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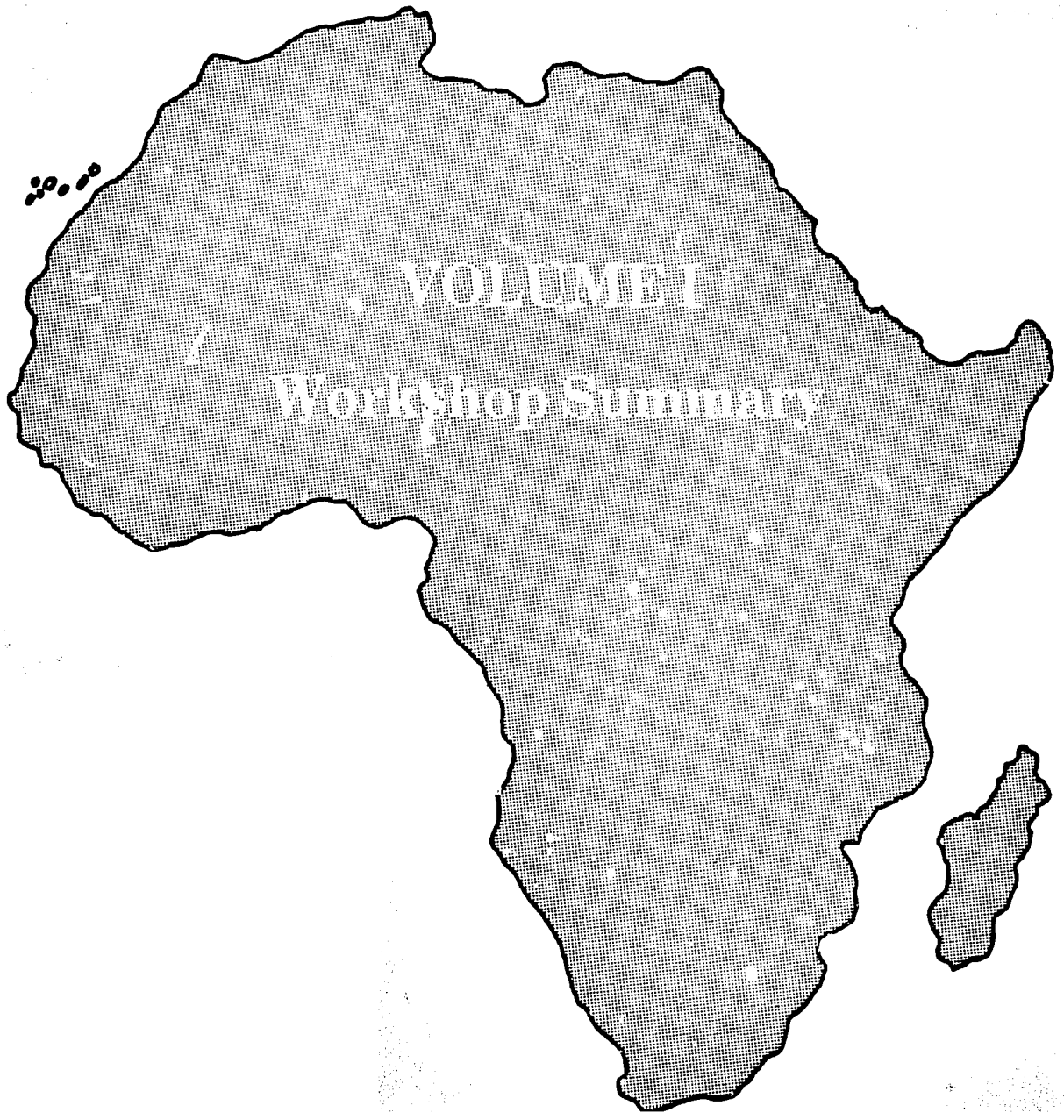
Proceedings of Workshop on Energy, Forestry and Environment



Bureau for Africa
Agency for International Development

April 1982

Proceedings of
Workshop on Energy, Forestry and Environment

Volume: I. Workshop Summary

Volume I includes the Workshop Report as prepared by the participants, a strategy for action and recommendations to the Assistant Administrator of the Bureau for Africa for implementing the strategy. In addition, there is information on the history of the Bureau for Africa's energy, forestry and environment programs.

Volume II: Discussion Papers/Case Studies

Volume II includes the 41 discussion papers and case studies which were prepared for the workshop.

