long-term use in the Malian climate.

Several lighting systems were combined with existing refrigeration systems in order to provide emergency lighting at health centers on an infrequent basis. Many of the problems which have plagued the refrigeration systems-- particularly the regulators, have also influenced the reliability of the lighting systems. These systems, although of 20-watt rating, are fitted with fluorescent tubes which are not readily available on the local market; consequently, provision for special importation had to be made.

Based on this initial experience, LESO has imported a stock of well-constructed DC fluorescent lamps which will be coupled directly to a 12-volt DC source, either in the form of an automotive battery or long-life deep discharge batteries intended specifically for stationary applications will be recharged directly by PV modules matched to the batteries, thus eliminating the need for charge controllers. These systems will be installed and operational by late '84 and will provide the basis to compare off-the-shelf imported systems with locally assembled systems designed for specific applications.

Technical assessment of PV lighting systems is difficult over a short period unless sizing problems are evident. Indications are that the system components, if well selected and well matched, can offer high reliability. Criteria to emphasize in an evaluation of this technology should be user-biased and economic. A longer-term objective of LESO is to manufacture the electronics component of the DC lamp through a licensing arrangement with a US manufacturer. Were this to materialize, the potential market for PV lighting systems could be significantly influenced.

A valid project for comparison is being implemented in Zaire, where 750 PV lighting systems are being installed with certain components locally manufactuired. Further information on the results of this project can be obtained from IT POWER LTD in the UK, who are responsible for project implementation.

PV Pumps

Four PV pumps are installed as a direct part of the USAID project at LESO--two for irrigation, two for village use (human and cattle); LESO and USAID have cooperated on others. LESO has installed and commissioned or has information about more pumps, as well. Technical data is collected and analyzed at LESO every three months. Needs for water by a given village are determined by the Department of Energy and Water Resources, and the PV array and system sized accordingly. What has not been done to date, according to PV-Section members, is an on-site study of whether the systems installed do indeed respond adequately to villagers' needs. These were to be demonstration pumps, to indicate the practicality, utility and reliability of PV pumps from a technical viewpoint only.

There is data at LESO concerning a PV pumping system at Mopti installed in 1980. The particular history of this intervention is illustrative of the problems LESO has faced in getting its programs operational; Phase IV staff should provide a vignette of this in their report to indicate the difficult relationship between LESO and its suppliers in the early years of the project.

This pump is to assist in irrigating five hectares of market gardens which were already served by a diesel pumping system. The PV pumping system was only able to furnish water to one of the five hectares, but the poor record of the diesel system with regard to frequent breakdowns led gardeners to move and to concentrate their efforts within reach of the more reliable PV pump. The result has been a demand for water far exceeding the pump's output, and gardeners have organized themselves to share access to water

This local organization (cf. the role of the genie rural of the Ministry of Agriculture, who run the diesel pump and charge 600F/plot/garden) should be studied closely with regard to local management of PV systems.

The apparent success of the Mopti system, with regard to technical reliability and the willingness of gardeners to organize to maximize spread of its benefits, does not mean that the installation has been a complete or "simple" success. In fact, on one occasion GI team members visiting Mopti discovered that the PV panels had been allowed to become so covered with dust that the production of eletricity had dropped to a level insufficient to start the pump. The old man responsible for array upkeep explained that the key to the enclosing fence had been lost. The chief of the regional cooperative responsible for the PV system had not been informed of this, nor had the president of the market gardeners (who had a spare key).

There seems a clear need for increased coordination of management and communication among interested parties. PV Section staff at LESO complain that they should not need to see to such petty affairs, that it seems the Mopti cooperative members are not sufficiently interested in the system to maintain it properly. It remains to investigate what degree of sensitization at the time of implementation might avoid or minimize such loss of interest.

PV pumping systems were cited in the mid-project evaluation as a high priority technology for village water supply. Taking advantage of major advances in the technology over recent years in terms of reliability, cost, and system efficiency, LESO has procured four additional pumping systems, which will provide a well-monitored guide of the technical performance of current commercially available pumping systems in comparison to the data available on the four demonstration pumps installed earlier in the project.

The Photovoltaics Group, responsible for PV pump monitoring, conduct regular site visits and keep precise records of the system performance upon which to base a technical assessment. Due to field instrumentation limitations, mainly availability and reliability of totalizing flow meters, no continuous monitor has been maintained for the installed systems. Tests have been limited to single day performance verification testing.

Many any of the criteria--technical, economic and social impact--will be developed by LESO within the context of a projet with IT POWER INC. The principal objectives of this project is are to develop a methodology for evaluation of PV pumping systems, test the methodology in Mali, and then adopt this methodology as a worldwide standard for an evaluation of PV pumping systems. Because of the specific natur of this project and LESO's direct involvement, it is proposed that the Phase IV assessment use this as a reference in the evaluation of PV pumping technologies.

More than 70 PV pumping systems of various types are installed in Mali. Few are monitored regularly, but minimal data does exist concerning reliability, maintenance and total volume pumped for many of the installed systems Much of this information is available at LESO, or can be acquired from other organizations responsible for installation and monitoring, and should be used to supplement the findings of the RE project.

