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Developing Common Information Elements for Renewable Energy Systems: Summary and Proceedings of SERI/AID Workshop

20-22 February 1980

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A Division of Midwest Research Institute

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DEVELOPING COMMON INFORMATION ELEMENTS FOR RENEWABLE ENERGY SYSTEMS: SUMMARY AND PROCEEDINGS OF THE SERI/AID WORKSHOP

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PREFACE

This report presents information developed during the Workshop on Evaluation Systems for Renewable Energy Technologies held at the Solar Energy Research Institute (SERI) on 20-22 February 1980. Funding for this workshop was provided by the Bureau for Program and Policy Coordination of the Agency for International Development (AID) through Participating Agencies Service Agreement (PASA) DOE/PPC-0077-1-79 with the Department of Energy (DOE). The authors wish to thank Stephen Klein of AID for his constant support and active participation in this project from its inception to the editing of the proceedings. Special thanks go to Nancy Graves of AID and Robert Snow of SERI, who expertly managed the unusual problems of arranging a major international meeting using the resources and procedures of two different organizations. We would also like to express our deep appreciation to the members of the SERI Conferences and Training Branch, whose excellent support provided for the smooth functioning of the meeting and the endless needs of a group of international travelers. Finally, everyone concerned with the workshop would like to thank the SERI coordinator, Zo Milne. Her unflappable professionalism, constant attention to detail, and ability to deliver the impossible made the entire meeting possible.

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SUMMARY OF THE WORKSHOP FINDINGS AND RECOMMENDATIONS

1.1 FINDINGS

- The collection of common sets of information elements on renewable energy projects is valuable and feasible. Further steps should be taken to develop common elements based on the initial categories and approaches developed at this working session.
- The development of information categories would assist the exchange of information among development organizations, researchers, and project field managers.
- Information is most useful when it is specific to a particular technology (although some information may be common to all systems).

1.2 RECOMMENDATIONS

- The information developed at this workshop should be refined immediately.
- A mechanism for information exchange should be established.
- As development organizations agree on the advantage of collecting specific data on renewable energy projects, one or more technology-specific (and perhaps application-specific) handbooks should be prepared to demonstrate how to collect data.
- There is an immediate need to catalogue all the centers in developing and developed countries that are currently collecting data on renewable energy systems and involve them in exchanging information.
- When the organizations developing the data and exchange systems have examined all options, the suggestions could be submitted to an international forum and coordinated with the preparations for the 1981 U.N. Conference on New and Renewable Sources of Energy.

1.3 MAJOR DATA CATEGORIES DEVELOPED

Economic

- Market price of current available fuels
- Capital costs
- Operating costs
- Existing government incentive and taxes
- Benefits from project
- Indirect effects

Technical Factors

- Local need for energy
- Resource base
- Technical readiness and commercial availability of the systems
- Existing energy resources and technologies
- System output
- Maintenance and repair
- Lifetime of system
- Optimization of system

Social/Cultural Factors

- Patterns prior to systems introduction
- Effects of project on local population
- Local receptivity to innovation and change
- Community participation in planning, operation, and maintenance

Institutional Factors

- Existing decision-making organizations and management capacity
- Existing support infrastructure
- Patterns of ownership of local facilities
- Institutional linkage between energy and other sectors

Environmental

- Impact of previous energy consumption patterns
- Direct impacts of renewable energy technology operation
- Indirect impacts of system operation

SECTION 2.0

BACKGROUND TO THE WORKSHOP

2.1 THE GROWTH IN INTEREST IN RENEWABLE ENERGY SYSTEMS FOR DEVELOPING COUNTRIES

In the past few years, planners in developing countries and major international institutions have been reexamining the role of energy in the process of economic and social growth in the Third World. Increasingly, this analysis has focused on the current and future role of renewable energy sources. This is due to three factors. First, there has been the realization that current patterns of energy consumption, accounting for over half the total energy use in most developing nations, are based on nonconventional, traditional renewable sources: firewood, charcoal, dung, and crop residues. Increasing use of these sources, due to growing populations and increasing energy use, has been destroying the resource base at a rapid rate. This has led to deforestation, increased erosion and siltation of downstream rivers, soil depletion, and hardship for those charged with the onerous chore of gathering and using these traditional fuels. Although attention has been focused on the firewood problem in sub-Sahara Africa, problems of similar magnitude have been noted in locations ranging from the Himalayan hills region of Nepal to the tropical lowlands of Central America. Planners have recognized the necessity of either finding immediate substitutes for these depleting fuel sources or else increasing the supply of traditional sources to meet current and future energy demands.

Second, spiralling costs of conventional energy sources and growing uncertainty of supply disrupted programs aimed at providing basic human services and creating new social and economic infrastructures. Between 1973 and 1980, world petroleum prices increased more than 1000%, adversely affecting a range of development objectives from the stimulation of agricultural production to the formation of transportation networks. Economic growth has slowed or stopped for many of the poorest nations, while balance of payments problems have mounted, due to increased petroleum import bills.

Third, major foreign assistance organizations and developing country planning agencies have recently added new concerns, such as the provision of goods and services to meet basic human needs of the poorest segments of the population, to the traditional concerns with economic growth. This refocusing of attention and funding has led to the search for technologies that could deliver services directly to the rural population. It also has led to a reexamination of the cost of distributing energy services (particularly electricity) from central locations versus the cost of decentralizing the energy production process.

These three factors—concern over the rapid depletion of traditional nonconventional energy sources, the sudden increase in the cost of imported conventional fuels, and the emphasis on providing services for the meeting of basic human needs—have led to increased experimentation with renewable energy technologies. For many applications, renewable energy systems offer alternatives to dependence on expensive and unreliable imported petroleum and to the depletion of natural resources. Simple solar thermal systems can provide crop drying and water heating, while wind and small-scale hydroelectrical and hydromechanical systems are well matched to the production of electricity and shaft power. Other decentralized systems, such as biogas generators, photovoltaic arrays, and flat-plate solar systems coupled with rankine-cycle engines, offer possible power sources for water pumping and the provision of potable water. All provide energy directly to end users without major distribution networks. They also appear to be cost-effective for certain types of applications, due to the rapid rise in the cost of imported petroleum products—particularly kerosene and diesel fuel.

To determine if these renewable energy systems offer real alternatives to fossil or traditional fuels, a great deal of field testing and technology modification will be required. Thus far, much of the initiative for this testing and installation in developing countries has come from the foreign assistance community. A small group of bilateral donors, led by the United States, France, the Netherlands, Canada, and Sweden, began in the middle and late 1970s to provide major funding to developing countries for renewable energy projects. They were joined by various organizations of the United Nations and regional organizations such as the Organization of American States (OAS). At the same time, individual countries such as India, Brazil, Israel, and Niger established ambitous internally-funded programs for the development and deployment of renewable technologies. These initial donor and developing country efforts recently have been augmented by other major bilateral, multilateral, and private assistance agencies including the government of West Germany, the Rockefeller Foundation, the aL Dir'iyyah Institute, the Inter-American Development Bank, and the European Economic Community. The result has been a sharp increase in the financial support for the installation of renewable energy systems. A survey published by the Solar Energy Research Institute (SERI) [1] in late 1979 located projects with a total funding of over $225 million from a variety of foreign assistance donors. A more recent, comprehensive project compendium for Africa, developed by the Overseas Development Council [2], uncovered over 300 projects involving fuelwood and other renewable energy sources for that continent alone.

2.2 THE NEED FOR INFORMATION IN PLANNING, TECHNOLOGY SELECTION, AND EVALUATION

Many of these projects have been seen by their sponsors as experiments, implemented despite a lack of preproject information on expected project outcomes or system performance. Given the immediacy of the fuel-related problems and faced with sparse data on performance and costs and with little experience on the acceptance of new energy technologies by the end users, program managers decided to try a wide variety of technologies. Despite the proliferation of projects, no systematic effort has been made to categorize and identify the information essential for planning future installations and future investment decisions. Information on field experience and system performance that planners will require has not been collected. The information collected has been gathered in a variety of fashions, often incompatible with one another. Different organizations ask different questions producing results that have not proved useful to other major agencies. Not only is reliable data needed on the actual cost and performance of renewable energy systems but also for nontechnical information on the economic and social benefits and the most effective institutional mechanisms for introducing, adapting, operating, and maintaining these systems in Third World locations.

2.3 THE FOLLOW-UP TO THE BONN SUMMIT

In July 1978, the leaders of the major Western industrial nations met in Bonn, West Germany to discuss joint economic cooperation in a wide variety of areas, including foreign assistance. Out of that meeting came a commitment for increased assistance in installing renewable energy systems in the developing world. Throughout the remainder of 1978 and into early 1979, representatives of the Organization for Economic Cooperation and Development (OECD) nations met periodically, under the chairmanship of

Donald McPhail of Canada, to discuss specific policy initiatives to implement this commitment. The meetings of OECD representatives were concluded in late spring 1979. The results of these consultations were published in the McPhail report and approved by the OECD Council in May 1979. This report endorsed an increase in renewable energy foreign assistance projects and agreed, in principle, to the desirability of collecting and exchanging information on these projects [3].

2.4 THE U.N. CONFERENCE ON NEW AND RENEWABLE ENERGY SOURCES

In a separate but related development on 1 March 1979, the U.N. General Assembly agreed to convene a world conference on new and renewable energy sources in Nairobi, Kenya, in August 1981. The focus of the U.N. conference is how to accelerate the development and use of renewable energy in meeting requirements for continued economic and social development, particularly in developing countries. The U.S. government has strongly supported this meeting from its inception and has a major interagency program underway to ensure active participation by U.S.-based technical specialists and development planners. This meeting will also serve as a natural forum for the expansion of current U.S. efforts to promote the coordination of renewable energy projects and exchange of project and technology information.

Because of the favorable response to the McPhail group resolutions and the need for advance planning for the 1981 U.N. Conference, AID decided to sponsor a workshop that would focus on the question of common information required for planning, monitoring, and evaluating renewable energy systems. This meeting was cosponsored by AID's Bureau of Program and Policy Coordination and SERI using AID funds. The meeting was held at SERI in Golden, Colorado, on 20-22 February 1980.

This report describes the preparations, internal process, and outcome of that 2-1/2-day meeting. Because of the participatory approach taken, considerable attention is given to explaining the planning that went into this workshop, techniques developed to ensure participation, modifications required during the workshop, and general concerns of the participants about information collection and exchange that might not be captured in the individual data developed by the workshop. Wherever possible, examples of the discussions in both the small working groups and the plenary sessions of the workshop are given to capture the flavor of the exchanges and the nuances often lost in the preparation of a final consensus.

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SECTION 3.0

PURPOSE OF THE WORKSHOP

Great attention was paid in the preliminary planning stages to narrow the focus of the meeting to make it useful for decision makers. That focus was well expressed in a portion of the invitation sent to all participants and reproduced below:

> The primary objective of the workshop is to explore whether it is possible to establish a common set of evaluation criteria among all individual renewable energy demonstration projects which will provide an information base for conclusions on the economic, technical, and social feasibility of the technologies. Based on our experience to date, we find that some technologies have an advantage over others in providing particular forms of energy. There is a strong rationale for developing the information base on alternative technologies to assure effective matching of the energy supply system with the energy needs.
>
> During the next ten years, several countries, foreign assistance agencies, and the private sector will be financing demonstration projects using renewable energy technologies (e.g., photovoltaic-powered pumps, solar hot water heaters, crop dryers, wind-driven generators, bio-gas plants, and micro-hydro systems). A significant number of projects using these systems are underway or in the advanced stages of planning. The rationale for these demonstration activities is, in part, principally to gain information, rather than just to produce energy. The workshop will serve as a forum for exchange of views on coordination of these projects among bilateral, multilateral, and private donor organizations. We would hope that a consensus on the role and components of evaluation systems for these activities could be reached at the meeting to enable the information gained from the demonstration projects to be shared widely and rapidly. . . .
>
> This workshop will consider the many components of technology evaluation and how these can contribute to future decisions on the choice of technologies. These components include energy systems' performance, benefit and cost analysis, interaction with the physical and social environment, and utility in meeting basic human needs for energy. This will not be another conference describing solar energy technologies to the uninitiated or a forum for solar energy experts to discuss the latest technological innovations in research and development. The exchange among developing country energy planners and foreign assistance agency officials will be supplemented by presentations from experts on the management and evaluation of renewable energy systems, including specific tools for technology selection, project identification and development, and post-investment evaluation. [4]

SECTION 4.0

CHOICE OF THE WORKSHOP FORMAT AND THE SELECTION OF PARTICIPANTS

AID and SERI staff decided in initial planning sessions to structure the meeting as a series of informal working sessions requiring active involvement by all participants, rather than a conference where alternative information systems or data points were presented by specialists. The participants would do the work. This had several implications for the organization of the meeting. First, the number of participants had to be sharply limited to facilitate discussion and the exchange of ideas. An arbitrary limit of 25-30 participants was imposed with only one representative being invited from each major non-U.S. governmental organization. Second, the work was to be done in small groups with the results consolidated by the larger plenary sessions later. Third, the meeting was to be loosely structured to accomodate the interests of the participants and allow development in the plenary sessions of concerns raised in the small working groups.

Participants were selected to represent a cross-section of important decision makers responsible for managing energy planning, new policy initiatives, or renewable energy technologies. An effort was made to include a representative from most of the major bilateral, multilateral, and private foreign assistance organizations actively involved in funding renewable energy projects in developing countries. To keep the attendance small, however, the organizers were forced to select among major donor agencies. Energy and planning officials from six developing countries were invited, as well as some experts on program planning, evaluation, and information gathering for rural development projects. A special effort was made to select administrators who needed reliable information in the course of their programmatic responsibilities, rather than the individual within an organization who was the best versed in the individual technologies. Appendix A lists participants along with their organizational affiliations.

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SECTION 5.0

THE PROCESS OF REACHING CONSENSUS DURING THE WORKSHOP

Since the object was to have the group reach a consensus about information criteria, the meeting was organized to ensure maximum participation of the members. Members were assigned to small working groups with specific tasks to perform. To introduce the members to the objectives and offer them some ideas about how to approach the small group tasks, the workshop also included initial presentations and some general discussion of the workshop's purpose.

The format succeeded in providing the type of group consensus that the sponsors hoped would be accomplished. The small working groups were excellent forums for identifying information that reflected the needs of development organizations, primarily because individual members devoted a great deal of time and effort to the drafting of the group product.

The individual sessions are described below with emphasis on how they helped the workshop attain its goal.

5.1 THE OPENING SESSIONS

The introduction was presented by the sponsor of the meeting, Stephen Klein of AID. Mr. Klein described the rationale and background of establishing the workshop. In addition, he emphasized that the object was for the members to determine whether information could be identified that would describe the results of individual renewable energy projects in a form useful to other organizations. This introduction identified the workshop's specific task and demonstrated to the members that their participation was essential.

5.2 BACKGROUND PRESENTATIONS ON PROJECT PLANNING, INFORMATION SYSTEMS, AND EVALUATION

Five formal presentations (see Appendix E) were given at the workshop to illustrate possible methods for approaching the issues of information collection and exchange for renewable energy projects. These sessions also offered suggestions on the important data for project planning, monitoring, and evaluation.

The first speaker, Alan Roth of the Energy Development Services Corporation, emphasized that information collection must serve the needs of the data user. Dr. Roth noted that each development organization has its own internal requirements for data, which will vary at each level of program management and field project implementation. An international information exchange must consider the differing needs of a number of institutions. He also emphasized the importance of collecting only enough information to get the project started and planning later modifications as field personnel gain more experience and information. Dr. Roth's points and the ensuing discussion stimulated the workshop participants to think about how information collection can support the objectives and management of the organization.

The process of project planning and the data helpful for this process were addressed by George Burrill, Rural Development, Inc., and John Ashworth and Jean Neuendorffer, SERI. From his experience in planning and conducting rural energy surveys, Dr. Burrill discussed alternative methods for collecting data in the field. He focused on what level of detail is possible and useful, as well as what some of the key social, cultural, and economic variables are that should be assessed for project planning. Dr. Ashworth and Ms. Neuendorffer illustrated how the selection of a renewable energy technology for a particular energy need aided project planning and enumerated the vital data required for this selection process. These presentations offered the workshop members information that could be helpful in planning a renewable energy project. This was designed to assist the attendees in the small working group session that followed in which they were asked to list the items they would like to receive from other organizations in planning their own projects.

