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International Workshop on Energy Survey Methodologies for Developing Countries

January 21-25, 1980
Jekyll Island, Georgia

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Board on Science and Technology
for International Development
Commission on International Relations
National Academy of Sciences-National Research Council

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

PREFACE

The decade of the 70s will be remembered as the time when the world came to the realization that an era of cheap and abundant energy had ended. International economic and political relationships were transformed, and national patterns of growth and development were, in many cases, radically altered.

Although the rich industrial countries have been significantly influenced by shortages and rising costs of energy, the developing countries that possess no major energy resources of their own have been profoundly affected. As these countries are forced to use increasingly large sums of foreign exchange for imported oil or other energy sources, resources that might be used for social and economic development purposes are diverted.

The developing countries, then, must plan their strategies for energy use with great care and must utilize a wide range of energy resources, especially those that are renewable. Sound planning and effective actions, however, are most likely to occur when they are developed on the basis of good information about energy supplies and especially about energy consumption.

Realizing that there is a need for better energy-related information in many developing countries, the Office of Energy of the U.S. Agency for International Development (AID) asked the National Academy of Sciences (NAS) to organize a workshop on energy surveys in developing countries. The workshop was held at Jekyll Island, Georgia, January 21-25, 1980, and the highlights of that meeting are described in these proceedings.

Also included in these proceedings is a directory of energy surveys in developing countries. The need for such a directory was expressed early in the planning stages for the workshop, and thus one was presented in draft form to the

workshop participants for review. The purpose of this directory is to present the current state of the art in the energy survey field. It lists all identified energy surveys, indicates which countries and which donor organizations have carried out surveys, and describes the goals and designs of those surveys. The directory is presented as a primary reference document indicating progress made in this field and areas requiring further development.

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INTRODUCTION

BACKGROUND

Energy is a critical aspect of the national development process. It is expended in agricultural operations, in food processing and transportation, and in the production of fertilizer, pesticides, and farm equipment. It is necessary for industrial operations that provide jobs. It is required for cooking, for household lighting and heating, and for the construction and operation of the infrastructure needed for schools, health centers, and water supply.

The growth rate of energy consumption in developing countries is even greater than in industrialized countries. From 1960 to 1974, the average annual energy consumption growth rate for low-income countries was 5.7 percent and for middle-income countries 7.6 percent, compared to a consumption growth rate of 4.9 percent for the industrialized countries. From 1974 to 1976, the consumption growth rate for low-income countries was 4.6 percent, for middle-income countries 5.2 percent, and for the industrialized countries only 1.3 percent (World Bank 1979:138-139).

The developing countries that rely heavily on imported petroleum find themselves in competition with the industrialized countries for available oil and the cost of that competition is high. In papers presented at this workshop (see Appendix A), several graphic illustrations of rising energy costs were made. Kenya, for example, imports petroleum at a cost of 25 percent of the country's foreign exchange earnings, while Bangladesh and the Philippines spend 27 percent and 36 percent of their foreign exchange earnings, respectively, for oil imports.

Although the energy situation is very troublesome in many developing countries, it is not a hopeless situation. The possibility of developing additional fossil fuel and other indigenous resources can help relieve energy pressures in certain countries. Several countries have relatively unexploited resources of coal, peat, geothermal, and hydroelectric energy.

Conservation represents another important energy resource in most countries. Significant energy savings often can be made with a relatively small investment, while even greater savings are frequently available but at greater cost.

The traditional sectors of most developing countries make extensive use of noncommercial or nonconventional energy sources. Firewood, charcoal, plant and animal residues, human and animal power, and direct and indirect solar energy are used in the household and for a variety of agricultural and rural industry tasks. It is estimated that while these forms of energy supply only about 5 percent of world energy consumption, they represent about half the total energy production of developing countries that import oil, and more than 85 percent of energy production in many of these countries (World Bank 1979:41). While nonconventional sources will not in themselves provide enough energy to power development in most countries, they do represent a means of substitution for imported fuels and can play an increasingly important role in national energy balances.

None of these alternative energy sources and technologies will alone offer a complete solution to the energy requirements of national development. It is clear, however, that all countries must use the broadest possible range of available energy resources, and must devote considerable effort to identifying, developing, and disseminating these resources.

Good information about and analysis of energy consumption is necessary if nonconventional energy sources are to be used effectively; economic and behavioral factors can be as important as technological feasibility. In some cases, for example, more efficient appliances have not been accepted because their use involved unfamiliar behavioral patterns in domestic work. In some cases, the initial capital costs of a technology may be out of reach of most potential users, even though the technology would save money over its lifetime. Some energy sources or technologies may not be economically attractive at present prices, but they soon may be as other energy sources rise in price or become scarcer.

Because of the constraints on resources and capital faced by most developing countries, the collection of basic energy-related information is essential for sound planning related to national development needs. One study on energy in the developing countries has characterized the information situation by saying "Information on the *supply* of noncommercial energy is not good.... For *consumption* the situation is even worse. Very few actual field studies have been done so estimates are largely based on guesses and suppositions (Palmedo, et al. 1978:77-78)."

Recognizing that existing information about energy use in developing countries is often limited in scope and inadequate for effective analysis and planning, AID's Office of Energy asked the National Academy of Sciences to organize a workshop on the topic. About 75 participants, including many from developing countries, attended the meeting. Information was exchanged on surveys that have been carried out or are under way in a number of countries. The special information needs pertaining to the urban, rural, transportation, and industrial sectors were discussed in working groups and recommendations were made.

OBJECTIVES

The major aim of the workshop was to provide a forum for sharing knowledge and experience about ways to improve information for energy planning and policy making. The underlying concern was expressed in an AID program paper for a related project on energy policy and planning:

> The potential gain from a good data base of energy information is great. The potential damage (in the form of inappropriate projects and mismanaged resources) from faulty or incomplete information is considerable. Thus it is worth devoting resources to collecting energy information in a systematic manner to clarify issues on which energy policy must be based.

More specific goals for the workshop formulated by NAS were:

- To discuss the goals and objectives of national energy assessment in developing countries and the

consequent implications for the collection of information

- To present information on the principal approaches that have been used for energy surveys in developing countries, emphasizing noncommercial demand and supply
- To examine ways of improving the collection of information about energy demand and supply in the household, in rural and urban areas, and in the agricultural, commercial/industrial, and transportation sectors
- To suggest ways of strengthening national capabilities to design and conduct energy surveys, including institutional requirements and relationships, personnel needs, and technical assistance possibilities

In his remarks to the opening plenary session, which follow, workshop chairman Philip F. Palmedo outlined the workshop objectives for participants.

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OPENING REMARKS

Philip F. Palmedo, Workshop Chairman

This workshop comes at a key time in the evolution of national energy planning in developing countries. While recognizing the great diversity of the nations that we refer to as developing countries, I believe one can detect a trend in attitudes and activities related to energy planning. Following the oil price increases of 1973 and 1974, planners in many countries were forced to think seriously about energy as a national problem. Since that time, several countries have started to piece together available information that would allow them to understand where energy is used currently and what options are available for the future. Unfortunately, soon after such an exercise begins, one finds that the situation is more complex than one imagined and that much of the information needed to analyze energy strategies is simply not available.

This has resulted, over the last few years, in the so-called second stage of national energy analysis. Having found available information inadequate, several national agencies and research groups have begun to gather and analyze the primary information required for energy policy analysis. A small number of surveys of energy use have already been carried out, others are currently under way, and many more will soon be undertaken if national energy decisions are to be based on foundations of fact.

It is for these reasons that this workshop comes at an opportune time. Some substantial experience has been gained in gathering primary energy consumption information, and many data collection efforts will soon be initiated--efforts that could profit considerably from the early experience in this field. As was found when compiling the bibliography for this workshop, this is a new discipline with no secondary sources of information. This meeting has the opportunity of making a significant contribution to the field at a crucial stage in its development.

PURPOSES OF THE WORKSHOP

Three primary objectives of this workshop can be identified:

- To review and analyze critically surveys that have been carried out on energy consumption and potential demand in developing countries as they pertain to national energy planning. All sectors, uses, and forms of energy will be considered.
- Based on experience in energy and related survey areas, to identify successful methods and approaches that can be used by national energy planning agencies and others to create adequate information bases on energy consumption.
- To suggest ways in which energy survey activities in developing countries can be strengthened and supported, for example, through international exchanges of information or bilateral assistance activities.

This is not a conference or a seminar. The word "workshop" has been chosen with care, for if the workshop is to accomplish these objectives, it will require considerable work on the part of the participants. The participants have been chosen with these objectives in mind, and I believe it is a group that can accomplish these ends. If the workshop is to have the effect that is intended, we must produce a report that is useful to our colleagues who would want to attend such a meeting were it held 1 or 2 years from now. In general, three groups should be kept in mind in preparing contributions to a report from the workshop:

- The practitioners--energy analysts, economists, and social scientists who will be organizing and carrying out energy surveys
- National energy policy makers who will be or should be supporting and using the results of surveys
- National and international assistance agencies who can provide technical or financial assistance in carrying out surveys or in creating national energy analysis capabilities

No doubt a major benefit of the workshop will be the communication that will take place among those attending.

A PERSPECTIVE ON SURVEYS

I would like to emphasize the overall perspective that I believe this workshop should take about surveys. We are not talking about the acquisition of energy information for its own sake. We are not talking about surveys as intellectual or academic exercises, but rather as a means of gathering information that is useful in making national energy decisions and to policy making. Even if there were no lack of money, most countries severely lack skilled manpower, and more severely yet, time. Energy problems are urgent, and we can not afford information-gathering exercises that are irrelevant to national needs. There is no benefit in gathering information on urban energy consumption patterns, for example, unless information is included that helps us anticipate what effects price increases will have on different income groups, or the degree to which new energy devices or practices will be accepted by different groups. Energy surveys must examine the present with an eye to the future.

Thus in this workshop we can not avoid the difficult questions raised by energy surveys. These are not questions of sample size or statistical interpretation. These are the complex questions raised by energy choices which inevitably involve trade-offs. As an example, regarding the use of kerosene in rural areas, the policy maker is not only interested in how much kerosene is used for what purposes by whom, but he will eventually want to know the impact of increased kerosene prices on various income groups and on the total demand in rural areas. The degree to which other fuels, wood for example, will substitute for kerosene in such circumstances will also be important. This may in turn affect soil erosion and agricultural productivity, as well as the supply of wood or charcoal to urban areas and to small industrial users. The availability of kerosene in rural areas will itself be affected by urban demand. As this simple example suggests, the categories in which we are discussing surveys are in a sense artificial. Our discussion, therefore, should not only have a view to the future, but also beyond sectoral boundaries.

Above all, we should keep in mind that ultimately our concern is with providing information that can improve energy policy decisions--decisions that, as we are now aware, can have a strong influence on human well-being.

CONCLUSIONS AND RECOMMENDATIONS

During this workshop, four working groups discussed past experience with and the special needs of energy surveys in rural areas, urban areas, and the transportation and industrial sectors of national economies. The reports of those working groups follow this section. A number of common conclusions and recommendations were generated within the working groups as well as within the plenary sessions. They are presented here as summarized during the closing plenary session by workshop chairman Philip F. Palmedo.

THE NEED FOR AND ROLE OF SURVEYS

The need for energy surveys (the acquisition of primary information on energy consumption) and their importance stem from two basic facts: (1) the seriousness and urgency of the energy problems facing developing countries, and (2) a lack of information on which solutions to those problems can be based. The lack of basic information spans all uses and sectors of energy consumption, including the use of traditional or noncommercial fuels in rural areas and the direct consumption of fuels in the modern sector, including industry. The role of energy surveys, therefore, is to provide a firm information base for analyzing energy decisions and, ultimately, for improving those decisions. Of course, a wide variety of decisions must be made in the energy sector, ranging from very specific decisions on the siting or implementation of a project in a particular area to broad issues of national energy strategy such as the reduction of oil imports.

PRECONDITIONS FOR SUCCESSFUL ENERGY SURVEYS

Two preconditions can be identified for the successful operation of energy surveys that serve national and local energy planning needs. First, government institutions at the local or national level must perceive energy problems properly. If national energy problems, for example, are not construed correctly, information will not be gathered on the right issues and phenomena. Thus in many cases a broad energy assessment aimed at identifying energy problems of greatest concern will be necessary. Second, the ultimate effectiveness of a survey depends on the existence of an institution that can absorb the results of the survey and use those results to formulate and carry out energy decisions.

Thus if surveys must be designed to serve energy decisions, they should be designed and directed by the government agency that eventually needs the information. At the same time, energy is not a simple entity and energy problems that might be dealt with by an energy ministry or commission often require an interaction with ministries and agencies in associated areas such as transportation, rural development, or industry.

THE DIVERSITY OF SURVEY NEEDS AND APPROACHES

Energy issues and problems of a country come in many forms. If surveys are to fulfill their role in supporting energy decisions, they must have a similar diversity. Some will be directed to a particular immediate decision; others will be undirected or more properly directed to a broader range of policy concerns. Even the longer-term systematic collection of energy information (which could be included in national census activities) should anticipate the kinds of energy issues and problems that may arise over the long term.

Choices among the diverse means of collecting information, ranging from highly localized, project-oriented data collection efforts to the use of previous surveys, depend very strongly on the immediate and future needs for information. Despite the urgency of many energy problems and the natural tendency to focus on immediate project and planning needs, due consideration should be given to long-term policy making and planning needs, which may be served by more general information-gathering efforts and approaches that combine energy with other data needs.

SURVEY METHODS

The workshop concluded that, for the most part, there are no general survey methods or approaches that are universally applicable. A partial exception to that conclusion may be the industrial sector for which, at least in countries with fairly advanced industrial activities, an established survey methodology could have general relevance. Generally, however, surveys must be designed for local situations and for the specific policy needs of a country. Nevertheless, a great deal can be learned from the survey experience of other regions and countries, particularly other developing countries.

SURVEYS AND ANALYSES

Energy decisions are not assisted directly by undigested information, but rather by an analysis using that information. The type of information and its accuracy will be determined not only by the policy issues, but also by the analytical approach. For example, if one is concerned with projecting future energy demand in a sector using econometric methods based on historical trends, then clearly time-series information must be gathered. Other types of energy projection methodologies, which do not depend on historical time series, but rather on the future growth of underlying determinants of demand and on engineering analyses, will not require that kind of information.

FLEXIBILITY AND RESPONSIBILITY IN PERFORMING SURVEYS

Given the concept that surveys and associated analyses serve decision making, surveys should be designed and carried out in as flexible a manner as possible. For example, during the course of an energy survey in Burundi (See Appendix A, "Energy Surveys in Urban Areas: Experiences in Burundi and Cameroon" by E. Mbi) a possible solution to the initial fuelwood problem was uncovered, namely, the use of peat in a modified wood stove. It was possible to adjust the survey in midstream to gather more information on this option so that a more substantial conclusion could be reached at the end of the survey than would have been otherwise possible.

This flexibility is only possible if a mechanical survey approach is avoided and if those who understand the basic policy issues and analytical approaches are continuously involved in carrying out the survey. Thus data gathering and analysis, an integral part of energy planning, must be carried out on a continuing and flexible basis and must represent domestic capability. This is particularly important in rural areas. The participation of local people has been emphasized in this workshop; local capabilities should be built at various levels to gather energy information.

ASSOCIATED INFORMATION

Energy is never an end in itself; it is always one element in a more basic production process or function in society. In most energy decisions, there is a trade-off between energy and other elements, whether this is in a rural setting where energy in the form of fuelwood or agricultural wastes is one element in a complex rural resource base, or in industry where energy is one factor of production along with capital, labor, and other resources. Thus when gathering information on energy, one must be sure that the associated important information is either available or gathered along with the energy information. This requirement is particularly important and particularly complex in rural energy surveys because of the intimate role that energy plays in meeting basic human needs. The need to gather information that is associated with the basic energy data could mean including energy in broader information-gathering efforts, at the local or national level.

DIVERSITY OF SOURCES OF INFORMATION

We have spoken about surveys in terms of gathering primary energy information. At the same time, secondary sources of energy information are usually diverse, rich, and often overlooked. These sources include national census data, tax records, agricultural surveys, records of imports and exports, transportation surveys, etc. These secondary sources of information should be thoroughly explored before the expense of a primary data collection effort is undertaken. Secondary sources should be critically evaluated, however, since they often reflect data-

gathering efforts that were carried out before energy was considered an important national concern. The existence of multiple sources of information can be useful to verify an energy information base.

IMPLICATIONS AND RECOMMENDATIONS

A number of implications regarding energy assistance activities can be drawn from the above series of conclusions.

- The concept that energy surveys serve analysis and policy making implies that survey priorities must be based on national energy needs. These should be determined at the country level and not by preconceptions on the part of assistance agencies.
- The importance of surveys and the need for indigenous capabilities emphasize the value of technical advice at the design and analysis levels of surveys or of financial support for practical training, which can be carried out by the local survey supervisors.
- There is a strong need to strengthen the transfer of information and experience among developing countries. Support is needed for centralized channels of information exchange, both on data and on survey methodologies. It would be unwise to rely on a single clearinghouse for information of this type, and multiple channels of information exchange, both regional and international, would be helpful. Regional information transfer can be particularly useful and warrants increased financial support.
- Finally, a high overall priority should be given to assistance in information gathering and associated analysis. This recommendation is based on three fundamental factors. First, as widely recognized, the energy problems presently confronting developing countries are critical in terms of continued economic and social development. Second, energy decisions to be made in the coming months and years will have a major impact and both the opportunity costs and the financial costs of bad decisions can be high. Third, in contrast to the cost of faulty decisions, the cost of improving

decisions through better information and analysis is very small. Therefore, the potential benefit of assistance efforts in the areas of information gathering and analysis are great and should be given high priority in the international energy assistance efforts for developing countries.

WORKING GROUP REPORTS

During the course of two days of discussion, members of the four working groups (rural, urban, industry, transportation) exchanged experiences and information on survey work within their topical areas. A background paper had been prepared for each group and was summarized by the author as a means of stimulating initial discussion. A fifth paper, on household energy use, was presented in both the rural and urban working groups.

Each working group was asked to prepare a report that summarizes the main points of discussion and highlights the group's observations on surveys within that area. The reports were then shared with the full workshop in the final plenary sessions.

With some editing for brevity, the working group reports are presented in this section. Excerpts of the five background papers are contained in Appendix A. Common conclusions and recommendations from the reports were presented earlier in these proceedings.

RURAL WORKING GROUP

Ramesh K. Bhatia, Chairman

The subject of rural energy survey methodologies proved to be complex, as expected, because of two main factors. First, the working group members, realizing the gravity of the rural energy situation in developing countries, had individually given this problem considerable thought, and had thus formulated their own unique assessments of needs and responses--assessments based on their own areas of specialization, yet which strived to incorporate the implications of other disciplines in their own work. The second factor stems from the first. It was evident that the subject could not and should not be approached from the sole perspective of specific methodologies. Indeed, different perspectives introduce numerous new elements into the whole analytical process. Focusing on methodological techniques alone may exclude the social, cultural, political, institutional, and even economic and technical factors that play a determining role in translating quantitative survey results into indicators of practical value.

A FRAMEWORK FOR DISCUSSION

In an effort to extract a succinct set of ideas and recommendations from the detailed working group discussions, a logical framework for considering the wide variety of ideas was developed. The framework addresses the questions that anyone doing a survey is bound to ask:

- *Survey objectives*
  Why is the survey needed? What practical role can it play? How can it be utilized?
- *Survey scope*
  What can or should a survey cover or not cover?
- *Survey methodologies*
  How does one construct/pretest/administer a survey? Who participates in the survey and to what degree? How should the results be analyzed?
- *Organizational, personnel, and management aspects of a survey*
  What problems might be encountered in conducting a survey, particularly in terms of management and associated support services?
- *Role of cooperative activities and technical assistance*
  How can the survey effort be enhanced in the national and international areas?

OBJECTIVES AND SCOPE OF SURVEYS

The working group felt that it was not possible or necessary to design a survey methodology that would apply to all developing countries. Countries differ with respect to: (1) energy resource availabilities and demand patterns; (2) availability of data; and (3) institutional capabilities to carry out, analyze, and utilize surveys. Thus it was concluded that their energy policy objectives, program strategies, and information needs would be quite different.

It was accepted that energy program strategies are governed by the broad objectives of national policy, including the promotion of economic growth, rapid agricultural development, attainment of self-sufficiency in energy supplies, reduction of foreign exchange expenditures, and increased equity between urban and rural areas. In broad terms, four energy program strategies were identified:

- Conservation, including improved efficiency of energy-using devices, changes in the output mix in favor of less energy-intensive goods, a new conversion technology mix, and reduced consumption
- Substitution, which may include interfuel substitution, diversification, etc.

- Augmentation of energy sources to improve the balance of payments or to meet the growing needs of the agricultural and household sectors
- Improvement of the information base for long-term energy planning

It was concluded that the scope of a survey would differ according to whether the objective is to define general policy problems at the national or regional level or to aid specific project design and implementation. A national energy demand projection, for example, might be based on extrapolation of information collected from a quick (rapid first-cut) survey that gives information on consumption of fuels by different households across incomes and other socioeconomic characteristics. It may also be based on a critical evaluation of existing information in the same country, or in another country having similar socioeconomic characteristics. However, long-term policy decisions and programs should invariably be based on reliable data obtained from microsurveys conducted at the village or household level.

Survey parameters such as the type of information to be collected, type of respondents and investigators, timing, frequency, and methodology (what, who, where, when, and how), depend upon the program strategy in question. For example, the information needs and methodology would be different if the program strategy were conservation than if the strategy were augmentation of energy resources.

These complex interactions between program strategies and survey parameters can be compactly and usefully presented by means of a simple two-dimensional matrix (see Table 1). Such a matrix helps identify how varying program strategies impinge on an equally varying set of parameters. The relevant parameters also impinge upon one another in terms of the degree of importance of the analysis, the time frame involved, and the specific methodologies to be used.

As stated earlier, not all parameters described in the matrix will be relevant to every program strategy or survey type, and not all kinds of information will have to be gathered under each parameter. This is true for at least three reasons. First, the resource requirements of surveys are high in terms of money, skilled manpower, and, especially, local persons. The matrix should provide some guide for choosing the critical information needed to support specific strategies. Time constraints may be

TABLE 1 Matrix showing parameters necessary to support program strategies.*

	Program strategies			
Survey parameters	Conservation	Substitution	Augmentation	Improve understanding for long-term planning
What: Resources (input and output, linkages, access, employment) Income (distribution, cash, total) Prices (markets for fuel, others) Sociocultural factors (education, health, family and political structure, sex roles) Infrastructure (distribution networks, credit) Environmental indicators (climate, soil) Technical parameters (wind, solar, etc.)				

Who: Who do you ask? (sampling) Who conducts the survey? (local or outside) Who uses the survey? (local, national, international) *Where:* Systems boundaries--unit of analysis (individual, household, village, region, nation) *When:* Timing, frequency, and duration (daily/seasonal/annual) Historical data *How:* Questionnaire Interview Direct measurement Secondary information (critically evaluated) Observation				

*One should keep in mind when viewing this matrix that the policy objective (e.g., reducing oil imports, rural development, environmental improvement, debt reduction) determines the selection of a program strategy, which in turn determines the applicable survey parameters. It is recognized that the survey parameters delineated here may be incomplete; region-specific parameters may have to be added.

important as well, even if financial resources are available. Second, other sources of information may be available --such as previous surveys conducted under similar circumstances--and these could provide relevant data and reduce the amount of new information to be gathered. Finally, the utility of the information gathered must be balanced against the human costs of surveys, that is, some interference in people's daily lives and the raising of expectations may occur in conducting a survey.

SURVEY METHODOLOGY

Critical Evaluation of Existing Information

Surveys are rarely done in a vacuum. There is always some existing information on aggregate fuel use, agricultural production, livestock availability, and so on, that can be used as a starting point. Such information must be located and evaluated not only to avoid needless repetition, but also in order to build upon existing groundwork. Existing information may also be available on either the economic, social, or physical aspects of rural systems. Sources might include academic studies, agricultural censuses, farm surveys, forestry data, meteorological measurements, and other survey or project studies that may not necessarily be energy related but could still be a valuable source of information. Preliminary efforts at searching for existing studies are almost always fruitful.

Collection of Information--Methodologies, Procedures, Instruments

Most rural energy systems in developing countries are characterized by:

- Dependence on organic fuels
- Seasonal variation in energy demand and supply
- Proximity of fuel supplies
- High human energy input
- Dwindling fuel supplies
- Fuel scarcity perceived by the local people
- Fuel in transition from "free" good to commercial

- Increasing fuel prices (commercial)
- Certain people experiencing greater hardship than others
- Land access in certain regions becoming restricted
- Fuel shortages bearing indirectly upon agriculture or household organization

An energy survey should attempt to consider the full spectrum of energy-related activities. It is not enough to examine production, distribution, and consumption of traditional and commercial fuels. Rather, this information needs to be seen against the social, cultural, political, and ecological background.

The different survey approaches should also reflect village resources and energy-related resource flows (see Figure 1). This information should lead to an understanding of the man-land-water-animal equilibrium and the different characteristics of their environments. The extent to which these resources and their flows differ among economic classes must be understood so that plans for modifications will be sensitive to the reallocations that may result and their impacts.

The range of physical, social, and economic information usually needed suggests that a single survey will require a combination of methodologies, procedures, and instruments. The questionnaire technique, sample stratification, and sampling frequency needed for exploring household energy use will probably be different from those designed for looking at village, agroindustrial, or the animate/inanimate energy uses in agricultural production. Similarly, the surveys necessary to increase the understanding of the interconnected aspects of energy supply production systems, the nature and extent of energy conversions, transportation, and end use each require different methodologies and procedures, including specific tools to measure conversion and mechanical efficiencies (see Figure 2).

Surveys can lead directly to specific projects or can be carried out in conjunction with immediate ameliorative measures such as planting trees. When the survey is followed by a project, an important element is an estimate of the costs and benefits to the local population who base their energy decisions on social as well as economic factors, and for whom the impact of such projects will obviously be the greatest.

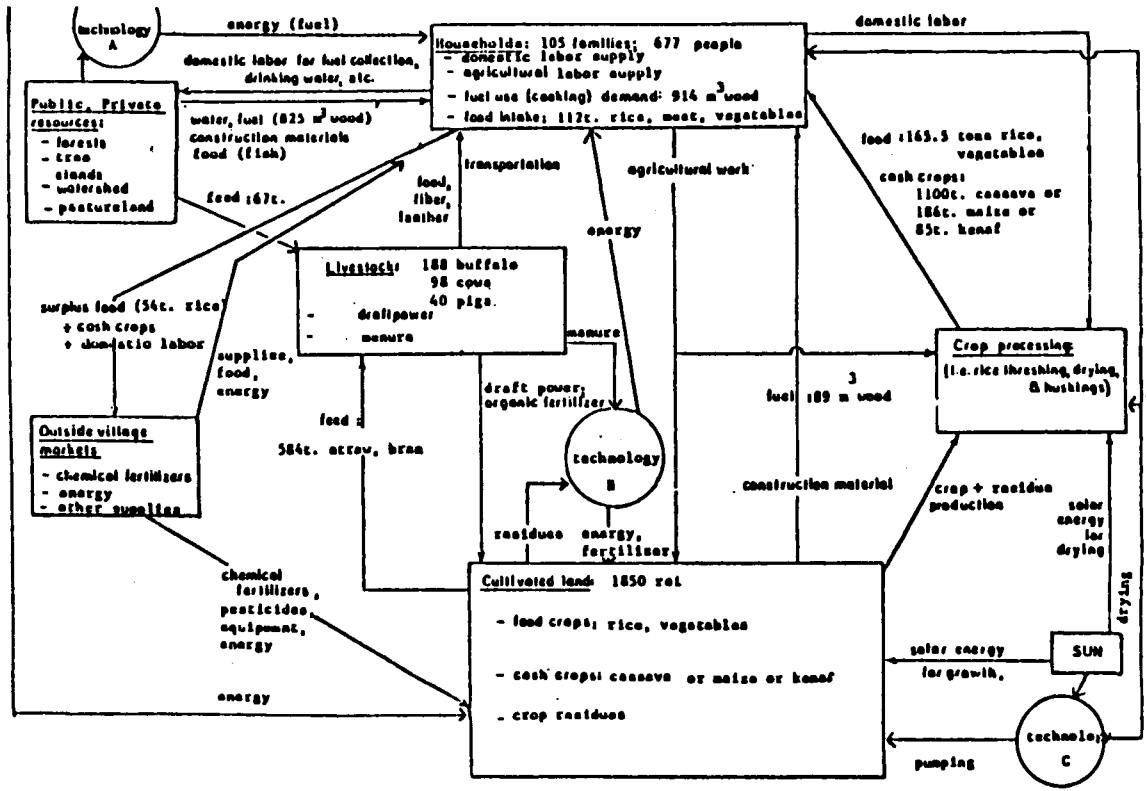

FIGURE 1 Village energy-related resource flows: Northeast Thailand. (Source: deLucia 1980)

Refrigeration, light, machine drive

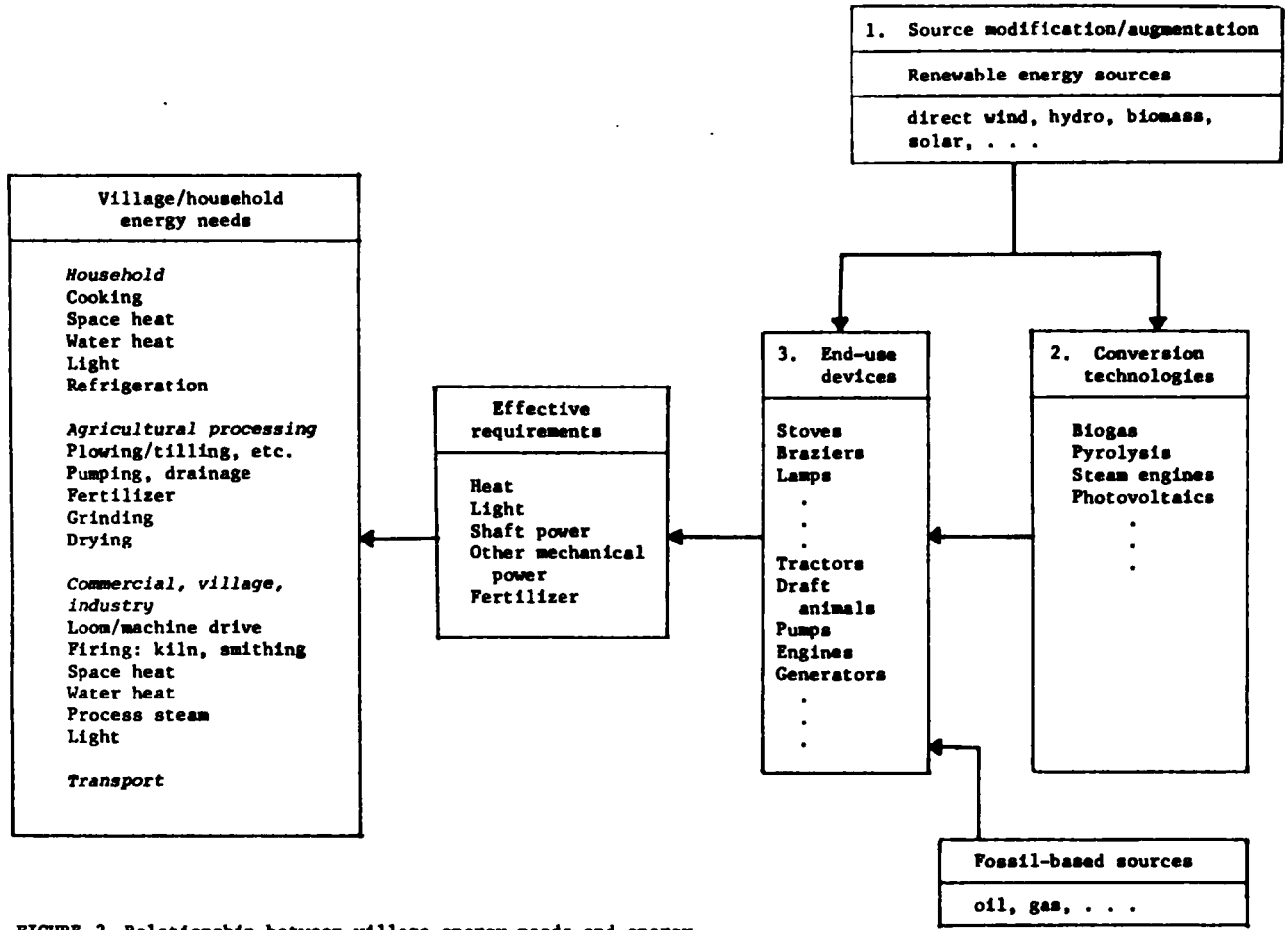

FIGURE 2 Relationship between village energy needs and energy technologies. (Source: deLucia 1980)

The magnitude of the data-gathering exercise should be consistent with the budget available and the degree of accuracy needed by the users of the results. In defining what data to collect, it is also necessary to know what facilities are available and what arrangements have been made for data processing.

Proper sampling is important, including such criteria as validity of the methods, degree of accuracy, ability to calculate error, and stratification needed to enable differentiation within the survey. In order to be able to subject field data to a range of data-processing procedures and statistical analyses, questionnaires that permit quantifiable or classifiable measurements should be used whenever appropriate.

If the survey is elaborate, pilot or test surveys are needed both to identify the main features of the data to be collected and to pretest the questions, data-gathering procedures, and measurement methods. These preliminary tests should include not only the relevance and practicability of the questionnaires and data-gathering procedures, but also the processes whereby survey staff can most effectively communicate with those being surveyed. It is important that questionnaires and field procedures are tailored both to the capabilities of the enumerator and to what information the respondents can be reasonably expected to provide.

In rural areas, where most energy decisions are made at the household level, it is important to understand how individual choices affect the pattern of daily tasks. These patterns have a direct impact on survival and future availability of energy resources. Quantitative data, such as economic and technical efficiency measures, are not enough to measure human behavior. Qualitative data, including marginal notes and observations which can not be codified, are often the most important indicators and should not be left out just because they do not fit the original survey design.

Experience has shown that field investigators can come from the same villages they are surveying or from other nearby villages. In either case, the results of their work should be checked by another surveyor as well as by the project director. Regular and thorough supervision is essential if the results are going to be valuable.

Participation of Local People in Surveys

Rural energy surveys benefit when local people are involved in the design and implementation of the survey. The type and degree of involvement will depend on the specific characteristics of each project and location. Ensuring involvement is always difficult but seldom impossible (see Mary Elmendorf's paper, "Human Dimensions of Energy Needs and Resources" in Appendix A for details). An essential first step is often to simply "walk and listen." The local people are rarely homogeneous. There are no simple, universal rules about *who* should be involved. It is seldom necessary to have the full-time, specialized services of an anthropologist in arranging local involvement, although it is helpful to have the advice of a social scientist with micro-level experience who is familiar with the area.