If LESO's aim is to determine which RETs are appropriate and meet "real" needs, then sensitization of villagers as to the means to maximize benefits from the system (including, of course, system upkeep) must be underscored as a component of all projects. To determine whether a PV pump responds adequately to the needs of villagers, a study should be conducted to map the spread of use. Ideally, this should be done over the course of a year to test seasonal change in water availability. A questionnaire which identifies users as to residence location in the village might respond to this.

Surveys making an attempt to determine quantities of water consumed or used, and the purposes to which it is put, are extremely problematic (cf. material from the Tangaye, Burkina Faso, PV pumping demonstration). A map of usage, on the other hand, will allow LESO staff to estimate who and how many in the village profit from the installation, and where another pump might be placed in the same village to complete adequate service.

The Mopti PV pumping system is well worth studying more closely. On-site fieldwork by GI team members should reveal how the gardeners have organized to share access to water, and how such organization might be exploited by extension agents to improve system upkeep. Here, too, the effects of a reliable pumping system might have an immediate effect upon agricultural production, profits to gardeners, and the quality of life for those within the nexus of benefits. Could drip-irrigation using PV pumps be useful in the Mopti area? Could a combination of PV pumps and solar dryers be implemented to maximize production, preservation of crops, and eventual availability of foodstuffs to hunger-stricken northeners?

Phase IV researchers will evaluate data resulting from the efforts of the GI team during the final months of Phase III. Since PV pumps have not been studied closely during the earlier parts of Phase III, it is likely that Phase IV staff will make recommendations as to future directions in this regard.

PV Refrigerators

LESO possesses user data on only two PV refrigerators being field-tested: that at Ntosso in a Protestant missionary dispensary, and that at Ouelessebougou, which is one of the NASA Lewis Research Center series of demonstrations in conjunction with the World Health Organization and the US Centers for Disease Control.

Data from the latter field test includes information on what vaccines are stored in the refrigerator, and how often they are removed to give injections. A problem surfaces immediately, however, since there appears to be data concerning use of only two vaccines: SAT/VAT for tetanus, and BCG for tuberculosis. Are these the only ones of several cold-chain vaccines used? If so, the questionnaire is clearly deficient, in that it does not allow the enqueteur, or perhaps does not encourage him, to comment upon the lack of distribution of other cold-chain vaccines. If these are not the only ones kept cold (or if other substances are put in the refrigerator that do not appear on the forms--which from other NASA experience, is highly likely), then here again is the problem of incomplete reporting encountered in the improved woodstove surveys. This raises a larger issue that must be considered in the final months of Phase III and in Phase IV.

The deployment of PV refrigerators in Mali (and elsewhere--cf. Gabon, NASA USDOE/GRG program for village PV power systems) illuminated problems and differences among a) a technical experiment/demonstration (desire to test a RET in different climates, different eco-systems, different cultural milieux); b)political priorities (need to distribute development benefit equitably to all corners of the country, no matter how far-flung); and c) the realities of distribution logistics for medicines, maintenance crews, and related goods and services.

If the goal is to test the appropriateness of a RET installation (as in the first two considerations, the technical and the political), then the last consideration (i.e. distribution) requires that the first installations should be gtouped near some central facility. In other words, if PV refrigerators are to be proved useful (as we all hope and expect them to be, in a domain of such critical necessity), then from the start the practical matter of distribution must take precedence in site selection. If the distance between PV refrigerators is too great, it is impossible to base a cold-chain distribution system upon their use. If, on the contrary, they are concentrated, then a campaign might be envisioned, using them as reference points, for stocking the live and perishable vaccines--e.g. measles--for which they were created.

In any case, LESO must work closely with Ministry of Health officials to maximize use of the refrigerators as points where vaccines may be held and used, not only within the immediate

vicinity, but outward from there using cold boxes (glacieres). LESO staff should coordinate their efforts in this regard with those of such projects as the mother-child health programs in the Bamako area, for which 15 PV refrigerators will be deployed (Dr. Peter Knebel, USAID).

A further promising use of PV refrigerators is being tested at Gao, as an element of a veterinary program, for the storage of vaccines against bovine plague and anthrax. The particular refrigerator installed at Gao has had technical difficulties, and as of this writing, has been brought back to LESO for further reseach and repair of its shortcomings.

A further problem has surfaced with regard to this particular application. Veterinary staff wish to have a refrigerator which not only conserves perishable medicines, but which will produce sufficient ice to allow distribution via glacieres during vaccination campaigns. LESO staff should determine the extent and nature of this need; can an existing system be adapted to produce greater quantities of ice, or does this require new R&D? If the latter is the case, then this might be the basis of a new PID; for surely, cattle must be considered a significant resource of Sahelian countries like Mali, and this might be an input of substantial long-term value. Furthermore, ice-makers could find other uses in human vaccination programs using existing PV refrigerators as storage centers.