Since information is also necessary to assess how well a renewable energy system performed and how closely a project met its objectives, two presentations were given on monitoring and evaluating a project outcome. Glenn Brandvold, Sandia Laboratories, emphasized that proven technologies should be the only ones installed in developing countries. Competent installers and operators and adequate back-up systems must be provided so that the energy systems will function well and demonstrate their utility to local users. Dr. Brandvold also discussed the need to monitor the technical performance of renewable energy devices in the field. He cautioned that the monitoring results must be viewed from the perspective of how the system was expected to perform. If a system is in a different climate and used for a different application than previously, the performance data should be analyzed in this context.

Irene Tinker addressed the issue of how to interpret data from evaluations of other projects, specifically the information on the social and cultural impacts that result from the installation of a renewable energy system. She listed a series of questions that must be asked about any project: who controls? who owns? who pays? who benefits? Dr. Tinker stressed that the identification of "who" in these instances must be disaggregated by sex and age as well as by economic class or geographical position. There may be multiple beneficiaries or losers. A reforestation project might control erosion and reduce floods in the plains while aiding local villagers with new wood sources. The weight given to the replies of these questions are influenced by the values and preconceptions of the decision maker about development, environment, efficiency, labor force participation, and world views.

5.3 INFORMAL TALKS

Informal presentations were given by the six members from developing countries, specifically Egypt, the Philippines, Sudan, India, Mexico, and Barbados. These members discussed their experiences in developing a renewable energy program and implementing field projects with solar devices. These talks served as informative case studies demonstrating the problems encountered in introducing renewable energy in the developing world. They also put the workshop's central focus in a broader development context.

Charles Berberich of the SERI International Programs Division gave a brief presentation on the Solar Energy Information Data Base (SEIDB) and how to use it. SEIDB has one subcomponent, ICON, that collects, catalogs, and makes information available to other organizations about international renewable energy projects, researchers, and manufacturers. The description of SERI's data system provided an example of how a sophisticated information system can assist in any international data collection and exchange effort.

5.4 DISCUSSIONS DURING THE WORKSHOP PLENARY SESSIONS

Discussion involving all attendees occurred throughout the meeting, giving members an opportunity to express and exchange views on important issues relating to renewable energy projects in developing countries and to information collection and exchange on these projects. Many comments were aimed at keeping the workshop effort relevant to the needs of renewable energy program managers in developing countries. The comments most often expressed were:

- The type of renewable energy project being considered must be defined when identifying important project information; data that is relevant to experimental projects and applications is very different from the information that is important to a proven technology.
- The societal values and the cultural adaptation to a new energy source will vary extensively. Consequently, to identify exchange data, the workshop must distinguish what information from other projects is relevant to other societies and environments and what reflects such site-specific conditions that they may not be useful to other locations.
- The collection of too much information without knowing who will use it or why it is needed should be avoided.

5.5 THE SMALL WORKING GROUPS

The small working groups were the key to producing the workshop's final consensus. The groups were small enough to solicit participation from each member, drawing on his or her information needs and experience. Because of the cooperative attitude and spirited debate among the participants, the groups were able to assemble comprehensive information that they felt reflected not only their own needs but also those of the whole international development community.

There were three small working groups, each of 8-10 members. The groups met twice, each time with a specific task. The first session was charged with identifying the specific information needed by a renewable energy project planner. The task was to list all the information a planner would like to have from other organizations when designing a renewable energy project. The groups were asked to identify information elements in five categories: Economic, Technical Data/Resource Base, Social and Cultural, Institutional, and Environmental. The purpose was to develop a master list from which the workshop could extract the top priority items considered essential for information exchange.

The first session identified a number of items useful for planning. By having three separate groups work on the same task, three lists were produced making it possible to see what similarities and differences existed. Much of the data was mentioned by all three groups in slightly varying forms. These lists have been consolidated into one that reflects the preferences of all the working groups. The combined list and accompanying comments are presented in Table 5-1 and Section 6.1, respectively.

Table 5-1. GENERAL PLANNING ELEMENTS: CONSENSUS OF WORKSHOP

ECONOMIC

Market Price of Currently Available Fuels to Consumer (both fossil and renewable sources)
- role of private sector in energy delivery
- available disposable income for energy

Capital Costs[a] (include foreign exchange percentage for each component)
- equipment and materials
- installation and labor
- engineering
- financing costs
- cost of energy delivery to final user

Operating Costs
- operation
- training
- maintenance
- monitoring of performance

Existing Government Incentives and Taxes

Benefits from Project
- value of energy produced, measured by most economical alternative

Indirect Effects
- employment and local income generated
- import substitution
- market provided for local industries
- costs of not doing the project (environmental degradation, etc.)

TECHNICAL FACTORS

Local Need for Energy
- quality and quantity of energy required
- time, duration, and seasonality of energy need

Resource Base
- inventory of local physical resources available for renewable energy use
- inventory of human and animal energy resources available
- availability of local materials for construction

Technical Readiness and Commercial Availability of the System

Existing Energy Resources and Technologies

[a]More important for demonstration and commercialization projects than for experimental R&D installations.

Table 5-1. GENERAL PLANNING ELEMENTS: CONSENSUS OF WORKSHOP
(continued)

System Output (versus resource availability in each case)
- type and quality of energy produced
- temporal pattern of output
- seasonal pattern of output
- availability of output (system reliability)

Maintenance and Repair
- skills required for operation, maintenance, and management
- local materials
- spare parts required

Lifetime of System
- degradation of components/materials

Optimization of System
- changes made to system
- local adaptations required
- additional research and development required

SOCIAL/CULTURAL FACTORS

Patterns Prior to System Introduction
- energy use
- energy materials collection

Effects of Project on:
- beneficiaries/losers
- family structure
- traditional roles/power structure
- migration/settlement patterns
- employment
- income distribution
- quality of life
- productivity

Local Receptivity to Innovation and Change
- compatibility or lack of compatibility of project with cultural patterns
- replacing existing system or introducing new supply

Community Participation in Planning, Operation, and Maintenance

INSTITUTIONAL FACTORS

Existing Decision-Making Organizations and Management Capability
- decision-making in village/household
- outreach/regulation from government to village
- communication/representation from village to government

Table 5-1. GENERAL PLANNING ELEMENTS: CONSENSUS OF WORKSHOP
(concluded)

Existing Support Infrastructure
- extension and education organizations
- skill training facilities
- repair and service facilities
- transport and communications facilities
- financing mechanisms
- availability of competent management services

Patterns of Ownership of Local Facilities

Institutional Linkage between Energy and Other Sectors
- agriculture
- transport
- health and education
- other development goals

ENVIRONMENTAL

Impacts of Previous Energy Consumption Patterns
- water quality and availability
- air quality
- soil quality
- other natural resources

Direct Impacts of Renewable Energy Technology Operation
- by-products produced
- land taken out of production

Indirect Impacts of System Operation
- displacement of other fuel sources
- increase in total economic production

Once the first working session had demonstrated that the members could agree on certain planning elements, the next session was devoted to determining what elements would be particularly instructive to other organizations in different locations. The experience of the first session indicated the need to be specific about the planned project. Participants agreed that it was more productive to think about information required for a particular renewable energy technology and application than for projects in general. Consequently, the task for the second session was narrower in scope. Participants were asked to identify information that they would like to receive from other projects. Two of the groups were assigned a single technology application, one examining fuelwood stoves for cooking and the other identifying information on small photovoltaic systems to power water pumps. The third group was asked to look at biogas generators for all applications. These three technology and application combinations were selected partly because they represented different types of projects. The photovoltaic pumping system was selected as an experimental project, while the fuelwood stove was identified as a technology requiring widespread distribution and diffusion effort. The biogas generator was considered to be in the demonstration and technology modification stage, in between the other two stages.

The purpose of this session was to determine:

- whether the groups could reach a consensus on what planning data would be useful to receive from other organizations;
- how different the information needs are for these three technologies; and
- whether each group could agree on the next steps required for collecting and exchanging international information.

To accomplish this last purpose, the groups were asked to make resolutions for the whole workshop considering future actions needed for information exchange.

SECTION 6.0

OUTCOMES OF THE WORKSHOP

6.1 SPECIFIC DATA FOR PLANNING

As mentioned in Section 5.5, the small working groups met for several hours to discuss what data would be useful to receive from other organizations in the planning of a project. The individual group reports are presented in Appendix C, to allow the reader the opportunity to examine the suggestions and approaches taken by the different groups. Table 5-1, consolidates and reorganizes the working group data lists. Common elements were selected, as well as items that were later raised in the plenary discussions and felt to be important by the participants.

6.2 SPECIFIC DATA FOR SELECTED APPLICATIONS OF SINGLE TECHNOLOGIES

In the second set of small meetings, data were developed for particular applications of individual technologies. The complete recommendations are contained in Appendix D. In Table 6-1, data are compiled and placed in a common format, so that the reader can cross-reference the technologies. While some nuances of the rank ordering of the data are lost in this presentation, it does ease the task of isolating the items considered important.

6.3 CROSSCUTTING DATA CATEGORIES

There was substantial agreement on the data developed by the working groups for the individual technologies (Table 6-1), even though these items were developed independently and specific to a single application. The consensus was strongest in the technical and economic sections, with less agreement on the sociocultural, institutional, and environmental elements. There was some disagreement on the relative importance of the categories within a project; i.e, is it more important to have data on economic and technical factors or on sociocultural and institutional responses? An outline of the consensus follows with points where the groups place different priorities on data elements noted.

Technical: All the groups agreed on the importance of information on the design specifications and material components of the equipment installed, along with detailed information on the actual system output and durability versus its rated or expected energy production and durability. All requested specific details on downtime due to routine maintenance requirements or system failures. This information was considered crucial, since it told the planner how reliable the system is in actual field installations, and, therefore, how likely it would be accepted as an energy source. It also provides information on what portions of the system need to be modified to increase reliability and lower the maintenance requirements.

Among the groups there was considerable variation in the technical information required. For demonstration/diffusion projects, such as the fuelwood stoves, major attention was placed on simplicity of maintenance and operation, although this was judged to be less central for the more experimental photovoltaic-powered pumping system.

Table 6-1. FINDINGS OF CASE STUDIES PERFORMED BY WORKING GROUPS

	Group #1	Group #2	Group #3	Consensus
Technology:	Photovoltaics	Fuelwood Stoves	Biogas Generator	
Applications:	Small-Scale Water Pumping	Cooking	All Applications	
Type of Project:	Experimental	Demonstration/Diffusion	Technology Modification	
Categories	**Major Criteria**			
Technical	Site Data - insolation - pumping lift - extraordinary costs System Configuration Operation and Maintenance of Pump and Array System Output/Durability - Actual vs. Rated	Design Specifications Tolerances Required by Design Material Components Flexibility of Fuel Sources Energy Efficiency Simplicity of Installation and Maintenance Maintenance Requirements Reliability Safety	Design of Digester/Gasholder Construction Materials for Digester/Gasholder Biomethanation Process Characteristics of Change - water content - toxic components - carbon/nitrogen - volatile solids Temperature Retention time Gas Production rates Maintenance and cleaning System Downtime	Design Specifications Construction Materials Resource Base/Inputs Output of System Installation and Maintenance - actual vs. expected System Reliability - downtime-actual vs. expected
Economic	Operator/Maintenance Training Costs Capital Costs - equipment - engineering - financing Backup System	Operation & Maintenance Costs Cost of Fuelwood Saved Social Costs/Benefits	Equipment/Materials Labor Operation & Maintenance Value of By-products Value of Fuel Displaced Social Benefits/Costs - increased agricultural production	Operation/Maintenance Capital Costs - equipment Labor/Training Social Costs/Benefits Value of Fuels Displaced
Sociocultural	Impacts - migration/settlement - employment generated - inside vs. outside income generated Beneficiaries/losers - equity of distribution	Beneficiaries Impacts on - income - employment - time required to gather fuel	Beneficiaries/Losers - sex/age - class status Changes in Health/Sanitation Perception of Utility	Beneficiaries/Losers Identification of Specific Impacts - income - employment - time required
Institutional	Support Provided by National, Regional, and Local Organizations Project Management	Needs for Education or Extension Service. Local Skills & Fabrication Potential	Institution in Charge Location of Expertise in R&D and Extension Supply of Materials/Equipment Village Organization Source of Financing	Support Available from Local Organizations Education and Extension Services Local Sources of Skills, Materials, and Fabrication
Environmental	Land Use/Availability	Impact on Deforestation	Reduction of Deforestation Reduction of Pollution Pollution from Pit Run-off	Effects on resources and Land Use

Economic: All three groups placed great emphasis on the operating and maintenance costs of the renewable energy system they were examining. In the case of photovoltaic pumping systems, its experimental nature meant that project managers considered the capital costs secondary to operating expenses, since the large front-end costs were due to the one-time fabrication of the array and assembly. These costs presumably would drop with mass production and system simplification. Conversely, the fuelwood stove group was concerned with O&M costs because the technology was considered already cost-effective. The widespread diffusion is slowed only by uncertainty about the system reliability, cost of maintenance (versus current cooking systems), and demands on the operator. All were concerned about labor costs, partly because employment-generation and training are objectives of many development programs and partly because the availability of skilled manpower is seen as a possible major constraint, requiring large initial investments in training.

All groups agreed on the need to assess the economic benefits as well as cost comparison, but recognized that quantitative calculations could prove difficult. How to value the displaced fuel (and other goods such as fossil-fuel-based fertilizer) was seen as a central economic element.

Sociocultural: All agreed on two elements that they wanted complete information: the beneficiaries and losers of a particular technology and the specific impacts on the demographics, welfare, and employment pattern of the village where the renewable energy system was installed.

Institutional: The key agreements were the need for information on project support provided by local, regional, and national organizations, as well as extension and educational services available for demonstrating the technology, training the operators and maintenance workers, and making field adaptations. There was considerable unanimity on the need for information on what supplies, materials, and fabricating skills, are available locally, since these were seen as essential elements for manufacturing and maintaining systems.

Environmental: There was only moderate agreement on what environmental information is required. The photovoltaics panel found few major environmental problems or constraints for a small system (1-kW). The other groups found environmental considerations important because problems caused by the fuels displaced or in demand, such as firewood and agricultural residues, are reduced.

6.4 ISSUES RAISED BY THE WORKING GROUPS

Each working group confronted a number of issues in preparing data for the individual technologies. These issues need to be resolved before final data can be developed for interorganizational exchange.

6.4.1 Extremely Site-Specific Data

While identifying data that would be useful to receive from other organizations, several groups noted that data that describe a project would not be useful. When information describes an extremely site-specific condition, it cannot be accurately interpreted by the recipients, unless the complete background of the site is known.

6.4.2 The Proper Level of Detail

The working groups debated the level of detail that should be specified for each element. One group felt that if a request was too specific, it might not indicate all the factors relevent to the success or failure of the project. Such a detailed request also might conflict with existing data collection efforts within each organization. Because each project has its own objectives and impacts, individual participants felt that it was difficult to establish detailed reporting requirements that would cover all goals and project outcomes. Some working groups felt it would be more productive to request general data such as the general topic headings given in Tables 5-1 and 6-1 as well as the overall project objectives and data on the social and cultural impacts.

6.4.3 Feasibility of Data Collection

The working groups addressed the issue of how feasible it would be to collect the useful data identified in the tables. During the course of the workshop, the groups did not have sufficient time to discuss the cost and feasibility of collecting each element, but they did emphasize that the issues of cost and collection must be investigated further before a successful universal data collection and exchange system could be established. One group suggested that existing data collection efforts by development organizations be examined to determine what is gathered routinely and in what form. If certain information is not readily available, its value should be carefully weighed against the cost of instituting and continuing its collection.

6.4.4 Reliability of Data

Several groups emphasized that the data sources, collection methods, and special constraints on data collection should be included in each set of data. Without this information, it would be difficult to interpret and use the data in planning, sizing, and evaluating renewable energy systems.

6.5 RECOMMENDATIONS TO THE WORKSHOP FROM THE INDIVIDUAL WORKING GROUPS

After specifying appropriate items for exchange on a particular technology, each group discussed and developed resolutions and recommendations for the plenary session. Some of these are reproduced in Appendix D, while others were given in the final plenary group discussions. The groups agreed that common elements could and should be established as the basis for standardization of information collection and exchange among organizations.

During the process of preparing the data for general planning needs and projects involving a single technology, the groups found that data for a specific technology need to be identified individually by a group more technically oriented than the participants at this workshop. One group formulated a recommendation to this effect:

> That in the future, small meetings of experts will be held on a specific technology. In these meetings, the experts will bring information on projects they are handling on the specific technology presented in the categories of information recommended in this workshop and, based on their

findings, refine these categories of information which they deemed necessary in evaluating a project on the specific technology. It is important that the participant of these meetings will eventually be the user of the information involved.