Questions relating to the involvement of local people in surveys are: Why should respondents become involved? How can we ensure that their answers are truthful, or at least that they reflect their perceptions of reality? How can motivation be increased? Response is likely to be better if the survey can be directly and explicitly connected to the local energy situation, and if some long-term improvements can reasonably be expected. However, people should not be given expectations that are unrealistic.

One novel way of increasing motivation was reported from Bangladesh (see Appendix A, "Energy Use in Bangladesh" by M. N. Islam), where seedlings were planted or distributed free to villagers in survey areas, most of whom planted them. Later, trees will be distributed to school children in survey areas, and it is planned to give prizes (after one year) to those who have the highest number of surviving trees.

Limits, Inadequacies, and Hazards

The accuracy of a survey is always contentious, but less so at the micro level than at the national level. Any competent supervisor with extensive and detailed local knowledge should be able to detect falsified or inaccurate responses. While energy surveys are usually an indispensable part of the planning process for energy programs,

there is a danger of overreliance on survey results. These should be treated with caution, even skepticism, and checked against other sources of information, including direct observation, and against comparative studies made elsewhere. Since published results can assume an unwarranted importance, it is necessary to maintain one's own critical attitude toward survey results, constantly questioning the clarity.

Surveys should not be treated as anything more than indicators or tools to facilitate the decision-making process by planners. Rural energy surveys alone are often insufficient to explain the broader parameters. For example, knowledge of village energy-use patterns alone may be inadequate for defining the processes that cause regional deforestation, depletion of organic material in agricultural soils, and consequent erosion and flooding. Clearly, several other factors (timber harvest, land clearing, overgrazing) combine with energy demand in influencing deterioration of the environment.

Parts of village surveys reflect what people think, which may or may not correspond to what the outside observer sees as reality. When possible, survey results should be confirmed with respondents and surveyors. Sometimes, a draft report can be circulated for comments among literate persons in the community, or portions can be collectively discussed, leading to clarification of ambiguities.

Surveys may also involve hazards relating to the rights of respondents. Surveys should be conducted with sensitivity and with awareness of the privacy of respondents.

Use of Results for Evaluation of Alternative Policy Options

Survey results can be used to evaluate alternative energy options, including: (1) new sources, i.e., minihydro, solar; (2) resource augmentation strategies, such as fuelwood plantations; (3) improvements in such end-use devices as chulahs, kerosene stoves, kerosene lanterns, or wick lamps; (4) price strategies including providing domestic fuels at subsidized prices to rural people, especially the rural poor. Each alternative can be evaluated using either a modified social benefit-cost analysis or cost-effectiveness analysis which takes into

account both the physical and social impact aspects. With benefit-cost analyses, data can be used to perform an analysis from the viewpoint of either the society or the user. Direct benefits and costs (capital and operating costs) of each alternative, along with the indirect benefits, should be clearly identified and quantified wherever possible.

ORGANIZATIONAL, PERSONNEL, AND MANAGEMENT REQUIREMENTS

The organizational structure used for a survey depends, of course, on the type of survey that is being conducted. National/regional surveys are broadly based on secondary data and information for various pertinent sectors. For those sectors for which data are not available, appropriate instruments and methodologies have to be formulated. Such an exercise would create within the government structure a permanent and continuing resource for updating, disseminating, and formulating investment plans and development plans. National/regional surveys would require a core group of experts and specialists relevant to the sectors, together with experts in trend analysis, projection, and forecasting techniques.

Local/area surveys would involve local institutions, agencies, and persons, and the compilation of inventories of local natural resources. Micro rural energy surveys should be sponsored or executed by agencies that are familiar with the realities of rural areas, and that have active extension or "outreach" services in those areas. Such services can prove indispensable in guiding or executing the survey itself, and implementing the interventions recommended by the survey.

In planning surveys, personnel requirements should be evaluated with a view toward maximum participation of the nationals of the country involved. It is important that field supervisors and enumerators be drawn from the regions and locales to be surveyed, thus bringing familiarity with their surroundings to the task. It is particularly important that enumerators are aware of the survey objectives, procedures, and proper methods of soliciting data. The use of students, extension agents, villagers, and others depends upon informed judgment as to which category of enumerator establishes the best rapport and greatest objectivity. Using women to collect data on tasks normally performed by

women can not be overemphasized. It may also be necessary to train planners and policy-making staff in the use of these surveys and methods. Training can be carried out as an individual project or through roving centers, depending on the specific objectives.

Rural energy surveys involving field data collection require an interdisciplinary approach if the realities of rural life are to be reflected in the survey. Planning of the survey and design of the survey instruments should involve no less than an economist, social scientist, energy technician, and a survey methodologist or statistician. More than one energy technician may be required depending on the technologies to be considered.

A number of implicit tasks are associated with survey management, including: identifying the financial and technical resources needed; establishing an organizational structure, together with a communication function and capabilities for information processing and presentation; pretesting; and attending to logistics and timing.

Management factors relevant to identifying resources are whether resources will be drawn from both external and national institutions and agencies, and whether more than one external or national institution is involved. The organizational structure must reflect two characteristics frequently associated with surveys: input of resources from multiple institutions and the needs of an interdisciplinary team. The communication requirements increase with the number of institutions involved, whether these institutions are separated physically, the number of disciplines represented by the survey team, and whether multiple field teams will operate. Budget control and normal project comptroller functions and problems are compounded by multiple institutions and funding sources. Insufficient attention to such problems can hinder the availability of technical inputs when needed. Consideration must also be given to overall data organization, requirements for data processing, and ultimate presentation of the material in report form. Further, management responsibilities include organizing a pretesting phase with lesser resources and organizational complexity before the actual implementation phase. Finally, the survey may include inputs from a number of institutions and team members, and scheduling these inputs and fieldwork tasks can be a significant chore. Schedule diagrams and even PERT (Program Evaluation and Review Technique) procedures both for overall schedules and for particular periods could be used.

ROLE OF COOPERATIVE ACTIVITIES AND TECHNICAL ASSISTANCE

Coordination among the diverse agencies involved in a national energy survey is obviously critical to the operation and success of the project. Such agencies should also collaborate with other countries undertaking similar projects.

Survey findings should be made available to the local population concerned and stored in a central repository of data accessible to all countries. Specifically, it is recommended that the United Nations Educational, Scientific and Cultural Organization (UNESCO), within the framework of its Intergovernmental Programme for Cooperation in the Field of Scientific and Technological Information (UNISIST), or some other international organization, work on the establishment, as soon as practical, of a central repository of data, survey methods, and findings to be accessible to all countries. Such data should include research and development pilot projects. Consideration should also be given to listing new survey projects in a periodic information bulletin.

Technical assistance aimed at energy surveys must be specific: for example, by helping in the design and preparatory stages, by furnishing outside experts or expatriate volunteers with necessary skills, and by processing survey data with sophisticated equipment and skills.

After the completion of the survey, it is important to ensure that its results are used by the relevant agencies. One aspect of utilization has already been considered under the methodology of social benefit-cost analysis, where these results are used in defining the design parameters and evaluating policy alternatives. Survey results should also be made available to the following groups:

- Policy makers and international financing agencies who may be interested in using these results in defining or implementing their programs and projects
- People in the surveyed area who should also receive information on decisions that have been taken on the basis of these results
- Other potential users such as researchers, educational institutions, government agencies not involved in the survey, and even other countries

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URBAN WORKING GROUP

Robert Nathans, Chairman

This report does not attempt to deal with the entire range of urban-related energy issues. Instead, this group concentrated on the kinds of information needed by policy makers for different kinds of decisions, the costs and benefits associated with various ways of obtaining that information, and past experience in carrying out and analyzing urban surveys. Thus this report reflects the feeling that attention should be paid to the methodological, procedural, and policy implementation aspects of urban energy decisions in the face of the demonstrable need for action on these issues. This, of course, in no way diminishes the need to understand the nature and interrelationships of different urban energy-using sectors in developing countries.

THE URBAN SCOPE

Urban-related activities account for a disproportionately large part of total energy consumption, and a very high percentage of commercial fuels, particularly oil. The sharp increase in oil consumption experienced recently in developing countries is closely associated with the growth of urban populations and the rapid rise in urban-based activities. In addition, urban areas also use substantial quantities of traditional fuels--wood and particularly charcoal. For many of the developing countries, payment for oil imports is a heavy drain on limited supplies of foreign exchange. Furthermore, it is widely reported, though as yet inadequately documented, that rising demand for fuels from urban areas is diverting supplies of traditional fuels from rural areas. Given the difficulties these circumstances pose for future development efforts,

further investigation of the urban energy system seems indicated.

Data needs for the transportation and industry sectors were discussed elsewhere in the workshop. Household energy usage in the urban sector is of particular concern here, including under this rubric the wide range of small-scale commercial activities that take place in urban areas, often closely related to the household. Very little is known about energy use in this wide and disparate area. Given the large number of units involved, surveys may be the only way of obtaining the information required for policy making.

A conceptual framework that encompasses the energy-urban system interaction should consider the ubiquitous, dynamic, and multidimensional nature of urban centers and yet allow sufficient disaggregation so as to distinguish and compare important characteristics. Beginning with an understanding of the national political and social context within which a given urban region lies, and then defining the characteristics of its boundaries, its "built" environment, its demographic characteristics, and its energy-use processes and activities, a comprehensive urban description can be developed.

Urban boundaries vary considerably according to geography, administration, population density, and especially the infrastructure of water/sewage, electric/telephone grids, and roads, which are all measures of modernization.

When viewed in terms of energy considerations, the "built" environment consists of energy consumers such as buildings and their auxiliary equipment, as well as the food distribution system, and energy suppliers such as both the centralized and decentralized utility delivery networks, and the physical aspects of transport systems (vehicles, roads, and their control systems).

Demographic considerations for urban areas should include size, growth, family/worker composition, and work patterns, as well as important locational variables ranging from socioeconomic enclaves to mixed-use patterns.

Processes and activities within the urban setting that are related to energy consumption should include both the formal industrial/commercial sector as well as the informal sector which encompasses home crafts and other individual and decentralized commercial activities.

A better understanding of the vulnerability and resilience of the urban system requires information about the temporary and permanent capabilities of various forms of energy substitutability. This information should be pertinent to situations in which equipment and appliances

are both fixed and changeable as well as to the substitution of human energy for fuels.

INFORMATION NEEDS

For Policy Decisions

Many important and immediate energy-related decisions must be made, and are now being made, in developing countries. Utilities, economic ministries, and newly formed energy offices in most energy-importing countries are being forced by the sharp increases in oil prices to make abrupt changes in government policies which affect every aspect of energy use in the urban environment. The relative and absolute prices of fuels are being set by pricing and subsidy decisions. The structure of import duties on energy-consuming products is being determined. New, unfamiliar measures to encourage use of alternative fuels are being introduced quickly; energy-conserving incentives are being formulated. The opportunities for government intervention to obtain quick payoffs from technological innovations are being explored. It is not surprising that with few exceptions decisions affecting these critical areas are being taken in the absence of an adequate informational base. What is disturbing is that in many of the lower-income countries there is almost a total absence of relevant information. In general terms, the basic information that is missing is who uses how much energy and for what activities? This particularly applies to direct and indirect energy uses in low- and middle-income urban households, to small labor-intensive industries in urban areas, and to the provision of transport and other public services.

International agencies, development banks, national independent assistance agencies, and export-import banks all face similar uncertainties in making decisions to invest resources aimed at the urban sector in a specific country. Their information needs are directed toward evaluating the fiscal integrity of project and program investments, being able to establish the beneficiaries of loans and grants, and estimating the impact of such investments on both the organized and unorganized sectors of the economy. As a result they require information not only on existing energy flows, but also on indications of future government, industry, and consumer behavior bearing on these concerns--a situation made more difficult by the lack of time to develop this base of knowledge properly.

Whether or not these same agencies should reorder their internal priorities may have even more importance for the developing countries if urban energy information is available. The fact that lending and donor organizations are making sweeping changes on the basis of little or no micro data of energy uses in the urban sector does not suggest that this information is not necessary, but rather that they are facing a sense of urgency in member countries and developing country recipients. The immediate information requirement for these types of decisions may be best satisfied by relatively crude cross-country time series of urban energy uses primarily as they relate to infrastructure investment.

For Planning Purposes

In addition to the immediate decisions affected by urban energy information, a number of planning issues would be facilitated by better energy information. Planning by energy ministries obviously would be affected by improved data, as would planning for urban public services, housing, infrastructure, and other sectors that have an energy component. The planning issues can be divided into two groups: (1) general policy concerns, and (2) project evaluation.

One general policy concern is predicting future levels of demand for energy, both of all fuels combined and of specific fuels. With better information, the likely response of households to future income and price changes can be estimated and used to forecast household demand, while better information about urban small-scale industry and informal production can be used to forecast energy-use patterns in these sectors. These demand forecasts can then be used in the long run to guide planning for resource development. In the medium term, the forecasts will help to predict likely bottlenecks, which can then be addressed before they reach crisis proportions.

A second general policy issue is identifying the most fruitful possibilities for energy conservation or for increased efficiency of fuel use. Painfully scarce resources dictate that developing countries concentrate their energy policies on projects that will produce the greatest effect per dollar spent. In addition, with more information, the likelihood of unanticipated adverse consequences of projects will be reduced.

A third general policy concern is the question of the resiliency of urban areas to sudden adverse events in energy markets. Will increased prices have a large or small impact on economic activity and household behavior in urban areas? Will a sudden shortage of petroleum fuels devastate cities in a country, or will adjustments be sufficient to avoid major dislocations?

Finally, there is a long-term need for more information to address the general topic of energy and development. With a better understanding of how energy in each country is used in households and in the marketplace, energy can be incorporated in an informed way into a country's development planning.

Questions related to specific projects can also be clarified by better information about energy uses. All projects, especially those undertaken quickly in crisis situations, benefit from scrutiny of their effectiveness. This post-project evaluation is an important medium-term use of information gathered on energy-use patterns. Both the successful and unsuccessful aspects of past projects can help in making decisions on possible future efforts.

Of the several uses of information discussed here, project evaluation most clearly requires an ongoing information-gathering effort. General policy issues need not wait for complete information before they are addressed, although they can be more clearly addressed as more information is collected. Household and other sector use of energy can be forecast, bottlenecks identified, etc. beginning with the first data collected. Successive increments of data will allow refinement of the analysis, but immediate tentative conclusions can be used as inputs into planning efforts. The plans and policies of the government can then be adjusted using the information from continuing collection efforts and the insights gained by further analysis of such data.

SURVEYS

The decision to carry out an urban energy-related survey is not one that should be made lightly. Surveys tend to be costly and time-consuming, and may not obtain the information desired. In general, a survey is only appropriate if it is clear that there are no easier ways to obtain the information and, even then, the benefits from the survey must be weighed against the costs involved. Nonetheless, there is clearly a role for urban surveys in the energy field.

The type of survey that would be appropriate depends on the kinds of information needed and the level of accuracy required. A survey designed to assess the feasibility of a specific project may be quite different from a survey designed to monitor the success of a project, and may be even further removed from a survey designed to aid in energy planning at the national level. For example, even within the restricted context of household energy surveys, a survey appropriate to determining the feasibility and desirability of introducing a more efficient charcoal stove is likely to be more detailed, with a larger proportion of open-ended questions, than one aimed at helping formulate fuel pricing policies. The feasibility survey, however, may not require as large a sample of households. In such cases, it may be less costly to carry out two separate surveys than one large, detailed survey.

In spite of the wide variety in survey types, most of the difficulties involved in designing and implementing urban energy surveys had already been encountered and to a large extent overcome before the first urban energy survey was even considered. Such issues as sampling procedures, bias, interviewer/interviewee interaction, memory problems, choice of question forms (e.g., open-ended versus closed), and even the difficulties involved in estimating the consumption of noncommercial goods and surveying in the informal sector are widely represented in the literature and are in no way unique to energy. Regardless of the urgency of the situation, it is clear that no large surveys should be carried out without the help of this experience.

The experience derived from the urban energy surveys that have been already carried out is also useful in identifying some of the problems likely to be encountered and the limits in the types of information that can be collected. Urban household energy surveys (focusing largely on the quantities, fuel forms, and uses of energy for different household groups) applied in cities with very different social and economic conditions have encountered very similar difficulties. Problems such as multi-household metering, lack of standardization of noncommercial fuels, and the simultaneous use of fuels for residential and commercial purposes appear to be endemic to urban household energy surveys. Similarly, in urban transportation it is generally difficult to obtain a clear distinction between personal and goods transportation and to obtain information on the use of illegal transportation modes. Unfortunately, while the informal sector has been

identified as an important area for gathering energy information, energy survey experience in that area is very limited. And so, despite the fact that some problems may prove to be very similar among cities, the large diversity of informal activities within cities is likely to make city-specific experience more valuable, even if it is not directly related to energy.

Traditional surveys are only one source of data. Other means of collecting energy-related data can also be used to supplement and check interviews or questionnaires. For example, trace measures record actual behavior by counting, weighing, mapping, or otherwise measuring its material components.

Trace measures have several uses. When a high level of accuracy is needed, they may be used as checks on interviews (e.g., utility company records are checks on reported fuel consumption). Trace measures may reveal divergencies between people's perceptions and material realities which have an impact on fuel use. Further, trace measures could possibly be used as relatively cheap and simple alternatives to surveys. For example, remote sensing (aerial photography, especially with heat-sensitive film) can be employed to separate neighborhoods into fuel-use strata and plot changes in the intensity of fuel use over time. Or, synchronized observations by several participants can provide information on the frequency of underreported activities, such as the use of illegal "taxis" or unlicensed breweries.

While trace measures avoid the problem of informant bias in surveys, they have built-in biases of their own. Their practical application seems limited at present, partly because they have rarely been used. Nevertheless, depending upon the reason for the survey, available funds, and the accuracy required, the creative use of trace measures can provide a useful alternative or supplement to traditional surveys.

EXISTING SOURCES OF INFORMATION ON ENERGY USE AND SUPPLY IN URBAN AREAS

Existing sources of information, including surveys, can often provide the necessary data for policy action and thus prevent the unnecessary and redundant collection of information already available. The use of such information can also show ways in which to refine methodologies to make them more effective based on past experience (including mistakes).

Urban areas generally have more information available on various activities than rural areas, including direct information on energy. There are, however, urban sectors for which energy information (direct and indirect) is very poor, notably low-income households (often the majority of the urban population) and the informal sector. These are important gaps.

Kinds of Existing Sources of Information

Three categories of information on urban energy use can be identified: urban energy surveys, nonenergy urban surveys, and nonsurvey energy information.

Few citywide (all sectors) energy surveys exist. The most notable ones to date are the Hong Kong Energy Study (Newcombe 1976) and the older study of three Indian cities done by the National Council of Applied Economic Research (NCAER) of India. General urban energy surveys have also been reflected in data collected for national energy surveys (e.g., the Bangladesh Energy Study--see Appendix A, "Energy Use in Bangladesh" by M. N. Islam).

Sectoral energy surveys have become more common, although they are rarely complete in their coverage of fuels or end uses and do not always show the energy flows between related energy sectors. Two recent surveys are notable exceptions to this problem: the urban energy surveys of Nairobi (Somasekhara 1979) and of Mexico City (McGranahan and Taylor 1977). Surveys on the use of energy by transport, industry and commercial buildings, and public services have usually been included in studies of national energy use (e.g., World Bank Energy Sector project appraisals of Korea, Nepal, and India), the large-scale industry section of the U.S. Department of Energy/Egypt Energy Assessment, or parts of studies on industrial output or transportation planning. Surveys of energy use and supplies in the informal sector are unknown, and in small industry are indirect.

Fuel surveys have been done in some countries (e.g., India) but often do not adequately reflect how well these fuels are being used, the importance of certain energy forms for different activities and tasks, and other policy-relevant variables.

A wide variety of nonenergy surveys can be used to avoid unnecessary field collection of needed data, to develop proxies or surrogates for unobtainable energy information, and to point to promising areas of investigation.

The following examples are illustrative. They entail some detective work and, of course, some thoughtful methodological integration to the rest of the energy study. Household expenditure studies of a central bank or other national statistics-gathering organization can provide information on household fuel purchases. Nutrition and fertility studies and the studies of household activities in the growing literature on women can provide useful information on energy-using appliances, lighting, cooking, etc. Industrial and transportation censuses can provide necessary information on car ownership and travel plans, kinds of energy used in industry (including labor), and other useful information. The World Bank and the International Labour Organisation have done or sponsored surveys of urban labor patterns that are almost the only sources of information available on the informal sector.

Nonsurvey information is most useful as preparation for doing surveys, as supplementary information to help verify survey data (triangulation), or as a surrogate for energy information unobtainable from surveys. Existing sources of information are potentially numerous depending on the need (lack of previous surveys) and time available to the surveyor. Examples include descriptions of urban neighborhoods or energy sectors by Peace Corps Volunteers, urban anthropologists, and sociologists (especially in Latin America). Other sources are city budgets, oil company sales records, physical evidence of energy use, and specialized studies (e.g., of the manufacture of construction materials, the efficiency of use of different kinds of cooking fuels).

RECOMMENDATIONS

Given the lack of sufficient information on energy use in urban areas of developing countries and the demonstrable need for it, assistance agencies and international lending agencies are long overdue and even remiss in not improving the capability of developing countries to compile this information. A serious effort to create this capability and gather such information should be made. Thus this working group recommends the creation and/or redirection of institutions to support and analyze energy information, including surveys, and to help train the necessary personnel. Surveyors, energy analysts, and field personnel should be trained to collect and analyze information and provided with the necessary post-training support. Training for individuals

right on down to the level of participant-observers and community groups should also be included.

This working group recommends the creation of a data clearinghouse for the energy information from developing countries. Such a clearinghouse would act as a repository for surveys and methodologies and their data and would be organized in such a way as to provide surveyors, policy makers, and researchers with information and experience relevant to a particular geographical area, energy problem, or potential solution.

The working group also recommends early attention to the energy data needed for problems requiring urgent attention, such as energy for basic household needs and municipal services and the use of specific fuels for these purposes, especially oil and wood fuels. This group also recommends increased gathering of data on the energy consumption and supply patterns affecting the urban poor, not only data on their household energy demand but also on productive and service activities associated with the urban poor: informal sector activities, small industries, and low-cost transportation.

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INDUSTRY WORKING GROUP

Thomas Veach Long, II, Chairman

The industrial sector is a significant consumer of fuels and electricity in all economies, often accounting for more than 30 percent of total national consumption. Given the constrained availability and increasing prices of energy goods, particularly oil, the *rational use of energy* to produce maximum sustained economic growth is a key element in overall economic and energy planning processes.

Universal recognition exists of the need for new and improved information about fuel and electricity use and optional consumption patterns. For the industrial sector, a survey is broadly defined as a quantitative and disaggregated data-gathering effort which is applied to individual industrial demand sectors and directed at decision makers for use in analysis, planning, and program implementation. The generic objective of an energy survey is to furnish information useful in: (1) describing and monitoring energy supply and consumption patterns; (2) modeling and analyzing these energy patterns to relate them to specific influences and policies; and (3) choosing and effecting energy policies from available options.

POLICY ISSUES: THE IMPORTANCE OF INDUSTRIAL ENERGY SURVEYS

The need for industrial energy surveys is best established by focusing on specific issues to which the data will be applied. This emphasizes the transition from passive data gathering to active policy implementation.

Energy decision making should be embedded in a broader framework. The two principal objectives of national economic planning are stimulation of vigorous economic growth so as to increase the welfare of the average citizen, and assurance of national security. Subordinated to these is

a desire to increase the value of exports and decrease imports so as to attain a favorable balance in the external sector. Reducing the dependence on imported fossil fuels and moving to the use of indigenous and renewable energy sources play an obvious role in achieving each objective, but in combination with other political and economic actions. For example, even though energy self-reliance may be a goal, certain projects may improve the balance of payments enormously despite an increase in imported fuel. Activities in the industrial sector are central to these considerations, and a special effort to design and conduct national industrial energy surveys is indicated.

Sectoral data on industrial consumption of fuels and electricity per unit output would be useful in addressing the following issues:

- Maximization of industrial output with a given energy consumption or minimization of energy consumption for a given output. In many countries, the lowest-cost, short-term source of an additional barrel of oil is through increasing the efficiency of current consumption in a rational energy-use program.
- Maximization of the use of indigenous and renewable resources at a reasonable cost in comparison to alternative opportunities. Actions directed at achieving self-sufficiency and improving supply security should be aimed at long-term, stable development rather than short-term comparative advantage.
- Evaluation of the opportunities and incentives for fuel switching
- Examination of the impact of energy prices on the balance of payments. In certain cases, it may be advisable to proceed to partial industrialization, exporting semi-industrialized goods, before the step in which large energy inputs would be needed. In other cases (e.g., for countries rich in hydroelectric resources), it may be advisable to export energy by embodying it in a processed good (intermediate or final).
- Determination of the environmental impacts of new energy supply and consuming technologies
- Assessment of the possibilities for dispersed vs. centralized energy supply consumption

- Design of procedures for the allocation of specific fuels and electricity under a supply price "crunch" or disruption
- Determination of the compatibility between private decision processes in industry and national interests. Policy issues require measures to guide the perceptions of private interests toward national goals. This is done by proper tax mechanisms and incentives. The surveys should include data suitable for the analysis of the effects of taxes, direct subsidies, and other financial instruments.
- Analysis of the trade-offs between energy production and consumption and the production of other essentials, such as food
- Evaluation of the consequences of energy policies with regard to employment, capital investment, and other economic variables

When resources permit, it may be advisable for different entities to conduct more than one survey. Such a procedure would allow both comparisons that would improve the quality of the surveys and analyses of discrepancies, and would avoid a monopoly of information that could lead to possible data manipulation.

THE INSTITUTIONAL ENVIRONMENT FOR ENERGY SURVEYS

There are four institutional planning levels: international, national, sectoral, and enterprise. All these levels may be tied to government, but, in many cases, the sectoral and plant planning activities may be wholly controlled by the private sector.

It is useful to relate data needs to specific issues, as we have already discussed. Often, these issues can be sharpened by identifying the level of planning at which the decisions will be made. At the national level, energy forecasting and planning to evaluate overall resource requirements and possible constraints on development represent the most important uses of data gathered from energy surveys. At the industry level, energy information is important for establishing targets and standards for energy use in each industrial subsector, as well as examining overall technology needs. At the level of a specific plant or enterprise, one of the most important energy-related tasks is the choice of new or retrofitted

technologies based on current or future energy prices and availabilities. Finally, an important international function of energy surveys is their contribution to the development of comparative data for industrial energy-consuming processes. These comparisons are useful in choosing specific technologies in the industrial sector, in forecasting the potential evolution of energy consumption in all sectors, and in evaluating the accuracy of energy consumption data collected in the individual surveys.

All national surveys are integrated into a national planning effort. Energy demand forecasting and scenario-building are perhaps the most important energy-related components of national planning. Thus energy surveys should be designed in accordance with the data needs of current forecasting models. Countries that are just beginning to use data-intensive national planning and energy forecasting should design a survey that will be compatible with their future needs.

The decision-making structure at the national level varies significantly from country to country. Some have more centralized systems, other more diversified systems, and several countries fall in between these two categories. In general, for an industrial energy survey, one could visualize a four-stage hierarchical structure:

I Ministers and deputy ministers who make the overall energy policy decisions on the advice of II.

II Senior-level civil servants who receive the survey and policy suggestions from III and who would, after review, submit them to I for approval.

III Engineers, statisticians, and economists who plan the survey and use the data. They communicate their policy recommendations to II and instruct IV on operational survey procedures.

IV Operational field staff who take the survey questionnaires to industry managers and assist in their completion. They should be trained to do this by III.

The survey design should be constructed so as to be compatible with this general institutional structure.

PRINCIPAL OBSERVATIONS FROM EXISTING INDUSTRIAL ENERGY EFFICIENCY PROGRAMS

There is large potential for more rational use of energy in the industrial sector, with a possible reduction in energy use per unit of output of 20-30 percent over 5 years. A first step might be improved operational and managerial techniques (better housekeeping). A second step might be minor additions to and modifications of a facility. For example, changes in lighting and space conditioning and better process control systems (solenoids, microprocessors) will reduce energy use dramatically. New technology can reduce energy consumption in some cases by 30-40 percent through inherent design. Thus a substantial decrease in energy consumption in the industrial sector could result without a deleterious effect on total production and economic growth.

Increasing energy efficiency by replacing existing production facilities requires major investments in new physical capital. This should be undertaken only in those cases where it would prove cost-effective, in conformity with usual economic decision rules. However, increases in the *real* prices of fuels and electricity, and the expectation that they will continue, make energy-saving capital investments an attractive option.

An additional observation is that the end-use application of energy is another important element in the analysis of industrial energy use, and survey design can often include questions relating to the breakdown of energy use for space heating, lighting, process use, and steam raising. This breakdown may provide an important guide to the potential for energy substitution.

COST-EFFECTIVENESS OF INDUSTRIAL ENERGY SURVEYS

Disciplined efforts at increasing the rational use of energy in the industrial sector can pay real economic dividends to the firms involved. The cost savings enable export-oriented industries to be more competitive in world markets and give import-replacement industries cost advantages. The total national impact is greater than the sum of these effects, because the health of the external

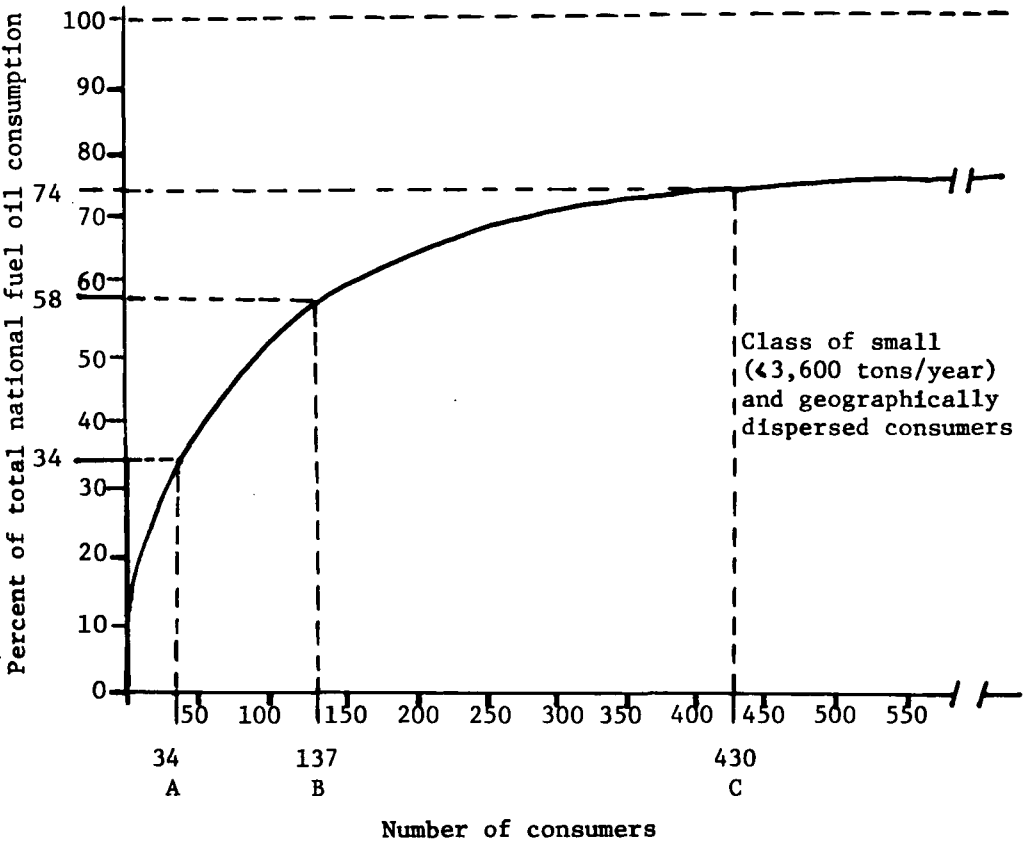
sector of the economy is increased, making the nation more creditworthy. Additionally, a reduced dependence on imports of essential goods has a positive effect on national security.

An integral element of a national program of industrial energy husbandry is a disaggregated survey of industrial energy consumption. Particularly compared to its potential benefit, the costs of such a survey are not great. There are several reasons for this. First, the necessary data have usually already been collected by individual firms, although this is not done systematically and the data are not analyzed to assess opportunities for decreasing energy use. Second, a coverage of 75-85 percent of total sectoral energy use can be achieved by surveying only a limited number of energy-intensive sectors. As Table 1 shows, surveys in four countries yielded a 75 percent or greater coverage with attention to 10 or fewer industrial subsectors.

TABLE 1 Coverage achieved by industrial subsector surveys.

Subsectors surveyed	Egypt	Peru	Portugal	Tunisia
Food processing		x	x	x
Textiles	x		x	x
Paper	x	x	x	x
Chemicals	x	x	x	x
Ceramics			x	x
Glass	x		x	x
Cement	x	x	x	x
Nonferrous metals	x	x	x	
Iron and steel	x	x	x	x
Petroleum refining	x	x	x	x
APPROXIMATE PERCENT COVERAGE	80	75	75	80-85

Finally, the number of actual establishments that must be surveyed for substantial coverage is also limited. This is true even within relatively large and variegated economies. Figure 1 illustrates this point in relation to Brazil. As a portion of total national consumption of fuel oil, 34 industrial consumers account for 34 percent, 137 for 58 percent, and 430 enterprises for a cumulative total



Classes of industrial consumers:

A More than 68,000 tons/year
B 18,000-68,000 tons/year
C 3,600-18,000 tons/year

FIGURE 1 Concentration of fuel oil consumption by class of industrial consumer in Brazil. (Source: Brazilian Ministry of Mines and Energy 1979)

of 74 percent. These facts indicate that industrial energy surveys will be considerably less costly than urban, rural, or transportation surveys.

There is an additional argument for carrying out industrial surveys and that is the difficulty of designing national policies for this sector without them. By comparison, energy husbandry policies for the transportation sector are fairly well defined even in the absence of surveys: stimulate efficient mass transportation and increase gasoline prices and private automobile licensing fees to discourage unnecessary gasoline consumption, with proper attention to ameliorating severe distributional impacts. For the industrial sector, one must design incentives for efficient energy use that do not have a major negative or distorting effect on economic growth and employment. This requires knowledge of the disaggregated, individual sectoral consumption patterns implied in a survey.

The level of effort needed for a survey obviously depends on the extent of detailed data required and on the specific purpose of the survey. The purpose of many current industrial sector surveys is not to build a statistical system but to provide quantitative guidance for energy policy decisions in the near term.

It is best to compare costs of industrial surveys in terms of person-months of skilled, professional effort. For moderate-sized nations, 5-8 person-months are normally required for a medium level of data development. This can result in the 70 percent-of-usage coverage desired.

Further detailed work, such as a comprehensive evaluation of fuel substitution possibilities, may take considerably more effort (perhaps several person-years). Gathering time-series data on energy consumption, which are valuable for understanding industry consumption patterns and trends, may also require a significant effort because good historical data are rarely available. A great deal of investigation of past records and a variety of sources may be needed.