Volume III: Country Energy Papers

Volume III includes the energy profiles of 21 African countries. The papers were prepared by energy, forestry and environmental officers of AID field offices.

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PROCEEDINGS OF

WORKSHOP ON ENERGY, FORESTRY AND ENVIRONMENT

VOLUME I: WORKSHOP SUMMARY

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FOREWORD

On July 14, 1981, the Assistant Administrator, Bureau for Africa, approved a memorandum authorized the funding for a workshop in Africa on energy, forestry and environment in Africa. This action initiated a process of organization and planning that culminated in Nairobi in December with the attendance of some 80 participants. About half were energy, forestry and environmental officers drawn from 20 AID field missions. The other half consisted of AID/W officers and subject matter specialists, expatriate and African, from both the public and private sectors.

The goals of the Workshop may be summarized as follows:

- to learn from field staff what issues seemed primary and how they should be addressed;
- to improve current information on designing and implementing projects in energy, forestry and environment;
- to present the Assistant Administrator with recommendations on how the Agency might proceed in the area of energy, forestry and environment.

Planning a Workshop to achieve these goals was not easy. One issue faced from the start was how to treat meaningfully, and not superficially, the Workshop's three complex and interrelated topics over a period of less than five days. A second was how to strike the right balance between formal presentations, panel sessions and small group discussions. A third was to achieve a proper mix between the wisdom or views imparted by the visiting experts and the sharing of practical experience and ideas among the participants from the field. These and other issues were the subject of lively debates as the planning process proceeded -- debates to which the views of the REDSOs and the field missions made substantial and valuable contributions.

How these issues were resolved may be seen from the agenda that appears in this volume of the proceedings. Initial sessions were devoted to setting the stage and outlining the context of the leading energy, forestry and environmental issues in Africa. This introduction was followed by presentations and panel sessions on approaches, techniques and methodologies for analyzing and addressing those issues. Then, in the latter days of the Workshop, sessions emphasized field experience and lessons learned from the success or failure of specific interventions. Meanwhile, four discussion groups, comprised of field participants, had been formed on a roughly sub-regional basis: Southern Africa, East Africa, the Sahel, and West/Central Africa. During evening sessions, these discussion groups reviewed the country energy papers which had been prepared by the missions in advance (see Volume III) and prepared reports on how AID should address Africa's energy, forestry and environmental problems. The four discussion group reports, synthesized into a Workshop Report to the Assistant Administrator, then became the main topic for the Workshop's final plenary session. It appears in this volume of the proceedings and incorporates the major suggestions made at that session.

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Was this expenditure of funds, time and effort worthwhile? If one looks over the reaction of the field participants, as indicated in the evaluation forms that they turned in, the consensus is distinctly positive (see evaluation statement on page xx of this volume). There was particular enthusiasm for the sessions devoted to exchanging field experience and the discussion group meetings.

From an AFR/DR perspective, the Workshop was both an enlightening and sobering experience. It was enlightening because of the broad range of insights and expertise that the Workshop generated, making possible a greater sense of comprehension of the topics and issues under discussion. It was sobering because it made even clearer than ever how critical and deep rooted Africa's energy, forestry and environmental issues are, and how far Africans and donor agencies must go to make an appreciable impact upon them.

Over the longer run, the value of the Workshop may be judged by the extent to which its wisdom and recommendations filters into the consciousness and actions of the Bureau's field missions and Washington decision makers. If it is successful in starting a process which causes the Bureau to give greater attention to Africa's energy, environmental and forestry concerns, it will have been indeed a worthwhile exercise.

ACKNOWLEDGEMENTS

The organizers of the Workshop on Energy, Forestry and Environment wish to thank the participants whose hard work and high quality of ideas made the workshop successful.

Mr. John D. Blumgart, Chief, Special Development Problems, AFR/DR and his staff -- Sally Patton, Mark Ward, Kevin Mullally, James Hester and Ruth Wilson -- also wish to thank the host Mission, USAID/Nairobi, under the direction of Allison Herrick. We particularly would like to single out the support given by John Greenough, Administrative Officer, and his staff member, Catherine Varley, who by copying numerous late arriving documents, allowed the Workshop to get off to a smooth start.