Another group concluded that an essential next step was the preparation of one or more handbooks detailing the common data that organizations should collect and exchange. The handbook would not only guide development organizations in information collection and technology performance and project outcome but ensure consistant data collection among the organizations participating in information exchange. For the handbook to be useful, it must be geared to the staff who will use it. Therefore, the group recommended that the handbook "be reviewed by a workshop or review committee of development planners/development organizations." The group also suggested that the handbook be organized by end uses and cover a range of technologies.

The third group made a recommendation that general information be the basis for (1) requesting information on other organization's projects, and (2) collecting data on an organization's own projects. In addition to collecting common items, this group also proposed establishing an information exchange. The group encouraged the workshop plenary to resolve that "a system should be set up to facilitate the exchange of certain information on project results among organizations which run renewable energy projects in developing countries." By this strong resolution, the group demonstrated its support for vigorous action to initiate and implement information exchange.

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SECTION 7.0

FINDINGS AND RECOMMENDATIONS

7.1 GENERAL FINDINGS

- The collection of common sets of information elements on renewable energy projects is both valuable and feasible. Further steps should be taken to develop common elements based on the initial categories and approaches developed at this working session.
- The development of information categories would speed the exchange of information among development organizations, researchers, and project field managers.
- Information is most useful when it is specific to a particular technology (although some information may be common to all systems). Data possibly should be divided further according to each application of each technology, but this can only be determined after several attempts at developing individual data and after the data have been reviewed by potential users.

7.2 RECOMMENDATIONS FOR FURTHER ACTION

The information developed at this workshop should be refined immediately. After detailed data for each technology have been developed, they should be reviewed by experts familiar with data collection, by practitioners familiar with the particular technology, and by program managers who would be the ultimate data users. Some mechanism such as an international workshop or task force should be established to review the information after their refinement to ensure that it is the most useful to collect and exchange. The level of specificity and the form of the data collected would also be reviewed by the task force.

A system for information exchange should be established. To do this, several issues need to be resolved including what type of organization is needed and what type of collection and dissemination system would be most accessible. Existing data centers should be consulted to find the best method for implementing such an international information exchange. Also, the tasks possibly could be coordinated or divided by either technology or application among the existing centers.

As development organizations agree on the advantage of collecting specific data on renewable energy projects, one or more technology-specific (and perhaps application-specific) handbooks should be prepared demonstrating how to collect data. These should be written for project planners, managers, and data collection staff. Each handbook would show how to collect information from field projects in the data categories that development organizations have determined are worthwhile. The handbook would improve the monitoring and evaluation of renewable energy projects as well as provide a method for collecting fairly consistant data in an understandable and helpful form. The drafting of these handbooks could be completed by late 1980, by one donor organization or individuals drawn from cooperating organizations. This effort should be coordinated with those of the technical panels of the 1981 U.N. Conference on New and Renewable Sources of Energy.

There is an immediate need to catalog all the centers in developing and developed countries that are currently collecting data on renewable energy systems. This would allow these centers to be involved from the outset in the development and review of common data.

When the organizations developing the data and exchange systems have examined the alternatives, they could report their suggestions to an international forum, which would then make the final decision on what mechanisms to adopt. The 1981 U.N. conference was suggested as that forum. These efforts on developing common elements and exchange mechanisms can be coordinated with the preparation for the conference.

SECTION 8.0

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4. John Ashworth and Jean Neuendorffer, SERI; 13 December 1979; Letter of invitation to workshop participants.

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APPENDIX A

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APPENDIX B

AGENDA FOR THE WORKSHOP

SERI

20-22 February 1980

WEDNESDAY, February 20

8:00-8:30 Arrival at SERI by shuttle from Holiday Inn West

8:30-9:00 Registration for the workshop, Building 10, Room 4B.

Session One: Workshop Introduction and Overview

9:00-9:30 Welcome to SERI: George Warfield and Denis Hayes

9:30-10:00 Background to the convening of the workshop: Stephen Klein, AID

10:00-10:30 Review of the agenda: Irene Tinker, moderator

10:30-10:45 Coffee break

10:45-11:15 Overview of the role of information and evaluation in the project cycle: Alan Roth

11:15-11:30 Discussion among participants

11:30-12:30 Lunch

12:30-1:30 Presentations on renewable energy programs by the attendees from developing countries

Session Two: Information for Planning

1:30-2:00 The Types of Information Required for Project Selection and Development: George Burrill

2:00-2:30 Matching Renewable Energy Technologies with Needs for Energy: John Ashworth and Jean Neuendorffer

2:30-4:00 Small working group, first session:
The groups convened to specify the information that would be useful for planning a renewable energy project. Group leaders were:

- Group A: Jean Neuendorffer and George Burrill
- Group B: John Ashworth and Glenn Brandvold
- Group C: Alan Roth and Irene Tinker

4:00-5:00 Reconvene as plenary group to review the results of the small working groups

THURSDAY, February 21

Session Three: Monitoring and Evaluation
Building 10, Room 4B

9:15-9:45	The important elements of technical monitoring of a renewable energy system's performance: Glenn Brandvold
9:45-10:45	The social and cultural factors on which data should be collected to determine local adoption: Irene Tinker
10:45-11:00	Coffee break
11:00-5:00	Small working group, second session: The groups were asked to: Specify what data would be most useful to receive from other organizations. Prepare a resolution for the whole workshop on the issue of information collection and exchange for renewable energy projects.
12:30-1:30	Lunch, with presentation from and discussions with SERI International Programs Division.

FRIDAY, February 22

8:35-9:15	Report of the working groups
9:15-12:30	Discussion of these reports and consideration of resolutions
12:30	Closing of workshop

APPENDIX C

FIRST SESSION
WORKING GROUP CRITERIA
FOR PLANNING RENEWABLE ENERGY PROJECTS

SERI

OBJECTIVES

ECONOMIC

TECHNICAL

SOCIOECONOMIC/CULTURAL

INSTITUTIONS—DELIVERY SYSTEMS

ENVIRONMENTAL

GROUP A

INSTITUTIONS

1. Current structure of institutions
2. Informal decision-making system at village/household level
3. Lines of communication from the village to national level
4. Lines of authority from national down to village level
5. Level of competence (and distribution)

ECONOMIC

1. Import policy of government
2. Taxes/subsidies
3. Role of private industry
4. Incentives
5. Labor capacity/potential
6. Potential employment effects
7. Perception of risk avoidance
8. Transport and communications infrastructures
9. Economies of scale
10. Existing energy resources
11. Available local financial resources

SOCIOCULTURAL

1. Perception of change in social-welfare of local population (other projects)

2. Subpopulation groups:
   a. economic class
   b. male/female
   c. religious

TECHNOLOGY

1. Origin of materials and expertise

2. Need for technical R&D

3. Need for adaptation

4. Technological base of country

5. Existing energy resources

ENIRONMENTAL

1. Potential indirect environmental effects (e.g., from industrial process)

2. Direct byproducts of energy generation/use (effluent from ethanol)

GROUP B

ECONOMIC

1. Economic costs comparable to conventional energy sources

2. Affordability

3. Direct economic costs (with special consideration to experimental projects)
   a. foreign exchange component
   b. local costs

   Capital Cost
   a. equipment and materials
   b. engineering
   c. installation/labor
   d. financing

4. Operating Costs—more important demonstration/experimentation
   a. maintenance/labor materials/local currency for exchange
   b. operating
   c. training

5. Projection of long-range costs

6. Instrumentation

7. Monitoring/evaluation

8. Cost of delivered energy

ECO-BENEFITS

1. Value of energy used from system
   a. opportunity cost (not subsidized) for most economic form of energy
   b. foreign exchange component

2. Import substitution

3. Intangibles
   a. providing market for domestic industries
   b. income generation
   c. employment generation

TECHNICAL

1. Energy Needs
   a. inventory of current desired needs
   b. quality of energy required
   c. quantity of energy required
   d. what needs will be served/addressed

2. Resource inventory
   a. animate
   b. inanimate
      (1) renewable
      (2) nonrenewable

3. Identification of technology/system
   a. type of energy produced
   b. quality of energy
   c. temporal pattern of output
   d. seasonality of output

4. Technical readiness and commercial availability

5. Availability of output—percentage of time

6. Optimization of system

SOCIAL/CULTURAL

1. Replace existing system or supply new to users

2. Compatibility with cultural patterns (social resiliency to innovation)

3. Level of impact
   a. family structure
   b. migration/mobility
   c. productivity
   d. traditional roles—village power structure
   e. equity—class structure
   f. education impacts
   g. demographic effects
   h. health services/hygiene

4. Barriers to acceptance

5. Community participation in planning, technology maintenance, and operation

6. Dependence on "outside" factors, self-reliance

7. Effects on community decision methods

INSTITUTIONAL FACTORS

1. Arrangements needed to implement:
   a. extension system
   b. local organization
   c. materials/parts availability
   d. support/service facilities

2. Allocation/distribution policies

3. Financing/credit availability

4. Type of ownership
   a. private
   b. community

5. Controls and regulations
   a. subsidies and incentives
   b. disincentives—i.e., sellback
   c. local/national control/interaction

6. Linkages with other sectors and impacts security
   a. agriculture
   b. transportation
   c. health
   d. education

GROUP C

ECONOMIC

1. Market prices of present energy sources (price to consumer)

2. Social costs
   a. doing project; e.g., alternative (land use)
   b. not doing project

3. Social benefits

4. Foreign exchange requirements and balance of payments implications

5. Available disposable cash income willingness/ability to pay (penny capitalism)

6. Capital requirements (feasibility-credit)

7. Operation and maintenance costs

8. Resource data

TECHNICAL PERFORMANCE

1. Lifetime of equipment

2. Maintenance and repair and management needs

3. Skill requirements

4. Spare parts

5. Reliability

6. Energy output/input
   a. form
   b. amount

7. Use, availability of local materials
   a. construction of equipment
   b. installation

SOCIAL AND CULTURAL

1. Present energy use pattern

2. Present energy collection pattern

3. Beneficiaries/losers/nonusers
   a. social group
   b. sex group
   c. economic group
   d. ethnic group

4. Impact on traditional roles

5. Employment effects

6. Income distribution effects
7. Level of resistance
8. Power structure, local level
9. How does it fit into large development goals

INSTITUTIONAL/INFRASTRUCTURE

1. Extension/education
2. Existing institutions
3. Government role
4. Facilities for transport and communication
5. Population size
6. Leadership/management capability
7. Approaches/biases/objectives of donor agency and host government
8. Existing mechanisms for energy institutions
9. Training structure

ENVIRONMENTAL

1. Environmental impacts that should be identified; i.e., negative/positive impacts on
   a. water
   b. land
   c. air
   d. other natural resources.

APPENDIX D

SECOND SESSION
DATA FROM OTHER ORGANIZATIONS

D.1 CHARGE TO THE WORKING GROUPS

As a result of comments from a variety of participants about yesterday's discussion, we identified a few key points

- people wanted to move into producing the product for the workshop;
- group discussions were meaningful and productive; and
- groups needed a greater focus for their work, specifically clarifying the type of projects they were addressing.

We now plan to move along and look at evaluation and the product we hope to achieve. The objectives described yesterday are:

- whether it is possible to establish a common set of evaluation criteria; and
- what a first cut of minimum, shareable criteria might be.

We will break up into groups again, and give each group a specific activity to work through in response to the need for clarification.

Each group will consider a different technology at a different stage of development. The assignments are:

Group A: Fuelwood stoves (Jean and George)

Group B: PV-powered water pumps (John and Glenn)

Group C: Biogas (Alan and Irene)

We are assuming that these activities have been financed through the best possible project planning and design criteria in full consonance with a national plan.

The groups will then look at the evaluation criteria for the project they have been given and assume that they are considering building a similar project and want feedback on how the existing project has worked.

This approach assumes the technology was matched and appropriate in the minds of the planners. The individual groups will want to evaluate that assumption as well. We believe that using three groups each with a specific activity will help focus the discussion on whatever common evaluation criteria the group might recommend.

The steering committee spent some time considering how to structure this session. Much of that time was spent deciding whether the group should be given this narrow charge as a focusing mechanism, or a broader one looking at end use. By giving the group a narrow charge, we believe the groups will have to work through the evaluation criteria to concretely test and address the objectives of the workshop.

Tomorrow we are asking the groups to report on the following:

- their judgment as to whether it is possible to establish common evaluation criteria that are useful;
- if so, what those would be; and
- comments on the philosophical problems, if any, your group had in working through the evaluation criteria in this way.

The group products will be extremely valuable for Friday's discussion when we look at common threads that have emerged and the problems and major conclusions of their discussions.

If the groups have time it would be interesting to compare the evaluation criteria the groups have come up with against the planning criteria the groups produced on Wednesday. We may also get a clearer idea of whether there is a difference in the criteria one would use to plan, monitor, or evaluate a specific project, a point that has engendered a great deal of discussion.

RESOLUTIONS FOR FOLLOW-UP TO THE CURRENT WORKSHOP

In addition, please draft, for the use of the plenary group on Friday morning, any recommendations that the working group as a whole might have on the steps required for the promotion of common information criteria, data collection, and exchange. If these are to be meetings, please indicate who should attend (the types of individuals and organizations), when and where it should be held, and under whose auspices. Any suggestions on the expected output of such follow-up activities would also be useful.

D.2 RECOMMENDATIONS FOR PARTICULAR TECHNOLOGIES AND APPLICATIONS

D.2.1 Group A: Case Study on Woodstoves

Assumptions About the Project

1. End Use: woodstoves would be used for residential, family use primarily for cooking.

2. Motivation for the project:
   a. deforestation, erosion, and cropland loss,
   b. distance villagers have to walk to gather wood, and
   c. increased price of wood in urban areas because of wood scarcity.

3. Project Design:

Step One: Test four prototype woodstoves in several sites.

Step Two: Choose the best prototype, adapt it to local environments, place it in local villages, and evaluate the project.

Before planning both steps of the project, we identified many questions which we would like answered.

After we listed all these information questions, we determined which ones could usefully be answered from the evaluation of other woodstove projects. We found that some information from other projects would not be helpful to use because it was too dependent on site-specific characteristics and could not be meaningfully interpreted for our own project planning needs.

The questions we specified as helpful to planning are listed in these categories:

- technical
- socioeconomic
- institutions/delivery systems
- environmental

Under these categories, we have listed:

- information helpful to receive about other woodstove projects, with xx, more important; x, less important; and
- information needed for our planning collected internally.

Information and evaluation issues and questions:

TECHNICAL

xx A. Complete design specifications and drawings

xx B. Energy efficiency of stoves

xx C. Material components and durability profiles

xx D. Maintenance requirements

xx E. Flexibility of fuel source and size

xx F. Complexity or simplicity of installation and maintenance

xx G. Reliability of stoves

xx H. Design tolerances

xx I. Safety performance

xx J. Impact on energy use patterns

K. Adaptability to foods, practices, and utensils currently used

L. Environmental impact of stove and its use

M. Energy sources
(1) Alternative uses
(2) Availability, price, and labor
(3) Method of obtaining and who obtains them
(4) Alternative sources
(5) Environmental impacts of using current or other sources

N. Relationship of project to energy and development plans and goals.

SOCIOECONOMIC

xx A. Social costs and benefits

xx B. Operations and maintenance costs

xx C. Amount of wood as other fuel saved

x D. Impact on employment

x E. Impact on income

xx F. Impact on time use

x G. Impact on effort

xx H. Identified beneficiaries

x I. Local institutional structures/social

J. Cost of stove materials and construction

K. Ability and willingness to pay

L. Opportunity costs

M. Foreign exchange costs

N. Impact on nutrition and health

O. Cooling habits and utensils

P. Auxilliary effects of cooking practices

INSTITUTIONS/DELIVERY SYSTEMS

xx A. Needs for educational program or extension

xx B. Local skill and material availability—local fabrication potential

x C. Local institutional structure/government

D. Institutional supports and barriers—national and local

ENVIRONMENTAL

x A. Impact on deforestations

B. Environmental impact of stove and its use

OVERALL

xx A. What the objectives of the other projects are

Conclusion on Specific Data Elements

Having identified the questions that we would like answered about other projects, we decided it was not useful to designate more specific data for these information questions for several reasons:

- Because other projects will have their own objectives and site-specific conditions, it is difficult for us to specify what the most relevent detailed data is for those projects.
- We are not equipped at this time to assemble a reliable and accurate set of technical performance information items that could apply to all types of systems. This task should be handled elsewhere by technical experts.
- If we request too narrow a list of data from other organizations, they may not send us all the information that they would have included if given a more general request.
- From the information questions assembled, we feel that other organizations would have adequate and appropriate guidelines as to what their project evaluations should include and what information we are interested in.

Based on these reasons, we have decided that our list of information questions reflects the best level of specificity for requesting information about other organizations' projects.