In general terms, data for most large subsectors are easily gathered (e.g., cement, steel, fertilizers, petrochemicals), while the most difficult-to-assess subsectors are those industries with large numbers of small plants performing diverse activities (e.g., the food and textile industries). The nonferrous metals industries are often complicated by the interchange of materials among centers of activities (e.g., mines, beneficiation plants, smelters, refining plants, and rolling mills).

Major industrial surveys should be timed for maximum input into national planning efforts, which take place usually at 5-year intervals. In the interim, more specific data gathering should track fast-changing sectors, monitor progress toward goals, and develop industrial commitment. There should be a simultaneous effort to establish a rational energy-use program. Too-frequent surveys may be counterproductive if they delay needed capital projects while the results of the most recent studies are awaited.

SURVEY DESIGN AND OPERATION: SAMPLE SELECTION, SURVEY PROCEDURES, AND DATA USE

Guidelines for Sample Selection

Since there is a practical limit to the resources available for surveys (time, manpower, money), it is necessary to decide on the priorities for investigation among industrial subsectors. Ranking of subsectors in order of importance for energy survey purposes should utilize available statistical data. The following indicates recommended ranking procedures in order of preference:

1. By current energy consumption
2. By contribution to the gross national product (value-added)
3. By value of shipments
4. By number of employees

Independent of the ranking procedure that is chosen, only reasonably accurate data are required, because this merely provides a rapid mechanism for screening the subsectors for their relative importance to the national energy balance. Again, a practical rule of thumb is that 70 percent or more of the industrial sector energy consumption should be covered by the subsectors chosen for detailed analysis, and this can usually be achieved with less than 10 major subsectors as shown in Table 1.

In a first-order assessment of the industrial sector, it is often true that subsectors accounting for less than 5 percent of industrial sector energy demand do not merit detailed consideration. A first-order survey is not intended to provide a statistical data base (census) of the kind maintained by a national statistical office, but, rather, to provide a picture of energy consumption patterns

that is appropriate for the analysis of development and energy policies. The results of a survey can also be used to update the initial ranking of subsectors and to improve the definition of priorities for subsequent work.

When selecting subsectors for inclusion in a survey, it is important to recognize the potential for growth of specific subsectors. Often subsectors that today represent a small energy demand may be expected to grow significantly in the next few years, with a concomitant increase in energy consumption. A typical example of such a subsector would be the smelting and refining of a nonferrous metal for which deposits of ore have recently been discovered in a country and are expected to be exploited in the near future.

Having chosen the subsectors for study, it is necessary to list the major activities within each and to decide on those that should be included in the survey itself. For example, the nonferrous metals industry may include the smelting and refining of copper, lead, zinc, and aluminum, and the food processing industry may include baking, flour milling, brewing, dairy products, meat packing, and many other activities. Based on the resources available for conducting the survey and on the relative importance of the various activities, a judgment must be made as to those activities to be included in the survey. In practice, it has been found that a reasonable sample of an industry's use can be obtained by including three or four activities, corresponding to a coverage of more than 80 percent of a subsector's consumption.

Survey Procedures

In performing a survey of industrial energy demand, it is usual to start by reviewing national energy statistics. These are typically available at a fairly high level of disaggregation and include a breakdown of energy consumption into electricity and fuels by type. Some problems may be encountered with the exclusion of "wholly-owned" energy sources (such as refinery gas used by a refinery or a chemical plant, or coal from mines owned by a steel company), and the form in which self-generated electricity is reported should be examined carefully.

The next step is to assemble data on quantities purchased by individual enterprises from electric utility companies and fuel supply companies (e.g., the national oil company and distributors). These sources will often have accurate figures, particularly for large individual consumers such as steel and petrochemical plants.

In order to gather more detailed energy data, it is necessary to contact the consuming industry itself, through national trade associations or headquarters offices initially, and subsequently at the plant level, if this level of detail is required. In fact, plant visits are very useful in obtaining data and in gaining an appreciation of the potential for energy conservation and fuel substitution. Irregularities in plant data from year to year may often reveal problems, such as unreliable electricity supplies, that have an adverse effect on the efficient use of energy.

It may be possible to use existing electric utility companies and other energy supply companies to initiate energy surveys since these establishments already possess appropriate technical expertise and organizational structures. However, the possibility of an unconscious bias in data acquisition and treatment will always be a barrier to use of the information by other agencies.

For some countries, information exists in sources that are not usually tapped, such as inter-firm market share comparisons done by some companies which may include other valuable statistical data.

Overall, it is valuable to have the survey and data analysis conducted in a manner that will foster the maximum integration and consistency in national energy policy and planning.

Data Needs

The minimum data needed in an industrial energy survey are physical quantities of fuels and electricity consumed. Although for some purposes, such as econometric modeling, it may be desirable to have information regarding the monetary value of fuel and electricity purchases, this information is generally less useful than the physical quantity data, particularly when unit prices charged to individual consuming industries for the energy goods vary widely. From this, total energy used per consuming unit can be derived. At the most aggregate level, measures of the numbers of consuming units--households, firms (or employees), vehicles--may be the only data available that are directly related to energy use by function. A more disaggregated study might consider numbers of pumps, stoves, or other energy-using devices.

One of the important questions related to energy surveys *in any sector of activity* is the link between energy consumption and economic or human activity. The most common measure of that link is energy intensity, or energy consumed per unit of output. Consequently, measures of units of output that correspond to the energy input data are also required. Output may be measured as units produced or as units shipped, the difference being the change in inventory level, which is usually small.

There is a strong consensus that the most useful numbers for energy analysis and policy formulation are energy intensities. There are several types of these, which correspond to different measures of productive activity. A commonly used measure of activity is the physical unit of output--weight (in tons) or volume (in liters). This yields an intensity measure such as gigajoule per ton or kilojoule per liter.

Some object that aggregation of the many products of an industry (such as high-carbon steel, stainless steel, and crude steel) into a single physical aggregate is a dangerous procedure. However, it is usually not so when one is aggregating in order to calculate energy intensities, because the principal energy-consuming steps apply to all units of production (such as the blast furnace and steel furnace steps in steelmaking) and the product differentiation procedures are much less energy intensive. While disaggregated physical measures can be difficult to come by without painstaking surveys, they are essential for careful planning, particularly when there is a nonmarket economy and monetary measures of activity are unavailable or irrelevant.

Financial measures of output yield intensities in the form of energy consumed per monetary unit of production. In general, the productive activity is measured as the value of the output (which includes the cost of intermediate inputs to production as well as the value of capital and labor services) or as the value added in production (which excludes the costs of intermediate inputs), in constant value units.

It is also true that for certain questions it would be desirable to construct the energy intensity in financial units using the current value of total output (or value-added). For example, such a measure may be useful in examining trends in economic activity per unit of energy input for export industries, where prices are set on world markets and one wishes to maximize export value per unit of energy imported.

Another question that must be addressed in the treatment of survey data is the aggregation of fuel and electricity quantity data into a single measure of total energy consumed. The most common method is simply to sum in energy units, with electricity evaluated at its direct value or at its thermal equivalent (dividing by a measure of system or generation efficiency). However, many researchers feel that this implies that individual fuels and electricity are perfectly substitutable, which is certainly not the case. Also, different methods, such as India's adoption of a coal replacement index, may be specific to a data use (the complexities of energy indexing were discussed at a November 1974 workshop on that subject held at the East-West Center in Honolulu, Hawaii).

Finally, it should be recognized that although most energy surveys deal only with direct fuel and electricity inputs, the output unit incorporates indirect energy inputs arising from the energy used to produce intermediate material inputs to the process. In some cases, this indirect energy component may be larger than the direct energy use. Thus it is possible that a ranking or comparison of industries or products based solely on direct fuel and electricity use may be misleading.

Policy makers should, therefore, be cautious in constructing, implementing, and evaluating industrial energy policies based solely on direct energy data. For example, a policy that places an absolute limit on total direct energy available to a firm may be evaded by purchasing an intermediate input at a later stage in fabrication or processing, thereby avoiding an energy-intensive process within the firm and shifting the energy burden from the viewpoint of the total economy. Indeed, such a procedure could result in an increase in total energy use for the vertically integrated process. *This is an important caveat for policy formulation.* However, a first-cut survey should concentrate solely on collection of data on the direct inputs of fuels and electricity. Indirect energy inputs should be analyzed in an industrial energy husbandry program that is a continuation of the initial survey effort.

For many developing countries, noncommercial fuels are an important source of energy and should be given consideration in energy survey design. For example, the recently published International Energy Agency (IEA) energy statistics for 16 developing countries show that industry accounts for approximately one-fourth of their total final energy consumption; of this industrial consumption, more

than 10 percent is supplied by noncommercial fuels. In several of these countries, the largest fraction of industrial energy was provided by noncommercial fuels. Noncommercial fuel use in the industrial sector will continue to be significant in the next decade because of economic pressures to use these energy sources rather than increasingly expensive fossil fuels.

SURVEY INSTITUTIONAL AND PERSONNEL NEEDS

Institutional Relationships

Political, institutional, organizational, and economic structures vary widely among developing countries. The primary differentiation is the role of "central" planning in the economy and the degree to which the national energy planning body is a coordinating body with representatives from the various ministries. This determines in part the extent of its power. In the smaller developing countries, this energy coordinating body is usually the main energy planning body that decides on both the overall and sectoral energy needs and priorities. It is thus the "user" agency. *Identification of the user is an important preliminary step to constructing a survey.*

In larger developing countries having a fairly well-diversified industrial sector, surveys such as those carried out by an industry federation would be an additional data source to evaluate and would improve on data collection by official government surveys. As the user agency, the professional staff of a national energy planning entity is one logical and desirable group to carry out surveys in either kind of country.

Other institutional mechanisms for collecting survey data may be equally recommended. In some developing countries (e.g., Ethiopia), central statistical organizations conduct surveys of industrial activities on other than industrial energy use, such as employment. In other countries with central planning (e.g., Turkey), planning organizations may be doing similar work. It may be beneficial and cost saving to use such agencies to conduct the industrial energy-use survey. However, if there is a loose linkage between industry and government, voluntary cooperation in reporting information could be important.

In some countries (e.g., the Dominican Republic), the collection of energy data is decentralized. In such a case, various state agencies would collect data pertinent to their interests and report such information to a central agency. However, such an approach could be difficult to implement if these agencies have conflicting objectives.

If an established energy department or ministry exists in a country, it could be charged with conducting industrial energy surveys.

Requirements for Trained Personnel

If a survey of industrial energy use is to be repeated as part of a periodic comprehensive data-gathering effort, experienced in-country personnel are needed. Continuity in personnel and techniques will be important. While a one-time survey can rely on experienced personnel from the international community with the cooperation and assistance of a limited number of in-country experts, continuity in collecting and analyzing information about industrial energy use requires that personnel within the country be trained to continue the effort after the first survey.

Two personnel training objectives should be considered in connection with this type of survey: (1) developing a cadre of in-country experts on the collection and analysis of industrial energy-use data through international training programs, and (2) encouraging the growth of an educational system at home that provides further training for this cadre and their successors. Generally, personnel training should be built into the planning, staffing, and funding of the initial survey; it is an important aspect of technology transfer. Establishing a local educational system might call for complementary technical assistance.

What does "continuity" in energy surveys mean? Since comprehensive surveys are required only every 5 years, what does a trained staff do in the interim? In fact, medium-term (e.g., 5-year) plans need continual reevaluation, at least partly because significant new events or trends can arise between comprehensive survey dates. There is a continuing need to monitor industrial growth rates and other key indicators, to conduct special-purpose smaller surveys to answer questions by policy makers, and to carry out assessments using survey data--all as part of the ongoing national planning process.

In addition, the industrial survey group might be able to provide industrial extension services, acting as a channel of communication about new options for improving industrial productivity, energy efficiency, and shifts to domestic sources of energy. In these ways, a country would get the full benefit of this pool of talent and experience.

COOPERATIVE ACTIVITIES

Comparing and Transferring the Results of Industrial Surveys

Industrial sector energy surveys can, in general, be compared across countries and the survey methodologies replicated with little modification in all developing and developed countries, given the basically similar nature of discrete technological processes in all countries. An energy analyst will ask more or less the same questions everywhere about comparable technologies using similar fuels. Where noncommercial fuels are used (e.g., the steel industry in Brazil or the beer industry in Kenya), there may be much less comparability, and surveys may need to be tailored individually.

Thus it is possible to transfer survey methodologies and analytic techniques from developed to developing countries with modifications for data limitations and institutional constraints. Because of this, it is possible and valuable to compare different national experiences in the same industry, looking at capital, labor, material, and energy inputs per unit of production in different countries. These comparisons can also be valuable in helping energy planners evaluate the accuracy and quality of data gathered in individual countries. Increased cooperation, institutional and individual, among developed and developing country industrial sector energy analysts is to be encouraged.

This comparability characteristic of the industrial sector is not true for rural and urban or transport sectors in developed and developing countries.

Collaborative Arrangements and Technical Assistance

What should be the institutional arrangements for energy survey collaboration among different countries? It is not clear that any new groups or organizations are needed, particularly in view of the spread of professional societies around the world. However, dissemination of information through these organizations and other means is greatly needed. What are the actual experiences with energy surveys and with increasing industrial energy efficiency? This is particularly important in lighter industry, where less expertise tends to be available in-house (a problem common to all developed countries).

There are numerous opportunities and problems involved in providing technical assistance to developing countries in the design, implementation, and analysis of industrial sector energy surveys. A general conclusion is that developing countries, for the most part, have established neither the energy policy priorities nor national energy plans that provide a well-reasoned focus for technical assistance requests. They also have not developed the institutional capability to carry out detailed industrial sector data collection and analysis. An urgent need exists to develop such a capacity and to train persons in analyzing the role of energy in various industrial processes and the potential for substituting alternative fuels and technologies as well as improving efficiency.

Multilateral and bilateral assistance organizations are beginning to support detailed energy surveys and assessments in developing countries that consider the industrial sector from an overall demand/energy efficiency perspective in contrast to the traditional electricity expansion approach. In this early stage, close collaboration in methodology development and data exchange (e.g., technology characteristics) between and among governmental and nongovernmental organizations would be highly beneficial. It is suggested that a comparative effort, involving the design, implementation, and analysis of benchmark surveys in a small number of developing countries, be undertaken as a first step toward consistent applicability to a broad range of developing countries. The AID-supported project on energy and rural development at the East-West Center's Resource Systems Institute was cited as an example of such a multinational research undertaking.

Despite the growing interest in energy, donor organizations have their own interests which may preclude assistance for industrial sector energy demand studies, e.g., surveys of heat/temperature requirements and characteristics in various industries. To ensure that these organizations respond to their pressing needs in the industrial sector, developing countries may wish to seek a more balanced program of energy assistance and request that a high priority be placed on such technical studies.

Finally, donors should be aware that preparation and planning on the part of developing countries with limited resources for technical assistance projects is very costly to the developing country, especially in terms of lost time and opportunities if these projects do not materialize.

RECOMMENDATIONS

- A longer-term indigenous institutional capability should be developed to design, analyze, and implement surveys and their results. This could be carried out through an international industrial extension service, or a series of training workshops conducted worldwide by experienced energy analysts.
- Funding agencies should give greater consideration to smaller technical energy studies that can be of immediate use to governments and industry participants. These are often overlooked or excluded in priorities developed for large assistance programs.
- Cost-effective attention should be given to analyzing modern sector energy use in middle-income as well as low-income countries. This will be the major factor in increasing energy demand over the medium to long term.
- Benchmark surveys of industrial energy use in specific sectors and facilities in a small number of developing countries should be carried out in order to establish a basis for international comparisons.
- A related effort that should be considered is evaluating and comparing existing surveys as to methodology, coverage, and other experiences in use.
- Assistance organizations should be aware that participation in technical assistance projects can be extremely costly to a developing country in

terms of trained manpower and facilities, even when there is not a direct financial contribution to the project. Every effort should be made to maximize the payoff to the effort and to minimize the possibility that the project does not reach fulfillment.

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TRANSPORTATION WORKING GROUP

Marianne Millar, Chairman

OVERVIEW

Transportation is a vital element in energy planning for developing countries because of three key relationships that are critical to development in general and energy demand in particular: the transport-development link, the petroleum-foreign exchange link, and the issue of government regulation or control. Each relationship adds to an understanding of the transport sector while at the same time constraining the range of potential solutions to the "energy problem." Although this report will not examine the role of transport in economic development or justify its inclusion in energy surveys, a brief discussion of these background issues or relationships is in order.

Transportation is a secondary or derived demand. Resources and materials must be brought to production centers; products must be brought to markets; people must get to schools, workplaces, and shopping areas. Transportation--whether by road, rail, bicycle, etc.--permits these various transactions to occur. Since it is the transaction, not transport, that is demanded, transportation is considered a secondary demand. As such, it permits development to occur, which in turn requires more transportation, which permits more development, and so on.

Since upwards of 90 percent of all transportation services are petroleum fueled (much of it imported) and transport accounts for 30-50 percent of all energy consumption in most countries, transportation takes on another important dimension. Because of spiraling oil import bills, energy costs are representing a larger share of production costs. Oil imports are contributing both to inflation at home and foreign exchange problems abroad. Moreover,

unlike industrial boilers, electric generators, residential space heaters, etc., there is little possibility for transport fuel switching, at least in the short term. Thus reduced consumption must come from increased efficiency or reduced activity.

Because of its association with economic activity, reducing transport activity is not likely to be a feasible alternative. Increasing efficiency, however, is both feasible and desirable. While developing countries' passenger transport systems are generally quite efficient (primarily because of high utilization of public transportation services and low auto ownership), their freight transport systems are relatively inefficient and could be significantly improved. The inefficiency is largely due to poor highway systems on which travel must be limited to smaller, lower-capacity (and therefore less-efficient) vehicles and slow speeds.

In many countries, transport systems have been developed not for internal mobility but to facilitate the extraction and export of indigenous resources. This is particularly true in Africa where the limited capacity and high cost of freight transport makes it more expensive to move a bushel of grain 700 miles from a seaport into the interior than it does to ship it the 7,000 miles from New Orleans to that seaport. Perhaps more than any other sector, transport presents clear opportunities for improvements in efficiency.

In addition to these fairly obvious energy relationships, the issue of government control has important implications for transport energy planning. The transportation sector falls under extensive government controls and regulations. It is also a major recipient of government capital. Thus the transport sector is often amenable to government policy that theoretically could be used to increase the efficiency of energy use. Unfortunately, however, it is precisely this flexibility that, combined with the political sensitivity of fuel price increases, often encourages governments to subsidize the transport sector, shifting the impact of increased oil import bills onto other parts of the economy.

From the standpoint of energy surveys, this governmental role is extremely important as it generates a considerable amount of data. The availability of this information--although obscure, disjointed, and often unrelated to energy--nonetheless helps to distinguish the transport sector from some of the other sectors discussed at this workshop. For

this reason, the use of primary data-gathering surveys is not emphasized herein. Rather, the emphasis is placed on the entire assessment process, from the selection of relevant information based on previously defined objectives or goals, to the utilization of secondary or surrogate information and, in a few cases, to the selective gathering of primary data. One of the few areas in which primary data collection may be needed is road freight. While trucking may account for as much as 15-20 percent of the total national energy use, truck activity is unregulated in many countries, and truck volumes and usage patterns are largely unknown.

Two final comments are in order before proceeding. First, it is important not to place transport solely in the modern, urbanized sector, for it is a major element in the integration of regional development and crucial for rural trade. The local transport of agricultural products, the use of human and animal power, and the existence of unregistered and unregulated vehicles should not be overlooked, although the collection of relevant data on these is extremely difficult if not impossible. While rural transport may not be a critical factor in a policy designed to limit oil imports, it may be essential if rural development goals are to be met.

Finally, an important caveat concerns the heterogeneity of countries. Country differences--in structure, data quality and availability, institutions, and analytical talent--all greatly affect the appropriateness of particular data items and the methods used to collect that data. This should be recognized at the outset and incorporated into any survey effort.

DEFINITION OF TERMS

Precise definitions of such terms as "survey," "assessment," and "analysis" are required for a useful discussion. In practice, however, the group encountered problems in adhering to a firm nomenclature when dealing with actual transport sector studies. The ad hoc nature of such work, the use of secondary and surrogate data, and the symbiotic relationship between goals and requisite information made clear distinctions between such terms difficult.

However, for the sake of presentation the group defined the term "survey" as a broad analytical process including the identification of policy options or targets

and data collection and assessment. "Primary data collection" was defined as the act of collecting new data. The term "secondary data" refers to already organized or predigested information from original, possibly unpublished, sources. Finally, the term "surrogate data" refers to data from which inferences are drawn about relationships not measured directly, or data from another country which are taken to represent a generic relationship or broadly applicable behavioral patterns.

PLANNING NEEDS

Although government has traditionally been responsible for regulating and planning transport, an important consideration in dealing with developing countries is the fact that transportation planning is usually target oriented rather than continuous. Local planners and engineers have had considerable experience in planning studies and feasibility analyses relative to road building, bridge construction, port dredging, and other public works projects, but often little, if any, contact with continuous, long-term transportation planning. This situation is gradually changing as governments recognize the need for long-range planning to support investment decisions and to insure the efficient utilization of limited resources. Greater emphasis is being placed on resource planning and, in the transport sector, the transportation planning process is being broadened to consider fuel issues. Transportation planners in developing countries are being called on increasingly to analyze the energy impacts of proposed policies using sound methodologies and reliable data sources.

Historically, it appears as if long-range planning has been an afterthought, suffering from poor quality and lack of coordination at both the formal and informal policy leadership levels. Today, however, with the newfound importance of energy, planners are addressing such policy questions as:

- What would be the effect of investment favoring a given mode of travel on the level of utilization of each mode?
- What would be the effect of a given level of capital investment on total travel and energy consumption?

- How can a nation maintain its population mobility objectives while keeping energy consumption within defined goals?
- How can a nation achieve development objectives such as increased per capita income, increased employment, and a rising standard of living while also achieving energy consumption goals?

These issues are beginning to surface as matters of great significance not only to internal policy makers but also to the international public, the private financial community, and international assistance agencies.

For policy makers to respond effectively to issues such as these, it is critical that objectives and potential measures to achieve those objectives be articulated and the necessary tools or techniques be developed to facilitate timely and informed decision making. One method of communicating between planner (analyst) and policy maker could be to develop a "goals-means" matrix to display the relationships between objectives and specific policies or measures. This method could facilitate rapid identification of options, and could also provide a preliminary feasibility screening. Clearly infeasible measures or alternatives could be discarded early in the process, while further analysis could be directed toward particularly promising alternatives. The hidden impacts of policy decisions could also be identified and appropriate mitigation measures could be incorporated into the decision-making process.

DATA COLLECTION AND ANALYSIS

Policy making has to be a conscious activity, and as such it has to be based on three types of knowledge: a thorough understanding of the current situation, a clear definition of objectives, and a plan or path that can span the current situation to reach the objectives. These considerations stress the need for data both as a source of knowledge of the current situation and as a background for formulating objectives.

Unfortunately, political pressure often forces speedy decisions. Policy makers can not wait for survey results if the survey is to be initiated when the decision is demanded politically. Frequently, policy decisions are made with very little data about the current situation and very little knowledge about what the future situation

is likely to be. Clearly then, surveys (and data collection) must anticipate, not follow, future policy needs. Planning bodies must be convinced of the necessity for energy surveys, and the work must be initiated well before the decision is needed. In a real sense, the technical community must "sell" planning commissions and high-level administrators on the benefits that they can derive from energy surveys.

In the transport sector, considerable data are regularly collected as part of the urban transportation planning process and in connection with fuel or vehicle taxes (e.g., vehicle registrations). However, these data are dispersed, often unpublished, among various agencies and are not generally oriented toward energy analysis. They must be supplemented, generally from secondary or surrogate sources. While much less expensive than primary data (in time and resources), surrogate sources may raise difficult questions of cross-country comparability and appropriateness. In many cases, the available statistics are used to exhaustion, often in circumstances for which they are not only inappropriate but often misleading. Energy intensity data are particularly misused, being applied across countries with vastly different equipment and operating characteristics.

That is not to say that there are no possibilities for designing surveys and using data across several countries. Depending on the particular data items and the countries under observation, it should be possible to develop a list of core data needs (see the following discussion) and under certain circumstances to actually develop a standard questionnaire (with a variety of flexible aspects) that can be used in several countries. In this vein, it is suggested that a manual be developed to provide general guidance for conducting energy surveys. This manual should indicate the general approach to be taken, what types of data and issues should be considered, possible data sources that should be obtained and reviewed, and general guidelines for primary data collection.

Key Data Items

In order to gain an understanding of energy consumption patterns and relationships between key parameters in the transport sector, a core of basic transport activity and energy intensity data must be obtained. Generally from

secondary sources, these data must describe the volume of passenger and freight transport (both urban and interurban), its distribution among available modes and fuel types, its translation into vehicle activity, the energy intensity of that vehicle activity, and the energy consumed. Data should cover a recent representative year (ideally, not a recession year, or one in which some major political or economic disruption occurred), and as many prior years as possible. Specifically, this core should include the following data items by mode (both motorized and nonmotorized) for urban and interurban travel:

- Passenger-kilometers traveled
- Ton-kilometers traveled
- Average length of haul (i.e., ton-kilometers/ton for each mode)
- Load factors (or vehicle occupancies)
- Energy efficiency or intensity by fuel type

Ideally, these data should also include some indication of the current transport characteristics of key commodities and any trends that have been or are likely to affect the mix or operation of the transport fleet. Since projections are likely to be highly influenced by economic and demographic growth, future urbanization and industrialization patterns, energy prices and availability, and technological characteristics, some data on these variables are also helpful. The level of effort devoted to obtaining data for these latter variables also depends on the particular issues being addressed in the study (especially if the study is a specific policy analysis).

Obviously, there is considerable variation in the quality and availability of the necessary data items. In some developing countries, much of the above data is available; in others, there is very little.

When data are available, checking and validation become the key issues. Three types of data checks can be identified: observation, cross-checking, and reconciliation between aggregate and disaggregate series. At times, observation of a small sample of cases may be a useful tool for verifying (and revising) suspect data. For example, informal vehicle counts can be used to detect major discrepancies in data on vehicle mix. Cross-checking of different data series can also identify inconsistent or counter-intuitive relationships which then can be investigated to determine if they indicate important or previously unnoticed relationships, or problems with the data itself. For example, recent

experiences with Argentine data series on diesel fuel sales for motor trucks and estimated motor truck activity indicated improbably high energy efficiencies, if both data series were viewed as equally accurate. More reasonable efficiencies would require that either motor truck activity estimates be revised downward or diesel motor fuel sales data be revised upward. Since motor fuel is more heavily taxed than other middle-level distillates which are used to run farm equipment and industrial machinery and which can also be used in trucks, it is likely that some highway fuel use is being attributed to the agricultural or industrial sector. In all probability, this data inconsistency is prevalent in many countries, both developed and developing.

Finally, macro-level estimates of total sectoral energy consumption, often tied to econometric analyses, and micro-level estimates of modal activity and energy consumption, either from transportation planning studies or energy surveys, must be reconciled. All these data checks employ informed judgment as a basic analytical tool.

Collecting Primary Data

Primary data collection should be avoided in most instances. If adequate data are not available from local transportation and energy planning organizations, private and quasi-governmental agencies should be contacted. Often, major oil companies or distributors, motor vehicle manufacturers, trade or professional associations, taxing agencies, police departments, etc., have useful data. Other potential sources include internationally compiled data series published by the International Road Federation (IRF), the International Union of Railways, the Organisation for Economic Co-operation and Development (OECD), and others, or data compiled for the United Nations Development Programme (UNDP) or World Bank studies. All these sources should be thoroughly explored before resorting to collecting primary data.

It should be noted that a major difficulty in using different data series is the variability of data definitions and measurement units. For example, vans may be registered as trucks, automobiles, or vans in different countries (or even in different states, as in the United States). A common definition would simplify and greatly improve analytical accuracy.

Once the decision to collect primary data has been made, a few simple rules should be followed:

- Do not lose sight of the purpose of collecting the data and the specific kinds of data needed.
- Select an appropriate methodology based on the purpose.
- Be selective; do not collect more data than absolutely necessary.
- Strive for multiple-use samples and data, particularly if cooperative arrangements can be used for data collection.
- Translate technical terms and concepts into things that are known to the respondent. Do not ask questions people can not or will not answer.
- Information should travel both ways. Explain the purpose of the instrument in terms that the respondent can understand. Emphasize its value to him/her.
- Use local people to collect primary data. Not only are they better equipped to explain the instrument to respondents, but this provides an opportunity to train them as technicians.

Based on experiences to date in transport energy analysis in developing countries, the collection of primary data is most necessary in the trucking sector. Because of limited government regulation, the preponderance of owner-operated trucks, and vehicle registration only at the national level, there are virtually no available data on truck activity and usage patterns. Although some data concerning truck volumes on the urban highway network may be available from metropolitan transportation studies, these data are only available for those cities for which such studies have been conducted and they do not provide the kinds of information needed for energy analyses. Since many developing countries rely almost exclusively on trucks for the movement of goods, collecting truck data could have a considerable payoff.

INSTITUTIONAL AND PERSONNEL NEEDS

A number of basic needs relating to transportation energy surveys for developing countries can be identified. First, planning ministries should take responsibility for coordinating overall transportation activities. This is

of utmost importance because transportation, especially with regard to its energy aspects, has frequently been ignored in overall development planning. Staff with professional training in transportation planning/engineering should carry out this responsibility.

Steering committees should be established for specific transportation projects. These committees should include staff persons with shared interests in the project drawn from the ministries of transportation, urban and rural development, and energy, as well as representatives from local universities and local and outside advisors. Cooperation and the removal of institutional jealousies should be a goal of these committees. Whenever consultants or advisors are involved, local staff should be assigned to work with these advisors to gain expertise and thus be able to carry out follow-up work. Recognition should be given to all contributing people and institutions.

Incentives should be established to attract local engineers and scientists into the transportation sector. Universities should include energy, transportation energy, and planning courses in their curricula. This should be part of national efforts to identify training needs and to select individuals to receive such training.

DIRECTORY OF ENERGY SURVEYS FOR DEVELOPING COUNTRIES

INTRODUCTION

PROJECT BACKGROUND

In the preliminary planning stages of this workshop, the steering committee expressed the need for a compilation of past and current work in the energy survey field. This "survey of surveys," as it came to be known, was compiled to reflect the present state of the art and was designed to be a primary reference document indicating progress made in this field and areas requiring further development. It indicates those countries or those donor organizations that have conducted energy surveys and describes how these surveys have been designed. It also identifies individuals working in the field who would be willing to share their knowledge and experience.

Initially, it was assumed that this field had the same support literature and secondary reference sources that one would expect of any established discipline. However, a review of the major energy data bases produced few citations and a search of various indexes proved equally fruitless. The traditional tools available to the researchers were of no use.

It then became apparent that this directory would represent a pioneering effort: not only had the literature never been compiled, most of it had not even been published. Therefore, those who were engaged in energy surveys were contacted personally. Each member of the workshop steering committee agreed to send documentation describing his own project and volunteered names of others in the field who might be willing to cooperate. Through this networking, an ever-increasing circle of nearly 150 resource people and a vast amount of unpublished literature were discovered.

CRITERIA FOR INCLUSION IN AND ORGANIZATION OF THE DIRECTORY

Only source documents describing actual energy assessment methodologies for developing countries are included in this directory. A demonstrated effort on the part of the researcher to review data collection problems and to solve these problems are the major criteria for inclusion. Because a number of projects are still in progress, neither completion of the project nor a final, published report are required for inclusion. If project plans or other detailed descriptions are available, the project is included in the directory. The annotations make no qualitative judgments as to the validity or effectiveness of various methodologies, but serve merely to present objectively those that are currently available to the researcher.

Annotations are organized into three main sections. Part 1 includes annotations describing general approaches to energy survey methodologies, procedures and guidelines for conducting surveys, lists of the required components of an energy survey, ways to define and develop information, and models for a total survey package. Actual implementation of the survey is not included.

Part 2 encompasses energy assessments based on actual data collection efforts. Part 2A includes surveys in which the collection of primary data is a fundamental part of the survey design. In these, a methodology has been selected and a critique of the methodology is often included in the survey analysis. Part 2B contains energy assessments based on secondary data collection efforts. Here the surveyors used information from existing surveys. For a survey to be included in this section, specific reference had to be made to the sources used and procedures for identifying and using these sources outlined.

Annotations in Part 3 describe systems that have been established to analyze energy data on a global basis. These systems are flexible enough to allow data to be manipulated in a variety of ways to serve the needs of the data base user. All are designed to be used as planning tools in the development of an energy policy.

ENERGY SURVEY INFORMATION CENTER

Participants in this workshop on survey methodologies recognized that this directory represents an important contribution to a growing field, but that it clearly would become outdated and thus diminish in value. To these points,

the following emerged during the course of the workshop: (1) the directory should be kept current; (2) the source documents should continue to be collected at a central location; and (3) a mechanism for distributing copies of the source documents is necessary.

As a result of these considerations, Volunteers in Technical Assistance (VITA) has expressed an interest in providing distribution of the source documents. They will announce the availability of this service through their newsletter. Documents annotated in this directory can be requested from: VITA, 3706 Rhode Island Avenue, Mt. Rainier, Maryland 20822, USA. Should readers of these proceedings have any information on energy surveys, please contact: Wendy White, Librarian, Board on Science and Technology for International Development, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, USA.

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1 GENERAL DESIGNS OF ENERGY SURVEYS

1-01 ENERGY NEEDS, USES AND RESOURCES IN DEVELOPING COUNTRIES

P.F. Palmedo, R. Nathans, and E. Beardsworth, Policy Analysis Division, National Center for Analysis of Energy Systems, Brookhaven National Laboratory, Upton, New York, and Samuel Hale, Gordian Associates, Washington, D.C. Contract report prepared for the U.S. Agency for International Development, Washington, D.C. March 1978, 143 pp.

This report examines the future energy requirements of developing countries that do not belong to the Organization of Petroleum-Exporting Countries (OPEC). It assesses the energy supply and demand situation, reviews the amount of energy required to satisfy basic human needs, identifies major energy problems to be overcome, and describes a taxonomy of solutions to these problems upon which energy assistance programs can be based. Energy supply and demand are examined by means of an analytical approach in which the developing countries are grouped into six homogeneous groups based on their economic structure and their general resource position. After a discussion of the characteristics and energy situation of each group, projections of energy demand are made. Commercial fuel demand is based on the growth rate of the gross national product (GNP) and the correlations between energy demand, GNP growth, and energy prices. Noncommercial fuel consumption is calculated on crude estimates of the minimum subsistence requirements. The supply of various fuels is then examined on a world and developing country basis.

The amount of energy required to meet basic human needs is also considered. The major problems addressed are data collection and ways to analyze that data. The authors cite, in particular, the lack of reliable measurements, the lack of agreement as to what kind of data should be collected, and the need to develop a good understanding of how subsistence and development depend on energy. The future course of energy use in developing countries can not be accurately anticipated without this data collection and analysis.