In addition, many substantive technical contributions to the format and agenda were provided by REDSO/EA. Director Ray Love generously lent the services of Weston Fisher, Energy Advisor; John J. Gaudet, Science Technology and Environment Advisor; and James Seyler, Forestry Advisor. We are also grateful to Daniel Creedon, PM/TD, and his staff, particularly Dr. Gene Ellis, for their contribution in helping us with the agenda. And last but not least, we wish to thank John C. Engle of Development Assistance Corporation, his Washington staff, Denise F. Thomas and Arnet W. Jones, his Nairobi staff, Bettina Paolozzi and Sandy Armstrong, for their management and support throughout.

AGENDA

WORKSHOP ON ENERGY, FORESTRY AND ENVIRONMENT

Hotel InterContinental - Nairobi

OPENING SESSION, SUNDAY, DECEMBER 6, 1981

5:30 Registration
Social Hour

7:00 Introduction of the Head Table by
Conference Convenor - John D. Blumgart

Address
Ambassador William C. Harrop
U.S. Ambassador to Kenya

7:30 Dinner

8:30 Workshop Format and Expectations
John D. Blumgart, Chief
Special Development Problems, AFR/DR

Assistant Administrator's Remarks
F.S. Ruddy, Assistant Administrator,
Bureau for Africa

DAY 1, MONDAY, DECEMBER 7, 1981

PROGRAM CHAIRMAN - Stephen Klein

MORNING PLENARY - OVERVIEW AND ISSUES

8:30 - 9:15 World Energy and the Developing Countries

James W. Howe, President, IRES

Discussion

9:15 - 10:00 Energy Issues in Africa

William Mbote, Managing Director
Kenya Pipeline Company

Discussion

10:00 - 10:30 Break

10:30 - 11:30 The Forestry/Fuelwood Problem in Africa and its Environmental Consequences

Marc Rene de Montalembert
Forestry Department
FAO

E.M. Mnzava
Director of Forestry
Ministry of Natural Resources and Tourism
Government of Tanzania

Discussion

11:30 - 12:15 Energy Trade-Offs in Africa: Laying out the Issues

Gene Ellis
University of Denver

12:15 - 12:45 Discussion

AFTERNOON PLENARY - ISSUES AND RESPONSES

2:00 - 3:45 Panel: Addressing the Energy and Environmental Problem 'n Africa: Role of the Private Sector, World Bank and ilateral Donors.

Introduction	John D. Blumgart
Private Sector	Colin Carter
IBRD & Other Donors	John D. Blumgart
AID	Blumgart/Klein/Jacobs/Feldman
Peace Corps	Paul Jankura
ECOWAS	Clarence Kooi/Mark Ward

3:45 - 4:00 Coffee Break

4:00 - 5:00 The Role of National Energy Assessment and Conventional Energy Planning

Asif Shaikh
Energy/Development International

Colin Carter, V.P.
Energy Economics
Chase Manhattan Bank

5:00 - 5:30 Discussion

DAY 2, TUESDAY, DECEMBER 8, 1981

PROGRAM CHAIRMAN - Gene Ellis

MORNING PLENARY

8:30 - 10:00 Panel: Assessing Energy Environment and Forestry Sectors

Richard Ford	ETMA
Weston Fisher	Energy Advisor, REDSO/EA
John J. Gaudet	Science, Technology and Environment Advisor, REDSO/EA
James Seyler	Forestry Advisor, REDSO/EA
Vernita Fort	Natural Resources Advisor, REDSO/WA
James Hester	Environmental Officer, AFR/DR

10:00 - 10:30 Discussion

10:30 - 11:00 Break

11:00 - 11:45 Private Sector Investment Analysis: What the private sector needs to know before investing in African resource development; Africa's relationship with multinationals

William Mbote
Kenya Pipeline Company

Carol Sakoian
Conoco, Inc.