Conclusion on the Feasibility of Collecting This Information

We feel that information in the form that we have requested is feasible for most other organizations to provide, based on their project evaluations. If it is not feasible for some organizations to compile and disseminate, then we obviously will not receive them. However, we feel these information questions are a reasonable vehicle for informing other organizations of what we would like to know.

RESOLUTIONS FOR CONSIDERATION

1. The information questions listed as most useful to receive from other organizations are at the correct level of specificity.

   If the plenary group agrees with Resolution 1, then:

2. The plenary group agrees to use this type of general information items as the basis for:
   a. requesting information on other projects, and
   b. collecting data on and evaluating their own projects.

3. A system should be set up to facilitate the exchange of certain information on project results among organizations that run renewable energy projects in developing countries.

D.2.2 Group B: Case Study on a PV-Powered Irrigation Pumping System

Assumptions and Premises

This is to be a small-sized photovoltaic-powered water pump. We have chosen to exclude agricultural benefits/costs (crop production and preparation, fertilizer). We are treating it as an experimental project, which increases the amount of information required and alters the emphasis among elements. This is designed to compare it to other irrigation pumping power sources.

In each case where we have looked at previous installations, we will assume each piece of information will be examined in two forms:

- the expected output, performance, cost, etc.
- the actual output, performance, cost, etc.

Planners Needs—General Questions on Previous Projects

- Does it fit the national plan of the country?

- How much did it cost?
- How did it perform?
- What were the problems encountered and how were they resolved?
- What were its impacts—economic, social, cultural, etc.?

Specific Data Required from Previous Projects Using Photovoltaic-Powered Pumps

I. Site Data

A. Major Information Needs

1. Physical data (insolation—direct/diffuse)

2. Pumping lift

3. Extraordinary costs (accessibility)

B. Secondary Information Needs

1. Environmental hazards
   a. wind loading
   b. dust pollution/degradation
   c. sandstorm degradation
   d. safety/security of system

2. Ambient conditions (predicted/actual)

C. Other Information Needs (soil conditions)

II. Technical Considerations

A. Major Information Needs—General

1. System configuration
   a. type of pump
   b. type of array

2. System output/durability
   a. water output/use per unit of time
   b. number of days/year above minimal amount
   c. expected lifetime

B. Major Information Needs—Specific

1. Components—for each the planner needs performance vs. rated capacity, durability, and maintenance (planned vs. actual)

2. Operation and maintenance of pump and array
   a. operator requirements

b. repair parts
c. maintenance

C. Secondary Information Needs

1. Components
   a. power conditioning
   b. controls
   c. storage

2. Operation/maintenance for all components except pump and array

III. Economic Considerations

A. Major Information Needs—General

1. Cost of delivery conventional energy at the site—projected vs. actual

2. Projected life cycle cost of delivered and used renewable energy at the site—projected vs. actual

B. Major Information Needs-Specific

1. Operating/maintenance
   a. maintenance
   b. labor
   c. operating expenses (includes downtime, but subtracts exceptional start-up costs)
   d. training

2. Loading factor rate of utilization for pumping only (includes separate calculation for multiple uses of electricity in off-season)

C. Secondary Information Needs

1. Capital costs—all include data on the foreign exchange component
   a. equipment and materials
   b. engineering (minus exceptional one-time costs and instrumentation)
   c. financing procedures
   d. installation costs
   e. construction time delays (including reasons)

2. Backup system
   a. cost
   b. operating time

IV. Institutional

A. Major Information Needs—General

1. Support provided by national, regional, and local organizations

2. Project management

3. Allocation of outputs/benefits

C. Secondary Information Needs

1. Linkages with other sectors

2. Performances of outside experts/donors/consultants

3. Bottlenecks

4. Role of local industry/materials

5. Public vs. private ownership

6. Involvement of locals vs. outside influence

V. Social/Cultural

A. Major Information Needs—General (social/cultural impacts [Were they the ones expected? Were there unexpected ones?])

B. Major Information Needs—Specific

1. Migration/settlement effects

2. Outside/inside income generated

3. Employment generation

4. Identification of beneficiaries/losers—equity of benefits distribution

C. Secondary Information Needed

1. Impact on decision-making structure

2. Life-style impacts/changes

D. Other Information Needs

1. Level of resistance/acceptance

2. Religious/social conflicts

VI. Environmental Assessment

B. Secondary Information Needs (land use/availability)

C. Other Information Needs

1. Noise, smell
2. Aesthetics/+ or -
3. Possible need for EIS

Issues for the Consideration of the Plenary Group

I. Establishment of Priorities—How Is It To Be Done?

II. Is There a Need for a Guidelines for Evaluating Renewable Energy Systems handbook?

   A. How Measured?

      1. Units
      2. Information collection methodology
      3. Frequency of measurement

   B. Do Planners/Industry/Donors Feel This a Useful Exercise?

   C. What Can We All Do Together?

   D. Is There a Need for a Follow-on Workshop?

   E. Can Some Organizations Prepare a Handbook on Cooking?

Working Group Proposal to the Plenary Session

There is a need for a development organization to create a detailed handbook for several applications of renewable energy systems. This could then be reviewed by a workshop or review committee of development planners/development organizations.

It might be useful to organize the analysis by end uses, including a range of technologies for each end use.

D.2.3 Group C: Case Study on a Biogas Digester

1. Is It Possible To Establish Categories Of Information Which Are Useful?

   YES — If everyone conducting a biogas project could codify certain minimum information within preestablished categories, it would be extremely useful, could be collected, and could easily be shared.

2. Information Needed From Other Projects

Institutional

Kind of institution in charge

Institutional location of technology R&D, technology, and extension

Supply of equipment and materials

Source of local/national financing

Organization at village

Formal and informal decision-making structure national to local

Technical

Output fluctuation over time

Characteristics of charge (feedstock)
water content
value
biodegradability

Fermentation process
temperature
retention time
batch or continuous

Construction materials of digester

Design of digester

Charge supply-flow characteristics

Frequency and duration of downtime and the reasons

Changes in design and operational strategy that have occurred during project and the reasons

What technical problems occurred?

Maintenance and cleaning requirements

Expected life

Economic

Cost of digester (energy supply system)

Cost of appliances

Cost of operation and maintenance

Cost of labor and materials

Cost of backup equipment

Cost of technical and management support

Subsidy and/or credit (if any)

Any fuel or fertilizer supply burden on poor

Value of by-products

Value of fuel replaced

Benefits on health, sanitation, etc.

Source of fabrication

Sociocultural

Who benefits/loses by:
sex/age
social strata

In terms of:
time/convenience
cost/income
health/sanitation
comfort
education
nutrition
population

Perceptions of utility of different kinds of use—changes over course of project.

Environmental

Reduction of deforestation (land cover)

Reduction of pollution

Improvement in ambient odors

Amount of pollution from pit run off (if any)

3. Minimum Information Needed From Other Projects

Institutional

Kind of institution in charge

Institutional location of technology R&D, technology, and extension

Technical

Characteristics of charge (feedstock)

Fermentation process

Construction materials for digester

Design of digester

Charge supply-flow characteristics

Frequency and duration of downtime and the reasons

What technical problems occurred?

Maintenance and cleaning requirements

Expected life

Economic

Cost of digester (energy supply system)

Subsidy and/or credit (if any)

Value of fuel replaced

Sociocultural

Who benefits/loses by:
sex/age
social strata

In terms of:
time/convenience
health/sanitation
nutrition

4. Feasibility Questions for Determining if Information Can Be Collected and Shared

Is the information site specific?

Is the information normally generated?

Should the information be generated?

Is it special information?

Are there reasons for not sharing information?

5. Definitional Comments

Our workshop felt that the term "evaluation" was better replaced with the phrase "to codify areas of information for assessment." Evaluation as a concept is often threatening and seldom done; thus, barring shared information on that concept might be self defeating.

6. Philosophical Comments

Useful areas of information for assessment are highly project specific. Priority information depends on objectives for the biogas digester. We assumed cooking fuel to households was the primary objective with equity as a goal. We noted that an objective of fuel substitution for kerosene would alter the priorities and, hence, the assessment.

The decision of a planner to select household units depends on amounts of local resources (perhaps even pigs) and technical infrastructure support. The extent of these factors will probably determine the socioeconomic class of beneficiaries.

A decision to consider larger size digesters, community or commercial, sets up different questions as to use, collection, beneficiaries, or technical need.

7. Recommendation

In the future, small meetings of experts should be held on a specific technology. In these meetings, experts will bring information on projects they are handling on a specific technology presented in the categories of information recommended in this workshop. Based on their findings, the categories of information that they deemed necessary in evaluating a project will be refined. It is important that the participants of these meetings will eventually be the user of the information involved.

APPENDIX E

PRESENTATIONS AT THE WORKSHOP

SERI

INFORMATION SYSTEMS FOR DECISION MAKING

Dr. Alan Roth

(Note: the following is a slightly edited transcript of an oral presentation. The visual aids used in that presentation have not been reproduced.)

I am speaking here today because of my background in information systems and decision making. I have not worked specifically on renewable energy projects in Third World countries, but I have worked on many rural development projects in Third World countries that had components associated with renewable energy.

To give you a little bit of background of my experience in the Third World, I originally worked as an economist and survey specialist going out into the villages, getting to know the farmers in various types of projects, and finding out what their conditions were and how the project might affect them. I then moved on to work as a consultant in planning and evaluation of projects. From there I started to work in the implementation of projects and also on the information systems required for implementation work and planning and evaluation. I have had experience as a decision maker, as a consultant on planning, implementation and evaluation, and as an information systems specialist. I have worked in South Asia, Southeast Asia, and East Central and West Africa. I have worked on many different types of projects; mainly rural development often related to agriculture, some health, and some women-in-development projects. Just recently I have been working on information systems concerning development and planning for the government of Indonesia.

Let me proceed with the subject of this discussion: information for decision making. As people who are responsible for development programs and projects, we look at information as being an input into decision making. The purpose for information in your work is to make decisions, and that often is overlooked: information is very often not well oriented to decision making. Information must fit decision-making needs and the decision-making structure.

When we are determining what information is needed, on thing we have to know is who will be making the decisions. We must be specific about "who." Most often I see projects in which consultants say "they" will need this and that. Well, who are "they"? Who needs this information? How do they make decisions? How do they use information when they make decisions? When we talk about "who" we are not just talking about titles and positions but specific people with very personal ideas about decision making and the role of information. Many information systems fail because little thought is given to the personalities that will be receiving the information.

Second, what information is needed? Again, we have a subject that is very often misunderstood. Most people who develop information systems think in terms of an ideal of what information is needed. The decision maker may have a very different view of what he needs. He may look at the idealized set of information and say "well, that's nice for the university to have, but I can't deal with it. It's too general and not relevant enough to what I need." What information is needed can also be misleading from the point of view of an institution. For example, consider the internal rate of return on a project. In this case, it is a number. An organization like the World Bank uses internal rate of return. In many projects, this information is required; so, people go out and calculate it using data that may not be reliable.

We are talking about the rational use of information—information that is useful for decision making. In one organization, you may need that particular information for a project to be approved: the internal rate of return must be at a certain level or it's a no-go. But for rational decision making, we need a number that means something to the decision maker in terms of the real merit and value of the project. Therefore, the information should be based on the best good data.

At this point, let me just refer to the distinction between data and information. Data are the raw numbers that come from the field. For example, a survey is undertaken: How many households do this and how many households do that could be the data that is processed. When the data is processed, you have information. Now, that information can be processed again to provide new information one step downstream. Along this stream of information, it is difficult to distinguish what is raw and what is a final product. But, what we want is information that a decision maker can use.

The next question is what will decision makers understand? You then determine who the decision maker is. If he is a project manager in Indonesia who works at the sub-district level and you give him a computer readout, it means nothing to him. Intermediates in the universities like to bring out numbers to show how sophisticated they are, and, I agree, it is impressive to see some of the things that they can do. But, unfortunately, the audience is a decision maker and that type of information is not appropriate. Thus, it is important how the information is presented and packaged, so that the person who is making the decisions will understand it.

Often voluminous reports come to a decision maker requiring him to go through the report and find out what information is beneficial to him. If he doesn't have time to do that, somebody else has to screen it first and then package the information specifically for that decision maker's needs.

The fourth question is when can the information be available? Very often we see work undertaken in projects to help the decision maker make better decisions, but the results arrive six months after the decisions had to be made. When do you have to make the decision? From there, you work back in terms of planning data collection. You analysis and do all that has to be done to get the information ready on time. How often do we fool ourselves into thinking the information is going to be ready in three months when it can't be. It is a very complex, laborious process and often overlooked. So we have to plan ahead and know when that information must be available.

Finally, we see if the decision maker can or will use the information. We are really going back to these other issues: what is the background of the decision maker, not only in terms of his needing certain types of information, but also the time he has available to analyze the information. You need to know how he likes to use information. Many decision makers use an intuitive process. They make decisions because something feels good, not because they've looked at all the information and have made a rational decision. We all make intuitive decisions some of the time, but some decision makers rely more on that than others.

There are many different levels of decision making. Very often when we are preparing information, we prepare it for someone in particular. Usually it is the office that is paying for the information to be developed and collected. So what you do with that information to gear it to the many necessary levels is important. You have to realize that many other people need that information. The people who are paying for it may have to compromise and have the information prepared so that it can be shared by others.

Sometimes the person paying for it wants a big report, and, yet, it may be unusable if we look at the many other users. Earlier it was mentioned that the farmers are important users of information. They make decisions. Information has to be presented in a very simple format for them. But some of the information may be used by national planners who feed it back to the farmers. Maybe the only thing the farmer wants to know on an agricultural project, for example, is whether other farmers are getting certain types of yield on certain types of crops. They are making a decision on planting a crop, and it is very helpful for them to know other results. What type of environments are similar environments? What are some of the economics? It may come from an information system that they should be privvy to.

Merchants and small industries involved in renewable energy projects are some of the people that are responsible for getting the technology out into the rural areas, and they have to make decisions on investments and level of resources.

Concerning level of resources necessary to collect information, a lot of information is available, but we don't think of some people as comparative users so we don't package that information for them, or see that they get it in a timely fashion.

Project managers usually are people that get information when they need it. It may be very different from that of program managers and national planners who like to see written reports and rely a lot on written information.

SERI

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PRELIMINARY

A PROCESS FOR MATCHING VILLAGE-LEVEL ENERGY NEEDS AND RENEWABLE ENERGY SYSTEMS

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SERI

SECTION 1.0

INTRODUCTION

In the past six years, the cost and availability of energy supplies have become the main factors in determining the direction and pace of economic and social development in the non-OPEC nations of the Third World. Spiraling prices of imported fossil fuels and the distribution systems for centralized electrical generation, along with increasing restrictions placed on nuclear power systems, have led development planners, international financial organizations, and foreign assistance agencies of industrial nations to examine the potential of small-scale, decentralized, renewable energy sources for meeting both immediate and long-range rural energy needs. A recent Solar Energy Research Institute (SERI) report (Ashworth 1979) has found that over $225 million currently is committed by foreign assistance organizations to the development, installation, field testing, adaptation, and manufacture of renewable energy systems in developing countries. In addition, many Third World nations have committed substantial amounts of their own internal development funds to the promotion of new indigenous sources of energy (Gall 1978; Ravenholt 1978).

Most of this current burst of activity in renewable energy systems has been undertaken on a project-by-project basis. The project planning and subsequent analysis normally has been restricted either to the field testing of a particular renewable energy system in one or more developing country locations or to an engineering feasibility study of one proposed system to meet the particular energy needs of a single site. What is missing is an overall analytic framework within which such field testing or specific feasibility studies can be conducted.

This report is a preliminary effort to provide an analytic context for the identification and development of specific projects. There are four major objectives:

- provide development planners and donor agencies with a set of characterization tools that, when applied to the energy needs in a particular location, will be readily compatible with information on the output of available energy systems;
- provide a current set of renewable energy technology alternatives for meeting a given rural energy need in a developing world setting;
- identify programs of basic and applied research, field-testing, and adaptation that may be required to improve the match between certain energy technologies and the characteristics of a particular rural need for energy; and
- identify areas where more information must be collected on the characteristics of either energy needs or of energy technologies in order to facilitate the choice of an appropriate technology.

Specifically, this report provides a process for the matching of energy needs with available energy technologies. The process is built upon two fundamental assertions, which are discussed at greater length in Section 2.1:

- the choice of an energy technology (or of any technology) must proceed from a careful identification of the basic needs of the final user and of the characteristics of those needs; and

- the match between the characteristics of each energy need and of the output of each energy option should be as perfect as possible, within the constraints imposed by the cost of the systems and by the ability to keep the energy systems in satisfactory operating condition.