LESO has installed three off-the shelf-PV refrigeration systems and procured, back in the beginning of the project, four zeolyte solar thermal systems. The zeolyte systems have not been field-installed because laboratory tests proved that the technology was totally unsuitable and inadequate to provide cooling for refrigeration in the Malian climate.

Of the three PV systems installed in '83, long-term reliable monitoring and data are available from one system. The two other systems have both displayed frequent unreliability due to technical defects, most of which have been within the voltage regulator circuit or compressor controller circuits and are primarily electronic. Occasional defects have been identified within the cooling circuit itself. The PV modules providing power have been 100 per cent reliable. The batteries used for energy storage have also in many cases failed prematurely.

Based on this early experience, LESO has procured two further systems which promise to eliminate most, if not all, of the earlier technical defects identified. These will be installed and available for assessment within Phase IV. LESO has also participated in the NASA-LEWIS world program of refrigeration testing, and together with NASA representatives, has installed one refrigeration system in Mali which is extensively instrumented and monitored on a regular basis. This plant provides excellent data for technical assessment of PV installations and can be readily compared with other installations elsewhere in the world.

Many of the difficulties stemming from refrigerators are user-associated and require careful review and a possible recommendation for design change to reduce the sensitivity of systems to misuse and user abuse. At present, data is being collected concerning the number of times the refrigerators are opened, and some notation is made as to the identity of medicines being preserved.

Such scrutiny needs to be expanded to include interviews with staff of the health care or veterinary staff using the appliance, to determine needs met or outstanding. Patient consultation records should be checked to verify the data collected otherwise about vaccines stored and used. Most importantly, a sense must be gained of what efforts have been or could be made to maximize the integration of the existing or planned PV refrigerators into programs of medicine diffusion and campaigns of vaccination. The PV refrigerator questionnaire from Guatemala, in the possession of the GI team, could form the basis of directed questioning by GI staff at field sites. Again, more substantive responses are needed than the figures we now have at our disposition.

The possibilities for a RET medical system should be explored, as opposed to LESO's deployment of individual parts of a system. This approach has been followed by NASA Lewis Research System, in collaboration with the World Health Organization, the Panamerican Health Organization, and the US Center for Disease Control. Data on these efforts is available from NASA or WHO.

Much significant research is underway in this field, and LESO should participate in it as a liaison between Malian and international efforts. Study should be conducted of the totality of energy inputs that could upgrade the quality of health care provided by a given type of facility. RETs already under consideration by LESO, such as PV lighting, radio transmission, refrigeration and water pumping, plus solar water heating, might be considered as an ensemble. This must be done in close collaboration with Ministry of Health staff, however, for dispensary or provincial hospital personnel will need re-training to exploit the devices fully in their daily consultations; and regional or national staff of vaccination, or other wide campaigns, must be sufficiently aware of the potential of these installations to integrate them into their strategies.

Again, it is likely that Phase IV evaluators will need to consider not only what has been done to date, but also what may be done in the future in this promising and critical area.

PV Mills

As defined in the Project Paper, a PV-powered grain mill for village use has been obtained, with assistance from NASA LEWIS Research Center, for installation in Tonfa. This latter is a village a convenient distance from Bamako, so that LESO staff can assist in case of technical difficulties, and near Bougouni, the zone of Phase II studies and Phase III RET deployment Tonfa has had no diesel-powered or other grain mill.

The PV team at LESO need to know if Tonfa villagers will have sufficient funds at their disposal to use the mill. Who will use the mill? Who will profit most from its installation? What are factors by which villagers' wealth can be determined, so that an estimate of who might use the mill, versus who eventually does, can be established?

These and other questions were studied in the NASA/USAID Tangaye (Burkina Fasso) PV grain-mill demonstration, and indeed, LESO staff visited Tangaye during Phase III to see the installation for themselves and to interview the station manager, millers, and other interested parties. In devising a research strategy for the Tonfa mill project, care should be taken, to the degree possible, to avoid pitfalls of survey design identified in the various Tangaye social impact assessment reports (Roberts 1980, 1982).

Doubts exist as to whether the present system, sized to operate about three and three-quarters hours daily, is sufficient to meet villagers' needs. Extra funding will be required to make changes in the system to rectify this seeming shortcoming.

The PV team wonders whether Tonfa villagers can be encouraged to contribute funds for this. Other villagers in the course of other development projects have been known to make initial capital investments; yet there has already been a four-month delay in installation from that date promised the villagers, and N'to Diarra suggested that this may have resulted already in a loss of confidence that would preclude villagers' willingness to take the risk of investment. Perhaps the building for the mill should be completed first, as a proof that LESO will, indeed, meet its commitment, he concluded.

It should be noted that at Tangaye, when the PV array and mill type were changed to increase milling time and thereby better meet villagers' needs, the result was not altogether expected; some Tangaye residents were able to use the mill more regularly, but the larger mill (strong enough to grind corn to a fineness which other, diesel-driven mills could not achieve) also attracted people from an estimated radius of 30-40 kilometers from the mill station, and capacity was still exceeded by demand.