11:45 - 12:30 Discussion

AFTERNOON PLENARY

2:00 - 4:15 Panel: Analytical Tools for Project Design

Introduction	Gene Ellis
Cost/Benefit Analysis	Asif M. Shaikh
Technical Soundness	Clarence Kooi
Social Soundness	Carolyn Barnes
Environmental Implications	Vernita Fort
Monitoring and Evaluations	George Burrill

4:15 - 4:45 Discussion

4:45 - 5:30 The Role of Remote Sensing in Resource Management

Merrill Conitz
Allan Falkoner
Regional Remote Sensing Facility

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5:30 - 5:45 Instructions to Discussion Groups

John Blumgart
Gene Ellis

EVENING SESSION

7:00 - 9:00 Country Papers Exercise (discussion groups)
Leaders: Phil O'Keefe/Asif Shaikh
George Burrill/Mark Ward

9:00 - 9:30 Discussion groups compose their summaries and conclusions

DAY 3, WEDNESDAY, DECEMBER 9, 1981

Discussion Group Sessions (Participants will break into two groups)

PROGRAM A. National Energy Assessments, Energy Management Policy and Planning
Discussion Leader: Asif Shaikh

8:30 - 9:30 Experience in Kenya and Sudan

Kenya Phil O'Keefe
Sudan Mike Bess

9:30 - 10:15 Discussion

10:15 - 10:30 Break

10:30 - 11:30 Rural and Urban Energy Surveys

Peace Corps Experience	Paul Jankura
Malawi	Richard Scobey
Kenya	Phil O'Keefe

11:30 - 12:00 Identification of Problems and Potential Solutions

1:30 - 5:00 Program repeats with next group

PROGRAM B. Energy Technologies
Discussion Leader: Clarence Kooi

8:30 - 9:00 Overview of Energy Technology Project Possibilities

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9:00 - 11:30 Discussions of Various Energy Technogies

Oil and Coal Development Technologies	Carol Sakoian
Geothermal	S.O. Bwire
Energy Conservation	Mike Jones
Mini-Hydro	Allen Inversin
Solar	Clarence Kooi
Wind	Mike Harries
Charcoal/Wood Stoves	Tim Wood
Charcoal Conversion	Keith Openshaw
Biomass	Keith Openshaw

11:30 - 12:00 Identification of Problems and Solutions

1:30 - 5:00 Program Repeats with next Group

NOTE: The following manufacturers will exhibit in room for program:

Jiko Stoves
Animatics, Ltd.
East African Hydraulics
Solar Electric International
Kijito Windmills
Kahawa Coal

EVENING SESSION

DAY 3, WEDNESDAY, DECEMBER 9, 1981

7:30 - 9:00 Discussion of "Energy Initiatives for Africa"

Project Paper - Mary Ann Riegelman, AFR/RA

DAY 4, THURSDAY, DECEMBER 10, 1981

PROGRAM C. Renewable Energy Center Project Management
Discussion Leader: Mark Ward

8:30 - 11:30 Highlights of AID experience.

Lesotho	Jay Stryker
Kenya	Joseph Pastic
Mali	Jon Anderson
Senegal	Carol Ulinski
Burundi	Abbe Fessenden

11:30 - 12:00 Identification of Problems and Potential Solutions

1:30 - 5:00 Program Repeats with next Group

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PROGRAM D. Forestry and Natural Resource Protection
Discussion Leader: Richard Ford, ETMA

8:30 - 9:00 Environmental Issues

Richard Ford, ETMA

9:00 - 9:45 Reforestation Case Study: Gujarat Project

R. Java

9:45 - 10:30 Highlights of AID's experience in Reforestation and Natural Resource Management

Sahel	Bob Winterbottom, AID/Ouagadougou
	Kevin Mullaly, AFR/DR
Range Management	Vernita Fort, REDSO/WA
Senegal	David Gibson, AID/Dakar
Mali	Jon Anderson, AID/Bamako
Niger	John Heermans, AID/Niamey

10:30 - 10:45 Coffee Break

10:45 - 11:00 The CDA Forestry/Fuelwood Initiative

Kevin Mullaly, AFR/DR

11:00 - 11:30 Agroforestry and ICRAF

Bjorn Lundgren, ICRAF

11:30 - 12:00 Identification of Problems and Solutions

1:30 - 5:00 Program repeats with next group

EVENING SESSION

DAY 4, THURSDAY, DECEMBER 10, 1981

7:30 - 9:00 Working session for discussion group participants and group leaders only. Purpose is to prepare issues for presentation to be made on Friday morning.