Built around the presentation of a process model, this paper does not serve as a comprehensive handbook to instruct program managers on what technologies to select for a particular project. Rather, such selections are the result of the process described here, with the solution being unique for each location and for each set of energy users. A set of potential technology options, based on a limited number of important requirements for each basic need is presented. Before an appropriate match between energy systems and energy needs can be made for a specific location, a careful survey of the local energy needs should be performed, the characteristics of these needs determined, and the needs ranked in their order of priority by the villagers or local planning officials.

The concern here is not only with the identification of systems that technically can provide the required amount of energy but also with the factors that determine whether a particular technology will be adopted and supported by the local user. Throughout this paper, great emphasis is placed on the involvement of the final village energy consumer in each step of the process of matching the energy technology with the local energy needs. Although initially more costly and time consuming, such active participation by the local villager speeds the process of technology introduction and adaptation, as well as facilitates maintenance and training activities. It is necessary that this methodology be tested in several Third World locations to determine (1) if all of the criteria important for need characterization and technology selection have been included or (2) if certain of the criteria could be eliminated without affecting the matching process. It is only through such field tests that this process can be proven to be a general methodology that would be applicable to rural development projects in a wide variety of locations.

Section 2.0 presents the outline of a proposed five-step matching process, explaining briefly what information needs to be collected to complete each stage and how each phase will help the decision maker in his choice of energy technology. The presentation closes with a discussion of the pressures to abbreviate the technology selection process and the problems that may be generated by neglecting one or more steps.

Section 3.0 presents a generalized illustration of the needs/technology matching process. A set of seven basic human needs for energy are selected, along with seven renewable energy technologies that are potential sources for those needs. A joint set of 12 criteria is developed that characterizes each of the needs as well as each of the energy systems.

Published reports detailing energy demand in rural developing country settings, energy resource availability, and the performance of specific renewable energy technologies were used. Because no individual site or group of energy users has been identified, this illustration of need/technology matching only outlines the process in general terms, using a range of characteristics common to many developing country sites. However, when applied to a particular location, this process is designed to ensure the acquisition and interpretation of basic information, such as local availability of energy resources (solar insolation, wind regime, supply of flowing surface water, etc.), local energy need characteristics, and detailed engineering cost estimates. The data on local energy resources are particularly important for renewable energy systems, since their output is highly variable according to local weather and environmental conditions.

Cost information for renewable energy systems has been included mainly to illustrate its position as a key criterion in the matching process and to indicate the enormous range of costs possible within a given technology. The cost of delivered energy is determined by a wide range of conditions, including the sizing of the system, the amount of storage included, the transformation of energy from one form to another, and the characteristics of the local energy demand pattern. As energy system manufacturers and development planners contacted during this study have repeatedly emphasized, the cost of energy output can only be determined on a site-by-site analysis.

Section 4.0 summarizes the advantages and difficulties presented by the needs/technology matching process for the selection of one or more renewable energy technologies for rural developing country applications. Emphasis in this concluding section is on how such a process can be integrated into existing development programs and how the results of the various steps can be integrated both into the project identification process and into the hardware adaptation programs of energy research institutions and equipment manufacturers.

To further illustrate the actual mechanics of the matching process, an initial matching of the eight basic needs was conducted with those renewable energy technologies that appear to have a good potential "fit" with each need, based on the initial screening performed in Step Three of the proposed matching process. The findings of each matching are presented in Appendix A and are summarized in the first portion of Section 4.0. A set of technology options is identified for each need, along with some observations on additional research and development needed to be performed to increase the quality of the matching between each need and one or more technology options.

As an aid to other researchers, Appendix B includes a review of the literature in the last few years that touches on either basic needs for energy or the renewable technologies capable of providing energy to rural Third World villages. This catalog closes with a short analysis of how these studies have raised many legitimate questions both about future energy availability and about the choice of energy technologies for development; but, the studies have not provided guidance on how to select technologies that would remedy these problems.

SECTION 2.0

A PROCESS FOR MATCHING ENERGY NEEDS WITH RENEWABLE ENERGY TECHNOLOGIES

This section presents an analytic structure for matching basic human needs for energy with appropriate renewable technologies. A general framework has been developed that is applicable to all developing nations and not oriented to any specific geographical area, climate, or culture.

The primary concern is with the particular problem of selecting energy technologies for projects funded by national governments, international organizations, research institutes, or nonprofit foundations and philanthropic groups. Such organizations and agencies have a pivotal role in the introduction and development of most energy-producing technologies in developing countries. This is particularly true for electrical generation and transmission capacity, but it now is true also for fossil fuel exploration and production. The public sector also has participated in the introduction of moderately capital-intensive, energy-consuming devices in the agricultural sector such as tube-wells and small-scale agricultural process heat systems, although the importance of this role has varied from country to country.

2.1 CENTRAL ASSUMPTIONS UNDERLYING THE PROCESS

This report concentrates on the decision-making process in governmental and philanthropic sectors and, consequently, it considers the social as well as private benefit of development projects. Two basic assumptions about the proper role for outside stimulation of development and about the selection of technologies already have been noted in the introduction; they are outlined and defended here in detail before proceeding with the step-by-step outline of the proposed technology selection procedures.

2.1.1 Basic Human Needs Approach

A central tenet of the recent development programs of many Third World nations and of virtually all foreign assistance and multilateral finance organizations is that priority should be given to projects that directly assist in the provision of life-sustaining goods and services for the poorest segments of the population. An international group of development planners described this orientation as follows:

> The basic needs of human beings in any society include food, water, clothing, shelter, health, sanitation, and education . . . The Basic Human Needs (BHN) development approach, then, is an equity-oriented effort at providing, in a sustainable way, these essentials of life to all people. The impoverished members of society, especially in the least developed countries, are the primary targets of the BHN approach. (Colglazier et al. 1978)

Any projects using the methodology developed in this paper is assumed to be designed from a BHN perspective. This underlying assumption has important implications for the report: the matching process focuses exclusively on meeting the energy requirements of basic human needs. Infrastructure-creation tasks are considered only if they contribute directly to the provision of energy for basic life-sustaining goods and services, such as adequate food, shelter, space heating, clean drinking water, hot water for bathing and disinfection, and protection from disease. For example, the development of telecommunication or road networks is not considered, although these may be important components of an overall national development program, but the provision for irrigation water and rural sanitation is examined. The focus is on basic rural needs for energy because the majority of the poor in developing countries live in the rural subsistence agricultural sector that does not have ready access to centrally generated energy sources or fossil fuels.

An important corollary of the BHN approach is that the choice of technology is governed by the requirements of fulfilling basic needs rather than by the desire to market existing technologies. This approach requires that energy needs be identified and ranked before the technology selection process begins and that the project planner avoid selecting technologies until the total impact of the need is estimated. Since the BHN approach is directed toward the poorest segments of the population, the planner needs to analyze who receives the benefits of the energy system as well as examine the physical outputs of the energy technologies.

2.1.2 The Necessity of Matching Characteristics of Needs and Technologies

This report predicates the desirability of carefully matching the characteristics of a range of renewable energy technologies with the site-specific characteristics of each basic energy need. There are three major reasons for this approach. First, the output of renewable energy systems is intermittent and variable. When the quantity or timing of energy output diverges from the pattern of demand, some form of mechanical or electrical storage must be used. This can adversely affect the cost, reliability, and maintenance of a renewable energy system. A careful matching of output with temporal and spatial requirements of the need can minimize the required storage.

Second, each need requires a particular form of energy: heat, mechanical shaft power, electricity, or combustible gas. Some tasks can use more than one form; i.e., lighting can be provided by electricity, a liquid fuel lantern, or a combustible gas. Others require a particular energy form, such as low-temperature heat for crop drying. Energy can be changed from one form to another through conversion devices; but this increases the total cost, decreases the overall system efficiency, and increases the complexity and maintenance requirements of the renewable energy system. An energy conversion device may be added to an energy source if it assists in the coupling of a technology to the characteristics of an identified need, but this must be determined on a site-by-site analysis.

The third rationale for the use of a matching process is that the acceptance and use of a new technology is more rapid in a rural Third World setting if its introduction causes little disruption in the practices and customs of the villagers. By first investigating a villager's particular energy need, the matching process can assist the analyst in selecting a technology whose output fits the traditional use patterns.

2.2 STEPS IN THE NEEDS/TECHNOLOGY MATCHING PROCESS

In this section, a five-step matching process is outlined to guide the choice of a renewable energy technology for any given basic rural energy need. The process is shown graphically in Fig. 2-1; a discussion of the components of each phase follows.

Figure 2-1. NEEDS/TECHNOLOGY MATCHING PROCESS

Analytical Tools Required	Matching Step	Output
National Development Plan Consultation w/village inhabitants	Choice of Project Goals	Rank Ordering of Development Objectives
Consultation with final End Users for Energy	Identification of Energy Needs	Ranked List of Energy Requirements and Characteristics of Energy Needed
Discrimination Criteria: Type of output Temp of output Spatial distribution	Preliminary Screening of Technologies	List of Technologies w/Appropriate Output for Identified Needs
Site Specific Inventory of Available Energy Resources Detailed Survey of Site-Specific Energy Needs Characteristics	Matching Technologies with Need and Resources for Each Site	Ranked List of Technologies According to Match w/Needs Requirement for Technology Adaptation/R&D
Detailed Cost/Engineering Estimates for Technologies with Characteristics Matched to Needs and Resource Base Cost Constraints for Energy Systems	Technology Choice	Selection of Technology for Project Identification of Areas for Cost-Reduction R&D or Demonstrations

The matching process should be viewed as an integral part of the energy project selection. Since each developing country's government and each development assistance organization has its own planning process, this report cannot detail how the proposed matching technique fits into each institution's internal project review techniques. Some parts of the matching process, like the social and cultural assessment components, already may be required in the planning procedures of some institutions. The development organizations may want to employ all aspects of the matching process to establish a thorough planning mechanism for energy projects.

2.2.1 Step One: Choice of Program Goals

The energy technology selection process must take into account a country's development goals and programmatic objectives. National leaders and planners determine the energy needs of the country and from these needs the long-term goals of the development program. Energy is an intermediate good used to provide services and to perform needed work. In areas where more energy is needed than is currently supplied, the development of a new source of energy may be set as an important programmatic goal. Where new conventional electrical generating capacity or additional fossil fuel resources is expensive, the goal may be to provide new renewable energy sources or to increase the efficiency of current renewable energy technologies.

Where a renewable energy provision has been identified as a major intermediate program objective, development planners rank energy and other priorities in order of importance. Since there normally is a requirement to ration scarce resources—capital, foreign exchange, skilled labor, management expertise, or raw materials—this weighing of objectives allows the planner to rank and use the available resources until the most scarce resources are exhausted. This process determines what resources will be devoted to the energy projects. However, it is important to remember that energy is an intermediate good, not an end unto itself. For each energy project, the planner must keep in mind one central question: to what end am I introducing one or more energy technologies? Without such objectives it is impossible to evaluate the success of a technology introduction. In the final analysis, the important question is not how did the system perform, but how close did it bring the user to the initial set of development goals.

The choosing of project goals also marks the beginning of consultations with the final consumers, the local villagers. The consultation process varies, depending on the social and political structure of the local community, but should be an integral part of the priority ranking phase.

2.2.2 Step Two: Identification of Energy Needs

Having defined the development goals, the next task for the planner is to determine for each site which needs are of prime importance to the villagers and what particular activities require energy inputs. Again, consultation with the villagers is essential to prevent outside biases. Too often, project planners autonomously decide what is needed; e.g., street lights, gas for cooking, an educational television receiver. Because much or all of the capital cost for the renewable energy systems is provided initially by governmental agencies or other funding sources, the villagers are likely to accept what is offered. But, if they do not have a substantial role in selecting what needs will be met first, the villagers are not likely to actively support the technology introduction process, to assist in any necessary modifications, or to maintain the system once it is installed. Broad-based participation also ensures that the benefits provided by the energy technology are not appropriated by a small number of villagers based on their monopolization of one or more factors: land, capital, status, elected or traditional authority, education, etc.

A brief analysis of the fundamental characteristics of energy needs—how much, when it is required, where it must be delivered, and in what form—also should begin at this point to facilitate the initial screening of technology options. A much more detailed assessment of characteristics of energy needs is undertaken in Step Four.

2.2.3 Step Three: The Preliminary Screening of Technologies

At this point, the development planner or project manager begins to use the available technical support. Having defined and ranked the energy needs that should be satisfied, the planner and the technical support unit can begin to narrow the range of renewable technologies capable of producing the required energy.

For this preliminary screening the planner can use several analytic tools called discrimination criteria. These tools characterize energy needs and energy technologies that are relatively insensitive to site-specific variations or social and cultural patterns. The major advantage is that discrimination criteria can be used to eliminate inappropriate technologies before extensive site-specific data has been collected. The three major criteria are:

- type of energy output required,
- temperature of energy required, and
- spatial distribution required.

Each of these three criteria imposes a different screen on the full list of technology options. The first criterion locates those technologies that provide the required energy form to meet the need without the use of an energy transformation device. The second identifies energy systems that produce a sufficient level of thermal or kinetic energy to perform the task required. For example, an absorption refrigeration system and a pottery firing kiln require temperatures of 100-130° C and 250-500° C, respectively. Both are beyond the normal performance range of flat-plate collectors, and the higher temperature range is beyond all but a small number of technologies including biogas generators, direct biomass combustion, and, possibly, resistance electrical heating from a large-scale generator. The third criterion, spatial distribution, addresses the problem of providing the energy where it is required. If energy must be delivered to a large number of sites, the technology options are reduced rapidly to those energy sources whose output can be moved efficiently from a central location—such as electricity, combustible liquids and solids, and, to a lesser extent, combustible gases—or that can be located at each site.

By using these criteria, the planner and energy advisor can reduce the number of technology options for each identified energy need. The criterion for the energy form is particularly useful in identifying technologies that do not require an energy transformation device. The spatial distribution criterion helps ensure that technologies are selected that most easily and efficiently serve the required number of locations. An ideal option includes all three characteristics of the need. Most of the feasible choices readily match the need on two of the three discrimination criteria.

Once certain technologies favorably match a need using the discrimination criteria, then only these technologies need to be evaluated on the other, more site-specific criteria. Consequently, the use of the discrimination criteria allows a planner to eliminate early certain technological options, thereby reducing the time and resources required to assess each site.

Of course, all these matching problems can be overcome by using energy-transforming and power-conditioning equipment. Mechanical wind power conceivably can be used for dispersed cooking sites by converting the power to electricity and letting it power electric-resistance hotplates or stoves. This option is doubtful, given the efficiency losses and cost of such a system, but the final screening is determined in Steps Four and Five of the matching process.

2.2.4 Step Four: Matching Technologies with the Needs and Resource Base of Each Site

This step is the heart of the matching process. It provides the data on energy needs and technologies that is necessary to determine their compatibility in a particular location. Here, most of the resources for the project assessment, both in terms of funds and of personnel, is expended. A group of planners and technologists together with a counterpart group of villagers inventories what local renewable resources (i.e., sunshine, wind, water flow, etc.) are available to power the technologies still under consideration. The energy resource base is evaluated on the basis of the following three general criteria:

- availability—size of the resource base, current demands upon the resource, restrictions placed on its use by law or custom;
- variability—seasonality, changes in the resource on a daily, weekly, and annual basis, size of swings as percentage of average resource availability; and
- constraints on use—ownership of the resource, historical, cultural, or economic constraints on use, conflicting or multiple uses of the same resource.

A more detailed list of site-specific criteria that describes the energy resource as well as the need for energy is given in Table 2-1.

Acquiring accurate resource availability information covering an entire year can be a formidable task, particularly for renewable energy systems whose sizing is highly dependent on the amount of local resource, such as wind energy conversion systems and small-scale hydroelectric generators. At this stage, preliminary observations can be made and simple measuring instruments installed for monitoring by village participants. Readings collected over the course of several months or longer greatly assist in the final design of the selected technologies and in the sizing of any storage and energy conversion devices.