One of several facets of the installation having wider implications than the project itself is how villagers organize themselves to manage the mill, its functioning and upkeep, and the collection and eventual disbursement of funds from milling fees charged. Again, this was a focus of the Tangaye demonstration, and useful parallels might be drawn.

Specifically, LESO should assist Tonfa villagers in this process so that tasks are assigned on a day-to-day basis, access to milling is made as equitable as possible, and fees collected are channeled into further development of the community. In this last regard, villagers could be told early on that when they have collected a certain amount of money from milling fees, LESO will be prepared to help them purchase and install a PV pump or some other RET applications that would fit a need they themselves can define. In this way, the PV mill installation is not a one-shot project, but the beginning of a program of community development that the villagers themselves manage and shape.

This, in turn, might provide an option for donor development agencies: an initial capital investment gift to sponsor a mill, the fees from which--little by little, to be sure--will then allow villagers themselves to support further RET installations for which funding will be necessary. If the Tangaye experience is any measure, villagers are able and willing to take such initiatives.

The mill design at Tonfa is based upon the learning experience of Tangaye, where NASA have now for four years operated and de-bugged a combined PV mill-pumping station within a village environment similar to that of Tonfa. The principal differences between the installations are that the LESO installation at Tonfa is limited to milling; there is no pumping component.

Although the first of its type in the region, the installation is expected to demonstrate a high reliability, principally as a result of the close collaboration with those responsible for the Tangaye installation, design and follow-up program; and also because an extensive study was performed to size the plant. Based upon operating experience, the control circuitry used to provide an interface has been substantially simplified from the initial system designed by NASA. The PV array is mounted on the roof of the millhouse as an additional protection measure and to optimize the comfort levels through a passive solar architectural design.

One aspect of the mill design is the retention of adjustable modules in the east-west axis. This feature, built in to the installation at an exceptionally low cost because the module supports were designed and manufactured at LESO, will enable LESO to determine within real operating conditions the net advantages of adjusting tilt.

This system will be operational during the Phase IV assessment and will be closely monitored by LESO throughout the period.

Although long-term monitoring will not have been performed, the short-term results can be compared directly with the results from Tangaye to provide accurate indicators of the mill's potential long-term performance. The economics of this installation require careful review. The plant was partially procured from RE Project funds (2.5 KW array and battery bank), and partially donated by NASA-LEWIS (hammer mill and control circuitry).

Scepticism regarding the economic potential of PV mills can only be allayed if careful measures are taken in Phase IV to assess the real operating costs of alternative technologies--principally diesel mills (normally available in urban environments) and the traditional mortar and pestle (which has no direct economic comparative factor, but can be transformed into a time equivalence).

The plant in Tonfa is equipped with adequate instrumentation to perform both a continuous monitor of energy-generated/energy used, and spot checks of sub-system performance. This data will be available for assessment.

Phase II data, and probably the protocols in particular, should be scrutinized for pertinence with regard to the nature of women's wealth that might allow them to purchase the services of a PV mill at Tonfa. GI team member M. Dembele has expressed the wish to study the village carefully with a specific baseline survey, but believes that time constraints may prevent this.

The various Tangaye (Burkina Fasso) PV mill demonstration assessments (Roberts 1979, 1980, 1982) should be scanned, and those variables and procedures which seem most reliable and most useful to LESO aims should be singled out and pursued. Mapping residence locations for mill users is a first step. Perhaps a researcher with training in the social sciences (from IER, the Peace Corps, or some other Malian or expatriate organization) could be engaged to study Tonfa in depth. Such a study, with as one goal the comparison with Tangaye findings, would be useful to Malian and to wider, regional energy planning.

Such a researcher should conduct at least a year of fieldwork residing in Tonfa itself. Reference should be made to the goals of the orginal USAID project as expounded in "Studies of Energy Needs in he Food System" (TAB Regional Project, No. 931-0234) and the Tangaye PID (Meyer et al, 1978, PID No. 686-0234, AID Ouaga).

Should it prove impossible to conduct a long-term, in-depth study such as that suggested above, crucial on-site research can nonetheless be undertaken by the GI team. Using the Tangaye studies as a model, interviews can be conducted and observations made as to how people organize management of the mill; guidance can be given as to how to collect, bank, and disburse funds for further community benefit. Tonfa results could be publicized, as long-term results are obtained, to indicate to potential donors how an initial investment can lead to community-based development.

PV Battery Chargers

Several prototypes of battery ('D' and 'C' cell) chargers have been developed; one can recharge up to 40 batteries, while a smaller model can handle five at once. LESO has only just begun to deploy these, in two villages of San Zone, and results so far are few.

Some questions from Maubrey's questionnaire (e.g. "Would you pay more for longer-life batteries?") elicit such idealized responses as to be of little use. Nor has a strategy been chosen from among the several proposed, for how and by whom initial capital investment for the PV system and Ni-Cad rechargeable batteries (estimated at about 145 for a 5-battery charger) is to be made. Should the system be purchased by a merchant, who then sells or rents batteries? Should systems be given at first, to test their appropriateness in the rural market? Should batteries be sold by the merhcant at full price (higher than off-the-shelf ordinary cells) with a slight recharging fee assessed, or should the merchant charge less than the battery price, and then assess a higher recharging fee to recoup his initial investment? Can one of these solutions be appropriate for all settings, and can LESO impose a single marketing strategy on merchants? The chargers mmight also be consigned to non-merchants, but then this would compete directly with established trade.