DAY 5, FRIDAY, DECEMBER 11, 1981

MORNING WORKSHOP WRAP-UP

Program Chairpersons: Herrick and Love

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Workshop on Energy, Forestry and Environment

8:00 - 10:00	Presentation of project program and policy issues and recommendations by the spokespersons of the four working groups.
10:00 - 10:15	Break
10:15 - 12:00	Discussion of Draft Report
12:00 - 12:15	Closing Remarks of the Convenor - John D. Blumgart

(During afternoon, drafting committee prepared revised Workshop Report to AA/AFR, based on morning's discussion)

2:00 - 5:00	Field Trips to Regional Remote Sensing Facility Clayworks/Kijito Windmills ICRAF Agroforestry Athi River Wildlife Ranch

WORKSHOP ON ENERGY, FORESTRY AND ENVIRONMENT
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NAIROBI, DECEMBER 6-11, 1981

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OPENING REMARKS

John D. Blumgart, Chief
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It is with great pleasure and anticipation that I welcome all of you to the Bureau for Africa's Workshop on Energy, Forestry and Environment. Its authorization and funding was among the early decisions of our new Assistant Administrator, Mr. Ruddy. In fact, this gathering represents the first time that our Bureau has convened a workshop on these topics. That we are about to do so demonstrates, I believe, a growing recognition by the Bureau that energy, forestry and environmental problems are critical factors in the development of Africa and that they must receive increased attention by both our field missions and by Washington.

Before proceeding further, I want to point out that this meeting would not have been possible without the collaboration and hard work of many of you both in Washington and the field. I particularly want to thank USAID/Nairobi for the logistical support it has generously provided through Mr. Greenough and his staff from the very beginning of our preparations. In addition, major substantive contributions to the topics and to the structure of our program were provided by both REDSOs, especially by their Energy and Environmental Officers. Thirdly, we have received indispensable help of both a substantive and administrative nature from two consultants, John Engle of the Development Assistance Corporation and Gene Ellis of the University of Denver. Gene's services have been generously provided by AID's Office of Training. Finally, I would like to take the opportunity to thank the staff of my office who have devoted most of their time and energies over the past 3 months to what seemed like an unending series of tasks and challenges.

Although we will all be introducing ourselves to each other at our opening session tomorrow morning, I do want to take this opportunity to welcome AID's Energy Policy Advisor, Steve Klein of the Policy and Planning Staff, who has been a source of strength and support to the Bureau on countless occasions, including when we needed more money. I want to equally welcome the Directors of the two Offices of the Bureau for Science and Technology with which our own Bureau directly interfaces when it is addressing questions of energy, forestry and the environment. Their presence here, despite almost paralyzing travel fund restrictions, is evidence of the priority which the heads of their Bureau -- Niles Brady and Leonard Yaeger -- attach to these subjects and to collaborating with us about them. I would also like to welcome Mary Ann Riegelman from our Regional Affairs Office who will be leading a discussion of the proposed Energy Initiatives for Africa project on Wednesday evening.

As I just mentioned, the Workshop program that we have developed is very much a joint product -- the product of a lively dialogue that took place

between Washington and the field. The result is an ambitious and very rich menu of plenary and discussion group sessions.

We begin tomorrow morning with a series of overview analyses to provide a framework of the dimensions of the problem and what various agencies, including AID, are doing about it. On Tuesday we move into a more specific examination of a number of key topics and issues which must be dealt with if we are serious about trying to address energy, forestry and environmental problems in Africa. Thanks to REDSO/EA's initiative, it has taken the lead in organizing the first of these Tuesday sessions -- the one titled "Assessing Energy, Environment and Forestry Sectors."

On Tuesday evening, from seven to nine, we first form our four Discussion Groups. These have been roughly organized by region and ecologic similarity, although some exceptions had to be made to keep the groups roughly the same size. The Discussion Groups will meet with their group leaders in the rooms that have been designated. Phil O'Keefe of the Beijer Institute is the leader of the East Africa group, Asif Shaikh of Energy/Development International will head the Sahel group, George Burrill of Associates in Rural Development will lead the Southern Africa group and Mark Ward, the Bureau's Energy Advisor, will head the West/Central Africa group.

The Tuesday evening session will be devoted to a discussion of the country energy statements that we have asked you to prepare and bring to the workshop. We will be duplicating these papers for distribution tomorrow. It is important that you read the papers of your fellow group members before the Tuesday evening session so that you will be prepared to comment on them.

On Wednesday and Thursday we will continue in the discussion group mode with each group going through a half-day program of more specialized topics. Program A is concerned with energy planning and energy surveys. Program B takes up the practicalities of managing and implementing energy projects, and what we learned from our experience. Program C examines an array of various energy technologies and their capability to deal with specific energy problems. Program D addresses the whole range of issues concerned with forestry and natural resource management and our experience to date with projects in that sector.