While the resource assessment is being conducted, other members of the project team can detail the characteristics of each of the local energy needs. The information collected provides detailed descriptions of all three discrimination criteria and as many of the other criteria as are pertinent to the basic need. As Table 2-1 illustrates, the criteria used to describe the energy needs virtually are identical to those used to characterize the output of the technologies, so that needs and energy systems easily can be compared and matched. The focus of the data collection is the current pattern of energy use: what quantities of fossil and renewable fuels are needed and what human and animal energy is consumed, in what form, at what time, and for what purposes. In a

Table 2-1. CHARACTERIZATION CRITERIA

Criteria	For Basic Needs	For Renewable Energy Technologies	Unit of Measure
	I. Discrimination Criteria		
Type of output	Form of energy that can satisfy demand	Form of energy produced	Not applicable
Temperature of output	Level of heat to perform required work	Range of temperature of energy system output	°C
Spatial dispersion	The number of locations per village needed for the performance of the basic need task	Capability to distribute the energy output produced by the technology	Number of sites per village required
	II. Site-Specific Temporal & Climatic Criteria		
Seasonality	Time of year when the energy demand occurs	Time of year when the resource produces useful energy output	Growing season, non-growing season, or all year long
Time of day	Time of day when energy is required to perform the basic need task	Time of day when the useful energy is produced	Morning, daytime, night, or 24-hr day
Duration	Duration of time per day required to perform the basic need task	Duration of time the technology provides useful energy during the day	Number of hours per day
Sensitivity to interruption	Length of time the performance of the task can be halted	Variability of output of the energy source	Can be interrupted or cannot be interrupted / Variable or not variable

Table 2-1. CHARACTERIZATION CRITERIA (concluded)

Criteria	For Basic Needs	For Renewable Energy Technologies	Unit of Measure
	III. Site-Specific Social/Cultural/Environmental Criteria		
Usage by Type of Person	Persons participating in the basic need task affected by changing the energy source	Persons likely to be involved in operating the renewable energy technologies	By sex, age, and class
Historical, social, & religious influences	Historical, social, and religious requirements/customs that affect how basic needs are met	Traditional patterns that could create resistance to the use of the energy technology and energy use	Description of the historical, social, & religious customs that affect basic needs
Traditional energy sources used	Sources of energy used to satisfy village requirements	Not applicable	Units consumed per capita or per task (kilograms of firewood, charcoal, dungs, etc.)
Environmental and ecological factors	Climatic and resource conditions that limit local ability to satisfy needs or that alter relative importance of basic human needs	Factors that influence energy system performance, durability, maintenance requirements, etc.; also factors that are affected by the installation of an energy system or the reallocation of resources	Qualitative descriptions
	IV. Cost Considerations		
Cost	The cost limits for new energy technologies (given the monetary, labor, and social costs of traditional and conventional energy used for basic need requirements and the financial resources available to the village)	Costs of the technology's local application	Costs given in dollars per unit of work or per unit of output; social cost qualitatively described

small rural community this information can be gathered rapidly either by a household-by-household survey, with the cooperation of local village leaders and using local enumerators, or by community discussions.*

The information collected in this phase of the project should be useful not only for the selection of technologies for an individual project but also for the later evaluation of the social and economic changes produced by the introduction of the new energy systems. Such information should be collected in as uniform a fashion as possible so that the results are comparable from project to project. There has been a great deal of research activity in the United States on the development of a common methodology for conducting such surveys of rural energy needs and resource availability. Effort is being directed toward the creation of a survey instrument that is broadly applicable and can be tailored to the specific needs of each site.**

With the information on the local resource base and on the characteristics of the local energy needs, the project manager and energy technologist can use an organized matching process to select the energy system or group of systems that most closely matches the needs. At the same time, the project team can identify the research and development work, field-testing, or technology adaptation that will improve the match between the needs and the candidate technologies. Where possible, this adaptation work can begin while the final detailed plans for the implementation of the project are being completed. This minimizes the time delays in the delivery of the energy technology to the villagers. Preliminary in-country training programs for the installation and maintenance of the renewable energy systems also can begin at this time so that the needed infrastructure will be in place by the time the complete systems are built or purchased.

2.2.5 Step Five: Technology Choice and Installation

With the detailed local data, the planner now can complete the detailed specifications of the renewable energy systems. These include the size of each system, the amount of storage (if any) to meet the energy needs with the reliability required, the coupling of the new energy system to existing power sources, and the providing of energy conversion devices where needed. For systems that are to be locally designed and fabricated, detailed designs incorporating readily available materials have to be developed and tested. The emphasis in this phase is on the minimization of costs and maximization of efficiency within the constraints imposed by the energy needs and other national development priorities; e.g., expanding rural employment in order to slow rural-urban migration. This might influence the technology choice in favor of those systems that can be assembled on-site using labor intensive techniques.

This last stage in the technology selection process corresponds to the engineering feasibility study that is performed for most major development projects today. It

*Thomas Graham (1979) argues that house-to-house surveys are often inappropriate and misleading due to cultural strictures.

**For a good example of the state of the art of rural energy surveys, see Donovan, Hamester, and Rattien (1979). The U.S. National Academy of Sciences, in conjunction with the U.S. Agency for International Development, is conducting a workshop in January 1980 that will focus on the development of a standard format for village-level energy surveys.

produces the detailed specifications for construction, system procurement, and project management. This phase also identifies additional research and development that is needed to lower the cost of renewable energy systems and still match the characteristics of the needs. For example, low-cost manual tracking mechanisms for concentrating collectors or solar cookers can be used to replace automated tracking subsystems. Field demonstrations of these proposed cost-reducing modifications may be required to determine if they are durable, reliable, and locally acceptable.

2.3 ABBREVIATING THE TECHNOLOGY SELECTION PROCESS

The needs/technology matching process just described provides a wealth of information to the development planner and renewable energy researcher. Tailoring the technologies to site-specific energy needs should help ensure that the energy provided is useful and welcome. The involvement of the local villagers in each step of the matching process helps identify and solve social, cultural, and religious obstacles to the technology diffusion process.

The collection and analysis of both performance and baseline data is important for the sponsoring development agency or donor organization, particularly when the organization introducing the technology is relatively unfamiliar with it. The data is required to evaluate the success of the system in advancing the development objective. Without information on pre-existing energy consumption patterns, it is impossible to determine the impact of this particular technology on the lives of the users of the energy. The information on the resource base also is important for the evaluation of the technical efficiency of the particular design and for sizing systems for particular end uses.

Each of these steps requires the expenditure of time and resources. They also may introduce activities that are unfamiliar to the sponsoring organizations: rural needs characterizations, time-series data on village energy resource availability, user-defined needs, and locally designed and constructed energy systems. The combination of cost and demands on staff may lead the project designer to eliminate one or more steps in the proposed process.

The most radical form of truncating the matching process is to send a team of outside consultants to a site to examine the feasibility of installing one or more predetermined, commercially available systems without assessing the needs of the area beforehand.* This bypasses Step Two, the identification of needs, or, more precisely, it inverts the process: the output of the energy system determines the use. It combines Steps Four and Five by eliminating the characterization of needs, particularly the social and cultural characteristics, and replacing them with a combined study of resource availability and system sizing requirements.

Such a compression of the technology matching process may produce serious problems for the project manager: it certainly makes the rapid acquisition of institutional experience on the deployment of renewable energy sources more difficult. The adoption of the technology is influenced heavily by how well it serves the needs of the villagers and how quickly it is adapted to the particular requirements of the site. The neglect of these factors in the past, along with unanticipated maintenance requirements, has led to the

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*Photovoltaic arrays, wind energy conversion systems, and other decentralized electric technologies are the most common pre-packaged energy systems.

abandonment of many such systems installed in remote areas. A complete technology selection process would help minimize the possibility of such abandonment. A complete analysis may prove impractical, either because of a time restriction to deliver a particular service or because it's a small project. However, for larger projects with normal planning horizons, a major data acquisition and evaluation effort is both feasible and cost-effective. The additional expense and time required to conduct Steps One through Four well may be recovered by the reductions in the information gathering required in Step Five. Early acquisition of this information also eliminates the possibility of having to go back and assemble it after the fact.

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SECTION 3.0

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UNIFORM DATA COLLECTION AND INFORMATION SYSTEMS
FOR RENEWABLE ENERGY PROJECTS

A paper prepared for the SERI Workshop
on Evaluation Systems for Renewable Energy Systems

by

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SERI

THE PURPOSE OF MONITORING AND EVALUATION SYSTEMS

Information is needed at all stages of project design and implementation. Good information is essential to a good decision making process, from conceptualization of a project through to a final evaluation. Ideally, a project should have a coherent information system that generates appropriate data, at the right times, to support all key decisions at the time they need to be made. Methods for collection and analysis of data during project design phases should be as compatible as possible with methods to be used during monitoring and evaluation. The system should provide neither too much nor too little information. Before discussing information issues related to energy projects I believe a short summary of why we should bother with information systems, and why past efforts have not always worked, is necessary to establish the context of our discussion.

Project monitoring and evaluation for renewable energy projects should:

- track project activities, inputs and outputs, for level of achievement;
- identify present problems and possible future problems;
- provide mechanisms for analyzing problems and identifying possible solutions;
- measure project impacts;
- provide the correct information to the correct individuals, agencies, villages, etc., at the correct

times to support good decision making related to the above items;

- answer all key questions about technology performance and transferability.

It is difficult to achieve these information related objectives, but we must grapple with the problems if we are to have consistently successful development projects, and ones which we know are successful. In reality, the literature and field experience tell us that this ideal is rarely achieved. There are some basic reasons why it is so difficult.

SOME PROBLEMS IN UTILIZING SUCCESSFUL MONITORING AND EVALUATION SYSTEMS

In general, most people working on project design and implementation have difficulty determining what information they really need. Moreover, information and data that are generated by a systematic process are often viewed as suspect and either non-essential or negative. Funding agencies must do more than establish the data to be collected, indicate how it is to be done, and believe that successful projects will be undertaken and that the expected information will come back. Certainly any discussion of uniform data collection must be placed within the context of managerial issues and problems in the field related to monitoring and evaluation systems.

- Project managers are often threatened by information systems because: 1) they don't really want to be held accountable in situations they feel are very difficult; or, 2) they don't want to discover problems or change anything.

- Project managers don't understand or believe in information systems because: 1) they believe it takes too much money and time away from the "real" part of the project; 2) they believe the cost is not worth what you get out of the system; or 3) they don't understand how they can use the information for their needs.

- Often, the only experience project managers have had is with systems designed for someone else's needs and goals rather than their own. Such information systems have, either through design or bad management, provided inappropriate or inadequate data at the wrong time for people in the field and have been designed for the national government (or an outside donor). The project is awarded the cost and job of executing what is for the project staff an unwarranted job.

In order to have a good monitoring and evaluation system it is highly important that:

1) the system be designed for each specific project, and fulfill the decision making requirements of the various groups and individuals associated with the project;

2) the project managers and field staff understand the importance and potential of the information system, and that the system is built into the project to coincide as much as possible with other ongoing project activities.

These two points are especially important for renewable energy projects. Most renewable energy technologies are in early stages of development or are new to the particular region where they are to be used. As has been pointed out so often, renewable energy technologies are usually extremely site specific in both design and cost/benefit calculation. In general, data should be collected and analyzed that will allow for technology improvement, identification and development of good strategies for implementing projects in the field, determination of technology and project cost/benefits, and transferability.

This brings us to a key point of this paper and a major reason for my previous general discussion about project managers and information systems. There is a real potential clash between the needs of national ministries and donor agencies (outsiders) and the needs of project field staff and villagers. The "outsiders" want and need comparable data and a set of common information criteria for larger geographic and technology analysis and discussion as well as issues of transferability. The project field staff and villagers need a successful project that results in positive on-site impact from that technology and project. This means that project implementation, if it is responsive to a dynamic situation, may have a tendency to drift from pre-set data concerns that do not relate directly to project staff needs for site specific success. The result can be a lack of comparable data as intended in project design.

Research and demonstration projects are doubly prone to this problem. Research mandates holding everything in as controlled and well defined a manner as possible, while demonstration often means changing things as the project develops. In such a situation there is, in addition to conflicting managerial forces, conflicting project purposes.

The point of this discussion is to indicate that the interaction of some human problems in operating successful information systems with the unique information needs of renewable energy projects, results in a particularly difficult information system situation. Due to the site specific nature of many renewable energy projects, and their newness, there is no way to completely eliminate potential conflicts. Assuming good project design, it can be minimized if project managers understand the importance, meaning, and use of a good information system and are rewarded for using it properly. If changes in data methods need to be made to achieve success in the field, this can be done while still gathering appropriate information for other concerns which include issues of comparability. I believe the key rule is that in establishing and designing common criteria, and putting them into information system designs, we do not forget to determine the feasibility of people in the field carrying out the work as designed.

THE DEVELOPMENT OF COMMON DATA ELEMENTS

Any scheme that lays out a set of common criteria has implications for all the normal information elements of a monitoring and evaluation system. For our purposes here I think we can identify three general focal areas in which people will want to establish comparable formats for renewable energy projects. They are listed in ascending order of difficulty for comparative or uniform data collection and analysis.

1--Data on system design, and on adaptions in system design.

There are common design elements that are present in every design of a particular technology (e.g., a windmill or a photovoltaic system), as well as common characteristics of the manner in which that technology can satisfy a particular end use (e.g., pumping water). Because most renewable energy projects are so site specific, the quality of technical reporting and design information and drawings is very important. That is, for each type of technology and end use of that technology, the standard design elements common to the technology should be explained in detail so that someone else could easily replicate the application. All adaptions or unique elements should also be detailed in the same manner. This is simply a matter of all project managers, donor agencies, and national ministries, requiring that good design information be developed and kept. One option which would make the process more formal and standardized would be to develop a set of case studies on each technology and its major applications that identified the common design elements, showed how drawings should be done, what quantitative data should be specified, etc. These case (model) studies could then be circulated among agencies involved in renewable energy work.

2--Data or measurements which are mostly physical data; that is, measurements of energy availability in sun, water, biomass: of energy inputs and outputs for a system; operating data and data on work actually accomplished by a system measured in other than direct energy output.

These kinds of data are covered by the comparable or common physical criteria identified on most energy surveys, and by common units of measurement for systems under operating conditions. That is, measurements in watts, BTU's, temperature, horsepower, time, etc., and measurements of work accomplished, such as litres of water pumped, kilograms of an item dried or produced, etc. Some of these are covered in the characterization criteria matrix in the paper entitled "A Process for Matching Village Energy Requirements and Small Scale Renewable Energy Sources" by John Ashworth and Jean Neuendorffer. Of course, project specific measurement criteria are dependent upon the chosen technology and/or the specific end use.

3--Impact and effectiveness data on both the technology and the project implementation strategies in terms of economic, social, and environmental criteria.

For most projects, it is in this area that the causes of success or failure are to be found. Yet, this is the most difficult area to establish common criteria that are specific enough to be meaningful. It is also the area that poses the most expense and difficulty for data collection.

I believe it is important that a comprehensive cost/benefit analysis be undertaken as part of any project. These cost/benefit reports should not simply give the formula used, highly aggregated data (with no explanation of assumptions), and the final results. They should be detailed and written so that the basic data used is presented in as disaggregated a format as possible. One way to assure being able to use data from various projects, related to impact and effectiveness, is if rigorous and systematic C/B studies are carried out.

Appendix One* is an outline of general common evaluation criteria covering all three of the local areas identified above. I believe they can be used as a guide for most renewable energy projects. Making them more specific requires application to a particular technology and project site. One final point. Energy use is a means to an end. Energy projects are a means to other development aims, and as such there are implicit assumptions in any energy project that a successful project will result in achievement of some type of development aim. These assumptions need to be constantly tested, as they provide the larger framework and rationale for our development efforts. Appendix Two places renewable energy projects in this context.

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*Appendices One and Two are adapted from a paper by George Burrill entitled, "The Role of Evaluation for Renewable Energy Projects in Africa," prepared for the Overseas Development Council and AID. The paper also outlines a model for project evaluation design for renewable energy projects. This model provides a basic and common format.

Appendix One

Finely detailed or specific data categories can only be developed with a particular project in mind. For example, the socio/cultural factors relevant to use of a solar cooker will be different than those of a village wood lot. Below is a discussion of a set of data categories and their sub-elements that are non-specific in terms of particular renewable technologies but which can be adapted to the specific technology and local setting of the project.

A. Data Categories

Technical

--Adequate physical data (amount of biomass, wind, solar, etc.) should be gathered to verify the original assumptions or estimates made during project design.

--Complete records of component acquisition in person hours, costs, and skill requirements.

--Complete records of technology installations in person hours, costs, and skill requirements.

--Complete records of system output.

--Complete records of system performance, down time, maintenance activities and costs.

--Records on environmental impacts.

--Changes that could be made, for example, in:

- overall system design
- component acquisition
- local manufacture of technology

- system maintenance

Information can then be assembled on the potential technical effects of such changes on the system.

Social/Cultural

--Relationship of the energy project and technology to the users or to village daily and seasonal life patterns. Also, data on behavior changes required by the technology, and on villagers' traditional habits or ways of doing things which are affected by the project, although not necessarily required to change by the technology (i.e., behavioral side effects).