This project was directed by Brookhaven National Laboratory but was structured to draw upon a wide spectrum of the energy community. A series of workshops was held in order to clarify key issues of energy in development assistance. The report, taken as a whole, provides a broad overview of the total energy situation in the developing countries.

1-02 ENERGY FOR THE VILLAGES OF AFRICA

J.W. Howe and staff of the Overseas Development Council, Washington, D.C. February 1977, 136 pp.

This report looks at village source energy (sun, wind, flowing water) and recommends a course of action for African policy makers and outside donors. It outlines a three-part methodology to develop the information needed in order for Africans to make two decisions: (1) whether village source energy warrants use on a wide scale; and (2) what kind of system would match energy hardware with village needs and provide for installation and maintenance of the hardware.

The first step is "software research," which involves identifying the tasks that the villagers want performed by nonhuman energy, analyzing the energy available to the village, and evaluating the quality of life in that village. From this one can begin to select the appropriate hardware and pretest it in the villages that so choose. This step should be designed and managed by an African national institution, perhaps with the assistance of an outside consultant group financed by a donor.

The next step is to create or strengthen in-country energy-related institutions by training African energy experts. The creation of new international institutions is another possibility.

The final step is "hardware research." Three recommendations are made: (1) industrialized countries should devote more research time to small-scale renewable energy; (2) aid programs should strengthen their help to African research on hardware, both in the application and adaptation of energy technologies developed elsewhere and in the development of indigenous technologies; and (3) aid programs should provide more help to African institutions in the designing and building of cheap, reliable tools, implements, and appliances that can be used with village source energy to perform village tasks.

Two case studies are included as appendixes, each an assessment of the energy needs and tasks in selected villages. Debarek, Ethiopia is analyzed by Jim Tarrant and a Sahelian village is assessed by John Holtzman. The case studies cover the background and setting of each village and look at energy needs and tasks in the agricultural, household, transport, and commercial sectors. Each case study is an energy survey in itself.

1-03 AFRICA ENERGY SURVEY METHODOLOGY

T. Graham and R. Gordon, Donovan, Hamester, and Rattein, Inc., Washington, D.C. Contract report prepared for the Office of Development Resources, Bureau for Africa, U.S. Agency for International Development, Washington, D.C. (No date), 2 vols., 253 pp.

The purpose of this report is to assist energy planners in assessing energy resources, uses, and suitable conversion technologies. The expressed goal is to design a methodology flexible enough to accommodate different operational objectives based on the specific needs of African countries. Four critical issues in the design of an energy survey are discussed in the first volume of the report:

1 For what purpose is it necessary to collect and analyze the data?
2 What specific data are required? This section includes a summary of the actual data base in which each information requirement is listed by category and class.
3 How should the selected data be collected? Unstructured methods such as reconnaissance and interviews

are compared with structured methods such as questionnaires, objective measurements, and experiments.

4 In what ways can the data be used? Both macro energy analysis and micro project assessment are discussed.

The second volume of the report is the data base or the list of detailed questions applicable to each data category. These include a measurement of household, demographic, economic, and political indicators, and the identification and quantification of household energy consumption as well as consumption by industry, agriculture, transportation, and government. The collection of this data enables the researcher to identify the social and cultural relationships associated with energy consumption. A final discussion on the means of implementing the instrument described above is given. Important considerations are *how* and to *whom* the instrument should be administered and the selection and training of personnel.

1-04 TECHNOLOGY EVALUATION FOR RENEWABLE ENERGY SOURCES: A FRAMEWORK FOR COORDINATED ACTION

J.H. Ashworth and R.E. Meunier, Solar Energy Research Institute, Golden, Colorado. March 1979, 11 pp.

In this report, technology evaluation of renewable energy sources is presented as a decision-making tool that will provide policy makers with valuable information on such areas of uncertainty as:

- The size of systems needed to provide basic energy needs for rural consumers
- The "fit" between an energy source and the machines or devices that will turn the energy output into useful work
- Identification of components or materials of renewable energy systems that might be rapidly degraded by extremes in climate or surroundings
- The change that a renewable energy system might trigger in local energy consumption and usage patterns

- The amount of institutional change and adaptation that a particular energy system may require in a specific setting.

Technology evaluation requires both a survey of energy usage patterns and a survey of basic needs and current consumption. In the first, the data will provide a base line against which all impacts of a project can be measured. They will also assist in the selection of technologies appropriate for local consumption patterns and available renewable resources. Finally, they will indicate what basic development requirements have to be met by the project. For the second survey, data must be collected before, during, and after a project. This report provides a list of the components (sociological and economic) necessary to conduct the village analysis.

The last part of this report considers technology criteria. The authors suggest that each project must be evaluated in terms of costs, benefits, system efficiency, amount of energy delivered, system characteristics, social compatibility, and environmental constraints.

1-05 IN-COUNTRY ENERGY STUDY

L. Ervin (Project Supervisor), Donovan, Hamester, and Rattien, Inc., Washington, D.C. Contract report prepared for the U.S. Agency for International Development, Washington, D.C. June 1978, 2 vols., 104 pp.

This two-volume study puts forth a program that is designed to improve understanding of the developing nations' energy resources and needs in the context of future energy and economic development options.

The specific object of this program is to design a survey that enables the researcher to collect the data needed for a country to make economic and energy development decisions in a rational manner. The survey is aimed at discovering the economic activities associated with the various forms of primary energy and following their transformation into secondary forms of energy.

The fundamental requirement for this program is a comprehensive information base that describes the central energy supply system as well as indigenous and imported fuel resources. The information base must portray end-use characteristics in the residential, industrial, commercial,

transportation, and agricultural sectors, and identify trends in lifestyles, urbanization, consumption, industrialization, and economic growth.

The energy distribution system and the end-use patterns of consumers are also explored. The questionnaire described in this report will provide data on the following:

- Past trends and present status of energy use by fuel form
- Trends in the growth of the overall economy as an indicator of energy consumption growth
- Program directions and capital requirements for developing energy resources to meet future needs
- Analysis of final consumption of energy by consumers
- Expected growth of future demands for various forms of energy
- Resources and various forms of primary energy available to meet future needs
- Problems of future energy supply

1-06 DESIGN OF COMMUNITY RENEWABLE ENERGY PROJECTS

G. Self, Near East Bureau, U.S. Agency for International Development, Washington, D.C. July 1979, 60 pp.

This report presents a methodology for assessing the nonengineering aspects of alternative renewable energy development and energy conservation investment schemes in developing countries. The report provides general guidelines for an energy development strategy that focus on planning based on the needs and desires of the target population.

The first part of the methodology section to this report describes the social analysis requirements for the project design. A social profile and a social feasibility study are needed to determine the intensity of behavioral changes necessitated by various types of energy-related projects.

The second part discusses in detail the proposed planning methodology, the first step of which is to analyze all community energy-related tasks and needs. This assessment involves making a detailed list of all tasks performed,

with their present associated energy resources. The community must also be polled to determine its preference and priority for additional energy resources.

The second step of the methodology is to undertake an energy resource assessment, which requires collecting data on potential alternative renewable energy sources, including wind velocity, water flow rates, quantity of organic wastes, and animal traction potential.

The last step is to coordinate each task with the new energy source in a manner acceptable to the community. The cost-effectiveness of various alternatives must be explored, and the community must determine which task they prefer to have augmented with the new source of energy and/or substitute process. A technical feasibility assessment must also be undertaken.

The author concludes this report with a discussion of the social issues that must be considered in any project design: the equity problem associated with energy commercialization, the institutional problems in the acquisition and operation of technology, the effect of time-saving devices on the family and village, and, finally, the community's willingness to accept and participate in the project.

1-07 CRITICAL ISSUES FOR DESIGNING ENERGY SURVEYS IN AFRICA

T. Graham, Donovan, Hamester, and Rattien, Inc., Washington, D.C. Submitted to the Overseas Development Council, Washington, D.C., as background material for the Workshop on Fuelwood and Other Renewable Fuels in Africa, November 29-30, 1979, Paris, France. November 1979, 26 pp.

The first part of this report is a detailed discussion of some of the issues that must be raised in the design of an effective survey. According to the author, energy surveys should reflect the needs, wants, and preferred solutions expressed directly by the people being surveyed. The surveyor must avoid collecting a surplus of data, engineering data should follow the initial collection of socioeconomic data, and energy conversion devices should be subject to formal feasibility tests prior to being built installed.

The second part of this report describes the author's recent experiences in Swaziland where he was involved in the design of a renewable energy survey. There he found that people are disillusioned with surveys and are reluctant to support any more. Some of the reasons given are a lack of connection between surveying and subsequent action programs, and the lack of communication between the surveyors and the government officials concerned with the findings of that survey. Choice of methodology and how to obtain a representative sample are problems with which the author deals.

The author concludes with a discussion of the need for feasibility studies to be used as complementary tools in the survey design. Because some officials in Swaziland were anxious to start field tests immediately, a way was found to design one device to be field tested after an abbreviated preliminary assessment, while more detailed energy assessments were initiated on other energy problems.

1-08 WOOD CONSUMPTION SURVEYS

K. Openshaw, Division of Forestry, University of Dar-es-Salaam, Morogoro, Tanzania. 1979, 28 pp.

A methodology for estimating the consumption of wood products by surveying the end user is outlined in this report. Such estimates are needed so that plans may be drawn up to supply present and future needs and so that there might be a savings of foreign exchange.

According to the author, a consumption survey does does have drawbacks: it is costly; without careful planning cyclical factors may affect the results; and there is always the chance that the sampling technique may be biased.

This report discusses solutions to these problems, and then outlines a methodological approach. First, one must select a representative sample of wood users which should be divided into rural and urban household users and nonhousehold users such as industry and public and commercial service organizations. The country should be stratified according to wood-rich and wood-poor areas. Cottage industries should be included in the survey and classified according to International Standard Industrial Classification (ISIC) codes. For the nonhousehold sectors, three types of end users should be identified: those that use wood directly in their business, those that use wood

indirectly, and those that use wood incidentally. Industries should be stratified according to size in order to represent an economic scale.

The author then discusses some data analysis techniques--conversion factors and double counting--and gives procedures that should be common to all countries. Sample questionnaire forms from the Gambia Wood Consumption Survey 1972/73 (see 2-009) are included, along with basic guidelines for administering the survey. The last section is a discussion of ways in which to compile the estimate of wood product consumption.

1-09 FIREWOOD SURVEY: THEORY AND METHODOLOGY

J.T. Thomson, Ouagadougou, Upper Volta. Contract report prepared for the U.S. Agency for International Development, Washington, D.C. September 1979, 148 pp.

This report presents a framework for a survey assessment of the dimensions of the firewood problem in Africa. The first part of the report is an overview of the problem, and it includes an analysis of the institutional implications of the problem, discusses constraints that appear to discourage the production of adequate fuelwood supplies, and addresses two approaches that may be useful in reducing firewood demand.

The second part, or the survey package, consists of four questionnaires and an alternative fuel prices inventory instrument for use in the host country. The questionnaires are designed to be administered to government officials, urban consumers, charcoalers, and rural producers and consumers. They are meant to reveal each group's perceptions of the firewood situation and of the feasibility of various solutions.

The final part discusses survey implementation, including the composition of the survey team and its training, the adaptation of the questionnaire, and the administration of the survey in rural versus urban areas. A model budget and a work schedule for implementation are also included.

1-10 ENERGY ANALYSIS IN COUNTRIES OF LATIN AMERICA

Institute for Energy Analysis, Oak Ridge Associated Universities, Washington, D.C. October 1979, 11 pp.

This report describes an approach to energy analysis that can be applied in developing countries. It is adapted from a methodology developed by the International Energy Agency and is designed to be flexible enough to reflect country-specific considerations. The methodology has two guiding principles: (1) government officials should regard energy analysis as a contribution to economic development planning; and (2) developing country analysts and planners should be able to understand, undertake, and complete their own energy analysis.

After discussing the stages one must go through to set up an energy assessment, the data analysis is described in detail. Basically, it comprises two levels. First, the fundamental variables that drive the economy are forecast: population, gross national product (GNP) for agricultural and nonagricultural sectors, labor force, number and size of households, and rate of employment. The second level includes all the intermediate factors that fall between population and GNP and the calculated energy requirements. After determining the size and shape of the economy, one calculates the energy needs of four sectors: (1) households; (2) commercial, tourism, and public services; (3) transport; and (4) agriculture, mining, and manufacturing. The level of activity forecast must be consistent with the overall GNP and population trends, as well as with the social, political, economic, and technological trends that dominate each sector.

The report concludes with a brief statement about the problem of data availability and the need for international workshops to discuss information needs.

2 ENERGY ASSESSMENTS

2A PRIMARY DATA COLLECTION

2-001 SURVEY OF ENERGY SUPPLY AND DEMAND IN THE REPUBLIC OF KOREA, 1966-1981

Korea Institute of Science and Technology, Seoul, and Battelle Memorial Institute, Columbus, Ohio. Sponsored by the Ministry of Science and Technology, Republic of Korea, and the U.S. Agency for International Development, Washington, D.C. August 1968, 175 pp.

This report is the principal output of a survey that was undertaken to help the Korean government develop guidelines for the establishment of a long-range energy supply and demand program. It forecasts the energy requirements of Korea through 1981, classified by type of fuel and by major fuel-consuming sector. The energy sources considered in this survey are coal, oil, hydropower, nuclear material, electricity, and vegetable materials. Human and animal energy, as well as solar, wind, and tidal energy, are excluded.

Separate attention is given to the demands for energy in the transportation, household, and electric power sectors. In recent years, these three sectors have accounted for about 80 percent of the total energy consumed in Korea. The methodologies employed in forecasting the volume of energy consumption in these sectors were in keeping with the availability and credibility of historical data. The forecasts required estimates of two critical independent variables over the forecast period: population and total real output.

An important part of the survey is an economic comparison of alternative sources of primary energy for power generation. A hypothetical program of power plant construction through 1981 is presented, and this is translated into demands for primary energy sources. Total energy demand is predicted, and an effort is made to reconcile the demand forecasts with the supply outlook for each energy source.

2-002 PHOTOVOLTAIC POWER IN LESS DEVELOPED COUNTRIES

D.V. Smith, Consultant, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts. Contract paper prepared for the U.S. Energy Research and Development Administration (now U.S. Department of Energy), Washington, D.C. March 1977, 90 pp.

The purpose of this project is to begin an economic and social analysis of the potential for photovoltaic development in rural areas of the Third World. A survey was made of existing and ongoing studies of national energy systems, power sectors, and rural electrification in the developing countries. This extensive literature search resulted in the finding that most of these analyses are of limited utility in assessing the role of a photovoltaic system because of concentration on centralized systems of electricity, oil, gas, or coal supply and distribution.

In order to accomplish such an assessment, the author uses a series of case studies, including an irrigation project on the shores of Lake Chad and irrigation sites in Bangladesh, India, and Pakistan. These case studies are followed by an analysis of the economics of a photovoltaic-powered village in northern India.

Each case study describes the region and examines the energy requirements that could be met by a photovoltaic system. The final evaluation compares the cost of photovoltaics with the cost of the least expensive alternative using conventional technology. Conclusions as to the use of photovoltaics will differ according to the region and the comparative price of diesel fuel.

2-003 MALI RENEWABLE ENERGY PROJECT

D. Koenig, Consulting Social Scientist, and A. Malik (Project Director), the Solar Energy Research Institute, Golden, Colorado, with assistance from the Peace Corps, the Malian Solar Energy Laboratory, and the Center for Research and Economic Development, University of Michigan. Project sponsored by the U.S. Agency for International Development, Washington, D.C. Initiated in 1979, 11 pp.

This five-year project, under the auspices of the 1977 International Development and Food Assistance Act, is aimed at introducing Mali to renewable energy technologies.

The overall objectives of the project are threefold: improve the quality of life in Mali by energizing tasks that are now largely human powered; help alleviate Mali's dependence on fossil fuels and firewood; and gain an understanding of the social and economic consequences of introducing renewable energy technologies in rural Africa.

The project is divided into five phases:

1 Provide material and technical and training support for the Malian Solar Energy Laboratory.
2 Conduct a resource and socioeconomic survey in 25 villages. This survey will provide base-line data on the local availability of energy sources and village preferences as to the tasks they wish to have energized, and the potential village capacity to operate and maintain energy devices. The survey forms and a description of how the survey would be implemented are in the draft status (they will be in French).
3 Test several devices and applications in a selection of the 25 villages.
4 Prepare a detailed analysis of the village experiments in Phase 3.
5 Provide transitional support to the Solar Energy Lab and promote the production and deployment of devices that were proven successful during the earlier stages.

The survey was tested during the summer of 1980, and enumerators from each village are being specially trained to implement the survey.

2-004 FOREST, FORAGING, FENCES AND FUEL IN A MARGINAL AREA OF KENYA

D. Brokensha and B. Riley, Social Process Research Institute, University of California, Santa Barbara. Prepared for the U.S. Agency for International Development/Africa Bureau Firewood Workshop, June 12-14, 1978, Washington, D.C. June 1978, 28 pp.

This report examines the use of firewood and charcoal in the Mbere Division, Embu District of Kenya. After a description of that region's demography and geography, the authors proceed to analyze the changing conditions in Kenya that affect the use of these resources.

Traditional usage patterns are examined and the perceptions of the role of firewood or charcoal in the society are given. Firewood species are classified according to their dimensions and use, their inherent qualities, their relative accessibility in both the wet and dry seasons, and their end use. The amount of time spent in gathering firewood is also addressed. The effects of land adjudication are discussed, with the authors concluding that government land grants to individuals result in very confusing situations. Finally, the sale of firewood and charcoal--covering both the prices and the market--is examined. Demand for charcoal is compared with that for wood, and arguments for and against the use of charcoal are presented.

In the conclusion, the authors state that the use of firewood is a significant part of the society and economy of Kenya. Recent drastic changes, such as an increase in population, the clearing of bush for agriculture, the decrease in available trees, and the restriction of access due to land adjudication, are threatening to alter that importance. Firewood, it is concluded, is a very commercial commodity in ever-decreasing supply.

The data for this report are taken from several previous firewood surveys and from the authors' own observations while engaged in this collaborative research in Kenya.

2-005 AN APPROACH TO THE ASSESSMENT OF RURAL ENERGY DELIVERY SYSTEMS IN DEVELOPING COUNTRIES

R. Nathans and R. Chatterjee, Institute for Energy Research, State University of New York at Stony Brook, Stony Brook, New York. May 1979, 17 pp.

This report presents an approach for looking at the total system employed to deliver useful energy to all consuming and producing rural communities. The authors begin by stating that it is imperative to formulate and test a systematic methodology that poses options on a broader basis than now available and provides an information set upon which future decisions can be based. Toward this end, they collaborated with the Ceylon Electric Board in Sri Lanka and the National Energy Administration of Thailand in order to develop and test their methodological approach. Field testing took place in six villages in each country.

The approach begins with a detailed survey of energy-consuming activities, fuel-device combinations, fuel inputs, and the distribution of agricultural and other locally produced products. Next, field measurements and interviews are conducted to obtain estimates of local energy resources. Village and household data are gathered and household energy use is determined. The energy consumption of community services, farm production, and local industries is also taken into account. With these data, projections of future energy requirements are made, and an analytical framework is designed to insure the balance among energy supply, needs, and demands. Possible solutions are then ranked with respect to criteria based on the ability to satisfy the needs of the community and, finally, these rankings are tested for sensitivity to the accuracy of each of the essential information inputs. The emphasis throughout the approach is on information that will reflect the economic and managerial aspects of the energy delivery system.

The purpose of the pilot efforts in Sri Lanka and Thailand is to test the methodology. The authors hope to use the findings to design more extensive rural energy delivery assessments.

2-006 FUELWOOD AND CHARCOAL CONSUMPTION IN THE MARGINAL MACHAKOS DISTRICT, KENYA

P.M. Mung'ala, University of Dar-es-Salaam, Tanzania. 1978, 224 pp.

The purpose of this project, presented as a thesis, was to determine current per capita and total consumption of fuelwood and charcoal in the Machakos District of Kenya and to forecast consumption for the years 1980, 1990, and 2000. For background information, the author reviewed the literature extensively and summarized the material he found on: the role of energy in the evolution of a society, energy and economic development, usable energy, comparative value of fuels, worldwide consumption of fuelwood and charcoal, and the fuelwood and charcoal situation in Kenya.

For the survey, the area in question was first divided into vegetation zones. The sampling frame was designed so as to represent rural and urban households, private and public services, and industry. Information was obtained through questionnaires based on that used by Openshaw in Gambia (see 2-009), and a different questionnaire was designed for each sector. Sample families and institutions were visited and their owners were interviewed. The quantity of wood consumed by each in a day's time was weighed, measured, and recorded. Weekly, monthly, and yearly consumption figures were extrapolated from the initial data. Prices and the method of procurement were studied for fuelwood, charcoal, and kerosene.

The author then predicts the future consumption of fuelwood. His forecasting model is discussed in detail, and his results for estimated future consumption and supplies are included. The various questionnaires are also included.

2-007 STUDY OF THE PROBLEMS AND PROSPECTS OF BIOGAS TECHNOLOGY AS A MECHANISM FOR RURAL DEVELOPMENT: STUDY IN A PILOT AREA OF BANGLADESH

M.N. Islam, Department of Chemical Engineering, Bangladesh University of Engineering and Technology, Dacca. November 1978, 26 pp.

This report describes a project that is designed to evaluate the prospects of biogas technology as a mechanism

for rural development. The methodology for collecting data and its analysis are two of the main themes of the research work.

The report begins with a description of the project region (Nabagram Union), including its location, size, and administration. The project area consists of 23 villages.

A complete census of the union was made by using household and village questionnaires. The household survey included information on: family demographics, housing, cooking ovens, fuel energy, number and type of domestic animals and poultry birds, present social practice and use of biogas, land, field crops, general economic conditions, trees and plantations, sources of water and use, and choice of health care specialist during sickness. The village information was obtained from the rural leader or village headman and included data on: educated manpower, rural industries, agriculture input/output, medical facilities, government offices in village, price of various activities, and transport facilities.

The author then assesses the preliminary results of these surveys. The parameters of evaluation include the economic situation, social conditions, settlement patterns, availability of land, energy consumption patterns, fertilizer consumption patterns, and job prospects. The future program is also outlined. It will involve a continuation of the data analysis and a shortened survey that will measure the physical dimensions of stoves and monitor the energy consumption of selected families. An appendix gives details of the research management and provides a time and action schedule.

2-008 PATTERNS OF URBAN HOUSEHOLD ENERGY USE IN DEVELOPING COUNTRIES: THE CASE OF NAIROBI

G. McGranahan, S. Chubb, and R. Nathans, Institute for Energy Research, State University of New York at Stony Brook, Stony Brook, New York, and O. Mbeche, University of Nairobi, Nairobi, Kenya. April 1979, 72 pp.

The approach described in this report is directed toward analyzing direct and indirect energy demand as it relates to various urban household activities at different income levels. It is the second application of an approach

that was first used in Mexico City (see 2-011). The methodology has been adapted for Nairobi in order to illustrate the relationship between urban household activities and the use of energy resources, to assess government policies in terms of their impact on energy resource consumption, to evaluate the potential impact of energy shortages on household activities in different income groups, and to project the future energy demands associated with each urban household activity.

A small household survey was conducted in order to determine energy consumption patterns. Some of the end-use activities considered in this survey were transportation, direct residential use, food consumption, housing (construction), and services. Energy requirements were expressed in terms of the primary energy inputs: oil, electricity, charcoal, wood, and metabolic.

According to the authors, the reliability of the results is limited by a lack of field data on energy inputs to the production of certain goods and services in Kenya. Their estimates, they say, have a degree of uncertainty but are not unreasonable. The measurement of income also represents problems.

Three limiting aspects of the methodology are mentioned First, it was found that not all energy consumed was used to support household activities; a certain portion of energy use was unaccountable. Second, the assumption that as households increase in income, activity levels alter to conform with those of higher income groups does not always hold true. A third problem was that energy profiles specify the average rather than the marginal energy values associated with an activity. This factor, the authors say, must be taken into account when doing future studies.

The study continues wtih an analysis of each end-use sector. The authors conclude with an overview of the results, a discussion of policy applications, and suggestions for refinements of the approach.

An appendix provides a comparison between Nairobi and Mexico City.

2-009 THE GAMBIA: A WOOD CONSUMPTION SURVEY AND TIMBER TREND STUDY, 1973-2000

K. Openshaw, International Forest Science Consultancy, Midlothian, England. Report to the Land Resources Division, Overseas Development Authority, London, England. July 1972-June 1973, 101 pp.

This report describes a total land resource development study that was undertaken under the auspices of Great Britain's technical assistance program to Gambia. The author was retained as the consultant for the forestry sector.

The goal of his portion of the development study was to obtain a preliminary estimate of the annual per capita consumption of firewood and charcoal, taking into account the differences in rural and urban requirements, seasonal changes, and ethnic variations. Another objective was to estimate the present consumption of indigenous, planted, and imported timber for all purposes. These data will be used as a basis for forecasting future consumption trends.

The wood consumption survey was undertaken first, and household and nonhousehold users were included in the survey sample. The latter group includes industries that use fuelwood: blacksmiths, boat builders, and furniture manufacturers. The household sample is large enough to ensure coverage of ethnic, regional, and occupational variables. The analysis of the questionnaire form is done manually and averages are determined for the different component factors. The results for households and each industry type are then given.

The second section of the report describes a methodology for forecasting wood consumption in 1985 and 2000. Population, rate of urbanization, gross domestic product, and elasticity of demand are all considered. The implication of the forecasts for future forest policy is discussed.

Final conclusions and recommendations are then given. The questionnaire is included as an appendix.

2-010 DOMINICAN REPUBLIC ENERGY IN THE FOOD SYSTEM PROJECT

S.R. Daines, Practical Concepts Incorporated, Washington, D.C. 1979, 20 pp.

This document is a workplan for a project that was scheduled to commence in 1979 but was delayed due to Hurricane David.

Three main analytical products are expected to come from this project: (1) an overview of the uses of energy fuels in the production, processing, storage, and transport of agricultural products in a form compatible with the Brookhaven Reference System (see 3-01); (2) detailed energy profiles of major agricultural products, disaggregated by region, size of firm/farm, and household income level; and (3) ancillary information on institutional, economic, and historic factors relating to energy and the limitations of natural resources.

Data will be gathered from three sources: secondary data sources; existing primary data files for agricultural production, industry and food processing establishments, and national consumption; and field surveys. The latter will consist of a rural and urban household survey; an agricultural production survey; a rural and urban small-scale industry and food processing survey; a rural and urban marketing, storage, and transportation survey; and a natural resources survey. The data will be field coded, punched, edited, and processed under PCI direction.

2-011 URBAN ENERGY USE PATTERNS IN DEVELOPING COUNTRIES: A PRELIMINARY STUDY OF MEXICO CITY

G. McGranahan and M. Taylor, The W. Averell Harriman College for Urban and Policy Studies, State University of New York at Stony Brook, Stony Brook, New York. December 1977, 72 pp.

According to the authors, very little work has been directed toward the urban areas of developing countries, and almost nothing has been done in the area of urban energy demand. Thus this report describes a methodology for characterizing the urban energy demand of developing countries. The authors explore the effects of urbanization and the interdependence between human activities in urban centers and national energy demand.

The methodology centers around household activities in several income groups and how these activities are linked to energy-use processes and the use of primary energy. The methodology is used for illustrating the effects of urbanization on the use of primary fuels, for projecting future energy demands associated with household activities in different income groups, for assessing alternative government policies in terms of their effect on primary energy consumption, and for evaluating the potential impact of energy shortages on the activities of people in different income groups.

The authors construct energy-use profiles for different income groups and then examine each income group's activities to determine the associated end-use demands: transportation, food, housing, residential uses, and public services. They next determine the primary energy inputs required by the activities (oil based, electric, and noncommercial). All estimates are based on information obtained from observation and interviews. After the approach is explained in detail and applied to Mexico City, the authors project energy demand to 1990.

2-012 REPORT ON ENERGY FLOW ON SMALL FARMS

N. W. Axinn (Project Leader) and G. H. Axinn (Collaborator), Institute of Agriculture and Animal Science, Rampur, Nepal. June 1978, 37 pp.

In this report, data gathered in several studies of small farms in Nepal are analyzed to identify the energy balances that develop in a nearly closed ecosystem, or a subsistence farm. Major attention is given to oxen as a secondary source of farm power and to firewood as a major fuel input. The authors' hypothesis is that the efficiency of energy conversion is an index of development and that the quantity of energy converted correlates with the socioeconomic status of the farmer.

Data on firewood use were collected by interviewing all the families living in three hamlets. The cost-benefit data for the oxen were gathered by interviewing 69 families in the Terai region and 70 farm families in the hills.

The final report of the study includes a general description of small farms in Nepal, a discussion of energy balances, a chapter on bullocks as a secondary source of farm power, and a section on firewood.

2-013 PATTERNS OF ENERGY UTILIZATION IN A PHILIPPINE VILLAGE: SOURCES, END USES AND CORRELATION ANALYSES

F. Manibog. Report presented to the International Energy Agency, Organisation for Economic Co-operation and Development, Paris, France, and the Rockefeller Foundation, New York, New York. December 1979, 90 pp.

The goal of this study is to provide a detailed analysis of noncommercial energy utilization within a total energy framework. To do this, two villages (sitios) in the Verde Island region of the Philippines were selected for a case study that addresses the following questions:

- What energy sources are now being utilized? How much is being used and for what end uses per source?
- Who uses what particular type of energy source?
- What economic, social, and political factors help explain the nonhomogeneity of end-use patterns even in a consuming unit as small as a village of around 100 households?
- What policy implications can be gleaned from differing end-use patterns among various strata of end users?

In discussing his research methodology the author reviews the criteria used for selecting villages for the case study and the difficulties encountered in dealing with questionnaires versus interviews. Due to trouble with the proposed questionnaire, the author opted for household interviews, but even this approach was not without its difficulties. Based on 80 visits out of 104 households, the respondents were stratified according to income group, number of household members, location, male occupation, and occupation of housewives and working children.

This report also includes a socioeconomic profile and an energy consumption profile which summarize daily energy consumption and compare communal use efficiencies for wood and kerosene. Furthermore, correlation analysis is used to explore the relationships between socioeconomic indicators and energy variables.

2-014 FUELWOOD USE IN A PEASANT COMMUNITY: A TANZANIAN CASE STUDY

P.C. Fleuret, Social Process Research Institute, University of California, Santa Barbara, and A. K. Fleuret, Department of Anthropology, California State University, Los Angeles. In: *The Journal of Developing Areas* 12:315-322, April 1978.

In this study, the authors undertake to measure accurately the fuel use in one peasant village of Tanzania. A description of the village of Kwemzitu is followed by a vignette describing wood collection habits: the time people commit to this enterprise, the distances they travel, and how they use the firewood.

A population survey was conducted first in order to arrive at a per capita consumption figure, followed by a direct measure of the wood consumed by sample families. The authors then investigated the labor involved in fuelwood gathering, expressed in terms of trips per week, hours per trip, hours per week, and the volume of the load. Next, the amount of wood collected and carried to one household over a one-week period was measured. Finally, charcoal consumption and the financial burden it represents to a village family were surveyed.

The results of these surveys are presented in terms of the trees that would have to be planted in order to keep pace with consumption. The need for massive reforestation is expressed.

2-015 BANGLADESH ENERGY STUDY

Montreal Engineering Company, Ltd., Montreal, Canada; Snamprogetti S.p.A., Rome, Italy; Meta Systems Inc., Cambridge, Massachusetts; and C. Lotti Ass. S.p.A., Rome, Italy. Sponsored by the United Nations Development Programme; administered by the Asian Development Bank. November 1976, 9 volumes, 2,000 pp.*

*Copies of this document are difficult to obtain. It is suggested that you write the Asian Development Bank, P.O. Box 789, Manila, The Philippines 2800, if you wish to inquire about the report's availability.

The Bangladesh Energy Study (BES), "the most definitive study of Third World energy to date,"* is the work of four companies and a counterpart Bengali study team. This study represents the first time a unified examination of the entire energy system of a developing country has been made. It highlights the contribution of traditional energy to Bangladesh's economy and presents commercial energy use for each economic sector. It also demonstrates the interaction between traditional and commercial energy use in rural economies and shows the relative insignificance of commercial energy inputs in agricultural and rural life. Further, the BES discusses the nutritional implications of an increased dependence on Green Revolution crops that divert more of the sun's energy to food production and less to biomass for cooking fuel.

The study team began by modeling agricultural output as a function of technical change, capital constraints, and pricing policies. They then devised a macroeconomic model incorporating population, capital/output ratios, shadow prices, and sectoral energy coefficients. Finally, they developed an input/output model that multiplied population, production, and project investment by energy coefficients to maximize the gross national product, and generated five economic growth and energy demand scenarios.

In this report, the team estimates the total energy consumption in Bangladesh in 1973-74 and finds that traditional sources account for 73 percent of the total. These sources include cow dung, jute stick, rice straw, rice hulls. bagasse, firewood, and twigs. To highlight the importance of traditional energy in the national economy, the survey shows that a 10 percent decline of supply from traditional sources would require a 30 percent expansion of modern sources in order to maintain the overall availability of energy.

The BES continues by comparing the costs of traditional and commercial energy. It shows that rural electrification is expensive and underused, and that the expansion of the electric grid would not generate much additional activity. Rather, rural electrification funds would produce far greater benefits, accruing to many more people, if spent on alternative programs.

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*This annotation is based, in part, on a review of the BES that appeared in *Soft Energy Notes*, August 1978, pp. 53-58.

2-016 TUNISIAN ENERGY ASSESSMENT

Gordian Associates, Middlesex, England.*
1979-1980, 2 pp.

This energy assessment has six principal objectives: (1) to analyze the current energy situation in Tunisia and make recommendations for improvements in energy consumption patterns in the short term; (2) to project requirements for energy products of the Tunisian economy from today through the year 2020; (3) to determine the quantities of energy products that may be substitutable by others; (4) to define available energy strategies for Tunisia and to determine an optimum strategy in the context of national development plans and priorities; (5) to develop implementation plans appropriate to the optimum strategy; and (6) to review tariffs on energy products and recommend a logical structure for pricing, consistent with the optimum strategy.

The project will involve gathering comprehensive data on energy resources, energy conversion industries, all energy demand sectors, and the potential application of new technologies, especially those concerning renewable resources. It will also include the construction of a simple economic model for projecting activity levels of major subsectors, and for projecting energy demands at the subsectoral level, which will be part of the input data for a comprehensive linear program model of the Tunisian energy supply-demand system. The methodology of this project therefore couples an energy assessment data-gathering effort with the construction of computer models for the analysis and evaluation of data and options for the future.

This project was described in a letter from Barry Tunnah of Gordian Associates. Data gathering for the project is just under way and little documentation is available as yet. The project should be complete by October 1980.