With the above unresolved questions in mind, there is another technical datum which has yet to be established, according to the GI team: the life of a charge. Does a recharged battery last as long as a new, ordinary one? Does the recharge life decrease in direct proportion to the number of times it has been recharged? Such factors will determine the convenience or inconvenience of system use, and, in short order, whether the RET is accepted by rural battery-users. The GI team believes that this RET is not yet au point, or at least that an overall sense of its purpose and possibilities has not been established.

Other issues arise. If the chargers are given to merchants, then one cannot know whether they would be purchased (i.e. whether merchants would be willing to take an initial risk). If they are not given away, can we be confident enough, not only in the technology itself, but in the way it will be adapted and interpreted by villagers, that the merchant is, indeed, taking a sufficiently qualified risk?

A study is necessary to determine the ratio of battery sales to batteries brought in for recharging. If customeers encounter a significant bottleneck, forcing them to wait several days to recuperate their batteries, then they will most likely return to ordinary battery purchase. Even if an alternative strategy is chosen, whereby the customer trades her/his batteries in for ones already recharged, the same bottleneck effect may arise; and if battery recharge life does decrease proportionately as the number of recharges increases, then the inconvenience to customers might

prove overwhelmingly complicating. (Someone trading in twice-charged batteries with a life of X hours would not be happy to receive in exchange 15-time charged batteries with a life of only Y hours, where X is of obviously greater magnitude than Y.)

The battery charger, entirely designed within LESO, is constructed in a modular form. The modular form permits easy system expansion in increments of five batteries as the demand increases. Additionally, each charge module, which accepts up to five batteries for recharging, possesses independent electronic charge circuits for each battery, which guarantees that the charge rate is established for each cell as a function of its state of discharge. This assists in optimizing the life of the Ni-Cad cells. A plug-in/plug-out arrangement for each cell charge controller has also been designed to facilitate extremely simple field maintenance.

LESO has the capacity within its central laboratory to trouble-shoot, rebuild and calibrate defective charge controllers. This technology, although economically attractive, may well be prone to severe user-associated problems, and because of its newness, may also encounter technical difficulties either associated with manipulation or operational reliability. THese factors require careful study, since if user and performance problems are diagnosed and rectified early within the field testing phase, then the technology potential will become principally a function of economics, thus promising to make this a very competitive technology.

Data from the Phase II baseline should be scrutinized, and additional information sought, as necessary, concerning ordinary battery sales over a period of time, prior to installation of a PV charger in that particular village. The strategy eventually chosen from among those proposed should be documented carefully so that if it proves troublesome, an alternative choice can be tested. Sales of rechargeable batteries must then be logged, with date and identity of purchaser (name, profession, location of residence). Sales of ordinary batteries in the same village should be monitored. Special care should be taken to note the date and identity of customers returning for battery recharge, and how long the customer must wait to receive recharged batteries, if this proves significant according to the implementation strategy chosen.

Interviews should be conducted by GI team members while <u>enqueteurs</u> collect the above data, to obtain more substantive opinions of merchants, system users and those who choose not to subscribe to the system. The identity of users, recorded as above, is essential to interviewing. Merchants may be willing to asist in data recoding, if they recognize an incentive to do so.

The matter of small business investment in rural Sahelian countries has been studied by USAID/Ouaga through a project in the late 1970s/early 1980s implemented by Partners for Progress. Results might prove interesting when LESO considers how merchants and customers can be induced to make initial investments; and such thought might lead to LESO proposing some wider program, based on battery chargers and other RETs, that a donor agency might suggest to increase small-scale capital building. Loans made to rural merchants through a program like that tested in Burkina Fasso, for instance, might be earmarked for RET implementation.

Wind Pumps

After testing available models of wind-driven pumping systems, LESO is perfecting its own prototype, constructed entirely from locally available materials. The system requires minimal maintenance, although the pump piston is prone to wear. Repairs of this nature can be made by the Water Resources Department field staff, with the assistance of local blacksmiths.

The most challenging problem to date has been determining average wind speed in particular settings. Although wind north of the 14th parallel is theoretically sufficient to drive a windmill such as the LESO prototype (i.e., in Gao and Nioro Zones), micro-variations may occur. LESO meteorological datapoints and other measuring devices should correct this lack of critical information. Locations south of the 14th parallel may also lend themselves to this RET--cf. San Zone, where market-gardeners might profit from it. Wind-measuring there to date proves promising, but inconclusive.