--People's attitudes towards the technology and the project.

--Behavior of organizations in the project.

--Other cultural constraints discovered during the project that were not identified by the project planners.

--Data on performance of the project's ownership strategy and maintenance strategy from a social/cultural standpoint.

--Equity results of the project as implemented:

- impact on male and female roles
- impact on local income level groups
- impact on ethnic sub-groups and castes
- related to individual vs. family vs. community

Economic and Financial

David French has suggested the following elements:*

*French, David, "The Economics of Renewable Energy Systems for Developing Countries", US/AID, Washington, D.C., January 1979.

--Value of a system's output (if measurable in market prices).

--Alternative employment opportunities (to measure benefits if the system chiefly releases labor from former tasks).

--Costs of site preparation and installation of the system.

--Direct operating costs.

--Degree of local unemployment (to find shadow wages).

--Existing uses of raw materials (to find their shadow price).

--Extension costs of introducing the system.

--Market interest rates for local borrowing (to estimate investors' discount rates).

--Characteristic local investments (to suggest willingness to take financial risks).

I would add two more elements. The investor's point of view is extremely important for the long-term success of any project, whether it be government, community, individual, or a combination of these. The extent to which the project is testing economic or financial acceptability to potential investors should depend upon the extent of proven technology development. Less developed technologies will generally have higher subsidies, and project results are therefore less of an indicator of future investor behavior than unsubsidized technologies. Moreover, investors very often do not act in a financially or economically rational manner. Economic and financial positive or negative analysis results may not correlate with investor decisions experienced in the project. Therefore, a reasonable estimate as to what can be determined about potential investor behavior based on project data should be clarified before any conclusions are reached. To do this, data should be gathered during the project on the additional elements of:

--investor perception of financial or economic cost/benefit, and

--investor opinion as to competing investment choices. (I am not referring to cost effectiveness analysis here, but to the fact that monies may be invested in items for completely different purposes.)

Appendix Two

There are three levels of hypotheses, linked together, which form a causal objective tree for any energy intervention or strategy. A graphic illustration of this is on the following page. This objective tree indicates that the logic of a project moves from lower to higher levels in the tree. In other words, if the energy technology performs adequately (level 4), the hypothesis is that the intended events or impact will occur on the next level up on the tree (level 3) Each level is linked by hypotheses which at the appropriate time should be tested by evaluative research. The higher one goes on the tree the more traditional impact evaluation one can utilize. I am suggesting that present energy projects are operating in the field almost exclusively at level 4 and somewhat at the level 4-3 hypothesis linkage.

Level 2-1, or the highest, concerns hypotheses about whether or not increased renewable energy supply will improve the quality of life. Before these kinds of hypotheses can be field tested, we will need a great deal more data at levels 2 and 3 than have yet been gathered by the development community. This situation for energy projects has been acknowledged (Howe, 1979), and I would suggest that for the moment evaluation design concentrate at evaluating links between levels 3 and 4.

Viewing evaluation as an incremental activity, wherein implementation is examined before impact, is quite accepted (Rossi, p.45). The idea that there exists eventual potential for a high level of impact is what drives the project and the evaluation design. Inferences about potential are made, but because the inferences are based on case studies, it seems more useful to focus evaluation primarily on implementation and technology development. Secondary focus can then be given to impact possibility. That is, the case study data with more general country or regional data is analyzed to make inferences.

This strategy is supported by the fact that most energy projects have small field samples (are at such a low level of intervention) that no formal or statistical valid inference of proof could be made anyway. Even in projects where large populations are affected, judging impact has been very difficult throughout various types of development efforts. Although it is certainly possible to lay the fault on evaluative design, the fact remains that little is known about quality of life impacts for large hydro-electric or road building projects in rural areas,* and these intervention strategies

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*For a discussion of this see "Evaluating AID Rural Electrification Projects," a report to AID by Robert Nathan Associates under Contract No. AID/afr-c-1380 (February, 1979).

Figure 1

Level 1

- Increased income
- Village self-reliance and prestige
- Unemployment caused by people being replaced by devices
- Altered socio-economic role of women
- Higher literacy
- Lowered birth rate
- Improved health
- Improved ecological conditions (e.g. slowed desertification

Level 2

- Increased agricultural production ← Increased acreage under cultivation; More intense cropping
- Increased off-farm production ← Increased small industry
- More energy efficient and/or intensive farming
- Increased educational/recreational activities

Level 3

- More efficient threshing, winnowing, irrigation, cultivation
- Better cooking systems
- Reduced time spent hauling and chopping
- Better lighting (possibility of working, playing and studying at night)
- Relief from onerous tasks
- Better heating/cooling systems
- Clean drinking water
- Washing and bathing in hot water
- Stop stripping of vegetation for fuel

Level 4

Performance of energy sources: the energy source or technology provides adequate quality, quantity, and convenience.

(The source or technology must be compared to traditional ways of accomplishing the work, if they exist, and to other feasible ways including imported or central sources if they are feasible. Criteria include:

--cultural and sociological;
--technical performance including maintenance and repair;
--costs, capital and recurring;
--extension and other social infrastructure requirements;
--political factors and managerial factors are also important in determining what may be needed for wide scale application.)

have years of development history.

The same problem is true of testing hypotheses linking levels 2 and 3, except that it is not nearly as difficult. One important point is that at these levels other energy projects can be used at testing proxies. That is, if energy devices result in improved and more efficient irrigation (level 3), and this does in fact result in increased production, then theoretically increased production is likely to occur from any efficient and appropriate energy source (as judged by level 4).

Level 3-4 hypotheses have been overlooked in evaluation of energy projects, although they have been given a great deal of thought by project planners and managers. These hypotheses are concerned about the successful design of both the technology and the energy project intervention implementation. That is, the institutional, incentive, and interpersonal dynamics that are used to operationalize the intervention. For example, can a particular solar fish dryer design perform at adequate physical and economic levels of efficiency that increased work will be done? Can it do so within larger environmental and social guidelines or policy? This is the level that most of the evaluation discussion to date has centered around.

Development projects usually have strategies for putting the project into place that are quite clearly discussed and often monitored. Sadly, the hypotheses and assumptions that these strategies rest on are rarely tested systematically or empirically validated so that there is some clear logic for their choice. This is now the case with energy projects, and this issue should be addressed. Projects often fail or don't reach their objectives because project hypotheses were invalid.

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*See, for example, Systematic Monitoring and Evaluation of Integrated Development Programmes: A Source-Book, United Nations, New York 1978; Evaluation: A Systematic Approach, Peter Rossi et al, Sage Publications, Beverly Hills, California 1979; Evaluation Research and Development Activities, Francis W. Hoole, Sage Publications, Beverly Hills, California 1978.

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MONITORING RENEWABLE ENERGY PROJECTS

by Dr. Glenn Brandvold

(Note: the following is a slightly edited transcript of a slide presentation. The visual aids have not been reproduced.)

Yesterday we all found that the planning phase of the project information that you try to get, and whether to start the project at all, is the most important part of any project. I'd like to share my philosophy with you. Once a project is selected and, in fact, the implementation process has begun, one must take the Dale Carnegie approach of being very positive in planning, monitoring, and evaluating programs so they provide a helpful assistance role. Structure it, to a major degree, so that you anticipate the project. If you feel the project has any problems or difficulties, you anticipate the best kind of help you might want and the best chance to provide assistance. Then, when the inevitable difficulties are encountered, you put it into a positive attempt to increase the possibilities that the project will succeed in the monitoring phase.

At some point in most projects, we are confronted with development aspects that are difficult; we all have to recognize that there are going to be difficulties and that we sometimes can get very discouraged. When we are monitoring, we must develop back-up material, and acquire some experts, so that we can assemble, acquire, and provide assistance when those problems occur and operate in a helpful mode.

I am going to point out a couple of examples of projects that I think may illustrate some of the things that are responsible for project difficulties and some of the things that are important to project successes in the monitoring/evaluation phase. I have labeled this "Foreign Renewable Energy Projects" but, in fact, it is probably just as valid for a conventional energy project in many ways.

1. The first principle, and it may be actually useful in the planning phase, is an engineering principle that it is seldom justified to propose a project in which the contractor or proposer has never built a system like this before. One potential contractor will say "I've done some of this before. I've done all the pieces." But you find that he hasn't done enough or had enough dedication to the idea or to the technology to have built his first prototype system in a controlled environment in his backyard. I don't want him making his mistakes and learning his lessons in my backyard.

2. There's sort of a corollary to this that may be more significant to foreign projects. In a monitoring and evaluation program, you are likely to have difficulty if it is also the first-of-a-kind for the proposer/contractor team. If they haven't worked in the part of the world where the project is being undertaken, you are asking for additional difficulties. He is going to have to learn a lot about everything from the governmental infrastructure (the institutional infrastructure) to whether there are hardware stores on the corner or not. The learning process may turn out to be painful, delaying the project and impeding results.

Participant: Speaking of your first principle in terms of an agency which is involved in these types of projects, it is our opinion that each of the projects cannot be that authentic at the first stage. It is not completely possible for a contractor to have this experience in an undeveloped country. There has to be a first time. So, if you maintain that experience is your first principle, then we would have to scrap, really, everything we are doing.

Brandvold: That is not a bad suggestion.

Participant: I'm not disputing the value of your principle, but this would be contradictory to the need for information and research that we talked of in the beginning. This would be the first discouragement of all.

Brandvold: I believe that when one is undertaking the transfer of a technology, say, from a developed country to a developing country—for example, if somebody wants to build a stove that is efficient in Africa—it would not be too much to ask that the stove should be first built and its efficiency proven in the U.S.

Please let me emphasize, these are just my views, certainly they are not the rules of nature.

3. The next thing that I believe will assist and is essential for a positive outlook in monitoring is to qualify the hardware. Again, I think it is a very great disservice to a renewable energy project if a contractor, proposer, or participant team winds up having a lot of hardware difficulties when they get to the field and begin the experiment—difficulties which may not be generic. There may not be any fundamental problem with the equipment, but because the problems from the unqualified hardware will consume everyone's attention and interest it will obscure some of the more basic underlying things they are learning about doing the project.

The developed countries are essentially attempting to implement technology somewhere else. I think it is completely reasonable to be sure in preparing the project plan that one insists that the people qualify the hardware—make their mistakes in their own backyard, not in the user's backyard.

Few renewable energy projects are at a sufficiently technologically advanced stage that a turn-key operation is feasible. Now, there may be exceptions, but I think there are developmental aspects in nearly all renewable energy projects. The responsibility for debugging essential operations should be included in the contractual responsibility. It should not be something that you think about afterwards, and it also has got to be included in the project cost.

We had a lot of discussion in our subgroup yesterday afternoon about the range of technology readiness between projects which are essentially fundamental research (where you are trying to learn something) and those that, hopefully, are the beginning of a commercialization wave which will perpetuate itself. I think in either case, in spite of trying to do the best planning and the best analysis, the true outcome may not always be known. At least in the experimental projects, a negative finding is just as valuable as a positive finding. Discovering that a system doesn't fit into a particular setting or isn't what the people want can be as valuable in some ways as a positive finding. We hope everything comes out fine, but experience suggests everything isn't always going to come out fine.

Performance monitoring, again performance in its broadest sense, is something that must be included in the planning phase, not added as an afterthought. In fact, planning must include safeguards that permit a negative finding to be reported. We do not want to encounter a situation like the one recently encountered in Russia in the case of the tractor factory. For five years, reports came in that everything was going along fine until somebody went and looked, and there was no tractor factory. There may be so much commitment, so much desire to not have hassles, that a negative finding gets completely obscured! You'll think everything has been working fine until you look. Frequently, there are not many chances to look. So, performance monitoring should be included in the beginning of the planning; budgeted at the appropriate level. If it is an experimental program, you will probably have to spend more. If it is a beginning of commercialization, perhaps it will cost less—perhaps in that case one should emphasize the different parts of performance monitoring.

Performance monitoring is more important in projects that are more experimental in nature. This is because everything may not turn out like we hope it will. We need to be conscious of creating problems and unnecessary negative aspects on experimental projects by basing the sale to a particular customer or user on the fact that something is going to work for him. It may not be so wonderful; instead giving him great difficulties. I believe that one should have a fall-back position—so, even if all else fails, your monitoring was success oriented and you did the best planning you could. You get deep into the project with most of the money spent, but it just turns out terrible, perhaps due to the stage of technology development, a change in situation, or a change in the user completion.

A fall-back includes having the capability of stopping the project. If it's clearly nonsense, you'll do more damage by continuing with a bad idea than if you have constructed the program in such a way that it can be stopped if necessary.

In 1973-74 the government of Mexico did an exceedingly commendable undertaking in trying some solar pumps. In this case, they contracted SOFRETES, who had a few years of experience with some small solar thermal pumps in former French colonies in Africa. The Mexican government wanted to look into this technology. They have a country that is not completely gridded with electric wires and they have several villages which would be prospective candidates for water-pumping systems.

Their initial program included ten 1-kW village pumps, as well as a first-of-a-kind 30-kW system—a large village water pumping system.

The collector field was the largest, that I am aware of, that was built at that time, about 1600 m^2 of flat-plate collectors. They used a locally available cement-asbestos construction board, which SOFRETES had used in other places, double-glazed ordinary window glass covering essentially completely site-assembled systems. The collector technology that was typical of the times for site-built systems used black aluminum roll bond absorber plates with fiberglass insulation.

For some reason, their system continues to have the cleanest thermal mechanical design. This is the best turbine generator system that I have seen in any subsequent pumps. The system uses Freon, which is widely available. The turbine/generator assembly in this system is hermetically sealed so you do not have any turbine shaft seals: a very nicely designed system. The solar collectors, though, quickly became obsolete. Also, all of the rubber hose connections that held the collectors together presented problems. In addition, the available evaluation system was essentially a pin-board with few electrical plug-ins or thermocouples. For the data collection, the technician needed a multimeter and looked in and read by hand, point by point, the few temperature readings on the system. It was also a turn-key operation. The contract stated that SOFRETES would come over, install the systems, and get them running.

The consequence of that operation was that: (1) the system was first-of-a-kind, and (2) there was no contractual provision for either baseline monitoring or subsequent evaluation for some period of time.

One thing that I have never seen done as well on any other project was a set of resource material that the Mexican government prepared. It is basically designed for their educational institutions, which range from grade school through high school to technical institutes and colleges and contains technical descriptions of what they were trying to accomplish with this solar experimental pumping system.

We talked yesterday about the social and cultural effects. I haven't seen a project yet that has done as well in informing a broad range of people at a level they can understand with the things they saw, some of which didn't work very well.

Now, let me contrast that with the project Steve Klein worked so hard on, and succeeded with, in Bakel, Senegal.

The Senegalese government is going to use a portion of the collector support structures for training and workshop offices in the village of Bekel. The turbine, the prime mover, is basically a 1979 model. In some ways, it is not as suitable for remote installation as the machine in Mexico. This one does have a high-speed shaft seal. It is a planned maintenance item; whether field maintenance is feasible isn't entirely clear at this point. Included in the contract were provisions for the best possible "state of acceptance requirements" for establishing the baseline performance of the system when it is installed and a five-year monitoring and evaluation phase, which includes sending somebody data about the water pumps or generators. It also includes an evaluation, asking what do the measurements mean over the first five years of the system? In addition, there is a contract that addresses the social effects of having a 30-kW generator supplant the villagers' current means of electricity. There is also a contract to compare the performance of this system with existing methods of water pumping, which were diesel-powered. This comparison includes fuel cost, the quantities of fuel consumed, and the maintenance required. The monitoring phase requires evaluation—not just to produce data; i.e., not just information we can write in a report, but also something called "soft operating data." This is an analysis of the facility log book and includes how many times did someone have to wash the collector? How many people did it take? What repairs were necessary that don't appear on the transducer?

This project is not operative yet, so it is possible that years from now we may say we made these grand statements about how keen this was going to be, but, in fact, there have been difficulties. At least, there has been some learning from the earlier experiences.

Changing Energy Usage for Household and Subsistence Activities

by
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CHANGING ENERGY USAGE FOR HOUSEHOLD AND SUBSISTENCE ACTIVITIES

Irene Tinker

Energy consumption for household and subsistence activities constitutes a major portion of the total energy budget in the less developed countries. Yet we know little about amounts or types of consumption, or about the flow of substitutions of one form of energy for another, because household and related activities were relegated by early development economists to the traditional sector which was targeted for extinction. Only data on economic or income-producing activities in the modern sector were collected or studied. Many miscalculations concerning economic development have resulted by this narrow vision of reality.