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*The Tunisian National Energy Commission gave the management responsibility for this project to the Tunisian national oil company, Entreprise Tunisienne d'Activités Pétrolières (ETAP), who in turn engaged Gordian Associates.

2-017 POLITICAL ECONOMY OF ENERGY USE IN RURAL BANGLADESH

J. Briscoe, Environmental Systems Program, Harvard University, Cambridge, Massachusetts.
August 1979, 85 pp.

This report is an analysis of energy use in a single village, Ulipur, in Bangladesh, where data was collected for eight and one-half months. This analysis of the production and distribution of energy at the village level is based not only on the quantitative data collected but also on the author's intimate, informal knowledge of village life.

This report is divided into four parts. Part one describes the study population and the method of data collection. In the second part, annual flows of energy use are examined, including: use of crop residues and tree products for cooking fuel; production of food grain for human consumption; production of animal fodder and organic fertilizer from crop residues; use of cow dung for fertilizer and fuel; energy expended by animals in doing agricultural work; and the energy expended by humans in doing agricultural and domestic work. Part three of the report looks at the social and economic organization and energy use. Land ownership and the reasons underlying social change are discussed. The final part examines the likely past and future patterns of energy use and indicates what the effects of specific energy and rural development projects on different classes in the village may be.

2-018 ENERGY ASSESSMENT IN JAMAICA

W.R. Ashby, Ministry of Mining and Natural Resources, Jamaica. Background paper presented at the International Workshop on Energy Survey Methodologies for Developing Countries, conducted by the Board on Science and Technology for International Development, National Academy of Sciences, January 21-25, 1980, Jekyll Island, Georgia. January 1980, 29 pp.

In this report, the author describes a program of national energy end-use surveys which would be used in the development of a National Energy Accounting System and the construction of a national energy model.

A set of six sectoral surveys are planned: household, tourism, industry, distributive trade, agriculture, and transport. For each sector, the survey aims to correlate energy consumption with other significant economic variables, such as employment, output, value added, and foreign exchange earnings. Other goals are to identify opportunities for energy conservation and for the substitution of alternative energy sources.

The tourism and household surveys are complete, and the remaining four are scheduled for 1980. The survey instrument is a questionnaire. The tourism study surveys energy use in hotels, including restaurants, bars, and gift shops within hotels. The household survey represents .63 percent of Jamaican households and supplies data on income, use of fuel, and the distribution of ownership of certain appliances.

The report emphasizes the total planning process of which the surveys are a part.

2-019 FUEL CONSUMPTION AMONG RURAL FAMILIES IN UPPER VOLTA, WEST AFRICA

E. Ernst, Peace Corps, Ouagadougou, Upper Volta. July 1977, 23 pp.

This study provides a measure of the fuel consumption of rural families. Rural families are defined as those in which the women and children collect all their own fuel from the fields and the bush. They account for about 90 percent of the total population of Upper Volta.

The survey was undertaken in the Kongoussi area in the two villages of Ranga and Boulenga while Ernst was a Peace Corps Volunteer there. In these villages, the main types of fuel are millet stalks and wood, used principally for meal preparation, heating of washing water, and limited home lighting and heating.

In Boulenga, 18 volunteers, half using millet and half using wood, agreed to measure their consumption for a period of 10 days. In Ranga, 36 volunteers measured their consumption of wood for one month. The fuel allocation was measured initially and the remainder was weighed each day thereafter. The measurements were taken according to the size of the family unit.

The author concludes her report with an analysis of the total amount of fuel consumed during the test period. The use of millet and wood is compared. One appendix provides the weight of various species of wood and another discusses the manner of wood collection.

2-020 NATIONAL ENERGY BALANCE (BALANCE NACIONAL DE ENERGIA)

J.L. Calabrese, United Nations Development Programme, and R. Giesecke, D. Tarnawiecki, and H. Portugal, Ministry of Energy and Mines, Republic of Peru. Sponsored by the Ministry of Energy and Mines, Republic of Peru, and the United Nations Development Programme, New York, New York. December 1978, 299 pp. (in Spanish)*

This report describes the methodology and results of an energy survey undertaken in Peru by the United Nations Development Programme. The methodology is described as a very general system of exploring all the physical energy variables necessary for a complete historical analysis, and it is explained in detail.

The results of the data collection are given in a series of matrices for primary energy balance, destination of primary energy, balance of transformation centers, origin of secondary energy, secondary energy balance,

*This annotation is based on an English abstract of this report written by Ricardo Giesecke.

secondary energy consumption, and recycling of secondary energy.

A separate chapter on noncommercial energy describes the special survey undertaken to gather data on the rural sector. After a pilot study, a general survey was implemented that included more than 8,000 interviews in 150 different villages. The villages were chosen to represent the coastal region, the inter-Andean valleys, and the highlands of Peru. Firewood, dung, kerosene, and LPG (liquefied petroleum gas) consumption were examined using 300 special measurements. In addition, 200 cottage industries were surveyed. The statistical analysis and the final survey results are discussed in this chapter.

The last section of the report discusses the elaboration of an Autonomous Model, which results from an energy mix structure. Such a model, by projecting historic dynamics into the future, allows one to determine the most logical scenario as long as substantial decisions that could change drastically the natural behavior of the energy system are not taken. In the Peruvian case, a non-autonomous Energy Substitution Model is elaborated. This model can ingest data on the rational use of energy resources, taking into account substitutions in the secondary energy mix and different consumption patterns. The authors stress the fact that an energy model should not precede the data base of a given country. Rather, the energy model has to be defined and constructed in accordance with the local data base.

2-021 A SURVEY OF DOMESTIC RURAL ENERGY USE AND POTENTIAL IN FIJI

S. Siwatibau, Center for Applied Studies in Development, University of the South Pacific, Fiji. Report prepared for the International Development Research Centre, Ottawa, Canada, and the Fiji Government. October 1978, 299 pp.

The purpose of this study is to fulfill a need for more information on local needs and potential demand for energy in rural areas. The report has been made available to the decision makers in the Fiji government.

This report presents an assessment of: (1) the present energy use and energy needs for an improved standard of living in selected rural areas; (2) available alternative energy sources (and a comparative evaluation of the social and economic costs of delivering those alternatives); and (3) the economic and social viability of existing biogas systems and the advisability of expanding biogas use in rural settlements. This project also explored the ways of conserving energy in, and improving conditions of, domestic cooking in rural and semirural areas.

The information was collected by a variety of methods and entered on data sheets. Interviews supported by questionnaires were designed to gather data on the patterns of end use, the source of energy for each end use, the amount of energy expended for each use, and the relative costs. People's perceived energy needs for an improved standard of living were also recorded, as were the means of providing the required energy locally. Costs of diesel generation and biogas production were assessed as well, along with the social acceptability of innovation and prevailing economic and social conditions.

The report includes a summary of the findings and observations, conclusions, and recommendations. Background notes on Fiji and a discussion of the survey methodology and its effectiveness are also included.

2-022 PEACE CORPS ENERGY PROGRAM

P. Jankura, Peace Corps, Washington, D.C.
Program sponsored by the al Dir'iyyah Institute, Geneva, Switzerland; the Overseas Development Council, Washington, D.C.; and the U.S. Agency for International Development, Washington, D.C.
March 1979-February 1981, 16 pp.

The Peace Corps Energy Program is based on the growing need to identify and develop renewable energy resources as well as energy conservation techniques and technologies. Part of the program is the design of an energy survey to measure fuel uses, needs, and potential resources in rural villages in up to 30 Third World countries.

The seed money for this project was supplied by a grant to the Overseas Development Council (ODC) from the al Dir'iyyah Institute. The U.S. Agency for International

Development (AID) provided the Peace Corps with an additional three-year $1.55 million grant. The Peace Corps will design and implement the energy survey, and enlist the necessary personnel. ODC will process all the data generated from the survey, statistically analyze the survey instrument and results, and make the findings available to interested parties. AID will sponsor the development of the survey instrument and methodology, and supply technical and organizational assistance.

This program has two main goals. The first is to increase knowledge of energy use in developing countries: the program will collect information on the uses of energy resources, will identify energy needs, and will identify and locate renewable, low-cost energy resources. The second goal is to increase awareness about the energy problem in developing countries and encourage participation in finding lasting solutions to those problems.

The Peace Corps Energy Program is divided into four parts: (1) development of an energy survey methodology that can be used by host country nationals to measure energy resources, needs, and potential in rural villages; (2) actual implementation of the survey in rural areas in up to 30 countries; (3) development and implementation of Peace Corps energy technology projects in 100 villages in around 20 countries; and (4) development and implementation of intensive skill-training modules appropriate for Peace Corps and host country use in several technologies.

The survey itself is designed to collect data about specific energy uses in rural villages and provide a basis for analyzing the current economics of that energy use. It will also serve as a community development tool for identifying village energy needs and raising awareness in the village about energy issues. Further, it will provide information that will help identify possible energy projects. Overall the survey is designed to be an instrument for energy planning. It will allow the examination of choice, costs, and social appropriateness of new technologies.

2-023 ENERGY USE IN HONG KONG

K. Newcombe, Human Ecology Group, Centre for Resource and Environmental Studies, Australian National University, Canberra.*

The Hong Kong Human Ecology Programme, which was initiated in the early 1970s, is coordinated by the Human Ecology Group of the Centre for Resource and Environmental Studies, Australian National University. Fieldwork was based at the Centre of Asian Studies of the University of Hong Kong and the Social Research Centre of the Chinese University, Hong Kong.

The first article in the four-part series describing energy use in Hong Kong, and published by *Urban Ecology*, reports the input, output, and end use of extrasomatic energy in Hong Kong for 1971. A detailed breakdown of the end use of major fuels is included, with an emphasis on their use in power generation. Trends in Hong Kong's energy use are examined over a period of 17 years in relation to the rapidly changing urban setting and energy forms that may be adopted in the future.

Conservation of energy is examined with regard to Hong Kong's total dependence on external sources of energy. An ecological strategy is also advanced for Hong Kong as a settlement with a continued reliance on high energy consumption. The study provides a data base which helps determine those principles concerned with the relationship between energy use and human well-being.

Part II in this series, "Sector End-Use Analysis," presents a sector end-use analysis of extrasomatic energy in Hong Kong for 1971. Consumption is divided into the

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*Some of the findings of the Hong Kong Human Ecology Programme were set forth in a series of four articles written by Ken Newcombe and published in *Urban Ecology*: Energy Use in Hong Kong: Part I, An Overview. *Urban Ecology* 1(1):87-113, 1975; Energy Use in Hong Kong: Part II, Sector End-Use Analysis. *Urban Ecology* 1(2/3): 285-309, 1975; Energy Use in Hong Kong: Part III, Spatial and Temporal Patterns. *Urban Ecology* 2(2):139-172, 1976; Energy Use in Hong Kong; Part IV, Socioeconomic Distribution, Patterns of Personal Energy Use, and the Energy Slave Syndrome. *Urban Ecology* 4(3):179-205, 1979.

domestic, industrial, commercial, and transport sectors. In moving toward heavier industries, adopting more energy-expensive modes of transport, and because of the higher energy requirements of new commercial complexes, Hong Kong is rapidly elevating its total energy requirements. The author indicates the options available to alleviate this trend and then discusses the consequences of, and the alternatives to, unabated increases in energy use in Hong Kong.

In Part III, the spatial and temporal patterns of distribution of energy use in Hong Kong are examined in detail. The author shows the variation in intensity of energy use from the more rural parts to the heavily industrialized and residential parts of Hong Kong. The highest intensities of energy use are comparable with any recorded in the industrial cities of the developed world. One simple index, combining energy use and population densities, shows that more people are exposed to the environmental impact of high energy use in Hong Kong than in most other centers with similar intensities of energy use. Urban planning and the environmental consequences of the spatial and temporal energy-use patterns are also discussed.

Differences in the form and level of energy consumption in the home, and in personal transportation, occurring over a range of socioeconomic classes within and around the urban settlement of Hong Kong, are described in Part IV. Conclusions are based on a 1974 biosocial survey which was conducted as part of the Hong Kong Human Ecology Programme. Further data were used from the 1973 Consumer Price Index survey.

A clear-cut continuum is shown across the income range in the use of the more refined energy forms, of which the upper-income groups use four times more than the lower-income groups. The author discusses how this variation marks a trend toward thermodynamically inappropriate uses of electricity in water heating, space conditioning, and cooking, and creates aspirations among the low-income earners for an all-electric lifestyle. Because Hong Kong generates all its electricity from fuel oil, inefficient end use has serious economic and strategic implications.

The benefit of energy-using, labor-saving devices, or "energy slaves," is questioned by means of an analysis of the impact of air conditioning.

According to the author, the ecological, economic, and thermodynamic directions for further energy planning in Hong Kong are clear, but the most important barrier to change

is believed to be the culturally rigid perception of the status of a high-energy lifestyle.

Hong Kong is far more advanced industrially than the other countries included in this directory, yet it shares some common problems with the developing world. Because of the disparity found in the distribution of its wealth, as well as its almost total lack of natural resources, Hong Kong has much in common with developing countries with respect to problems of energy use and distribution. Thus this study may be of value to readers of this directory.

2-024 ENERGY DEMAND AND CONSERVATION IN KENYA

L. Schipper, Beijer Institute of Energy and Human Ecology, Stockholm, Sweden, and Lawrence Berkeley Laboratory, Berkeley, California, and O. Mbeche, University of Nairobi, Nairobi, Kenya. Presented at the Conference on Energy and Environment in East Africa, sponsored by the Beijer Institute and the Kenyan Academy of Sciences, May 5-11, 1979, Nairobi, Kenya. 44 pp.

In this paper, the authors look at the nature of commercial energy demand in a growing country. An energy overview of Kenya is provided using International Energy Agency data for commercial fuel consumption and various other data for noncommercial consumption. The authors disaggregated important energy end uses into various economic or physical activity levels and into energy intensities in order to relate energy demand to specific economic development.

A survey of industrial energy use was undertaken. Officially published statistics were used when available, and these data were supplemented by interviews with key institutions and people, such as oil companies, architectural engineering firms, industrial plant engineers, transportation experts, and producers of solar heating equipment. Energy use was discussed with 15 of the largest industrial firms in Kenya and sample data gathered from each. The authors looked at the energy intensities in all the process industries, spotting trends that tend to reduce a specific fuel use. They found that the cost of energy and the need for conservation programs are a concern to most industrial planners.

The authors also examined energy conservation measures in other sectors of the economy. Using oil company data, they estimated building energy use for such key structures

as hospitals and schools. Looking at household energy use, they found that only 6 percent of the population has electricity in their homes, the majority still depending on noncommercial sources such as fuelwood and charcoal. Energy conservation in the transportation sector was also examined, but the authors found figures available for the aggregate only, not ones corresponding to a particular class of vehicles.

The report concludes with a discussion of energy prices.

2-025 INDONESIAN ENERGY DEMAND SURVEY: A REVISED METHODOLOGY

J. H. Arnold, Jr., Energy and Transport Consultant, Boston, Massachusetts. This project is sponsored by the U.S. Agency for International Development, Washington, D.C., as part of the Environmental Review of the Indonesian Rural Electrification Program, and by other international donors. 1979, 39 pp.*

The goal of this survey was to identify the factors that determine the types and quantities of fuels consumed by the rural household--factors that affect the rate of acceptance and potential demand for a new energy source, such as electricity. Separate schedules were prepared to collect data at the district, county, village and household levels, using both fixed interviews and participant observation.

Three survey sites which represented the different geographical and agricultural characteristics of the project area were selected. Within each site, poor, average, and prosperous villages were selected. Household fuel use was measured on a daily basis by third- and fourth-year college students. Data were gathered on local and regional agricultural energy use by interviewing the extension agents.

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*The description of the survey design is available from VITA, but requests for the actual data should be sent to Paul Weatherly, U.S. Agency for International Development, Jakarta, Indonesia.

According to the author, this survey has three distinguishing features: scale of data collection, separation of energy demand and fuel selection, and use of repetitive physical measurements. These characteristics are discussed in detail. The methodology contains four major sources of bias: close interaction between surveyors and supervisors, intensity of surveyors' involvement in village life, procedure for selecting households, and the time allotted for the survey, which prevented accurate measurements of the changes in fuel selection and energy use during the year.

Most of the problems with the implementation of the survey are attributed to limitations on time and experience. Future changes would involve strengthening the training, tightening the supervision, and allowing more time for preparing and testing the questionnaire. The results of the survey are now being reviewed.

2-026 ENERGY DATA BOOK

Energy Resources Cell, Ministry of Petroleum and Natural Resources, Government of Pakistan, 1979, 162 pp.

The *Energy Data Book* of Pakistan represents a pioneering effort in the energy statistics field. The base information--statistics of commercial and noncommercial energy resources by source, form, and sector--has now been collected and will undergo continuous improvement, both in quality and accuracy. An annual bulletin will track these changes in Pakistan's energy statistics.

The *Energy Data Book* is a reference document based on the Comprehensive Energy Resources Survey, which the government undertook as a prerequisite for formulating a national energy policy. With the assistance of the United Nations Development Programme, comprehensive data and statistics were compiled for the period 1965-1975.

This document reviews the basic facts of Pakistan's energy picture by looking at gas, hydroelectricity, coal, biogas, and solar, wind, and geothermal energy. For the commercial fuels, data are compiled from producing and marketing organizations, which maintain fairly accurate statistics. For the noncommercial fuels, a field survey was taken to measure the use of firewood, charcoal, animal dung, cotton sticks, bagasse, weeds, and crop roots. The survey approach is explained in detail, including the sample design,

the scope and coverage, and the field organization and methodology. The consumption patterns for both commercial and noncommercial fuels are given.

This document also contains chapters on Pakistan's energy balance, pricing policy, and organizations dealing with energy. The statistical section gives figures for Pakistan's energy resources, energy production and supplies, energy consumption, the noncommercial energy resources survey, and world energy statistics.

2-027 WOOD FOR FUEL--ENERGY CRISIS IMPLYING DESERTIFICATION: THE CASE OF BARA, THE SUDAN

T. Hammer, University of Bergen, Norway. Doctoral thesis in Geography. November, 1977, 128 pp.

This thesis presents desertification as a global problem resulting from the human mismanagement of land. It focuses specifically on the problems of the Sudan. The lack of knowledge about the removal of vegetation for energy and its ecological consequences led the author to conduct a field study in 1976-1977 on the collection, production and distribution, and consumption of firewood and charcoal. The author, the first woman to do fieldwork on the energy situation in the Sudan, interviewed women in 10 percent of the households living in Bara, a town in a semiarid area suffering from desiccation, and also visited the main wood and charcoal supplying villages.

In her thesis, the author formulates a model of fuel supply for domestic use in dryland population centers. Population centers in the area of study are then classified according to the model, and Bara's future energy outlook is discussed in light of the model. The energy situation in Bara, based on the fieldwork data, as well as Bara's physical and human features are also presented.

The survey methodology centered on interviews with 137 households, which were carried out in Sudanese and Arabic. In these interviews, the author tried to determine the natives' perception of desertification problems. The interviews also asked about the supply, consumption, price, and change in use and procurement of kerosene, firewood, and charcoal. Energy consumption by public institutions such as schools, prisons, hospitals, bakeries, and tea shops was also surveyed.

In July 1978, the author returned to Bara and carried out a follow-up study. For this, the data were collected

in a more impressionistic manner. Much of the study was based on observation but some interviews were also conducte(The results of this second visit are written up in an addendum to the thesis.

2-028 RURAL ENERGY UTILIZATION PATTERNS: SOME PRELIMINARY OBSERVATIONS FROM PANGMA

D. Bajracharya, Science Policy Research Unit, University of Sussex, Falmer, Brighton, England, January 1979, 32 pp.

This study considers four components of energy use--food and fodder, fuel, human labor, and animal labor--within four different sectors--domestic, agricultural, cottage industry, and miscellaneous--in an area of Nepal.

The author chose three sites from the Kosi Zone of Eastern Nepal, along a north-south axis in order to make a comparative study of the mountain, mid-hill, and plain regions. These areas are known as Hongong, Pangma, and Madheli, respectively. The most basic of data were collected (covering population numbers, land-holding arrangements, cropping patterns, etc.) by means of a household survey to cover every household in the concerned area (every third household was chosen for detailed questioning), and a second questionnaire for weekly questioning in only a few selected households. The program continued for a complete year in Pangma and for four months in each of the other areas.

Analysis of the data allows a general description of Pangma--its geography, ethnic distribution, cropping methods, livestock rearing, cottage industries, and domestic activities. Analysis of the weekly data collected from 14 households presents a microcosm of life in Pangma--family conditions, land holdings, and productivity of the land. The data also reflect food habits, fuel consumption, and labor utilization in the various sectors.

2-029 THE DESIGN OF A RURAL ENERGY CENTRE FOR PURA VILLAGE: Part 1, Its Present Pattern of Energy Consumption; Part 2, Developmental Implications of Pura's Present Energy Consumption Pattern

N.H. Ravindranath, H.I. Somashekar, R. Ramesh, A. Reddy, K. Venkatram, and A.K.N. Reddy, ASTRA, Indian Institute of Science, Bangalore, India. 1978, 25 pp.*

This study reveals the inequity of existing electrification efforts to supply energy to the rural poor in India, and proposes an alternative system based on biogas and solar energy technologies. The energy survey conducted as part of this study was one of the first to show village energy budgets and the village dependence on firewood as a fuel source.

The first part of the report is the village survey, which shows the time spent on various economic activities as well as the use of resources. The authors state that 15.5 percent of the villagers' time is spent collecting fuelwood, most of which is gathered without payment. The wood is used for cooking and heating water. By redistributing the larger wooded areas and increasing the land available for fuelwood collection, Pura could prevent deforestation.

The survey also studies commercial energy use and concludes that the village poor do not benefit from electrification. Electricity is used in Pura mainly to run four irrigation pumps owned by three farmers. The rest is used to run a flour mill and for lighting purposes by affluent families.

The second part of the report describes the alternative energy supply system recommended by the Indian researchers. The heart of the system is a communal-scale biogas unit to convert overnight cattle excreta into methane gas. An old satellite-TV parabolic receiver will be used as a solar collector to preheat water communally. This design, after approval and modification by the villagers, will be built by Institute's Rural Extension Center.

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*This annotation is based on a review of the Pura Village project by Peter Hayes in *Soft Energy Notes*, July 1979, pp. 53-54. Copies of this report may be obtained by writing: ASTRA, Indian Institute of Science, Bangalore, 560012, India.

The goal of the entire system is not only to help the poorest in Pura village meet their basic human needs, but to increase the villagers' self-reliance and social control over energy and their environment.

2-030 METHODOLOGY OF FUELWOOD SURVEYS, WITH REFERENCE TO INDONESIAN DATA

K.F. Wiersum, Department of Silviculture, Agricultural University of Wageningen, The Netherlands. May 1979, 31 pp.

Fuelwood accounts for 70 percent of all the energy consumed in Indonesia, and good quantitative data about its us and sources of production are vital. Several firewood surveys have been undertaken in Indonesia to collect this important data, yet all consist of direct consumption surveys at the level of individual consumption units. The results of these surveys vary considerably but the general collation of the data does yield valuable information on several factors influencing fuelwood consumption.

In the preparation of this report, the author makes use of his experience with a fuelwood survey implemented as part of the Food and Agriculture Organization Upper Solo Watershed Management and Upland Development Project. The methodology used for this survey is described. First, 1 percent of the households in the project area were interviewed to obtain data on the consumption, production, trade, and general features of the fuelwood situation. One village was then selected and actual fuelwood use was measured during a several-month period. The data obtained from the village survey were used to formulate a questionnaire for a rural household income and expenditure survey. Finally, the actual production capability of fuelwood was estimated in two villages by taking sample measurements of standing volumes of wood in main production units and estimating total productivity.

Based on the information from the survey, the author discusses the general fuelwood situation in Indonesia. He indicates the difficulties encountered in administering fuelwood surveys and discusses factors that can influence the reliability of the results. Some of these problems are the lack of a definition of firewood, the different kinds of populations surveyed, regional differences, and the effect of the substitution of fuelwood by other fuels. The author

also discusses fuelwood production and trade in Indonesia and evaluates the possible uses of the collected fuelwood data.

Finally, the author uses the material presented above to discuss methodologies for fuelwood surveys more generally. Basically, three factors must be considered. First, the purpose of the survey must be clearly defined and the expected use of the results anticipated. This will enable the surveyor to choose the type and quantity of data to be collected. Second, the advantages and disadvantages of various methods of measuring fuelwood consumption must be examined. Third, methods for measuring additional fuelwood consumption must be formulated in order to relate consumption to production capacity.

2-031 CAPE VERDE NATIONAL ENERGY ASSESSMENT

R. Gordon, Donovan, Hamester, & Rattien, Inc., Washington, D.C. April 1979, 16 pp.*

The long-range program objective expressed in this report is to provide data and information bases to attack long-term energy problems in Cape Verde. The recommended assessment would include (1) a rural and urban household energy-use survey; (2) an energy survey of the commercial, industrial, agricultural, transportation, and utility sectors; (3) a survey of present sources of energy supply; and (4) an assessment of the indigenous energy resources not now exploited (e.g., geothermal).

To prevent a glut of information, the survey would be targeted to meeting well-defined objectives. Eight potential objectives are discussed in detail.

Actual implementation of the survey would require outside technical assistance and Cape Verde counterpart cooperation. The first step would be to refine the project objectives and design a project implementation plan. Next, the survey instruments and analytical tools must be developed, using the experience gained from prior Donovan, Hamester, & Rattien studies (see 1-03, 1-05, 1-07) and the Stony Brook

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*Preliminary outline drafted in response to a request from John Blumgart of the U.S. Agency for International Development/Africa Bureau in conjunction with Hugh Smith of the USAID Mission in Cape Verde.

urban surveys (see 2-008 and 2-011). Enumerators would be selected and trained, village selection criteria defined, and the analytical methods needed to translate the raw information into useful tools for local and national decision making developed. After pretesting, the four-part assessment would be implemented.

This survey description includes a time schedule, a budget, and a sample questionnaire.

The Cape Verde Energy Assessment is part of the USAID/Africa Bureau Rural Energy Survey Program. Plans are under way to use the same general methodology in Cameroon, Mali, and Rwanda.

2-032 PLANNING RURAL ENERGY PROJECTS: A RURAL ENERGY SURVEY AND PLANNING METHODOLOGY FOR BOLIVIA

M. Hageboeck (Project Director/Editor), G. Burrill, S. Forman, and E. Gomez (On-site Consultants), Practical Concepts Incorporated, Washington, D.C. Contract report prepared for the U.S. Agency for International Development, Washington, D.C. April 1980, 178 pp.

Practical Concepts Incorporated (PCI) has developed a survey and planning methodology for assessing rural energy needs and village-level energy resources in Bolivia. The methodology is designed to facilitate the selection of the most appropriate and effective ways for rural Bolivians to meet their energy needs.

The survey, when implemented, will provide data on energy uses in rural areas, local energy resources, socio-cultural and environmental conditions, and village-level energy needs. The survey data will be analyzed by matching a set of ranked energy needs and local resources to a selection of appropriate energy conversion technologies. PCI recommends that the U.S. Agency for International Development undertake the initial testing, translation, and application of the survey instrument and engage a Bolivian institution in the survey and analysis process, gradually transferring both the capacity and responsibility for the process to a local organization.

This report also includes a discussion of two different data collection methodologies. The first involves gathering data from centralized, existing sources. Information on climate, geography, economics, sociology, and technology is

often available in published sources. The second involves collecting village-level data by observation and interview. Some of the issues raised here are the characteristics of the survey instrument, the selection of the respondents, and the management of the village data collection process. A section follows on the analysis and use of these data.

A description of the overall energy situation in Bolivia and the energy survey instrument (both in Spanish and English) are included as appendixes to this report.

2B SECONDARY DATA COLLECTION

2-700 INTERNATIONAL ENERGY DEVELOPMENT PROGRAM, U.S. DEPARTMENT OF ENERGY

R.A. Summers, Country Energy Assessment Program, Office of International Affairs, U.S. Department of Energy, Washington, D.C. 1979; Executive summaries, 14 pp.; full reports, 5 vols. (Egypt and Peru).

The U.S. Department of Energy's International Energy Development Program (IEDP) is a cooperative undertaking aimed at helping other countries strengthen their energy planning capability, reduce their dependence on imported oil, increase use of indigenous energy resources, and avoid a premature or excessive commitment to nuclear systems. Toward this end, a methodology was developed to carry out a comprehensive energy assessment that would, with the use of the appropriate analytical methods, relate energy resources to future demands for energy in various sectors of the economy.

In 1978 and 1979, energy assessments were conducted in Egypt and Peru. Representatives and technicians from each country and from the United States worked together to assess both the energy resources that will be required in each country by the year 2000 and the energy demand and supply options that are now or could be available to each country over that interval. Currently, assessments are under way in Argentina, Portugal, and the Republic of Korea. The products of these assessments are joint reports. Executive summaries are available for the Egypt and Peru studies as well as multivolume final reports. The executive summaries present the setting for the energy assessment, explain what was done, and summarize the principal insights to be drawn.

The assessment procedures are outlined briefly. Researchers, using available data to analyze economic development and the energy resource base, identify energy supply and demand options. The demand sectors examined are industry and services, residential and commercial (both urban and rural), transportation, agriculture, and public. The energy supply and demand network, derived from the analytical model developed by Brookhaven National Laboratory (see 3-01), is used to represent energy consumption and production in 1975-1976 and to project energy supply and demand balances for 1985 and 2000. The prospective availability of energy resources and energy-related materials is assessed, and the prospective application of existing and advanced energy supply and utilization technologies and their potential impacts are explored. The assessment identifies areas where further data or more in-depth evaluation are required. It also identifies specific energy supply options.

The final report offers a comprehensive picture of projected energy demand through 2000. It includes an assessment of basic fuels and energy resources available to meet that demand and examines alternative energy planning strategies. Aggregated estimates of capital and operating costs, manpower, and equipment needed for energy supply facilities are also discussed. Finally, it identifies factors that should be considered in evaluating various options and suggestions regarding the next steps for more comprehensive and systematic energy planning.

2-701 HOUSEHOLD ENERGY AND THE POOR IN THE THIRD WORLD

E. Cecelski, J. Dunkerley, and W. Ramsey, Resources for the Future, Washington, D.C., with an appendix by E. Mbi, World Bank, Washington, D.C. Resource Paper R-15, Resources for the Future. 1979, 152 pp.

This report* brings together what is known about household energy consumption needs among the poor in developing

*Resources for the Future (RFF) originally undertook this project at the request of the Energy, Water, and Telecommunications Department of the World Bank. Later, when the authors wished to broaden the final report of the initial project, funds were made available by the RFF Center for Energy Policy Research from a Ford Foundation grant.

countries and supply alternatives for meeting those needs. The first part of the report constructs household energy consumption patterns of the urban and rural poor. Existing data are searched exhaustively to produce end-use statistics, the costs of energy, and the amount of the household budget devoted to the purchase of energy.

The second part of this report analyzes the supply possibilities and cost factors of renewable energy sources. Some of the alternatives considered are biogas, solar, wind, fuelwood and wastes, charcoal, petroleum, and electricity.

The cultural and equity constraints conditioning energy use are reviewed. Some of these may be cooking habits, attitudes toward use of biogas, and income distribution as it relates to high-cost energy sources and new energy technologies.

Finally, institutional experiences in managing some of the difficulties encountered in introducing new energy systems for the poor in developing countries are examined. Community energy systems are discussed, as are appropriate technical assistance programs.

The three appendixes to this report include a comprehensive biography, "Observations on Some Aspects of Energy Use in Cameroon," and a list of energy consumption definitions and estimates.

2-702 CONSUMPTION AND UTILIZATION OF FIREWOOD IN WESTERN AND CENTRAL AFRICA (CONSOMMATION ET UTILISATION DES COMBUSTIBLES LIGNEUX EN AFRIQUE OCCIDENTALE ET CENTRALE)

A. Bertrand, Centre Technique Forestier Tropical, Nogent-sur-Marne, France. Sponsored by the Food and Agriculture Organization of the United Nations. April 1979, 103 pp. (in French).

This project aims to review and make available all the current information on the consumption and use of forest products in Western and Central Africa; thus a bibliography makes up the main part of this report. The report also analyzes and presents principal factors to consider when collecting information about firewood and charcoal consumption, discusses the availability of this information, and suggests better ways of conceiving and executing further studies on these questions.

Following the bibliography, the different results of the projects listed are discussed and compared. Urban and rural consumption are examined, as is the price of wood and charcoal in different regions. General conclusions about the study methods and about the problems inherent in collecting this kind of data are also examined.

2-703 HOUSEHOLD ENERGY USE IN NON-OPEC DEVELOPING COUNTRIES

J.C. Fernandez, Rand Corporation, Santa Monica, California. Contract report prepared for the U.S. Department of Energy. May 1980, R-2515-DOE, 76 pp.

This report explores the relationship between household energy consumption and the income level and location (rural or urban) of the household in developing countries. The author summarizes data from eight developing countries that bear on these aspects of energy use. These data, although few, include the total amount of all fuels consumed, as well as the distribution of the total among specific fuels. Household or domestic sector fuel consumption is emphasized because this is the largest single sector in developing countries that includes all fuels--commercial and noncommercial.

The data that are available are summarized and a preliminary assessment of the eight countries is made. For India, Brazil, and Mexico City, the data report actual quantity of fuel consumed. For South Korea, the Sudan, and Pakistan, household surveys provide information about household expenditures on fuel and light. Figures on ownership of televisions, cars, stoves, radios, and other energy-consuming durables are given for Malaysia and Guatemala.

An overview of the findings is given, and then each country and its respective data are examined in detail and tentative conclusions are drawn. The conclusion emphasizes the importance of the domestic sector in energy planning. It also discusses the dominant role of noncommercial fuels.

2-704 ENERGY AND DEVELOPMENT: A PRELIMINARY ANALYSIS OF LESS DEVELOPED COUNTRIES

R. K. Trehan, J. G. Leigh, and W. R. Park, MITRE Corporation, McLean, Virginia. Contract report prepared for the U.S. Agency for International Development and U.S. Department of Energy, Washington, D.C. July 1979, 103 pp.

This report describes the results of a quantitative analysis of the relationships between energy production and consumption and economic and social development in developing countries. For example, it looks specifically at the relationships between energy consumption and economic growth; the impacts of energy cost increases on economic growth, the balance of payments, and inflation; and the relationship between energy and social progress. In all, 112 developing countries, grouped according to type of economy, are examined.

This report concludes that (1) the gross national product (GNP) per capita is strongly related to commercial energy consumption; (2) growth rates in the gross domestic product (GDP) are related to growth rates in investment, employment, and energy; and (3) the Physical Quality of Life Index is related to commercial energy consumption and to GDP per capita.

The initial study was based upon readily available published data, which was both limited in coverage and highly aggregated. The methodology used was primarily linear regression analysis. The authors looked to the related work of Resources for the Future, the World Bank, Brookhaven National Laboratory, the United Nations, and the Food and Agriculture Organization to supply data for the appropriate areas.