Except for differences in maintenance demand (wind-driven pumps may require less maintenance than PV systems), wind pumps and PV-powered pumps should receive similar social impact assessment with similar strategy. Archival research might prove useful here, since in the last years of the colonial period, the French installed a series of windmill pumps which were problem-prone and allowed to fall into disrepair and disuse after Independence. Any existing documentation on this program would be of immediate interest to LESO and may be accessible through French development agents.

The great advantage of wind-driven over PV pumps is that all parts of the system are immediately available or can be constructed in Mali. This RET, then, may well prove an important element of commercial growth as well as rural development strategy, and once systems are in the field, close scrutiny of their operation and acceptance should be undertaken by LESO.

Development of a product in LESO has been long and difficult, but has provided an extremely valuable learning experience which promises a locally manufacturable and maintainable windpump which is well-engineered, reliable, and not prohibitively expensive. All construction materials are available on the local market.

Developmental programs began with laboratory and field-testing of a low-technology windpump manufactured in Segou and with a design review of US-manufactured wind-pumping systems with potential for local manufacture. The low-technology model was both unreliable and complex, and manufacturing problems were associated with acceptance of US models. Thus LESO was forced to embark upon a program of design which would eliminate the problems of unreliability associated with the low-technology approach and avoid unnecessary manufacturing difficulties.

LESO has now extensively field-tested a three-meter diameter pumping system intended for working heads of less than 10 meters and has almost completed the construction of a four-meter diameter multi-bladed system intended for heads of up to 40 meters. Both of these systems will be operational during Phase IV. If the field installation program maintains its schedule, then several other units of the same type will also be field-installed to increase the testing sample.

Windpump design and manufacture is in itself a major technological undertaking. The results which will be available within the framework of the RE project can only be considered preliminary, but should be adequate to provide clear indicators for the potential of local manufacture in production quantities, since both the engineering aspects of products will have been studied and an accurate economic base established.

Continuous monitoring of the field-installed system has not been done. Monitoring has been limited to a series of one-day periodic assessments upon which system performance can be determined. An essential parameter required with any field-installed pump is that of totalized flow, which, combined with a precise knowledge of system performance, can be extrapolated to determine the local wind regime.

An extensive review of technical and economic viability of wind pumps should be made during this assessment. If well engineered, they can be extremely competitive with alternative technologies, especially in the area of one important rural need in Mali--that of water pumping.

Improved Woodstoves

Throughout the Sahel, a major effort is being made to coordinate firewood conservation projects with reforestation. Improved woodstoves play a major part in this effort. LESO has lab-tested a series of prototype improved woodstoves, which are now being tested in the field. Resources have been concentrated on metal stoves partially designed within LESO and now made in the LESO shop. These stoves can eventually be made from readily available raw materials elsewhere in Mali as a commercial venture. They overcome some of the problems of massive or other fixed stove models, while maintaining high fuel savings and providing and convenience to the cook. Difficulties persist, however, in

measuring the degree to which village use of the stoves provides fuel conservation; it is hoped, of course, that savings will approach those obtained under laboratory conditions, but determining this has proved very problematic

During Phase II, village wood consumption was estimated in each zone according to questionnaires devised by Dolores Koenig; it was against this data that changes were to be compared to register fuel consumption savings, with further comparison to be drawn with lab tests of the improved stoves. Regis Maubrey composed questionnaires for Foyers Ameliores Portatifs (FAP) tests to be carried out during phase III. Because of delays in implementing other RET applications planned for Phase III, a disproportionate amount of interviewer time was spent on following up FAPs, to a degree unforeseen in early phases of project planning.

A great deal of data from completed questionnaires has been amassed. Consultant Brooke Schoepf was to work with Mohammed Dembele to find a suitable computer program to analyse this information; Schoepf's report explaining methodology for this has not been received at LESO at the time of writing. A test-case computer analysis effected by Dembele on a small sample of FAP data found no significant difference between FAP wood consumption and that of "traditional" three-stone hearths (Foyers Traditionnels = FT) in the same villages. The data was, however, neither complete enough to allow explanation of this finding, nor reliable enough.

The main deficiencies of the existing data are as follows:

a) Many variables have been recognized as affecting fuel consumption, including cooking habits, location of the FAP within the compound (susceptibility to wind), species of wood used, amount of grain cooked, and whether other activities are undertaken during cooking. All of these may offset savings measured under the controlled circumstances at LESO.

b) The reliability of data depends on the reliability of the person recording it. Schoepf examined points of this sort from Koenig's reports, and expounds upon them. Tardiness or absence of an interviewers on a given day may be masked by invented "data." Difficulties of this sort highlight problems of management of field staff by the GI.