Ignoring these activities of the informal sector is not confined to less developed countries. Similar limited vision skews information on the poor in the US as well. Psychiatrists at the National Institute of Mental Health looked at the income statistics recorded for low income residents of several major cities and decided that people there must suffer from severe mental illness. In a monetized society most of these residents did not appear to earn enough to survive, much less cope with their situation. But when they began to study these inner city residents they found an economic reality unrelated to the official statistics, one they called "economic terra incognito." Within this informal sector they found a plethora of legal, marginal, and illegal activities which completely altered the economic picture. Even this improved view of economics among the poor may still be distorted since it is difficult to obtain truthful responses to questions among this segment of society who fear their answers might be repeated to tax or police officials.[1]

This study illustrates two axioms of survey research:

- --questions must be framed in such a way that they do not impose a preconceived reality on the situation, and
- --interviewers must be trusted, and the use of the survey understood by the respondents, if accurate rather than convenient answers are to be given.

Reality at subsistence levels

A first step in any energy survey of household and subsistence activities is to understand the reality of life at the poorest socio-economic levels of society. For many years the only data collected outside the modernizing sectors were provided by anthropologists who tended to focus on tradition rather than change. Even as anthropologists began to study village economics or politics, the problem of linkage between micro studies and national trends remained. Nonetheless these micro studies have been essential in challenging theories or generalizations about life among the people which were built into much of early development economics. The "take-off" theories of the 1950s, which projected rapid movement from traditional to transitional to modern, detailed little of the socio-economic realities at any level, but merely assumed modern to resemble the US or Western Europe. They were blithely unconcerned with the traditional sector, since it was assumed to be rapidly disappearing with little impact on modern economic, political or social organizations.

What we see today is not only concurrent existence in most less developed countries of all three stages of development, but an inter-penetration of these levels to such an extent that we require a new perspective. Instead there reamins a tendency to divide reality into "the poor" and "the elite"; "the traditional" and "the modern" without recognizing the constant changes within these vague categories or observing the kaleidoscopic society in between. Much of the problem is due to the divisions within and between academic disciplines themselves into macro and micro--between the macro-orientation of the development economist and the micro-orientation of the anthropologist, for instance. There is, however, a growing body of literature which is trying to bridge the gap between the various levels of society by focussing at all levels on the inequities of development as now practiced because of the differential impact it is having on men and on women.

According to this literature, referred to as "women in development", the penetration of a modern economic sector has tended to benefit men by employing them while at the same time its products have reduced or eliminated markets for homecrafts generally produced by women. Cash crops have been introduced to men even in areas where women traditionally did the bulk of farming. The strain within family groupings caused by men having access to money while women were left in subsistence activities has undoubtedly contributed to the worldwide rise in the number of women-headed households. Today it is estimated that one out of three families has a woman as de facto head; further, this trend is more common among the poor.

Even where families remain together as a unit, severe inequities develop in those societies where men and women continue to maintain separate money budgets and separate spheres of responsibility. In much of Africa women continue to be expected to provide food for the entire family without help from the man. Thus there are many examples of villages where development has raised the gross national product but the nutritional levels have fallen because women had less opportunity to raise their own supplemental food and little access to money with which to buy it. In the Mwea irrigated rice scheme in Kenya these problems were exacerbated by the scarcity of fuel in this resettlement area which meant that women also had to find money to buy firewood.[2]

This tendency of developers to target economic opportunities at men has its parallels in the introduction of technology and hence of new types or forms of energy at the village level. Since such substitution of more efficient means of mechanical energy for human and animal energy is at the heart of our modern society, men have been pushed into the modern sector, leaving women behind. Women traditionally pound grain, but grain mills are typically run by men; women fetch and carry water, but men are given control of water points and the responsibility of pump maintenance. Such choices may appear logical if the image of a modern society is one where men work and women are kept in relative leisure at home. Few societies can afford the luxury of so large a leisure class; certainly in subsistence economies every member of the family had important economic tasks--from watching the animals to carrying wood and water. That development economists do not class these efforts as economic simply contributes to the failure of those economic theories to explain contemporary reality.

If we are to survey the reality of the household and subsistence activities related to energy, we must put aside preconceptions of what work is appropriate to women or to men, and find out what in fact are the daily activities which use, or might use, energy.

Rapidity of changing energy usage

It is important to stress how quickly energy use patterns are changing. Even considering that the first survey would provide baseline data would itself impose the unreality of a static society on groups studied. While I would like to see the historic perspective as a part of any energy survey, methods of ascertaining such information would best come from such questions as: "Do you cook the same way that your grandmother did?; As often?; With the same fuel?" Such data would give some sense of the speed of change and the level of concern among the respondents, but would be fragile for estimating actual usage.

Assumptions about baseline data for consumption of non-commercial energy also suggest linear development. In fact, as energy costs rise, there is a tendency to drop back to human or animal energy. Women go back to handpounding grain, men again use bullocks for ploughing. Women cook fewer meals, or change to faster-cooking foods. Energy consumption may be going down, and so conclusions may be drawn about more efficient energy use, yet in fact the quality of life may have deteriorated. Or has it? Are tractors essential to increased production? Are high energy solutions always better than low? It may help us to answer these questions if we distinguish between those activities for which fuel is necessary and those for which human or animal energy might be substituted.

Necessary fuel

Fuel of some sort is necessary for cooking, heating, and lighting. Human energy cannot heat water, or space, or provide light. Whatever fuel is available will be used to meet these requirements rather than as a substitute for human energy. Insufficient fuel simply means eating uncooked food, getting cold, and living with the dark. As fuel costs rise or traditional fuel sources disappear, most poor households will seek wood, waste, leaves, or other energy sources wherever they can, ignoring property rights as well as national concerns for forest reserves or erosion control.

Households operating under such crisis conditions are likely to be more responsive to changes in cooking methods, in cooking utensils or stoves, or in types of fuel than cultural traditions would suppose. New technologies designed to reduce the amount or type of necessary fuel consumption must be judged with several thoughts in mind:

1. New alternatives must serve the same multiple needs that current methods do.

If smoke from the fire cures meat or dries grain or if it destroys insects or provides heat or light, these functions must be done by the new energy, or those needs must be met by other methods, if the alternative solution is to be adopted.

2. Before alternative stoves are introduced, it is important to know the variety of cooking methods, and the relationships between food cooked and fuel used.

Even in subsistence villages water for tea might be boiled over kerosene while grain is cooked slowly on fuelwoods and breads are baked in an oven. Will new technologies be acceptable if they require new cooking methods? In Bardoli, Gujerat, solar cookers, which are really solar ovens, are being used to boil pulses; is such adaptability possible elsewhere? A squatter's home in Cebu, Philippines, uses pressurized gas with a modern ring during the week when everyone works, and cheap sawdust with a clay cooker on the weekends.

3. When new types of bushes or trees are introduced to increase availability of biomass, the ownership, maintenance, and uses of currently grown trees must be known.

In many societies ownership of trees is distinct from that of land ownership. Even so, ownership is irrelevant if the tree cannot be protected. Who has the right to grow trees on the rights-of-way? How can trees be protected there from animals or people? Trees whose bark might be used for medicines, or leaves for fodder, or nuts for food, are more likely to be allowed to mature than those grown only for burning.

Communal or cooperative attitudes of the villagers must be surveyed if village wood-lots or communal ovens or other community solutions are to be tried. In all of these questions, it is important to ask who will benefit from the new trees, and who must do the work in watering and maintaining them. If women plant and maintain wood-lots but men sell most of the harvest and keep the profits, women are unlikely to give wood-lot activities a high priority.

4. Solar ovens may be too expensive for individual use and may therefore be more practical if used by the community. This in turn requires information on social organization and cultural attitudes toward food.

In an Egyptian village solar ovens for baking are being used by the entire community. However, communal baking facilities are traditional. In India ovens using reflectors and black boxes may be too expensive for a single family but caste divisions may make village-wide use impractical. Cooperatives or women's groups might use such an oven to produce and sell some foods or to parboil grain. Cultural attitudes toward food cooked outside the home may limit its use.

5. Biogas digesters require adequate amounts of available wastes.

Digesters work best in countries where pigs are part of the diet. Pigs can easily be penned in a small area that facilitates collection of their waste. Feeding penned pigs is also no strain on household time. Cows in subsistence societies are usually let out to graze scattering their dung. If penned, their feed must be collected. Generally the cost in time to gather fodder is uneconomic except in dairies.

Where cattle wander, ownership of waste may become an issue as economic value is assigned to formerly free goods. Who owns the leaves being swept up in Delhi streets? Currently they belong to the sweepers who sell them to eke out a bare existence. What would happen if the tree owner taxed them? Who owns the cow dung on a village path? If the cow's owner pens the cows, where would the poor get their fuel?

6. If biogas digesters are to be used their benefits must be obvious to the users.

Collecting wastes for and feeding the digester requires time. In most subsistence societies women work much longer hours than do men. Chores adding tasks to an already intolerably long day are unlikely to be done unless they reduce other necessary activities. Collecting dung for a community biogas digester, for example, would take as long as making dung cakes for fuel. Yet the women would have to carry the waste to a central place. If her benefit was only the biogas, is the supply as reliable as the dungcakes? Will she have to learn a different cooking style to use the methane gas? Is there any additional incentive--fertilizer for her garden--payment for the collection?

7. Improved treatment of human waste is considered an important advantage arguing for the use of biogas digesters.

Certainly in China where night soil has traditionally been used untreated, the improved sanitation in villages has been a stimulus for building biogas digesters. In the Philippines and in India, at biogas demonstration projects, human waste has been mixed with animal and vegetable wastes without reaction. Is such tolerance possible among the general public? Is the present energy crisis grave enough to challenge long-held cultural biases?

Substitutable energy

Mechanical technologies can readily be substituted for human and animal activity and reduce drudgery via a wide range of activities at the subsistence level: pounding or grinding grain, hauling water, pressing oil. The tendency has been for planners to introduce technologies of greater complexity and therefore greater costs than is necessary, frequently pricing the service beyond the reach of the poor.

A diesel-powered millet grinder in Upper Volta was used by the poorer women farmers only in the dry season when they had to work long hours in the fields; the cost of the grinding keeps the women from utilizing the technology most of the time. Similarly, in Indonesia, the women continue to pound rice to husk it even though small rice mills with rubber rollers are competitively priced and result in more useable rice per amount ground. While such rice mills clearly benefit the commercial users of rice, their rapid introduction between 1970 and 1974 displaced some 7.7 million women from their jobs hand-pounding the rice![3] If the women could make money another way and so afford the electrical energy of the rice mills, the technology would clearly benefit them. Under the circumstances, the use of the rice or millet mills depends on the cost versus the substitutability of human labor.

The appropriate technology (AT) movement is designed to match technology and need in order to avoid large-scale displacement. Often the AT solution is a hand- or foot-pump to provide energy for grinding or pumping; plastic pipe and gravity-feed can often supply water to a village easier than a deep well. Appropriate control and maintenance then becomes an issue. Public water sources are quickly out of repair. If women, as primary users, are trained in simple repair, the pumps or spigots are more likely to stay in use since the women benefit from their use.[4] It has also been found that women trained to repair small pumps or motors are more likely to remain in the village than are men similarly trained. Women benefit from the new technology more, and lack the mobility to move.[5]

AT solutions are seen as more people-oriented. Proponents also argue that intermediate technologies are often more efficient than more complicated larger machines. A study in Nigeria compared two techniques for processing gari from cassava. Not only was the product perceived of as better, but the unit costs of production were about 20 percent lower with the intermediate machine.[6]

When assessing energy for substitutable activities, then, a broader set of variables will govern whether and when the technology is utilized. Issues of who benefits, who pays, who controls, who maintains, who introduces any given technology are central to estimating whether the technology will remain in use and what its impact will be. Perhaps the key question is, who benefits? Local people or the nation? Men or women? Rich or poor? Is the benefit in terms of time or money or food? What might be the impact if the energy costs restrict or reverse its usage?

Total energy systems

Having distinguished between necessary as opposed to substitutable fuel, it is useful to see how these types of energy are used in a total energy system in order to see where there might be savings from the completed product. Take, for example, the growing, harvesting, processing, and cooking of millet. Millet takes a long time to cook. In Upper Volta the increasing costs of fuel have caused a reduction in the times that millet is cooked: from a normal twice a day to once a day or even once every other day, with the family drinking millet flour mixed in water for other meals. Would some sort of processing of millet, similar to parboiling of rice, reduce family cooking time and also cost incrementally less than the cost of the fuelwood? Could women's cooperatives process the millet using solar ovens? Could income from this be used to buy mechanical grinders, freeing women from that onerous chore as well?

To take another approach, would biogas digesters provide sufficient fuel to substitute for the presently burned millet stalks that might then become fodder? Would the added value of the fertilizer increase the crop to give the total energy budget a better balance? What type of organization of energy supply would benefit the greatest number of poor?

Before any of these possible interventions can be tried, much better data on village reality must be collected. But the crisis in energy use is such that long-term studies are neither possible nor desirable. What is needed is reasonably accurate information about present and changing usages in order to identify these points where the system is straining or even breaking. To get at data about household energy it is necessary to reach women themselves. Measuring consumption of fuel, number of logs, amount of dung, etc., used by a household without also knowing something about uses of this energy gives only a limited idea of consumption patterns. However, the data desired need not be overly detailed. Local women might be recruited as informants who could monitor consumption at home and in their neighborhood. Short training courses in survey techniques can be given to these women who can then re-survey the area at frequent intervals, providing data on changing stress and use patterns, a sort of village Gallup poll. Even quicker samples might be taken by utilizing school children who interview their own mothers.

Conclusion

Women are the primary users of energy in the household and provide much of the energy needed in subsistence activities. Preconceptions about their economic roles have masked their daily work. Interventions to change energy use at the village level, whether for necessary or for substitutable fuels, must take into account the total time budget and roles that women play. Similarly, any attempt to change fuel type must consider the several functions which the present fuel performs. More also needs to be known about the variety of fuels used in cooking, as well as the variety of human and animal tasks that might be more efficiently done with other forms of energy. This information must be gathered from women, by women or children, so that the replies are reasonably accurate. Interventions have the potential of great improvement of the human condition in the villages or among the city poor, but only if the total world of women becomes an integral part of the planners' framework.

1/ Berndt, Louise, and Louis A. Ferman, "Irregular Economy: Cash Flow in the Informal Sector." Center for Metropolitan Problems, NIMH, 1977, mimeo.

2/ Palmer, Ingrid, "Rural Women and the Basic Needs Approach to Development," International Labour Review, Vol. 115, No. 1, 1977. For a detailed discussion of food technologies, see Irene Tinker "New Technologies for Food-Related Activities: An Equity Strategy," Women and Technological Change in Developing Countries, to be published by Westview Press for AAAS in the fall of 1980.

3/ Timmer, Peter, "Choice of Technique in Rice Milling on Java," Indonesian Economic Studies, Vol. IX, No. 2 (July 1973), reprinted by the Agricultural Development Council, September 1974, p. 20 and Collier et al., Comment, reprinted by the Agricultural Development Council, September 1974.

4/ The Peace Corps in Nepal brought water to villages through plastic tubing to village taps. Only after women were trained to do repair did the taps stay in constant use.

5/ UNICEF surveyed the conditions of hand pumps in South India which it had installed previously and found four-fifths not in use. They then instituted a system of repair which has reversed the percentage, with four-fifths now in use. Villagers are trained in repair techniques but also provided with a pre-addressed postcard to mail to the county center if they are unable to make repairs. If the county technologist cannot repair the pump he calls someone in Madras. This three-tiered system depends on the villager who notices breakdown; the village women trained in this program have stayed while several men have sought higher-level technical jobs in the towns.

6/ Carr, Marilyn, Appropriate Technology for African Women, African Training and Research Center for Women of the Economic Commission of Africa, Addis Ababa, 1978.

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

This report describes the activities, conclusions, and recommendations of the Workshop on Evaluation Systems for Renewable Energy Systems sponsored by the Agency for International Development and SERI, held 20-22 February 1980 in Golden, Colorado. The primary objective the workshop was to explore whether it was possible to establish common information elements that would describe the operation and impact of renewable energy projects in developing countries. The workshop provided a forum for development program managers to discuss the information they would like to receive about renewable energy projects and to determine whether common data could be agreed on to facilitate information exchange among development organizations. Such information could be shared among institutions and used to make informed judgments on the economic, technical, and social feasibility of the technologies. Because developing countries and foreign assistance agencies will be financing an increasing number of renewable energy projects, these organizations need information on the field experience of renewable energy technologies. The report describes the substance of the workshop discussions and includes the papers presented on information systems and technology evaluation and provides lists of important information elements generated by both the plenary sessions and the small working groups.

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