3 DATA ANALYSIS SYSTEMS

3-01 ANALYTICAL FRAMEWORK FOR THE ASSESSMENT OF ENERGY RESOURCE AND TECHNOLOGY OPTIONS FOR DEVELOPING COUNTRIES

Policy Analysis Division, National Center for the Analysis of Energy Systems, Brookhaven National Laboratory, Upton, New York. Contract report prepared for the U.S. Department of Energy International Energy Program, Washington, D.C. February 1978, 19 pp.

This report describes the Reference Energy System (RES), which is designed to present an overall view of the energy supply and demand system of a country, integrating data from a variety of sources and specialized models. It is also designed to identify major energy resource and technology options for those countries that belong to the DOE International Energy Program, which can then be used to formulate collaborative energy programs of various kinds.

For this system, resource and technology options are analyzed with respect to a number of parameters: total fuel demand and fuel mix, oil imports and exports, national social goals, total energy costs, balance of payments, labor requirements, capital requirements, and environmental quality. This requires a number of steps. First, a view is constructed of the energy implications of current national economic development plans. A consistent description of a future energy system is then constructed for reference years in the future. The values of certain objective functions are calculated for a reference case. The major resource and technology options are identified and rates of implementation are determined. Finally, the impact on various objective functions of each option is calculated.

The analytical framework consists basically of the Reference Energy System, which, again, is a set of estimated energy demands, energy conversion technologies, fuel mixes, and resources required to satisfy demands. The RES has a pictorial format, a network diagram that indicates energy flows and associated conversion efficiencies of reference technologies employed in various stages of energy production/transmission/distribution/end-use systems. For each resource, the diagram shows extraction, refining, transport of primary energy source, centralized conversion, transport of secondary energy form, decentralized conversion, and utilization in an end-use device.

The analytical approach is "driven" by a detailed consideration of energy demand. Specification of demand for the RES requires three types of information: measure of demand activity, direct fuel consumption, and relative effectiveness (the relative efficiency with which various fuels provide energy to satisfy a specific activity). The RES also includes the characteristics of each process element or technology.

Once the RES is established for the future years of interest, one can perform impact analyses for various options. One can identify processes or sectors in which a new resource or technology can be substituted, establish feasible rates of introduction, produce a new system description, and calculate changes in resource consumption, cost, and other objective functions. A computer model corresponding with the Reference Energy System for developing countries has been developed (see 3-04).

3-02 THE IEA/OECD APPROACH TO BASIC ENERGY STATISTICS AND BALANCES

P.D. Huggins, Energy Statistics and Data Processing Division, International Energy Agency, Organisation for Economic Co-operation and Development, Paris, France. In: International Energy Agency. 1979. *Workshop on Energy Data of Developing Countries: Proceedings*. Organisation for Economic Co-operation and Development, Paris, France. Vol. 1, pp. 29-32.

The International Energy Agency (IEA) is involved in a wide range of projects that require data processing. These include:

- Analyses of medium- and long-term energy supply and demand trends to promote optimum use of resources
- Investigation of the current oil and energy market situation to provide warnings of short-term energy supply bottlenecks
- Provision of an overall framework for examination and elaboration of energy sector research and development policies of OECD member countries
- Assessment of the effectiveness of conservation policies of member countries and the setting of conservation targets

The data system used by the IEA must meet demanding criteria, including: relevance to policy work; rapid availability of data, which must be reconciled with the need for high standards of accuracy and consistency; ease of access and manipulation; acceptability to administrations; and compatibility with internationally accepted standards.

The IEA energy data system covers detailed statistics of primary and secondary energy production, trade, output, and final consumption on an annual, quarterly, and monthly basis. The system also contains long-term forecasts produced in the context of the *World Energy Outlook* and certain forecasts submitted by OECD member countries. Detailed balances are produced for oil, coal, electricity, and natural gas, both on an annual and a quarterly basis.

Considerable theoretical work has been carried out in search of energy balance methodologies suitable for various analytic and policy purposes. The highly compressed form of the OECD balances, which allows users to determine quickly the data of importance to energy policy problems, has resulted in wide international acceptance of the balances.

3-03 BASIC ENERGY STATISTICS: A GLOBAL PERSPECTIVE

A. Ramsdell and K. Walton, United Nations Statistical Office, New York, New York. In: International Energy Agency. 1979. *Workshop on Energy Data of Developing Countries: Proceedings*. Organisation for Economic Co-operation and Development, Paris, France. Vol. 1, pp. 33-44.

This paper briefly describes the work of the United Nations Statistical Office (UNSO) and reviews the conclusions reached by the Expert Group on Energy Statistics, representing

international organizations that compile and publish energy statistics, which met under the auspices of the UNSO in March 1978.

Since for many countries a detailed discussion of energy balance methodology is premature, this workshop focused on the development of basic statistics, without which none of the source/sector accounts or overall energy balances are possible. The types of statistics needed in order to make available a basic set of data concerning energy processes and activities are: resource, production, trade, gross consumption, energy converted or transformed, final consumption, and capacity and plant data. Some of the problems that must be addressed when collecting the data are interdependence, timeliness, noncommercial fuels, and comparability of statistics.

Forty-one recommendations were made by the Expert Group. Generally, these covered:

- Problems of terminology and definition of boundaries that arose in the elaboration of the conceptual and methodological approaches to be adopted in the development of energy balances
- Accounting levels and conventions to be followed in the preparation of energy balances
- Problems of accounting units, conversion factors and routes, and calorific values
- The structure of energy balances and associated tables
- Question of classification
- The methodological problems of incorporating particular flows and accounting methodology in the overall energy balance
- The immediate steps that should be taken, in addition to the development of the format of the energy balance itself, in order to provide guidelines and assistance to national statistical offices in the improvement of energy statistics as a whole

3-04 LESS DEVELOPED COUNTRIES ENERGY SYSTEM NETWORK SIMULATOR (LDC-ESNS): A BRIEF DESCRIPTION

A. Reisman and R. Malone, Policy Analysis Division, National Center for Analysis of Energy Systems, Brookhaven National Laboratory, Upton, New York. Contract report prepared for the U.S. Department of Energy International Energy Development Program, Washington, D.C. April 1978, 73 pp.

The LDC-ESNS is a tool that provides a quantitative representation of the flow of energy within a country, from the initial resources through the processes that refine it, convert it from one form to another, transport it, and finally deliver it to the consumer. The system includes the monetary cost of each pathway, as well as its environmental impact. The LDC-ESNS should not be considered a "model" as such in that no decisions are made within its framework. However, this term could be applied in that the LDC-ESNS is a quantitative representation of a country's energy system.

The primary information input needed to operate the LDC-ESNS includes data on the overall supply-demand structure of the energy system, the magnitude and type of energy demand, the efficiency of each technological process represented, the market allocation of each process, and costs. Given these inputs, the LDC-ESNS will reproduce a base-case Reference Energy System (see 3-01) for a specific country and year. The system can then be manipulated to modify any or all of the inputs so that the effects of that change can be observed. One can trace a pathway through the entire system or display just the portion of the energy supply system that serves one type of demand. One can also introduce a new technology for evaluation and comparison.

3-05 AL-EDIS PROGRESS REPORT

Institute for Energy Research, State University of New York at Stony Brook, Stony Brook, New York. August 1979, 12 pp.

In September 1978, the Institute for Energy Research, under a grant from the al Dir'iyyah Institute, began development of an information system for energy planning in developing countries. More than a data bank, this system will provide

a framework in which data can be organized to serve usefully the needs of the energy planning sector.

AL-EDIS will place emphasis on providing a system of access to information directed specifically to the needs of policy makers. These needs include a set of simple models that link energy requirements to development goals in individual sectors and methodologies to collect information on the energy required to satisfy basic human needs, on new energy technologies, and on sources of financial and technical assistance.

The system will contain two broad categories of information: generic (not country-specific) data pertaining to energy sources and production and distribution systems, and country-specific data, such as local energy resources and demographic, geographic,

There are three modes of access to AL-EDIS: (1) the computer-graphic energy network simulator, designed for on-line, interactive use and modeled on the Brookhaven Reference Energy System (3-01); (2) direct queries to the system; and (3) projection models linked to the system.

Progress is being made on the design of the data base and the software. Contacts with developing country users are under way. In the future, country coverage will be expanded, and demonstrations of the entire AL-EDIS system are planned.

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APPENDIXES

APPENDIX A

Excerpts of Background Papers

This appendix contains excerpts from 12 background papers prepared for the workshop. Because of the number of papers and their lengths, they have not been reproduced in full. These excerpts, prepared by the NAS staff for this volume, are intended to convey either the emphasis of a paper or points of special interest. They are in the order in which they were presented during the workshop.

Readers who are interested in having copies of the complete version of a paper may obtain them, while supplies last, by writing to:

Energy Surveys Workshop
BOSTID
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
USA

ENERGY AND DEVELOPMENT: THE NEED FOR RELEVANT INFORMATION (Excerpt)

Lincoln Gordon
Resources for the Future

To place the issues of energy information in developing countries in a broader perspective, one might well ask; "Information for whom and for what purpose?" Today that may seem like a naïve question, to which the obvious answer is "Information for energy policy makers and development planners for the purpose of resolving each country's national energy crisis."

Upon investigation, however, it soon becomes clear that energy policy is itself not a simple or clear-cut concept. The relationships between energy policies and development are highly complex. The crises or problems to be resolved or managed require careful definition. Unless systematic thought is given to the linkages between problems and policies, and the relevance of information to policy issues, the gathering and analysis of information may waste budgetary resources and scarce technical talent.

Energy policy makers must consider the effects of energy supply and use on development processes: To what extent does energy constrain the rate of economic growth or force development into particular patterns? What is the relationship between energy policies and alternative development strategies? Are there particular aspects of development on which energy policies exert a decisive influence? If energy is certain to become scarcer and higher in cost, what adaptations and adjustments can minimize the adverse effects on development? In order to answer such questions both developing and industrial countries are now trying to work out comprehensive plans for their energy sectors. Such plans include an analysis of demand related to the hopes or expectations for economic growth; an analysis of supply, examining alternative ways of meeting the projected demand; and a financial analysis covering investments in the energy sector and the impact on the balance of payments.

An important component affecting both demand and supply concerns the possibilities for conservation, or improved efficiency in energy use.

THE DEVELOPING COUNTRIES AND THE WORLD ENERGY FRAMEWORK

As a group the developing countries account for about 75 percent of the world's population, but only about 22 percent of the world's economic output. When the exchange rates are corrected to reflect comparative purchasing power more accurately, 22 percent becomes something like 37 percent. Since developing countries now consume about 20 percent of total commercial energy and very large amounts of traditional noncommercial energy, there is a rough correspondence between total energy consumption and total economic output.

For most purposes of development planning and energy policy making, aggregated figures on developing countries as a group are useless. The group is much more heterogeneous than the industrial countries. Per capita incomes range from $100 to $2,500 per year; some have large industrial sectors while others are almost purely agricultural; some are oil exporters and others are entirely dependent on imports for commercial energy supplies; some are enjoying rapid growth while others are suffering from stagnation or even retrogression. The aggregate figures, however, are interchangeable to some extent at the margin and most countries are either energy importers or exporters, so that all changes in supply or demand ultimately impinge on the world oil market. Oil accounts directly for 45 percent of commercial energy consumption, and almost 60 percent of the oil produced in the world moves in international trade. For cereal grains, in contrast, total exports amount to only about 11 percent of world production. Of total oil exports, 86 percent comes from developing countries (80 percent from OPEC members), and only 14 percent from industrial countries --mainly, the Soviet Union, Canada, Norway, and Britain.

Much less widely appreciated is the growing importance of the developing countries on the demand side. For example, three salient aspects of change in the world energy economy between 1955 and 1978 were: (1) the large increase in total energy consumption (2.7 times, or 4.4 percent per year); (2) the even greater increase in consumption of liquid fuels (6.2 percent per year); and (3) the spectacular growth in the developing countries' share (from 9.5 to 21.1 percent) of the total, reflecting a 7.9 percent annual growth rate.

For all energy projections for the rest of the century consumption growth rates for commercial energy in developing countries will most likely exceed those of the industrial countries by 2-4 percentage points. Part of this reflects the differential in population growth, while the rest reflects differences in the character of structural change in the two sets of countries and in expectations concerning demand response to higher prices. That outlook might be reversed, either by a major and long-lasting worldwide economic depression or by unavailability of adequate energy supplies at costs affordable to the developing countries. Assuming, however, that macroeconomic disaster can be averted, a continued energy consumption growth differential of 3 points or more between industrial and developing countries appears highly probable. If realized, the developing countries' share in world commercial energy consumption would rise to about 25 percent by 1990 and over 30 percent by the end of the century, which could have a major impact on market conditions.

If additional commercial energy consumption continues to take the form of imported oil, as has been the case for many developing countries, pressures on the balance of payments may lead either to cuts in other essential imports or to levels of borrowing that undermine the countries' creditworthiness. In either case, the prospects for sustained development will be jeopardized. At the same time, the added demand will put further upward pressure on world oil prices. The 1973 oil price jumps affected the growth rates of developing countries less than those of the industrial group, although it should be borne in mind that with population increasing at over 2 percent a year, the 21 percent reduction in overall growth rates (6.7 to 5.3) translates into a 30 percent reduction in growth rate per capita. Still, the catastrophes anticipated in 1974 did not come to pass, largely due to international borrowing by developing countries, mostly from commercial banks--so large, in fact, that it not only covered the increase in trade deficits but also built up reserves of foreign exchange. Meanwhile, the real price of oil was being eroded by general inflation and the OPEC (Organization of Petroleum Exporting Countries) countries were increasing their imports very rapidly, so that the volume of surplus petrodollars fell from $62 billion in 1974 to $9 billion in 1978. It looked as if the world were making a successful set of adjustments to the oil price shock.

That optimistic prospect has disappeared with the second round of major price increases--roughly a doubling

during the course of 1979, and more in 1980. The OPEC surplus surged back to over $60 billion in 1979 and may reach $90 billion or more in 1980. High interest rates have made borrowing more expensive, and a growing number of developing countries are approaching the limits of ability to service debt; the banking system is also showing signs of nervousness. There is no realistic prospect of repeating in the early 1980s the comfortable adjustments of the mid-1970s. The world energy situation now facing us, therefore, combines both long-term problems and short-term crisis, the latter arising from the absence of coherent policies for assuring a gradual and nondisruptive longer-term transition.

Policies are needed in four areas: (1) national and international macroeconomic adjustment to sudden price increases, including the recycling of petrodollars; (2) minimizing and managing the short-term disruptions arising from any supply-price "crunch" that may occur in the oil market; (3) coping with the international security dangers of supply interruptions (to which might be added the other set of security dangers related to nuclear proliferation); and (4) defining and moving to patterns of energy supply and use to replace the era of cheap oil and gas. Developing countries are deeply involved in all these areas, and relevant information is an essential ingredient of policy making in all four.

ENERGY POLICIES AND DEVELOPMENT STRATEGIES

Energy planning must be an integral part of broader development planning and must be subordinated to wider goals and strategies. Energy supply and use are not ends in themselves; they are only means or instruments.

In examining the relationships between energy and development, one concludes that the energy sector is more strongly linked to economic growth in the developing countries than in the industrial countries, and that there is no alternative development strategy offering an easy escape from the constraints of higher energy costs. Energy self-sufficiency is not to be pursued at all costs; for many countries, economic development will be better served by maintaining some level of imports, perhaps replacing some oil with coal, and by other forms of energy interdependence. Nor are there any panaceas in the form of either cheap supply substitutes or dramatic conservation opportunities.

Rather the answers will be found in a host of actions on both the demand and the supply sides, sector by sector and region by region. With energy now a costly resource, the needs, costs, and benefits must be evaluated objectively. That purpose can only be served with a foundation of reliable and relevant information.

INFORMATION NEEDS FOR ENERGY PLANNING

On the supply side, the starting point is obviously an inventory of known and probable conventional energy resources: coal, oil, gas, and water power. With the escalation of oil prices, many formerly submarginal resources of these types will now be competitive with imports or close enough to become so soon under plausible estimates of further oil price increases. An analysis will require geologists, engineers, and economists. Unless all three are involved, the end results are likely to be misleading.

With old or new types of renewable resources, other than large hydropower, supply information becomes much more complex, involving insolation at various places and seasons, water runoff at different seasons, soil and forest surveys, and wind measurements. Thus it might be best to concentrate on information relevant to clearly applicable technologies and avoid the dissipation of resources on comprehensive surveys with no visible applicability.

This workshop, however, is mainly concerned with information for demand analysis, including conservation opportunities. In many cases, of course, demand and supply are inseparable, one creating the other. The starting point is a reasonably complete base-line picture of how energy is presently used, arrayed by sectors and major subsectors and by principal forms of energy. Noncommercial sources must be included. If any historical data are available, they will help suggest trends and perhaps give some guidance on price and income elasticities.

One object of demand analysis is to predict with some confidence the energy implications of major policy measures, either programs or projects. Examples might be increasing agricultural yields, building a highway, encouraging industries to produce wage goods, rural electricification in a given region, or providing new types of urban services. In most cases the purpose will be to determine the energy requirements associated with these policies so that they can be supplied at least cost. But there will also be an

increasing number of cases in which higher energy costs will sufficiently affect the cost-benefit balance to lower the priority of a given project or to rule it out entirely. Alternatively, the energy analysis may point to the need to revise the program or project to obtain greater energy efficiency or to adapt it to the use of lower-cost energy sources.

Information is not a free good. Its collection and analysis require not only money but a combination of scarce talents, and the design of every information project should therefore be consciously related to the purposes it is intended to serve. If those purposes can not be specified, the project itself becomes questionable. But as we open this new decade, the critical place of energy as a constraint on both rates and patterns of growth looms so large that there will certainly be an ample supply of important policy purposes necessitating energy information programs of sound design and execution.

ENERGY USE IN BANGLADESH (Excerpt)

M. Nurul Islam
Bangladesh University
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PRESENT ENERGY SITUATION

Most of the energy used in Bangladesh comes from traditional sources, for example, muscle power—both animal and human—used for plowing and other farm tasks, irrigation, and road and water transportation; direct solar energy used for crop drying and salt production; natural wind power used for water transportation; and traditional fuels (firewood, animal dung, jute sticks, straw, rice hulls, bagasse, twigs, fallen leaves, crop residues, etc.) used for domestic cooking and by small rural industries.

Traditional sources of energy, often assumed to be a commodity, are consumed mainly in rural areas. Rational development and utilization of these sources have not been possible due to the absence of appropriate institutional mechanisms and the lack of information in this field, a major constraint to planning.

The urban areas of Bangladesh are the chief consumers of the commercial energy sources (coal, oil, gas, hydroelectricity). Multiple government agencies are responsible for the exploration, procurement, production, distribution, and consumption of these sources, and published statistics are available to aid in their planning and development. Capital investment in the energy sector is mostly allocated for the development of commercial energy sources.

The Bangladesh Energy Study (Montreal Engineering Company, Ltd., et al. 1976) estimates the total energy consumption of Bangladesh in 1973-1974 as 68.5 trillion kilocalories (kcal). Of this amount, traditional fuels supplied 73 percent and commercial fuels, 27 percent. Only 1.6 percent of the total energy consumed was electric. Estimated total energy consumption did not take into account

such traditional sources of energy as wind power, muscle power, direct solar, etc.

BANGLADESH ENERGY STUDY (BES)

The Bangladesh Energy Study, an important study of the energy sector, presents energy data in terms of different growth rate scenarios, especially relating to commercial energy sources. The study recommends an investment of Tk13 billion (1975 price*) in the commercial energy sector between 1976 and 1985 in order to maximize the growth of national income. However, the actual investment will be more after duties, taxes, interest during construction, the cost of preparatory studies, and price increases after 1975 are taken into account. The distribution of this investment would include: the rehabilitation and expansion of electric generating capacity and grid interconnection, 22 percent; gas pipelines, urea plants, and gas distribution, 77 percent; and 1 percent for the rehabilitation of oil refineries.

The BES stresses the importance of traditional energy in the national economy and suggests that its sustainability and efficiency be promoted in order to reduce the strain on the commercial energy sector. It has been estimated that a 10 percent decline in traditional source supplies would require a 30 percent expansion of modern sources in order to maintain the overall availability of energy. However, the BES did not suggest possible expansion of the traditional fuel supply because of the scarcity of land and did not recommend any investment in this important sector for sustained growth and development.

The BES estimated that in 1973-1974 traditional fuel sources were supplying 50.4 trillion kcal as follows: Cow dung, 25 percent; jute stick, 6 percent; rice straw, 18 percent; rice hulls, 24 percent; bagasse, 5.5 percent; firewood, 3.5 percent; twigs and leaves, 9 percent; and other crop residues, 9 percent. Because of the considerable uncertainty of these estimates, the BES stressed the need for detailed studies on rural energy demand and supply.

Estimates of the demand and supply of firewood were particularly uncertain. On the basis of aerial survey data

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*The exchange rates used in the Bangladesh Energy Study are 14 taka/US$1 and 20 taka/US$1.

the BES estimated tree biomass at 2.12 million tons per year (t/yr); 625,000 t/yr firewood and 1.5 million t/yr pruning, twigs, and leaves. Estimates of firewood consumption by other studies varied from 4 to 22 million t/yr.

OBSERVATIONS

Energy Consumption

Various surveys indicate that traditional sources of energy contribute the major portion of energy consumed in Bangladesh. As we have said, according to the BES, traditional fuels contributed 73 percent of total fuel consumed. Tyers (1978) and Islam (1979) estimate that traditional sources contribute 93 percent of the total fuel consumption in rural areas.

The estimated composition of traditional fuels varies quite widely from study to study. The BES estimates agricultural residue, 62 percent; tree biomass, 13 percent; and animal wastes, 25 percent. Tyers (1978) estimates 66 percent, 7 percent, and 27 percent, respectively, while Islam (1979) estimates 24 percent, 71 percent, and 5 percent respectively.

The total per capita consumption of fuels in Bangladesh in 1977-1978 can be estimated as 1.47 million kcal/person/yr of which commercial fuel consumption is 0.27 million kcal/person/yr (18 percent) and traditional fuel consumption is 1.2 million kcal/person/yr (82 percent). With the existing socioeconomic conditions, the present pattern of energy consumption, with less dependence on commercial fuels, will continue. In order to meet the increasing fuel demand due to population growth, effective policy decisions are required in the traditional fuel sector to maintain a sustainable supply even at existing per capita consumption.

Increasing the Supply and Efficiency of Traditional Fuels

Because of the scarcity of available land and the unevenness of its distribution, careful planning is required for equitable distribution of the benefits from land-based production.

Increasing the overall efficiency of the traditional fuel utilization system requires the successful diffusion of technology (optimization of a system), which in turn

requires field-level scientific study to identify inefficient steps. Some of the factors that could be considered are: production, gathering, transportation, processing, combustion, heat transfer, process requirement, the human factor, etc. For example, the introduction of an efficient stove fitted with a chimney may increase efficiency of the combustion and heat transfer steps, thereby reducing fuel consumption, yet may require special processing of fuel (e.g., cutting firewood into smaller pieces), changing the cooking habit from a sitting to a standing position, or more personal attention to using all the openings of the stove simultaneously. In a situation in which the opposing factors are stronger than the prospective benefits, the diffusion of efficient technology may be a problem.

Commercial Energy Sources

One area in which the commercial energy requirement needs special attention is agriculture, particularly irrigation, selective mechanization, and synthetic fertilizer. The potential of organic fertilizer should be given due consideration in assessing a total fertilizer requirement.

SUGGESTIONS

Presently, the Power and Natural Resources Division of the Planning Commission is responsible for energy planning. This division has separate sections for the planning of power generation and other commercial energy sectors. A separate planning section should be established under the division for the assessment and planning of traditional energy sources.

The energy planning methodologies presented by BES and Tyers (1978) can be updated using reliable current data about the supply and demand of various energy sources. For commercial energy sources, the available data base may be sufficient for this purpose; however, studies should be undertaken to create a reliable data base for traditional energy sources.

Long-term, in-depth energy studies should be undertaken in selected locations to collect data on resources and the technical, social, political, and anthropological aspects of energy consumption. These selected areas should be used as test bases for the evaluation of various alternative technologies before their large-scale adoption.

In-depth energy survey and assessment studies should be undertaken by a multidisciplinary group of people rather than specialized groups doing specialized jobs, e.g., a social scientist conducting a socioeconomic survey, technologists developing the prototypes of new technology, and extension people working with the diffusion of new technology. Considering the proportion of traditional energy consumed in domestic cooking, the participation of women at various steps of the studies is essential.

A separate national institution should be established to efficiently manage the rural energy program as a whole rather than separate institutions managing different energy technologies, e.g., Rural Electrification Board Biogas Directorate. A single rural energy administration would facilitate deciding on an appropriate form of energy supply for a particular situation after rational comparison of various alternatives.

Various administrative agencies presently engaged in the management of different commercial energy sectors (power, oil, gas, etc.) and the proposed rural energy administration should be brought together under a single national energy administration. This will enable it to develop a balanced energy policy with proper attention to both traditional and commercial energy sources.

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ENERGY ASSESSMENT IN JAMAICA (Excerpt)

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JAMAICA'S ENERGY SITUATION

Jamaica is the world's third largest producer of bauxite and aluminum, and this single industry accounts for nearly half of the country's total energy consumption and for about two-thirds of its total foreign exchange earnings. The existence of this large and energy-intensive industry also places Jamaica among the highest per capita consumers of energy in the developing world.

Jamaica's energy supply is almost wholly dependent on imported petroleum (90 percent), the balance comprising bagasse, which is the sugar cane residue used as fuel in sugar factories, and a small amount of hydropower. It is not clear how Jamaica will cope with the latest round of price increases in fuel imports. Jamaica's foreign earnings and economic activity in general have by no means kept pace with these rising costs, and the country could be described as being in a state of crisis.

What alternatives are open to Jamaica? The hydropower contribution might be increased to about 4-5 percent but this will require the development of a large and costly multipurpose hydro scheme that would involve substantial tunneling in the Blue Mountain region. Such a scheme would be largely concerned with supplying domestic and irrigation water to Kingston (the capital) and surrounding areas. Bagasse efficiency can certainly be improved, but no quantitative estimate is available. Finally, solar energy in its various manifestations (solar thermal, photovoltaic, ocean thermal, etc.) is surely the ultimate energy reserve that Jamaica possesses, and it must play a major role in the long term as technology develops. However, the present applications that are economically viable, namely, water-heating and crop drying, amount to no more than about 1.5 percent of total energy consumption.

ENERGY END-USE ASSESSMENT

All the alternatives listed have fairly long lean times varying from 5 to 12 years for full implementation. But the most striking fact that emerges from this brief survey of alternatives is that if all of them were to be fully developed, including conservation, Jamaica, given its present economic structure, would still be nearly two-thirds dependent on imported petroleum. Both the long-term prospects before the world and the short-term economic prospects before Jamaica indicate that that is hardly a viable position. Consequently, we must produce an economy less energy-intensive, and therefore less constrained by petroleum imports.

To attempt such a challenging feat in anything like an orderly way (assuming that both time and OPEC allow such a thing), it is essential to proceed with detailed information on how energy is used in the economy as it exists, how the economy responds to major impacts such as changes in price and supply, and therefore what avenues of economic development will attain the desired end.

Some of the answers are obvious, in a broad sense. It is clear, for example, that intensive development of efficient agriculture is one of the imperatives of national policy, since agriculture is apt to provide greater employment at smaller energy cost than any other sector. And it is clear that, insofar as there is a manufacturing sector, it must aim not so much at producing commodities for local consumption (import substitution), as at producing commodities for export that are able to survive competition. It is also clear that tourism must be developed as much as possible. Of course, responding to all these challenges will mean an important test of national fiber, discipline, and cohesion.

Policy planning must not merely indicate directions, it must also indicate quantities, targets, and objectives. Therefore, in pursuit of these objectives, a national program of energy end-use surveys has been undertaken to provide information leading to the development of a National Energy Accounting System and to the construction of a national energy model. This model will coordinate with and supply information to a general economic model being constructed by the National Planning Agency, which has overall responsibility for macroeconomic planning. Given sufficient time, it is expected that these activities will lead to the fulfillment of all the objectives defined above.

INVENTORY OF ALTERNATIVE ENERGY SOURCES

As far as Jamaica is concerned, energy conservation has greater potential than any other single alternative. Its lead time is shorter and the investment cost much less, although the figure used of 15 percent is a rather subjective estimate and needs to be reviewed in light of more accurate studies. But it follows from this that the highest energy priority for Jamaica is a series of detailed energy audits of the major consuming sectors in order to identify and realize the potential for energy conservation. This program is being actively planned.

On the side of actual alternative supplies, the highest priority lies in a program of oil and gas exploration, and it is expected that drilling activity, both offshore and onshore, will begin within a year. Regarding other alternative energy sources, peat is the most significant indigenous energy source that Jamaica possesses. It exists in two major deposits, and if mined and burned as a power plant fuel it could provide about 40 percent of the current level of electricity-generating requirements, or about 7 percent of total energy. However, its development may be subject to environmental constraints.

ENERGY SURVEY PROGRAM

The program of energy end-use surveys is conceived as a set of six sectoral surveys, namely, tourism, household, industrial, distributive trade, agricultural, and transport. Of these, the first two have been carried out, and a contract is being negotiated with a consulting firm for carrying out the other four, which it is hoped will be complete within a year. The rest of the commercial sector and the public administrative sector will be added at a later date.

For each sector, the survey aims to correlate energy consumption with other significant economic variables, such as employment, output, value added, foreign exchange earnings, etc., to the extent that they are applicable to each sector. Other aims include identifying opportunities for energy conservation and for substitution of alternative sources; therefore, the questionnaires must be structured in such a way as to reveal this information wherever possible. For example, the industrial survey will attempt, among other things, to arrive at an inventory of

major energy-consuming equipment and an indication of, for example, the temperature and pressure at which steam may be used in industrial processes and an overall indication of the probable efficiency of energy use.

Tourism Survey

This survey actually examined energy use in hotels, excluding villas, guest houses, or private cottages and such areas of energy consumption as air or ground transportation for tourists. However, the survey is believed to include the bulk of such areas of tourist activity as restaurants, bars, in-bond shops, gift shops, etc., since most of these are located in hotels.

Jamaica has approximately 8,000 hotel rooms available to tourists, and some 70 percent of these were included in a survey carried out by a single staff member of the Ministry of Mining and Natural Resources between July and December 1979. The data collected actually cover the years 1977 and 1978, when the average occupancy of these hotels was 31 percent and 43 percent, respectively. A statistical analysis of the data has not yet been done.

While hotel occupancy rose by some 39 percent between 1977 and 1978, actual energy consumption per room increased by only 12 percent and the total energy consumption by 7.7 percent, though the cost of this energy increased by 58 percent. That effect, however, was mainly due to devaluation of the Jamaican dollar, since the actual foreign exchange cost increased only slightly. An analysis of any relationship between energy consumption, occupancy, and price levels still remains to be done, and will, of course, be obscured by the very steep price increases that have occurred since.

Two important conclusions from the survey are that in 1977 energy costs amounted to about 8 percent of total hotel operating costs, and that US$1 of energy expenditure generated between US$6.80 and US$13.80 in net foreign exchange revenue. The reason for this wide range is the difficulty in estimating how much of the gross foreign exchange earnings remains within the system, and how much is either lawfully expended or else "leaked" in various ways. The corresponding figures for 1978 are not yet available, but both should increase significantly.

Another important observation is that actual energy costs per room varied very widely among the hotels visited, ranging between 28,500 megajoules (MJ; 27 million Btu) and 225,000 MJ (213 MBtu) per room. There is no reason to believe that any more than a few of the operations are particularly efficient. A good deal of further technical and statistical analysis will have to be done before one can draw general conclusions about the efficiency or otherwise of various kinds of hotels. This also reinforces the points made earlier that surveys of this kind give only broad indications of energy use, that detailed energy audits are needed to quantify conservation opportunities, and that both are very different kinds of exercises but that both are necessary.

Household Survey

Jamaica has approximately 438,000 households, and it was proposed to carry out a survey on a sample approaching 1 percent of that number. To do this, 3,800 questionnaires were issued to 80 interviewers, who conducted a survey over a period of 5 weeks during April and May 1979, the survey having been extended due to heavy rain and in order to improve the response on certain questions. Of the questionnaires issued, 3,331 were returned; the rest were either not returned or rejected for various reasons. Of those accepted, a further 562 failed to respond adequately to questions on income, so that a final analysis was carried out on 2,769 responses, representing approximately 0.63 percent of the households in the country.

Survey responses were broken down into nine income categories. While the level of response was probably adequate for the lower-income groups, the absolute numbers in the upper-income groups were too small to be useful for certain kinds of analysis, such as assessing the use of domestic water heaters. This suggests the need for an additional supplementary survey, confined to the upper two or three income groups, to obtain more accurate information on this and similar points.

ENERGY USE IN KENYA (Excerpt)

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SOURCES OF ENERGY IN KENYA

In addition to its renewable resources, Kenya continues to depend on imported oil and hydroelectric power for its commercial energy consumption. An estimated one-third of its hydroelectric potential of 700 megawatts (MW) has already been developed; another estimated 30 MW is still imported from Uganda. The country's first geothermal station, which will supply 15 MW of energy, will be operational by 1981--Kenya's total geothermal potential is put at 500 MW (Government of Kenya 1979). A comparison of the commercial energy used in Kenya in 1973 and 1977 is represented in Table 1, as well as a forecast of consumption in 1983. Eighty-three percent of the total commercial energy consumed in 1973 was imported; 74.4 percent in 1977. Per capita consumption (oil equivalent) in 1973 was 127 kilograms (kg); 131 kg in 1977.

Kenya's noncommercial energy--firewood, cow dung, and crop residues--which sustains a majority of its population, has unfortunately not been quantified and should be thoroughly investigated. The effects of aridity and desertification, a phenomenon that is now measurable, is causing the government quite a bit of concern.

Kenya's total energy production in 1976 was estimated at 3.8 million tons of coal equivalent, where 1 ton of drywood is equivalent to 0.68 tons of coal (Kenya Pipeline Company 1978). This can be broken down into firewood, 86.4 percent; charcoal, 3.3 percent; and hydroelectric, 10.3 percent.

TABLE 1 Consumption of commercial energy in Kenya.

Form of energy	Oil equivalent (thousand tons)		Annual rate of increase (percent)	Total energy consumed (percent)		1983 forecast	
	1973	1977	1973–1977	1973	1977	Oil equivalent (thousand tons)	Percent share
Coal and coke	50.0	43.8	-2.9	3.2	2.3	36.3	1.5
Oil	1,359.9	1,605.9	4.2	86.0	85.0	2,085.3	84.7
Electricity	170.4	232.6	8.1	10.8	12.4	339.0	13.8
TOTAL ENERGY	1,580.3	1,882.3	4.5	100.0	100.0	2,460.6	100.0

PRINCIPAL ENERGY NEEDS IN KENYA

In the urban sector, electricity, gasoline, liquid petroleum gas, kerosene, charcoal, and solar heaters (a new addition) are used for the following activities:

- Household: cooking, lighting, refrigeration, and appliances
- Commercial: lighting, refrigeration, air conditioning (i.e., along the coast), and some heating
- Industrial: textiles, canned products, leather industries, breweries, food industries, steel fabrication, paper manufacturing, and construction
- Transportation: road, rail, air, and pipeline.