Visits to San and Bougouni zones between July and September 1984 showed considerable dissatisfaction among interviewers about supervision procedures for their work, and about the lack of feedback on overall survey progress, which might have given them a sense of purpose. GI staff have taken measures late in Phase III to rectify this by scheduling longer stays at given sites; this management strategy dovetails with the emphasis of the revised research plan to conduct fieldwork on selected RET applications for longer periods (10 days to two weeks).

c) Reliability of data is also dependent upon the nature of social relations between enqueteur and cook. To take but one example, the amount of grain being prepared has been determined by asking the cook, who responds in local units of measure. These rough estimates are then converted to "kilograms" by the enqueteurs. The result is approximate at best. According to GI, economic considerations further complicate the issue: to disguise their poverty, some households may indicate they are using larger amounts of grain than they actually are. Such factors undoubtedly biased some of Koenig's baseline results as well as those of Phase III, a matter for evaluation during Phase IV.

d) To obtain comparative data on fuel consumption between FAP and traditional hearths (FTs), Maubrey instructed participants to cook for ten days on an improved stove, then return in the following 10 days to use of a foyer traditionnel. GI team members subsequently decided this research method was unacceptable, both in terms of the demands made on the participants and the effects on test results.

e) Malian women use a range of pots. For comprehensive village testing, foyers ameliores corresponding to each pot must be installed in participating households (maximum efficiency can only be achieved if there is a "correct" fit between pot and FAP). This was not, however, achieved during Phase III. Data collected so far cannot always be relied upon to distinguish between households using FAPs exclusively and those using a combination of FAPs and FTs. This omission will clearly affect the fuel savings recorded.

f) Finally, FAPs were given to participating households for the purposes of the research. It is therefore impossible to say whether these same households would be willing or able to purchase an improved woodstove under non-research conditions. With the present price of FAPs (about 4000 CFA, or a little more than $8), it is unlikely that rural Malian women will have the capital to purchase a complete set of FAPs in the foreseeable future.

GI staff have revised the methodology for village testing of FAPs in order to overcome some of these difficulties, which have been recognized in a series of reports, including the mid-term assessment and Schoepf's work. The proposed changes are outlined in a trip report of October 84. It is unlikely, however, that a clear-cut proof will emerge of the effectiveness of FAPs on fuel saving in a rural setting.

Phase IV should examine the evolution of research strategies over the life of the project in relation to results obtained, since the problems encountered are also of interest to development anthropology in general. This should be borne in mind by Phase IV evaluators, both in their assessment of the project and in the dissemination of results. The problems encountered in testing this one RET should not lead to a negative interpretation of the entire field-testing program. Rather, as with any scientific

experiment, failure can reveal as much or more than "success". hopefully, what we have learned from the present generation of energy projects (including that at Tangaye) will lead to improved methodologies and avoid the repetition of mistakes

LESO has approximately 1000 stoves installed and monitored in rural applications. The engineering sample generated has provided accurate information on manufacturing costs, time, level of effort, machine tool needs and many other factors, including performance measurements within laboratory environments

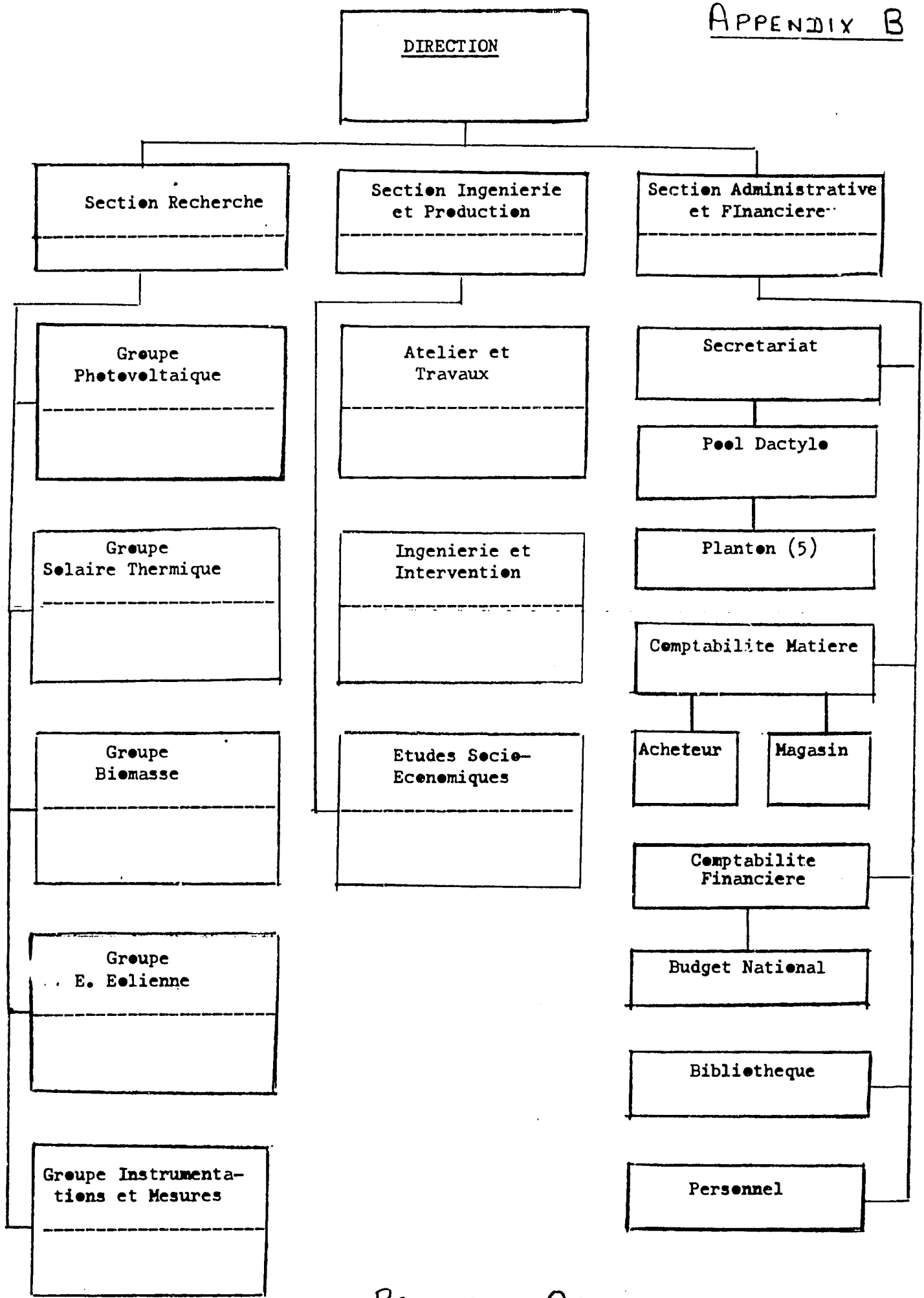
What has not been attempted within the framework of this project (because it is programmed for an urban stove project to be implemented by LESO and VITA) is the transformation of the present metallic stove into a production unit, which in Mali will almost certainly vary as a function of the tooling available, and the economic standing of the user Hence it is not anticipated there will be one standard stove The need for stove quality may well vary across the market ranging from a cheap non too durable model to a more costly product demonstrating higher efficiency and extreme durability These factors will be addressed during the VITA/LESO urban stove project schedule to begin in the spring of 85 Input from this project will be available for assessment during this evaluation

The technical performance of improved woodstoves has been well established The life of field installed metallic stoves has not been studied in depth, but many projects, both in Mali and regionally, are available and can provide information to supplement the findings within the RE project.

LESO has purposely avoided involvement in the one-hole mud stove commonly referred to as LOUGA, since this unit is being extensively field-introduced by Peace Corps and is available for comparative reference in this context.

Improved woodstoves have been a popular technology with many projects throughout the Sahel over the last five to seven years, but it is only now, after more than five years of disappointing results and disillusioned users, that sufficient is understood about the engineering, training, and user aspects of the technology to avoid the earlier pitfalls and provide a product which is needed and accepted within the rural and urban market throughout the Sahel. An assessment of LESO's involvement, findings, difficulties and the cost of this extensive learning experience must all be parameters for assessment.

APPENDIX B



PROPOSED ORGANIGRAM

BACKGROUND DOCUMENTATION

Mali Renewable Energy Project Paper, Hammond, Kooi, Spooner, Steedman, Sylla, June 1978

Mid-Project Evaluation Report, Fall Kooi, Stier, Graham, May 1982

Energy Use in the Region of San: Preliminary Results (draft), Koenig, March 1983

Energy Use in the Regions of Niono and Bougouni: Preliminary Results (draft), Koenig, January 1984

Energy Use in the Region of Gao: Preliminary Results (draft), Koenig, February 1984

"Women, Work and Energy Use in San", paper to the Association of Women in Development, USA, Koenig, October 1983

Energy Use in Malian Villages: A Preliminary Report, Koenig, August 1981

Reflexions sur la Conception de Projets Energetiques pour les Pays en Developpement, Koenig, August 1980

Trip Report, Koenig, August 1980

3 Trip Reports, Koenig, 1981-82

"Monitoring New Energy Technologies" (trip report), Koenig, May 1983

"Battery Use in San" (memo), Koenig, November 1982

Trip Report: San, Gao, Dire, Anderson, Taylor, Mattern, March-April 1981

Preliminary Evaluations, Gao Zone Energy Survey, Cashion, May 1982

Trip Report, Roberts, May 1983

Rapport du Consultant en Recherches sur l'Impact des Technologies LESO Diffusees en Milieu Rurale, Schoepf, August 1984

"Projet Energies Renouvellables Annexes" (4 IER reports), Coulibaly and Cisse, received November 1984

Zone Controller Reports (as available)

Groupe Intervention Mission Reports (as available)

Assorted documents on individual technologies and how to conduct studies, instructions to interviewers, etc., Maubrey, December 1983

A.I.D. Policy Paper Energy, July 1984

Country Development Strategy Statement FY 85 Mali and update FY 86

LESO Technical Reports (17)

SAI Quarterly Reports

Project Engineer Monthly Reports

Zone Advisor Monthly Reports

GRM Five-Year Plan

TRANSENERG Report
- -Synthese - Rapport Finale
- -Annexe IV (RE Technologies)

CRES Programmation (Nationale et Regionale)

IT POWER PV Pump Methodology (to be published Spring 1985)

SAI Final Report

SAI Consultant Reports (Cf. SAI Final Report for complete listing)