In the rural sector, commercial fuels, with the exception of kerosene, are used only by industry and transportation. Otherwise, firewood, charcoal, cow dung. crop residues, and kerosene dominate. The rural sector includes the following activities:

- Household: cooking, lighting, and heating
- Agriculture: pumping of water and irrigation
- Transportation of produce and people
- Commercial and social amenities: trading centers, hospitals, schools, government administration centers, etc.
- Industrial production

THE ENERGY PROBLEM IN KENYA

The rising cost of energy products, petroleum in particular, has led to rising production costs since 85 percent of commercially traded energy in Kenya is derived from imported petroleum. This has affected the country's foreign exchange adversely, for 25 percent of Kenya's foreign exchange earnings is used for importing petroleum.

The majority of the people in Kenya (87 percent) live in rural areas and are almost entirely dependent on firewood, charcoal, and other vegetable materials. The quantity of firewood and charcoal consumed every year in the country is difficult to ascertain, although figures from the *1977 Statistical Abstracts* distributed by the

Department of Forestry show that 189,000 cubic meters of charcoal and firewood were sold. The actual level of consumption is apt to be higher because purportedly much of the charcoal industry works outside the formal sector.

Because so many people in Kenya rely on wood and charcoal for energy, the potential for environmental hazards from deforestation and desertification is quite evident.

Realizing the vital role energy plays in the country's economy, the government of Kenya, in November 1979, established a Ministry for Energy for the "comprehensive planning of the development of the energy sector (Government of Kenya 1979)." This ministry is entrusted with carrying out the energy development objectives of the 1979-1983 planning period. These are: (1) increasing the supply of energy to meet the requirements of the economy; (2) rationalizing the use of imported petroleum; (3) developing indigenous energy sources; and (4) lessening dependence on imported fuels.

INFORMATION ON ENERGY IN KENYA

At the time of the Workshop on Energy and Environment in East Africa, held May 7-11, 1979, in Nairobi, the Central Bureau of Statistics introduced and carried out a pilot survey to determine energy-use patterns in Kenya. The initial data obtained were not meaningful but several years of proper follow-up to obtain more accurate data may allow better future projections of energy use.

Energy data are difficult to obtain in the rural sector as opposed to the urban sector. Some of the problems encountered in collecting data in the rural sector are:

- Difficulty in quantifying nonconventional sources of energy
- Lack of systematic governmental monitoring of the operations, i.e., illegal felling of trees, firewood gleaning and burning
- Lack of well-trained personnel capable of collecting, analyzing, and interpreting data
- Lack of funds
- Lack of a proper medium of communication between the government body responsible for formulating energy policy and the professionals, e.g., the university not being asked to act as a government consultant

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ENERGY INFORMATION NEEDS IN THE PHILIPPINES (Excerpt)

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THE PHILIPPINE ENERGY PREDICAMENT

Oil prices continue to have a serious impact on the Philippine economy, which has compelled the nation's policy makers to focus on this problem. The country remains dependent on imported oil for nearly 92 percent of its total commercial energy requirements (Ministry of Energy 1980:4).

The National Economic Development Authority postulates in its 10-year plan that economic growth through export-oriented industrialization is desirable, thus making greater commercial energy consumption a necessity. The Ministry of Energy (MOE) in its own 10-year plan (Ministry of Energy 1980) forecasts considerably greater energy demand by the industrial and commercial sectors and electricity generation, constant demand by the residential sector, and a drop of 9 percentage points for the transportation sector. Based on these assumptions, the nation's planners expect for the coming decade an unavoidable increment of about half a percentage point over current total and per capita energy demand growth rates, even if the population growth rate remains constant. This may seem small but the implications remain serious--total energy use will double shortly before the end of the decade.

The seriousness of the problem is most evident in the external sector. Oil imports now account for about 28 percent of the total import bill, more than double their 13 percent share in 1973. By necessity, about 36 percent of 1979 export revenues had to be allocated to pay the fuel bill. Oil imports alone have accounted for around 71 percent of the perennial trade imbalance since 1974 (Ministry of Energy 1980:8). The problem becomes particularly

frightening when one considers the sensitivity of energy consumption levels to growth in the gross national product, with econometric studies suggesting an income elasticity of energy use of 1.5-2.0 for the Philippines.

Among the first responses of the Philippine government to this problem was the creation of a Ministry of Energy and the development of a 10-year energy plan. The MOE is charged

> . . . to ensure a continuous and adequate supply of energy with the end in view of ultimately *achieving self-reliance in the country's energy requirements*, through intensive exploration and development of indigenous energy resources, and through the judicious conservation and efficient utilization of energy consistent with the country's accelerated economic growth (emphasis by the author; Ministry of Energy 1979:89).

The Energy Plan has three fundamental objectives: increased supplies, managed demand, and protection of the environment. The supply objective includes a resource diversification policy which, in addition to domestic coal and oil exploration, provides for the development of alternative, nonconventional energy sources.

The creation of the MOE institutionalizes planning as a permanent fixture within the Philippine energy economy. Energy planning, however, can not function in a vacuum. An immense body of information is necessary for effective planning, particularly when the government aims not only to augment and diversify resources, but also to manage the demand for available resources through belt-tightening, waste-plugging, conversion mode-mixing, and product output-juggling policies. However, one must carefully define from the start what data methodologies are needed.

Economic information is a necessary complement to energy statistics for planning purposes. Broader objectives and additional data categories need to be incorporated when moving from regional/sectoral to national/international assessment and planning. At the two latter levels, planners have to consider the following constraints: the trade balance, development of industries closely associated with the energy sector, availability of manpower, changes in lifestyle, saturation effects on demand, estimates of potential resources, environmental damage levels, social impacts, and so on. Although progress is being made, the rate of discovery and delineation of indigenous conventional and nonconventional

energy resources needs to be accelerated to provide a confident planning base, since delayed knowledge of proven reserves can result in the commitment to an inferior or misdirected energy development path.

COMMERCIAL ENERGY SECTOR

Data available for the Philippine energy sector as a whole are of satisfactory quality but remain limited in scope. Recently, a systematic series (Bureau of Energy Utilization 1978) on commercial energy was started that includes total energy consumption, distribution by fuels, and sectoral consumption. However, no information exists on sectoral and subsectoral allocations for specific end-uses, forms of energy delivered, and grades of heat required. There is a lack of geographically-disaggregated consumption figures built up over a long period. In addition, there is almost no historical information on comparative real prices of various input and output energy forms and on the behavior of associated costs. Historical data on commercial energy consumption have been compiled primarily for the purposes of keeping statistical and corporate records. Since energy was previously assumed to be purely a commodity transaction without consideration of supply penuries and price hikes, the data do not address many of the policy issues now under consideration.

These missing data make it almost impossible to translate the high substitutability among commercial energy forms into a realistic conservation and industrial restructuring policy in which energy prices are adjusted so as to direct consumer preference and capital investment decisions toward an energy route that reflects more truly the replacement costs of energy for a country as import-dependent as the Philippines.

A pioneering effort at providing a complete, nationwide profile of energy consumption is currently under bidding and negotiations through the auspices of the MOE's Ministry of Planning Services. This consumer energy survey is part of an overall process aimed at systematizing the Ministry's data collection and retrieval mechanisms. The survey uses two approaches that represent the different nature of mass consumer markets and institutionalized industrial consumers. The project aims to generate baseline data on the different energy sources, end uses, and conversion systems used by various sectors; establish the intensity and manner of energy use; measure consumption;

and examine conservation and fuel substitution possibilities (Bureau of Energy Development 1978:40, 1979:23). Data are disaggregated into a matrix of energy items versus: (1) consumption by region, by rural-urban classifications, by income class, by family size, by type of household appliances owned and transport facilities used; and (2) the amount of energy produced, purchased, and obtained. A vital component of the project involves quantifying the usage of traditional, organic renewables. A further step would be distinguishing between organized ("commercial") and unorganized ("noncommercial") portions of these traditional fuels. Tentative sectoral surveys have been conducted, but these comprise only a fraction of each sector's activities. This consumer survey is clearly an immense task which, if done carefully, could provide the first acceptable basis for forecasting energy requirements and formulating short-term adjustment policies and long-term substitution strategies.

TRADITIONAL ENERGY SECTOR

Data must be collected not for the sake of completeness alone but, especially in the traditional energy sector, to fill in site-specific data categories that have direct use in addressing problems of greatest urgency. These problems, which may be economic, environmental, sociopolitical, or a mixture of all these, are in turn defined by the following factors: the time frame and resources (broadly defined) needed and available to address them, resolvable and unresolvable constraints, and real or imagined policy tools. The Energy Plan gives nonconventional energy resources a modest role, forecasting a 6 percent share in the national energy source mix by 1989. This may be due to too many unknowns in the data needed to prove the much greater potential of these resources--relying on inspection does make their contribution seem potentially small. However, such an underestimation may also be due to an overemphasis on seeing the Philippine energy problem as mainly a petroleum problem. In a country where the use of traditional fuel is predominant, this is hardly the case.

Apart from the fact that the problem may be too narrowly defined, other logistical, methodological, and institutional problems are encountered by field researchers. The Philippines has 7,100 islands and more than 90 dialects,

making field surveys a formidable task. This has led to a tendency to oversurvey not-so-remote areas, leading to an increasing resentment among rural folk against being frequently interrogated for nothing tangible in return. Other ingrained cultural attitudes (e.g., the tendency to give responses that will please the researcher even if they are inaccurate) cast doubt on the validity of such surveys, and more closely pit the relative merits of house-to-house interviews versus questionnaires administered to a small sample against each other. In some cases, field manpower and live-in village personnel support are lacking.

In spite of these difficulties, the Bureau of Energy Development continues to carry out an impressive, 2-year-old nonconventional energy resources development program (Bureau of Energy Development 1978, 1979). The new and renewable resources defined in the Energy Plan include: biomass plantation systems that provide alcohol for motor power, electricity, and solid fuels; biomass for methane generation; and utilization of direct solar radiation, wind energy, hot springs, and surface gas emanations. About 30 applied research projects are now under way, emphasizing reduction of the uncertainties in technical and economic parameters that make an assessment of the potential role of such resources difficult. It appears to be a program oriented more toward reality than technology, and one that gives equal attention to both village-level and urban-oriented systems while specifying that "rural-based applications have social and economic significance which is more important than the energy actually produced (Bureau of Energy Development 1979:54)." An important recent development is the availability of significant foreign financial and technical assistance for the program, particularly the $8.6 million loan/grant package negotiated with the U.S. Agency for International Development. This project is geared toward Philippine rural areas and includes, among other subprojects, an intensive energy survey. U.S. Peace Corps Volunteers already living in selected villages will serve as field researchers. This survey, the author's own study (Manibog 1979), and the MOE's demand survey mentioned earlier constitute the more recent concentrated efforts at data collection in the Philippine traditional energy sector.

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HUMAN DIMENSIONS OF ENERGY NEEDS AND RESOURCES (Excerpt)

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In any given society, there exist unknown or poorly understood sociocultural factors that have a direct bearing on ways in which planning and policy determination can be designed and implemented. This paper provides an overview of the most useful social science data-gathering methodologies that can be used to determine what these factors are, how important they may be in determining acceptance of change, and what strategies or tactics might best be used to create community awareness of actual practices and options in energy-related activities.

Horror stories abound with respect to large and small projects that have failed because some "apparently" insignificant cultural factor was either unrecognized or ignored. It is rarely possible to design projects or to arrive at useful policy guidelines which affect the daily lives of people in traditional societies without having detailed information about the perceptions such people have of themselves: their value systems and priorities; their fears and aspirations; and their customs, traditions, and taboos.

BACKGROUND

Existing inventories of community energy needs and resources are woefully inadequate for the requirements of planners and program designers in the developing countries, particularly in rural areas. Lack of adequate information may well result, in part, from the lack of recognition by villagers of what constitutes an "energy" factor in their daily lives. While most of them are aware of the need for fuel, for example, few recognize the "energy" factor involved in the time and *human* effort required to gather or cut wood.

Nor would similar efforts required for drawing and hauling water be singled out as energy until, perhaps, the advent of electricity, pumped water, and home distribution suddenly dramatizes the vastly increased released time enjoyed by the women and children who had previously provided the water.

The social science methodologies needed to obtain behavioral, attitudinal, and social organization data related to energy are in some ways less difficult to implement than the "software" components for projects involving water supply and excreta disposal or contraceptive usage, since the latter often involve taboos or matters of a highly personal nature. Energy needs and resources are more complex and interrelated, and, therefore, must be viewed in a holistic way within the environmental setting as well as within the sociocultural context and the changing economic systems.

It is probably safe to say that decisions on energy use are made universally on the basis of what seems logical, reasonable, and acceptable by all energy users. As energy becomes relatively more costly in both developing and developed nations, changing patterns can be seen. The fuel-efficient, wood-burning stove begins to sound like a good idea to the woman who now spends several hours a day gathering firewood, just as the compact car looks like a good idea to last year's full-size car owner.

New techniques and approaches designed to conserve or maximize energy seldom have immediate acceptance. They must first be understood and then seen as socially acceptable before being used. Consider how much greater a technological leap a woman in a rural village must make to move from a three-stone hearth on the ground to a Lorena stove than the one an American motorist must make when he or she moves to a more energy-efficient automobile. And consider then the difficulty so many motorists have in making that relatively minor adjustment. Clearly, there are important considerations here that are unrelated to economic factors of the choice.

DATA GATHERING: SURVEY INSTRUMENTS

In using survey instruments, great care should be taken to use culturally-specific categories and language. If a standardized instrument is used for cross-cultural purposes, it must be pretested and adapted to local con-

ditions. An alternative methodology, which is really a technique for refining an instrument or preparing a more reliable one for assessing attitudes and beliefs and values, is the Heuristic Elicitation Methodology (HEM), originally designed by Harding and Canfield. For this, focused group discussions of particular problems and solutions are followed by individual open-ended interviews with both men and women to elicit attitudes and perceptions. The dialogues precede the preparation of a more general survey instrument, with culturally-specific categories and local terminology.

The social science techniques found most useful in determining existing attitudes and practices, as well as in designing more acceptable and effective projects, are those in which the local people were most involved in identifying community needs and priorities. When problem-solving approaches are substituted for or used in addition to a structured questionnaire, the result is dialogue between community users and agency representatives or social scientists involved in project promotion and research. Much more data are generated than just answers to preconceived questions.

Face-to-face communication raises awareness of present practices and alternative opportunities, and defines problems and priorities. Ultimately, the joint analysis by the community and social scientist or agency leads to a greater understanding of needs and resources and, of course, alternatives.

BASIC APPROACHES TO FIELD RESEARCH

In evaluating various field techniques designed to promote an understanding of energy use and supply in the daily lives of people, it is important to remember that there is no ideal or best method. Various techniques have disciplinary overtones and complexities that tend to confuse the picture in transdisciplinary, international research. However, nearly all field techniques are based on a combination of three main approaches: *observing, listening,* and *asking questions* (Whyte 1977).

The following are selected data-gathering methodologies for obtaining base-line information on the human dimensions of energy needs and resources (perceived and real).

Observation

Observation can be direct or indirect, structured or unstructured, using various specialized techniques. Observing actual behavior is a basic tool for understanding the human dimensions of energy needs and uses, especially within the context of household economies. Public behavior is much easier to observe and analyze than practices within the private sphere.

Along with community knowledge, practices, and beliefs, which questionnaires may reveal, there is a need for detailed information on individual behavior, attitudes, and hopes. Ethnographic data highlight some of the more intimate household routines and energy uses. Most of this can be obtained through indirect observation, indirect questioning, and participant observation.

Participant Observation

Participant observation--observing, listening, and asking questions--used to be considered primarily an anthropological method for understanding foreign cultures, but more and more it is being used to obtain valid data and can serve as an adaptable method for field investigation of energy uses. The researcher lives with and participates in the daily life and activities of the people being studied. As a specialized technique, participant observation is less concerned with tools for handling data after they are collected than with obtaining valid data.

Some of the existing sociological and ethnographic studies contain energy-related data gathered by participant observation which could be useful in preparing specific energy-related schedules. Furthermore, the researchers who have done such ethnographic studies make up a pool of talent that could be mobilized for specific follow-up research.

Behavioral mapping is a reliable, simple technique for observing and recording specific behaviors in relation to specific locations. Such observation could be useful for analyzing daily energy needs, resources, and available options.

Map-making

The actual preparation of a wall map, noting house-

holds, streets, and community resources, particularly those being analyzed, is an extremely useful tool. For instance, in Chan Kom, a remote Mayan village of 650 people, the bilingual students in the sixth-grade social science class, together with their teacher and the researcher, made a household survey and prepared a village map showing existing services. The map is still used by the mayor and the teacher, as well as by outside agencies as a basis for planning. In fact, villagers used the research data and map to develop a proposal for improved housing and received a government grant.

Pictorial Analysis and Sorting

The director of an extremely successful integrated rural development project (with a health component) in Colombia related how difficulties between the villagers and the interdisciplinary team were solved by a relatively simple technique--pictorial analysis (Elmendorf and Buckles 1978). Selected villagers were asked to sort photographs of the community into categories of needs or priorities, and then to rank these. Although the villagers categorized the needs and problems somewhat differently, parallels could be drawn with respect to their priority ratings. However, when this same task was assigned to the professionals, they sorted things in very different categories according to their disciplines. Most significant, however, was the fact that their understanding of the priority needs of the village were very different from those of the villagers. As a result, comparison of the two interpretations provided an excellent tool for self-analysis on the part of the staff and a new understanding of the need to give a high status to village priorities.

Asking Questions (Interviews and Surveys)

In the World Bank case studies on appropriate technology for water supply and waste disposal, structured interviews with the local leaders, adapted to the local situation, were used successfully in one village in Guatemala. In another village, a more open-ended unstructured schedule was administered to obtain extremely useful information from both leaders and innovators. The dialogue of the interviews in both villages gave the

leaders an opportunity to explain local needs and resources as they viewed them and to learn about possible alternatives including past projects that were unsuccessful.

The interview becomes an exchange of information, not just an extractive process. In interviews with other knowledgeable people, such as midwives, healers, and storekeepers, new clues to problems, needs, and resources often surface, more basic to reality sometimes than information from community leaders. Interviewing selected families or categories of people, such as mothers, can be extremely useful if carried on over a period of time.

It is important to remember in all interviewing to record in full, using the language of the respondent when possible. Taping is a helpful tool but not always appropriate during the interview session. If sociological surveys are needed, they should be based on the results of the preliminary interviews and prior observation (participant observation, if possible) and should be designed keeping in mind local terminology and categories.

Oral History

Oral history is a method of recording open-ended questions concerning a single topic or specific topics. With good rapport and sufficient time, material collected in this manner has high validity and is less researcher-dominated than most. This technique is particularly useful with the elderly.

Informal Listening

Informal listening, particularly to school children, even overhearing them at play, can add new insights. Listening to the statements that are not answers to structured questions is often useful in the data-gathering process. Often we do not know the questions!

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CHANGING ENERGY USAGE FOR HOUSEHOLD AND SUBSISTENCE ACTIVITIES (Excerpt)

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Energy consumption for household and subsistence activities constitutes a major portion of the total energy budget in developing countries. Yet we know little about amounts or types of consumption, nor much 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 from this narrow vision of reality.

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 socioeconomic 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 power, the problem of linkage between micro studies and national trends remained. Nonetheless, these micro studies have been essential in challenging the theories or generalizations about life that 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 socioeconomic realities at any level, but merely assumed modern to resemble the U.S. 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 developing countries of all three stages of development, but an interpenetration of these levels to such an extent that we require a new perspective. There remains 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 among 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 focusing 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 the 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 most of the farming. The strain within family groupings caused by men having access to money while women are left in subsistence activities has undoubtedly contributed to the worldwide rise in the number of households headed by women. Today it is estimated that one out of three families has a woman as de facto head; furthermore, this trend is more common among the poor.

This tendency of developers to aim economic opportunities at men is similar to 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 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 for 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. However, 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. The fact 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 that use, or might use, energy.

Women are the primary users of household and subsistence energy, but preconceptions about their economic roles have masked their daily work. Interventions to change energy use, whether for necessary or for substitutable fuels, must take into account the total time budget and roles that women play. Similarly, changes in fuel types must account for the several functions the present fuel performs. More also needs to be known about the variety of fuels used in cooking and 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 can greatly improve the human condition in villages or among the city poor, but only if the total world of women becomes an integral part of the planner's framework.

RURAL ENERGY SURVEY REQUIREMENTS: SOME COMMENTS AND PERSPECTIVES (Excerpt)

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PERSPECTIVE

A discussion of survey methodologies should start with the questions to be answered and the use to which the answer will be put. A basic premise of this paper is that the appropriate questions and answers should be related to the design and implementation of improvements in the rural energy system. There is a need for a clear picture of micro issues, at least for a handful of situations if not for representative sets of rural areas or villages. Underlying this need is a basic perception that rural areas, in order to increase their production and well-being, require either more intensive energy utilization or more efficient and effective use of energy. Thus the information gathered should reflect possible interventions.

The information required on interventions should encompass more than just specification of demand; in many cases, a wide range of physical, economic, and social information is needed. In getting started, it is helpful to distinguish choices of interventions. A useful distinction can be made among three classes of technologies and/or supply modifications that may be the basis for intervention: source augmentation, conversion technologies, and end-use devices.

Present and future village energy requirements and the technologies to satisfy them should be examined with particular focus on the thermodynamic structure and quality of the end-use energy requirements. In many cases, the economic viability of "decentralized/dispersed/soft" technology alternatives is enhanced by two factors: the lack of existing infrastructure for fossil-based alternatives and the high transport cost of fossil fuels. Village energy requirements consist of heat, light, shaft

and other mechanical power, as well as the energy embodied in fertilizer. In general, village energy requirements are often dominated by the heat requirements for cooking; most other heat requirements are low to medium temperature. Increasing attention has been paid to technologies related to this dominant village energy requirement, namely, the design, construction, and diffusion of more efficient stoves.

It is important to distinguish between technologies such as those that improve the end-use efficiency of energy utilization per unit of cooking (stoves) or work (e.g., better harnesses or plows for animal draft), those that either augment or modify the sources, and those that convert the energy sources to a more usable form (or store it). Augmentation technologies and procedures include such techniques as the development of village woodlots and the planting of fast-growing species. Conversion technologies include such new ones as photovoltaics for converting sunlight to electrical energy and age-old ones such as the production of charcoal or the production of low Btu "biogas" from biomass residues and dung.

Viewing rural energy issues from the perspective of both demand and intervention design has obvious implications for information requirements of both the characterization of the end-use demand and the evaluation of possible supply or demand modification interventions. This means knowing about all demands, not just cooking, and about a series of intervention pathways that are the equivalent of alternative fuel cycles from source to end use. But rather than elaborate on these issues, it is useful to cover some conventional areas--namely, the use of traditional fuels and some of the characteristics that have an impact on information methodology--and then return to another view of the intervention process.

TRADITIONAL FUELS: SOME CHARACTERISTICS THAT HAVE IMPLICATIONS FOR INFORMATION NEEDS

The traditional fuels of firewood, agricultural residues (rice, straw), etc., are largely noncommercial in the nature of their paths from point of supply to ultimate use, that is, through the fuel cycle; charcoal is the one general exception. Most traditional fuels are gathered by the users, and women (and children) are the major users and gatherers in much of the world. Cash markets usually exist mainly for firewood and charcoal, the more concentrated

fuels, but occasionally for dung. These markets are generally geared to urban consumers, but also to some rural households and institutions. Although cash or formal markets may not play an important role for many traditional fuels such as rice or millet straw, there are frequently complex service or exchange relations at work in rural societies in which traditional fuels are just one component.

This noncommercial nature of traditional fuels is one of the reasons that these energy supplies are not generally accounted for in national (not to mention regional or industrial) energy statistics. To the statistician energy has traditionally included only those energy supplies marketed on a large scale by some centralized market system (coal, oil, electricity)--referred to as commercial energies. Although the perceptions of the energy statistician are changing rapidly in this respect, the number of statistics is woefully inadequate.

The complex and competing nature of traditional energy has also been discussed by various investigators (Briscoe 1979), but it should be noted that a single crop or forest area can serve several functions: the trees for fodder (leaves, small branches), building poles, or firewood; the rice straw for fodder, fuel, building material, or fertilizer (when left in the fields). These complexities make the estimation of "fuel supplies" difficult and, when coupled with other characteristics of the problem, argue for a multifaceted approach to the problem. The problem of traditional fuels is one of development; consideration of these problems in rural areas must be an integrated approach that includes agriculture and forestry policies as well as other issues.

DIFFICULTIES IN ESTIMATING TRADITIONAL FUEL SUPPLIES AND USE

Estimates of availability and consumption of agriculture- and livestock-derived traditional fuels are related to a number of factors: primary agricultural or livestock production; forestry production levels; coefficients relating residue production to production of primary product; availability of residue to potential user; and problems encountered in consumption surveys.

In many countries reliable data are lacking on crop production levels or numbers of livestock. Many nations lack reliable estimates of crop areas; crop yields are

always less well known. Information necessary for agricultural (not to mention energy) planning is insufficient.

Benchmarks for crop and livestock data are often agricultural censuses which may have been done at much earlier dates. Forest statistics are even less reliable (or available) than agricultural statistics. Because fuelwood is not directly related to roundwood, statistics that are usually available are of limited use in extrapolating to fuelwood.

The literature varies widely in coefficient estimates of residue to primary product production for certain crops and for cow dung production. A number of possible factors could be the source of these discrepancies. For example, grain-to-stalk coefficients can vary widely depending on the particular crop varieties in use. Thus in Bangladesh, high-yielding rice has a coefficient close to one; traditional rice, three; and floating rice, over four. Such *legitimate* differences need to be considered, and care must be exercised before using coefficients based on another situation in which the varieties (and/or yields) are quite different.

Large country-to-country differences in dung production exist because of differences in breeds, diet, and herd management practices. Use of U.S. numbers in these cases usually results in overestimating dung production. Analogous differences exist regarding the ratio of total biomass available (leaves, twigs, branches) to production measures that are designed primarily for estimating roundwood production.

For a variety of reasons, residue and firewood availability to the user can vary markedly from country to country, within a country, and across groups at a given place. A number of factors influence this. For example, some countries mandate that residues be burned in the field to control disease (e.g., cotton in the Sudan). In other countries, field burning is a traditional practice. Access to residues of the rich may be denied to the poor so that even in such a fuel-poor country as Bangladesh, rich farmers now burn rice straw in the field. This phenomenon accompanies the transition from traditional to market rural economies.

In many countries, the degree of forest depletion in areas of population concentration is extreme. Consequently, while firewood may be available on a national level, if the nearest woodstand is 100 kilometers away, there will be little firewood use. In other cases, the forest stands may be available in terms of distance, but

government or other ownership and use regulations will prevent utilization of firewood.

The problems of access to dung are not just a matter of ownership, although this is a factor. Animals that graze in forests and uncultivated lands have a much lower availability fraction of dung than those kept in stalls.

Finally, one of the greatest difficulties in estimating relevant traditional fuel factors is that traditional (and commercial) fuel consumption studies are particularly hard to design and implement. Most of those undertaken suffer from numerous defects. In most cases they do not actually measure use, but rely on users' estimates and recollections, as with the India, Nepal, and Bangladesh consumption surveys. Frequently, there are terminology problems between enumerator and respondent, such that distinctions between firewood and agricultural residues become blurred.

SUMMARY

1 Any discussion of energy information needs should start from the perspective that the purpose of information is to lead to interventions that make things better in the rural area.

2 Any program design should first acknowledge that there are a number of points at which it is possible to intervene, and that the information requirements for an intervention may differ dramatically. For example, one geared to modify end-use demand is markedly different from one geared to supply augmentation, and the selection of what class of intervention is best is less than obvious.

3 Current rural energy balances are dominated by traditional fuel use. A better understanding of this use and its sources is important in intervention design, but the information-gathering (either primary or secondary) problems are large.

4 Rural production systems are complex physical/social systems frequently at low-level equilibrium, and energy-related interventions may "cascade" through the system. Adequate intervention design requires analysis of this cascade as well as more conventional technique and cost analysis. Even then, however, there are no guarantees.

5 The reasons for success and/or failure in known rural energy intervention programs are less than

clear. It is here that the "literature" and the "experts" are weakest.

6 A country- or region-specific energy information program should synthesize and learn from existing work. But general survey work and resident observation efforts are still needed, since there is no appropriate model applicable to all situations and problems. More important is an understanding of the problems and of the possible interventions to be designed.

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ENERGY SURVEYS IN URBAN AREAS: EXPERIENCES IN BURUNDI AND CAMEROON (Excerpt)

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Only in recent years (largely the last two) has adequate attention begun to be paid to the problems facing the urban populations in developing countries. In these countries, energy information needs for the urban sector are not much different from those for the rural sector. If energy supply and demand are not clearly understood and if adequate information on those areas is not available, then the tasks of forecasting trends in future energy usage and supply as well as making decisions on energy assistance projects become quite difficult.

This author has been involved in conducting household energy surveys in the capital cities of Burundi and Cameroon over the past six months. Prior to these surveys very little information on energy consumption existed in the cities of Bujumbura and Yaoundé. It was realized that some sort of assistance was needed to help alleviate the situation arising from the steeply rising costs of energy; however, very little information existed on which to base a decision as to what kind of assistance could be given. Any assistance given for these cities had to be components of general urban development projects.

This paper is based largely on the author's field experiences and observations during the course of five trips to Burundi and Cameroon during which the two household surveys took place. Although these surveys were carried out as part of an urban development project, they dealt solely with energy matters in Bujumbura, while in Yaoundé, a section on water was added.

CONSIDERATIONS WHEN CONDUCTING AN URBAN ENERGY SURVEY

When conducting surveys in urban areas, a number of key nonenergy issues arise; principal among these are institutional and personnel issues. Prior to conducting a survey, a local institution that deals with urban issues should be located and involved in the survey, particularly the questions to be posed. The cooperation of the officials of such institutions is often necessary because respondents might more readily respond to questions from such an institution rather than others. On the personnel level, when interviewers are selected, again usually in cooperation with an urban institution, a number of issues need to be emphasized to them. The manner in which they conduct their interviews and solicit responses from respondents would in part determine the cooperation of such respondents in providing reliable answers or their readiness to respond at all.

The nature of the questions being asked and the manner in which they are presented are also very important. Questions should generally be short whenever possible, to the point, and in some cases should be posed more than once in different words.

Urban populations are usually the most diverse in terms of economic and social make-up, which should be reflected in the selection of the sample population. The actual numbers of persons to be interviewed should also reflect the relative densities of the various neighborhoods.

While data and information on industrial energy use are easily available, the same is not true of the domestic and small enterprises areas, when energy information is currently lacking. One reason for this is that the energy consumed by these enterprises is usually a combination of traditional and commercial energy, while most or all of industrial energy consumption is supplied by commercial (often imported) sources.

Utilities and planning departments in most developing countries generally have information available on levels of electricity consumption and not much else. Energy information presently available therefore does not adequately address such aspects as:

- Tasks that energy performs for various sectors of the population and to satisfy various activities, and priorities for these tasks
- Degree of reliance on particular forms of fuels to satisfy the energy needs that are established

above, and quantities demanded per task per household and/or enterprise
- Efficiency with which each task is performed
- Relationship of energy use both by quantity and type to income level and other factors
- Types and quantities of energy resources available in the area
- Availability of these resources in terms of costs, time spent for collection, problems with conversion, transportation, etc.
- Existing possibilities for improving the efficiency of fuel supply as well as use
- Feasible technological options that permit the harnessing and use of some energy resources of an area, particularly renewable resources (e.g., solar, wind, etc.), and the potential for the use of these resources
- Possible applications for the range of energy resources in an area

A few studies have addressed one or more of the above aspects. Information that comprises most or all of these aspects are needed in urban areas to provide a sound basis for decision making or understanding the energy problem in any given urban sector.

OBSERVATIONS

Following is a summary of some observations made during these field surveys and some possible questions that they may raise. Although not listed in order of importance, these observations should highlight problems, gaps related to information collecting, personnel issues, etc.

- Some respondents usually lost patience after a certain question, sometimes due to the length of question and/or misunderstanding the question posed. What should be done in such cases?
- The lowest-income groups tend to be the most suspicious about surveys and such interviews, but they loosen up after reassurance and a careful, polite explanation of the purposes of the survey. The fact that answers or questionnaires are anonymous should be mentioned at the outset whenever possible. This group usually complains of how they have no services, no money, etc. The

interviewer, while sympathizing with these complaints, should at the same time try to steer the interviewee gradually away from complaint back into the general theme of the survey.

- Some respondents abruptly refuse to cooperate midway through interviews. In that case the interviewer should again try to explain the purpose of the survey and try to point out what benefits could be derived from such surveys.
- Generally, interviewers should conduct these surveys in pairs, and undergo a sufficient briefing on the area before going out into the field. At times, interviewers come on too strong for the comfort of the respondents or do not explain their aims well enough to put the interviewees at ease.
- Whether the respondent is a female or male apparently makes little difference, although women hold about a 60-40 edge over the men in more precise and immediate responses.
- Questions should be asked in different ways to get more definite responses. However, regarding household energy use and costs, 90 percent of the households interviewed were acutely aware of their expenses, prices and price increases, as well as the quantities they consumed.
- A combination of prices, quantities, and expenditures should always be determined. Prices, in particular, vary from neighborhood to neighborhood, and an assumption of a set price level could prove wrong when costs are estimated. For example, in Yaoundé a liter of kerosene is sold in some neighborhoods for 45 CFA (French African currency; 820 CFA = US$1) and in others at 60 CFA per liter.
- Questionnaires should possibly address uses per day, per week, and per month. If questions address only uses per month, for example, there is sometimes a tendency on the part of respondents to exaggerate.
- Questionnaires should take into account seasonal variations in energy use. Most households are aware of variations in their use of fuels, expenditure on energy, etc., during a month and usually have reasons why these variations exist.
- Some questions arose as to quantities consumed because the very poor bought their fuels in very small quantities that are difficult to measure. For example, charcoal, while generally sold in

kilos, was sold in heaps in some neighborhoods. These heaps could be measured, however.

- Questions should not be adhered to rigidly. However, divergences and follow-ups should be noted.
- Problems arose as to how to measure the time some households spent collecting and/or preparing their own fuel, but such households are not numerous in urban areas.

RATIONALES AND FRAMEWORKS FOR ENERGY INFORMATION SURVEYS FOR THE INDUSTRIAL SECTOR IN DEVELOPING COUNTRIES (Excerpt)

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Since 1973, the energy information industry in industrialized countries has experienced phenomenal growth. Because energy use is tied so tightly to almost every part of the human enterprise, its collective usage and patterns are the result of a large number of individual actions and decisions which depend strongly on both the social and institutional system within which they are made. It is therefore no surprise that a broad spectrum of planning and management methods at different institutional levels, coupled with a wide variety of analytical methods, has produced a great number of divergent approaches to energy statistics and surveys.

ENERGY ISSUES AND THE INDUSTRIAL SECTOR

Industry is quantitatively the most important energy-consuming sector in many, if not most, of the industrialized countries, and thus plays a major role in shaping energy needs and policies. Although the industrial sectors in developing countries are not, on the average, the largest energy consumers, they appear to be experiencing the highest growth rates in energy use. Industrial development and employment rank very high on the list of priorities of most developing countries, and the employment/development relationship to energy supplies and consumption is perhaps of no less importance. In countries where rapid economic growth is viewed as the main hope for improving its citizens' welfare, any development constraints arising from high prices or lack of availability of energy are viewed with great concern.

The extremely wide range of socioeconomic systems, natural resource bases, levels of industrial development,

and overall national goals found in developing countries make it difficult to enumerate explicitly the major industrial energy issues in this large class of countries. Thus it is perhaps more useful to consider the purposes of energy data gathering in the broader sense. We can identify three general objectives or uses of energy data systems or surveys: *(1) monitoring* and *describing* energy supply and energy consumption; (2) *modeling* and *analyzing;* and (3) *evaluating* and *prescribing* policy, planning, and management.

Monitoring energy system behavior is fundamental to planning and implementing energy policy and management; it implies continuous or repeated measurements. However, monitored data reflect *all* of the factors that influence the energy system, i.e., old policies and factors as well as more recent ones, which is a limitation of monitoring for purposes of policy making. *Modeling* and other analysis help explain the causes of the energy system behavior and foresee future behavior under various possible circumstances. However, *evaluating* alternatives and *prescribing* policy or management may go beyond the scope of the existing models and rely on further information and the specification of preferences. Each of these three objectives or functions may require different types of data which may be further differentiated by the requirement of users at different institutional levels, i.e., individuals, firms, and local, regional, and national governments.

ENERGY-USE PATTERNS AND INFLUENCES IN THE INDUSTRIAL SECTOR

In many countries, industrial energy consumption is dominated by processes that use fuels and electricity to produce heat. Furthermore, a substantial fraction of industrial energy consumption is generally used by a small number of basic material processing industries for which energy costs are a significant fraction of operating costs. It is convenient to group industries into categories that emphasize the different types of processing and the energy used per unit of output, i.e., the energy intensity.

In many industrialized countries, much of the industrial energy is used to make relatively homogeneous intermediate products such as steel and plastics. These intermediate products are then typically sold to other firms for processing, and eventually turned into a final product. Usually the largest part of the embodied energy

in a final product is determined by the energy of the *basic* process, and to a lesser extent by the subsequent process energy converting the product into its final useful form. This observation may also be valid for the developing countries. However, a consistent analysis on the basis of embodied energy requires that the energy content of imported and exported goods be taken into account. This question is of interest in the comparison of highly industrialized countries with developing countries. Preliminary assessment of available data indicates that, excluding the major oil producers, developing countries are significant net importers of embodied energy.

The energy content per unit of material output in the most energy-intensive industries is one measure of industrial energy efficiency. Changes in the technical characteristics of the machinery and equipment, or the materials used as inputs, will lead to changes in energy input per unit of product output. Factors such as actual or anticipated energy prices and availability may play a major role in influencing the resulting energy content. For those industries in the energy-intensive group, it appears desirable to monitor energy content per physical unit of output; similarly, in these industries useful models can be constructed explaining change in energy content per unit output. The attractiveness of the process approach for these industries can be supported by at least three major arguments:

- The most important determinant of energy consumption is the process used to modify the basic input materials.
- In general, there are alternative ways to process these raw materials; in the high-growth sectors of developing countries there may be opportunities to choose between these alternative technologies.
- The attractiveness of an alternative technology is strongly affected by energy prices and availability.

Influences and Changes

The industrial classifications of many developing countries are undergoing major change. In many of these countries, industrial growth is relatively high, with significant changes in both the volume and mix of output.

Expansion of plant capacity and the need to install new equipment offers the chance to introduce alternate processes and technologies. Some process changes may allow or require a different fuel or different applications of fuels currently used.

Changes in Industrial Processes

In many industries, existing alternative technologies could greatly reduce industrial energy consumption per unit output (e.g., the electric furnace vis-a-vis the blast furnace, the dry cement process vis-a-vis the wet process, and new aluminum smelting processes). The most useful data for estimating the penetration of these technologies might be industry projections of future energy costs. However, if the industrial equipment is imported into the developing country, the actual technological choice related to energy efficiency might often be made elsewhere! Nevertheless, any proposed industrial survey should incorporate the capability to monitor and analyze the major process changes in the major energy-consuming industries.

Changes in Fuel Types and Applications

Different types of fuels or different applications of fuels currently used may represent another change in industrial energy use, i.e., a gas-fired furnace for glass-making is considerably more efficient than an electric furnace. Again, information about future fuel availability and price may be the most important factor in understanding changes. In large developing countries, it may be desirable to address this issue from the regional level since highly aggregated national information might not be adequate.

The use of internally produced fuels and noncommercial fuel by industry, and the possible shift to commercial fuels, must be treated carefully. Quite clearly, their use tends to reduce apparent fuel consumption if only sales and purchases are reported.

Changes in Product Volume and Product Mix

Developing countries will likely continue to experience changes in their final demand for goods and services,

which will in turn affect the volume and product mix of their industrial output. A change in the volume and mix of their exports would have an analogous effect. Energy survey design should take into account the need to relate industrial output to these changes in final product volume and mix.

INDUSTRIAL ENERGY DEMAND FORECASTING AND ANALYSIS: DATA IMPLICATIONS

Energy demand forecasting (or scenario building) is one of the most important energy-related components of national planning. As stated earlier, there is a mutual influence between the approach (models) to industrial demand forecasting and available or needed data. Some major approaches to industrial energy forecasting are:

- Extrapolation models and statistical trending
- Econometric models
- Disaggregated final demand models, e.g., input/output models of the "Maryland type"
- More aggregated macroeconomic models of the "Wharton type"
- Linkage approaches where aggregate models of the above two types are linked to more highly disaggregated models of the energy-consuming industrial sector
- Sectoral energy analysis based on aggregate technical energy efficiencies
- Detailed engineering process models

Although all of these suffer from data limitations in developing countries, each has advantages and disadvantages with respect to specific forecasting objectives and data requirements.

The extrapolation models have the minimum data requirements, but are unable to treat rapid structural change. A difficulty associated with econometrics is the usual lack of data on fuel prices, as well as the problem of a rapidly changing demand structure. Maryland-type input/output models exist for some developing countries (e.g., Korea and Mexico); however, they require relatively detailed, industry-by-industry data. In contrast, the Wharton-type models (e.g., for Mexico) do not require such disaggregated industrial information, but they do not

permit the more detailed analysis of each industry. The so-called "linkage approach" permits some flexibility in response to data limitations, but neglects some energy/economic interactions or feedbacks. The last two approaches listed, technical sectoral analysis and engineering process models, are in fact similar approaches, differing only to the degree to which the technical process is explicitly described. They usually require data at the plant or process level. For developing countries with a small number of important industries and plants, these approaches are perhaps the most feasible to carry out within limited resources. One example is the industrial energy assessment conducted jointly by the United States and Egypt.

INDUSTRIAL USE OF NONCOMMERCIAL FUELS

For many developing countries, noncommercial fuels are an important source of energy and should be given important consideration in energy survey design. To better understand their significance for the industrial sector, we have made a cursory examination of the industrial use of noncommercial fuels for the 16 developing countries included in International Energy Agency (IEA) energy statistics and balances (International Energy Agency 1979). It must be emphasized that the IEA data are defined to include only bagasse, fuelwood, and charcoal; their data are obtained from the Food and Agriculture Organization (FAO) of the United Nations, rather than from national sources. It is likely that this source and classification neglects important noncommercial flows and markets in many of the countries.

For these 16 countries as a whole, the IEA data indicate that industry accounts for approximately one-quarter of total final energy consumption, while noncommercial energy is approximately 10 percent of final energy consumption in the industrial sector. Thus it appears that noncommercial energy is an important source of industrial energy in several of the countries, although in most of them the largest fraction of industrial energy is provided by commercial fuels. The limited scope of the fuels included in the FAO data may have resulted in an underestimate of the use of noncommercial fuels. Furthermore, a close look at some of the individual country statistics in the IEA data base revealed some erratic

year-to-year variations that were very difficult to interpret. It would be very useful if this data base could be carefully examined by country representatives and updated on an iterative basis in the future.

Although the noncommercial fraction of industrial use may continue to decline, it will remain sufficiently important that the design of future energy surveys should include the possibility of a more disaggregated enumeration of noncommercial as well as internally produced energy in industrial establishments. The United Nations has recommended a breakdown into peat, fuelwood, bagasse, charcoal, dung, tar, wood wastes, municipal and other waste, others.

CENSUS AND SURVEY METHODS

Because of the wide diversity of statistical reporting systems and institutions in developing countries, it would be presumptuous to present detailed conclusions and recommendations on implementing censuses or surveys. However, some general observations can be made.

From discussions with experienced professionals it appears that personal enumeration rather than mailed questionnaires is the most successful tool for surveys in developing countries. Although this approach is time-consuming and has reporting problems, the personal control associated with it may permit better assessment of actual and anticipated structures of industrial energy consumption.

One of the most-often mentioned problems is the availability or creation of an appropriate administrative list from which to take the census or survey sample. Once these lists are established, a common procedure for manufacturing surveys in industrialized countries is to sample all manufacturing companies that have more than a specific number of employees (e.g., 250 in the United States); smaller companies are sampled in accordance with mathematical theory for optimum allocation of a sample. For energy surveys in developing countries, one or more of the following criteria may be useful in an initial survey of companies:

- Identify the "X" major energy-consuming industries (classifications).
- In these industries, identify each company that conceivably uses more than "Y" units of energy annually.

- Of these companies, survey the top "Z" companies in each industry.

Benchmark surveys of industrial energy use (according to function or process) in selected industries and plants would be very valuable in defining industry or plant energy targets or goals. Limited benchmark surveys and analysis of energy-consuming processes, including prices of commercial and noncommercial fuels, would be valuable for forecasting future changes in processes and fuel types and applications.

In many developing countries, chemical and petrochemical production are an important use of energy (e.g., Mexico). Design of energy surveys should include a consistent treatment of fuels used as feedstocks in these and other industries.

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NATIONAL ENERGY ASSESSMENT SURVEYS FOR THE TRANSPORTATION SECTOR (Excerpt)

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In many countries, energy requirements for the transportation sector are the most important component of the total energy needs. Even in the United States, as late as 1976 the transportation sector consumed more than 26 percent of the total energy consumed that year, exceeding even the industrial sector (24.9 percent). Only utilities used more energy resources (29 percent). In countries with reduced residential consumption for heating purposes, the transportation sector looms still more important, exceeding even the consumption levels of utilities.

The transportation sector utilizes petroleum products almost exclusively, and these have been the center of concern in recent years. In 1976, only 2.4 percent of the transportation energy used in the United States was other than petroleum products. In fact, transportation consumed about half the total petroleum products in a typical developed country and much more in proportion in many developing countries where the industrial sector is not yet developed and home heating is not particularly demanding.

TRANSPORTATION ENERGY ASSESSMENT SURVEYS

There are essentially two types of transportation energy assessment surveys: the aggregated sectoral survey and the disaggregated transportation activity survey.

Aggregated sectoral surveys deal with the entire transportation sector, or major components thereof, and their major objective is factoring upward or downward the energy share of the sector. The essential tools in these surveys are econometric models which assess the impact of at least three factors: population growth, personal income growth, and price of gasoline. Population growth

reflects increased number of users, while increased personal incomes reflect increased ability and/or desire to utilize more transportation inputs. Price of gasoline is utilized in order to factor in price-demand elasticity of transportation as a consumed good.

The use of aggregated sectoral surveys is quite appropriate and convenient when quick, inexpensive gross forecasts are desired, or when sweeping changes occur, such as multifold price increases. Usually these surveys are restricted to either short-range gross forecasts or generalized long-range policy directions. Unfortunately, this approach can not be more detailed or more inclusive of the multiple changes that take place in a country when transport activities grow or decline. It does not indicate what activities, or parts of activities, can be controlled or induced to respond to energy change scenarios; and it can not reveal the relationships between transport activities and other activities such as urbanization, industrialization, technological change, governmental capital investments, or managerial improvement programs. When insight into these aspects of the problem is desired or required, then the second type of transportation energy assessment survey, based on transportation activity analysis and projections, is imperative.

DISAGGREGATED TRANSPORTATION ENERGY ASSESSMENT SURVEYS

These surveys are based primarily on the measure of three major components: (1) disaggregated national transport activities; (2) energy efficiency of the transport fleet in use; and (3) utilization of the transport fleet. The three inputs produce a comprehensive table of energy consumption in the transportation sector, by mode of travel and by type of fuel utilized. Figure 1, showing a base-year analysis, indicates the central place of these three components in the assessment survey, as well as the required inputs for their completion. The process continues with a repeat of this analysis for each target year (i.e., 1990, 2000) following at least two scenarios: (1) an extension of recent trends, and (2) an attempt for energy conservation. The analysis in each case starts with assumptions or projections of basic inputs, and concludes with the energy-use assessment in terms of cost acceptability and feasibility.

What follows is an elaboration of Figure 1 in terms of data requirements and types of analysis involved in each component of the survey.

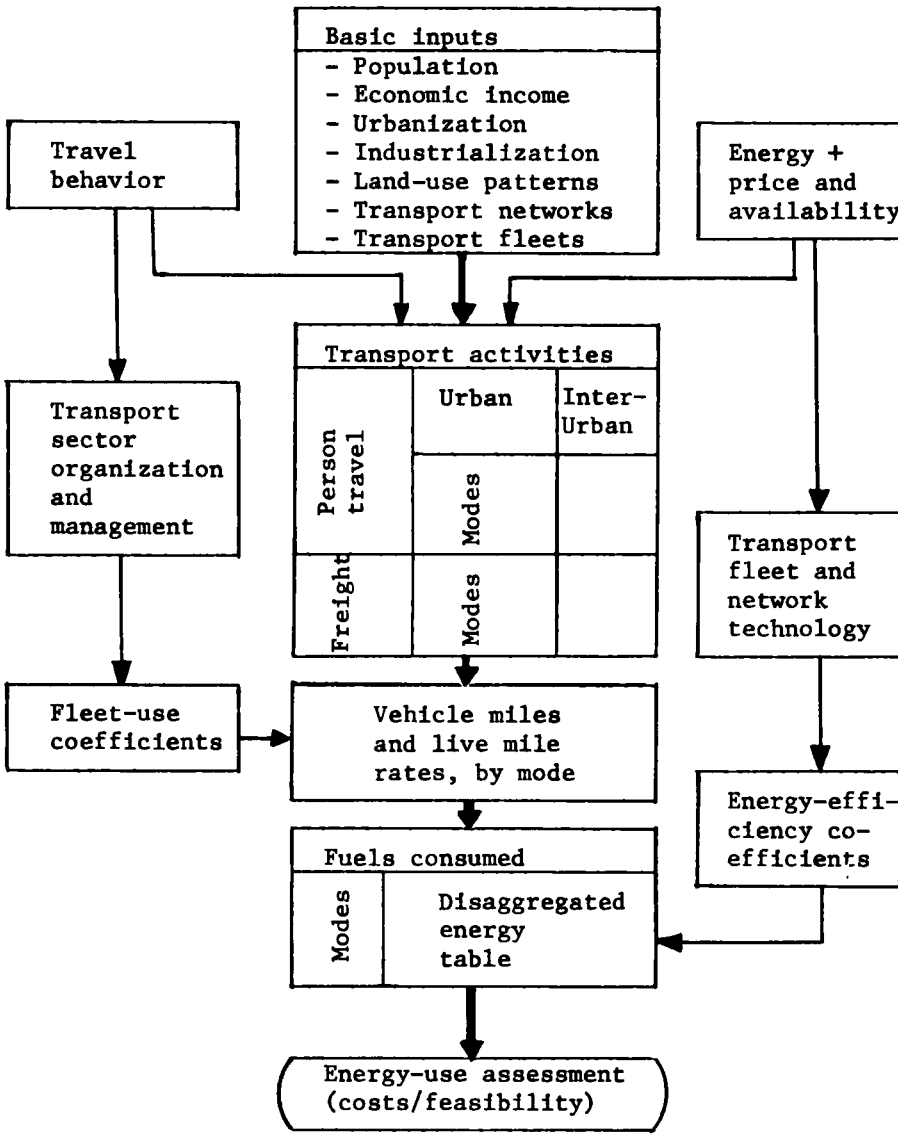

FIGURE 1 Disaggregated transportation energy assessment survey, base-year analysis.

Basic Inputs

It is important to initiate the disaggregated transportation energy assessment survey with a complete set of data of basic inputs of the base year of analysis. The basic inputs data set starts with information on a country's population size, the demographic pyramid, and the areal distribution of population and economic activities. It continues with data on levels of personal income and the essential distribution of economic activities. The third and fourth sets of data include patterns of urbanization and intensity of development. The fifth set of data involves information about land-use patterns and densities within the major metropolitan regions of the country. Finally, the sixth and seventh sets of data focus on the transport networks, the transport fleets available for the base year, together with their capabilities and operational quality.

Travel Behavior

Information concerning the travel behavior of individuals and households in the major metropolitan regions and towns of the country is also highly desirable to explain both any available statistics on transport activities at the base year and to be used as the basis for projections of future transport activities for urban and interurban travel. In case such data are not yet available for any part of the country, it is then necessary, with guidance from the basic inputs data, to assemble data on travel behavior from other regions or countries with similarities.

Energy Price and Availability

The energy assessment for any region needs to be associated with a framework of energy cost and energy availability for all types of fuels. The availability of petroleum products and electricity needs to be recorded in terms of both areal distribution and time schedule availability.

Transport Activities Inventory

The fundamental table of this survey presents the disaggregated transportation activities of the country at

a given time and for a given scenario. Transportation activities should be segregated into enough distinct entities to reveal all the important differences in energy coefficients.

The transport activities table for the base year includes essentially two types of data: trips made and distances traveled by each mode for urban or interurban travel. The trip measures can be expressed for a typical workday, or a typical day, or on a yearly basis, whatever is more expressive of the travel activity under consideration. The final product would then be person-trip miles and ton miles of travel, preferably per year for urban and interurban travel and for each mode.

Data sources for transport activities are usually previous transportation studies on urban areas, resource regions, or the country as a whole. Where such studies are not yet available, it is important to establish a simulated transport activities table from the three previously collected sets of data and from other sources, including other regions or countries with major similarities to the country under study.

Transport Sector Organization and Management, and Fleet-use Coefficients

These two sets of data are important in many countries because they have significant impact on the process of translating person-trip miles and ton miles into vehicle miles and live mile rates [a live mile is one that produces revenue, e.g., when the meter is running in a taxicab]. Both measures refer to the way the transport fleet is utilized, what load factors are being achieved, and the extent to which empty vehicles are circulating within the system. Energy consumption differs so dramatically depending on the size of the vehicle and the type and amount of load it carries that it is imperative that such statistics be taken into account.

Vehicle Miles and Live Mile Rates

The next step is determining vehicle miles by each mode of travel and live mile rates by each mode or major system. The data needs at this stage represent a kind of summation of transportation activities as they are translated operationally in the field.

Transport Technology and Energy Efficiency

Before transport activities can be translated into energy requirements, it is necessary to factor in the energy-related technological state of the art of the country in terms of the energy efficiency built into the system. Such factors as the level of quality of the highway network, railroads, waterways, and mass transit systems need to be translated into actual energy consumption coefficients. Similarly, the transport fleets in all modes of travel need to be translated into Btu per ton volume, per passenger volume, per vehicle volume, etc. Actual operational data of the situation prevailing in the transportation system need to be developed and factored in.

Disaggregated Energy Table

In this phase of the energy assessment survey, all of the previous information is pulled together to produce a disaggregated matrix that shows in detail energy consumption by the transportation system by *type of consumed fuel* and by *mode of travel*.

Energy-Use Assessment

At this final step the results of the analysis are evaluated and compared with those of other countries and the needs and energy assessments of the other sectors within the country. Also at this point the basic directions of energy planning are being formulated to be included in future energy projection scenarios.

SOME SUGGESTIONS AND RECOMMENDATIONS

A national transportation energy assessment survey should be comprehensive, analytical, and disaggregated with emphasis on:

- Completeness and accuracy of the base-year data inputs
- Relationships between energy inputs and transportation activity levels, modal split of person trips and freight, intensity of use of the transportation hardware, energy coefficients of the

transport fleet, and urban and regional developmental and industrialization indices
- Sensitivity of the projection scenarios to energy inputs and growth trends, and objectives of the country

Energy assessment surveys by their very nature deal with practically all sectors of the national economy and all types of development plans. As such, one cannot overstate the significance of the proper institutional framework within which such surveys should be undertaken. When international technical assistance is also involved, the significance of the proper institutional framework increases dramatically. In general, emphasis should be placed on:

- Joint responsibility for the base-year inputs of all sets of data
- Joint analysis of the implications of the projection scenarios for the short- and long-range periods of projections
- High-level sponsorship for the survey and the ensuing recommendations, knowing that the study will deal with many sectors and will produce recommendations of singular significance for the directions and policy of many of the sectors
- Work inside the host country and fully communicated analytical approaches and derived conclusions so that the survey's main recommendations receive the support and endorsement of the leading technical individuals of each sector (or system) of the host country.

ENERGY USE IN THE RURAL AND URBAN HOUSEHOLD SECTORS OF DEVELOPING COUNTRIES: AN ASSESSMENT (Excerpt)

Elizabeth Cecelski and Joy Dunkerley
Resources for the Future

INTRODUCTION

Household energy consumption accounts for a major part of total energy consumption--about 50 percent--in developing countries, and household energy needs take up a substantial portion of the resources of many households. Not only is household energy consumption quite large, but it draws heavily on fuels that have important consequences for economic development generally, e.g., kerosene, which has an impact on the balance of payments, and traditional fuelwood and dung, overuse of which may create severe environmental problems and affect agricultural productivity.

Its importance notwithstanding, little reliable information is available on the level and quality of energy services presently consumed by developing country households. This paper outlines the energy information needed in this sector to formulate and carry out certain policy objectives; reviews what is known about household energy consumption on the basis of limited surveys and other activities; identifies specific data-gathering problems and gaps; and suggests some improvements in the collection and use of information on energy use in the rural and urban household sectors. Although the emphasis is on the household sector, many of these informational, measurement, and definitional gaps and problems are also applicable to other energy-using sectors.

ENERGY INFORMATION NEEDS

How is information on household energy uses likely to be used? Two general purposes can be envisioned. First, planners would like to be able to project future

energy demands in order to determine future supplies and conservation efforts, for example, how much oil it will be necessary to import, how long forests can sustain the demand for fuelwood, what effect urban migration will have on demand for kerosene. Key information required includes the *tasks* that energy performs, such as cooking, heating, and lighting; the *amount* and *type* of each form of energy used in performing each task; and the *efficiency* with which that task is performed. It is important to have some idea of how consumption patterns of energy and of goods and services that use energy are likely to change over time with rising incomes and prices, and with increasing urbanization.

The traditional fuels situation is a critical unknown here too. Are traditional fuels supplies under stress, likely to decline in importance, or increase in cost in the future? What are their real costs--environmental, labor, and opportunity? Are they sold in markets or traded for services? Are they used in urban areas? Has their availability or cost changed recently?

A second use of household energy information is in planning new energy sources that will be more efficient and cheaper in a private and/or social sense, or that will provide additional or higher-quality energy services. Here, in addition to the above factors, the socioeconomic context of use becomes important. Cultural patterns--cooking habits, roles of men and women, feelings about waste utilization, attitudes toward risk, and tribal or social organization--can influence the acceptability of new energy sources. Class and social structure as well affect access to capital, cattle, land, and other energy-producing resources. The availability of human resources--labor surpluses or bottlenecks and maintenance and operational skills, for example--is also relevant to the choice of new technologies. Finally, the relationship of the household to other economic sectors must be taken into consideration.

WHAT DO WE KNOW?

Energy Forms and Tasks

In the modern sector of the developing countries, much of the household energy consumed is in the form of commercial or conventional energy, mainly petroleum and

natural gas products and electricity. But most people in developing countries, including virtually all rural consumers, the urban poor, and a fairly large part of the urban "nonpoor," meet their household energy needs through noncommercial or traditional fuels, which in rural areas are gathered and used by family members, but in urban areas are often bought and sold in organized markets.

The form in which energy is consumed is, among other factors, closely related to the tasks it is designed to perform. For most rural consumers, and for the urban poor, these are habitually summed up as "cooking and lighting" of which cooking is usually estimated to account for about 80 percent. Such a rudimentary breakdown is, however, misleading. Lighting may not exist as a separate task for large numbers of the developing world whose working day is geared to daylight.

There is also evidence of wider energy tasks even at very low levels of income. Thus in rural Gambia cooking is estimated to account for 53 percent of firewood and charcoal consumption, the balance being accounted for by water heating (36 percent), ironing (8 percent), and protection (3 percent) (Openshaw 1978). In many areas of Africa and in the Andean countries, space heating may be a major use of fuel, although often integrated with other energy uses (see Digernes 1977 and Fleuret 1978). As incomes rise, people in developing countries begin to use energy in forms and tasks similar to those in the industrial countries.

Rural Energy Use

Most household energy in rural communities is produced locally from human labor, woodfuels, and animal and crop residues, with commercial fuels brought in from outside on a limited scale. Traditional fuels are usually gathered by family members, although wealthier families may purchase charcoal, dung cakes, or wood. The poor may have to pay with services for the privilege of gathering fuelwood or residues on land that is privately owned. Commercial fuels are used by rural households for lighting (candles, kerosene, or electricity) and by wealthier families for ironing, radios, cooking, and other uses.

Since most traditional fuels are not traded commercially, estimates of their consumption are of questionable accuracy (see below for measurement problems). Nonetheless, the Food and Agriculture Organization of the United Nations

has attempted to estimate woodfuel consumption, and others have made rough "guesstimates" of residue consumption. It has been estimated that nearly 1,300 million cubic meters of wood, 400 million tons of dung, and an unknown but perhaps equally large quantity of crop residues are being burned as fuels each year in developing countries (Knowland 1979, Arnold 1978, Spears 1978), roughly equal to 2.5 billion barrels (or 7 million barrels a day) of oil equivalent. Most of this amount is consumed by households.

Urban Energy Use

Household energy consumption is weighted more heavily toward commercial fuels in urban areas, where such fuels are easily available, incomes are higher, traditional fuel use is not tied so tightly to productive activities, and monetary price and convenience become much more important considerations in the choice of fuels. Even so, commercial fuels are commonly used together with traditional fuels, both of which are sold in organized markets, in urban households. Charcoal is generally preferred to wood in cities due to its convenience, compactness, and cleaner burning.

As incomes rise, commercial fuels are typically substituted for traditional ones. In urban areas of India, for example, commercial fuels (mainly soft coke and electricity) account for 60-70 percent of consumption (by quantity), a much higher proportion than in rural areas.

Several studies of urban household energy use (see Cecelski, et al. 1979) indicate levels of consumption below or at least not much higher than those in rural areas. There may be some measurement discrepancies here, for at first sight this finding is counterintuitive. It is generally recognized that incomes are higher in urban than in rural areas, which would be expected to lead to demand for greater energy services. The more efficient fuel supplies available in cities, however, permit these energy services to be satisfied with less gross energy input.

Energy Efficiencies

The prospect of an increase in energy consumption as economic development proceeds focuses attention on the

efficiency of fuel use. As we have seen from looking at the domestic sector, energy efficiency increases as consumers move from traditional to commercial fuels. Though the effect has been to increase the overall efficiency of the fuel supply system, the substitution of traditional by commercial (frequently petroleum-based) fuels led to increased import bills. For the future there is every interest in exploring means of increasing efficiencies of all fuels, not only to minimize imports, but also, in the case of traditional fuels, to diminish the environmental costs of overuse. These costs, though domestically incurred, also have an indirect effect on the balance of payments. Thus the diversion of dung or drop wastes from agriculture may require the import of chemical fertilizers or even food grains; and the destruction of ground cover through deforestation may also lead indirectly to the import of extra food supplies.

It is well known that traditional methods of cooking are carried out at efficiencies estimated at 10 percent or less. Given the high costs of using energy, this fact merits careful investigation as it implies that strong forces are at work inhibiting change, and that more information is needed if efficiencies are to be improved.

PROBLEMS AND GAPS

Although a good deal more is known today about household energy consumption in developing countries than was known only a few years ago, a number of problems and gaps in knowledge are still evident. The most important of these include measurement difficulties, both of physical quantities and of real economic costs; a model of energy consumption responses to changes in income and price; the relationship of household energy use to other sectors that produce and consume energy; and the interaction of government policies with energy use.

Measurement Problems

The difficulties associated with any survey in developing countries are well known. In the energy field, a number of specific physical measurement problems should be resolved.

The problems involved in measuring physical or heat content values of traditional fuels--wood, dung, and crop

residues--are familiar. Wood heat contents vary according to species and proportion of twigs and bark, and cartloads or headloads must be converted to weights. Dung produced varies by size and type of animal and nutrition, and crop residues depend upon yields and kind of crops. Production of both is not equal to consumption, since only a part of the residues are collected. Different amounts may be collected in different seasons as well. Even if the correct quantities could be established, different efficiencies of end use mean that it may still be hard to establish amounts of energy actually consumed.

Given all these difficulties, some conversions are scientific standards and should never differ. In other cases, it should be possible for analysts to agree on a range of definitions and values (especially for heat content), perhaps on the basis of scientific testing that has not yet been done. Of particular concern are the varying heat content values used for wood.

Effects of Income and Price Changes

Household data on the effects of income and price changes on energy consumption and interfuel substitution, although lacking in developing countries, are critical to making demand projections and management. In particular, pricing could be a key element of government policy. The situation is not really much better in the industrial countries, even with a long history of gathering such data.

A crude model of the relationship between income and energy consumption and interfuel substitution does exist. We know that energy consumption rises with income, though less rapidly, and that at the same time traditional fuels are gradually replaced by commercial ones. However, two problems exist. First, the quantification of these effects (see, for example, Fernandez 1980) has been based on inadequate data; more case studies would be necessary to confirm these results. Second, the information available from past surveys may not be as applicable as energy prices rise. Based on past trends, we would probably guess that the use of traditional fuels would rise about in line with population growth, and that most of the rise in commercial energy use would be due to the growth of the modern sector, including urban households. But rising incomes and traditional fuel shortages in rural areas, and rising commercial energy prices, may be changing this picture. As prices for petroleum products rise, urban

households (and industries) may shift or are already shifting back to traditional fuels--now commercialized but which still may be less costly than alternatives--or simply may not move as fast to conventional "modern" fuels. So we can not really be sure of the relative rates of growth of commercial and traditional energy consumption within total household use in the future.

Relationship to Other Sectors

Energy use in developing countries is far more complex than once believed, and it is tied tightly to social and cultural uses (this is probably less true in cities than in rural areas). These relationships pose both measurement difficulties in separating household from other energy uses, and conceptual problems.

First, energy production in a village ecosystem is highly dependent on agriculture. The village energy system tends to be a tight subsistence economy in which little material output is wasted and most energy is produced and used locally. A change in the number of livestock or the ratio of grain to straw (as in the introduction of high-yielding varieties) could upset the balanced subsistence village energy economy, which uses dung and straw. Labor availability for peak agricultural seasons will be affected by time needed to collect fuelwood. Draft animals provide pulling energy and dung, and consume straw. Dung use as fuel rather than fertilizer affects soil fertility, and housing and cattle fodder compete for crop residues used as fuel. Conventional surveying does not take into account the complexity of these relationships.

Second, the value of nonenergy and nonmaterial services produced along with energy can not enter columns of Btus consumed. Energy use may provide social, cultural, and religious services along with heat for cooking or light, and factors such as convenience, cleanliness, and reliability of supply or use are also important.

Third, household energy use may compete with or complement other sectors' use outside of agriculture. The possibility of competition among rural and urban households and urban industries for commercialized traditional fuels, especially as oil prices rise, has already been mentioned. A potential complementarity is the use of agricultural crop or sawmill processing wastes, such as the distribution of sawmill offcuts for use as fuel by

urban households, as has been suggested in Lae, Papua New Guinea (Ministry of Minerals and Energy 1979).

Interaction of Government Policy and Energy Use

In many cases government policies can influence or even determine amounts, types, and efficiencies of household (and other) energy consumption. This works in two directions: the effects of present government policies, purposeful or inadvertent, must be taken into account in estimating effects on current energy use; and the possibilities for government policies to influence future energy consumption should also be considered. Knowledge of this interaction between government policies and energy use is critical, as effects could well be the opposite of those intended if these implications are ignored.

Perhaps most importantly, government policy can affect the price of energy or of energy-using appliances through explicit energy pricing, household credit, and taxation policies (for example, of imported appliances or automobiles). Subsidization of kerosene, electricity, and industrial fuel oil use, often accompanied by heavy taxation of gasoline, is widespread.

Secondarily, however, government policy may affect the availability of certain supplies. In many countries, for example, the growth in electricity consumption can be accurately predicted simply by government plans to extend the central grid--certainly where there is no grid planned, the future consumption of electricity by households can not be based on consumption at similar income levels in fully electrified areas. Long-run government planning and policies on housing, electrification, and urban planning will heavily influence energy use as well.

CONCLUSION

Since nearly everything is related to energy, an ideal data base for analyzing energy use by households would be truly comprehensive. This is neither practical nor desirable, however, and a more realistic approach would be (1) to collect general information on energy quantities, qualities, and efficiencies to provide a basis for projecting future energy demands and planning conservation and supply needs; and (2) to aim more detailed information-gathering activities at specific projects or programs.

For general planning purposes, basic information on end uses, quantities, and kinds of energy consumed, and the efficiencies of energy use by households would at a minimum be gathered, together with, on the supply side, the impact of use on the resource base, particularly for the traditional fuels. This information, modified by planned government policies, together with data on rates of urban migration, population, and income growth, could be quite usefully utilized to project future energy consumption.

Regarding more detailed information-gathering activities aimed at specific projects or programs, a national program to introduce improved and more efficient cookstoves in rural and urban areas, for example, would require more focused information to be successful. Information on cooking habits, the role of women, capital availability, attitudes toward risk, and--if the program were to be subsidized--an evaluation of offsetting social and environmental benefits that would be gained, would have to be gathered. For a village forestry program, knowledge of community organization, land tenure, and class structure could be critical.

Thus energy data, like energy quality, will be used most efficiently if closely matched to the desired end use. For the basic planning data referred to above, a national survey attached to or along the lines of national census surveys may be an appropriate first step. More focused purposes, on the other hand, may require more specific data-gathering efforts, including case studies.

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APPENDIX B

List of Workshop Participants

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