I would like to emphasize that the purpose of the Discussion Group meetings is not only to provide information to our field missions on these topics -- although that is a very important objective in itself. The even more important objective is to obtain the reaction, experience, opinions and wisdom of our bilateral field missions on these issues. Therefore, participation by our bilateral mission personnel is the key to the success of the Discussion Groups.

Those persons not assigned to Discussion Groups should feel free to sit in on the Discussion Group programs and discussions. However, I would ask such persons to limit their participation and refrain from dominating the discussions with their technical expertise. Clearly our technical experts and visitors should provide advice on technical points when this information is needed by the Discussion Groups. But I would

caution them to think of themselves as servants rather than as guides of the Discussion Groups. Otherwise, I am very afraid the discussions will become overly influenced by outside experts and distinguished visitors, and we will lose the field orientation and expression of views that we want to obtain from the Discussion Groups.

The evening session on Thursday is being held so that Discussion Groups may continue to work on their reports for the Friday plenary session. We may again wish to use that time to ask the energy experts to be available to our mission people for individual consultations.

Friday morning is the day when all that has preceeded is summarized in a workshop report. We will be looking to the Discussion Groups -- through their spokepersons -- to present their views as to the leading project, program and policy issues the Bureau faces in the fields of energy, forestry and the environment, and their recommendations as to what the Bureau should do about them. We will be getting, I believe, further guidance on these points very shortly from Mr. Ruddy. It is our expectation that during the Friday presentations and discussions we will be able to reach a consensus that will provide the basis of a report by the Workshop to Mr. Ruddy -- a report that will articulate your views on the issues and your recommendations as to how we should proceed.

Once again, let me welcome all of you to this workshop and to thank those of you who have done so much to make it possible and who will be working with me over the next few days to help us to realize the Workshop's potential.

I would now like to turn the chair over to Mr. Ruddy.

OPENING REMARKS

Francis S. Ruddy
Assistant Administrator
Bureau for Africa
Agency for International Development

Mr. Ambassador, Mr. Muturi, Mr. Mbote, Directors Herrick and Love, distinguished visitors and all my AID colleagues from our African Missions and from Washington. John Blumgart, Convenor of this Workshop, has told you that authorizing this Workshop was one of my early decisions as Assistant Administrator of the Bureau for Africa. I made that decision for several reasons.

I come to this job from an energy background and for the past few years I have followed closely our own country's struggle to accommodate the legitimate and farsighted demands of conservationists under the National Environmental Protection Act and the nation's need for energy to get us to the year 2000 and I have been part of the litigation and strategy of that debate.

As I travel through Africa, I see at firsthand Africa's energy forestry and environmental problems -- I see that cars cannot be driven on Sunday in Tanzania because there is not enough petrol, even at $5.00 a gallon. I have seen desertification in Senegal and I have seen an ever widening circle of trees cut down for firewood around Ouagadougou.

Peter McPherson has urged that AID should increase the total level of funding devoted to energy-related activities in the years to come. President Reagan, in his recent Philadelphia speech, has singled out energy activities as an area for practical proposals for cooperation between the United States and developing countries.

For these reasons, I wanted to be here to participate with you during the first few days of this Workshop and to learn more about the nature and significance of these problems from you the real experts, to hear what you have been doing to solve them and, above all, to think about how we can do better and how we can do more.

As I am new to AID, I learned quite a bit from the background paper that John has prepared for this meeting. It describes the origins and evolution of the Bureau for Africa's energy, forestry and environmental activities and summarizes their status. I am sorry to have to say that while our renewable energy and fuelwood programs more than tripled between FY'78 and FY'81 (from $5 million to $16 million), they show a decline in this fiscal year and an even further decline in FY '83.

Why is this? Certainly it is not because we have solved Africa's energy problem and can turn to other matters. And how does this trend in '82 and '83 square with the Administrator's guidance to "increase significantly" our energy-related activities? I really will look to

this Workshop for answers to how we can do more in energy with less money.

One thing that I have learned since joining AID is that AID -- in contrast to most other donor agencies -- is decentralized. In AID the center of gravity for decision making at the operational level lies heavily with the field missions in conjunction with their host country governments -- and that's the way it should be. We in Washington, can set the tone and the general direction of our programs. But the translation of such guidance into specific activities and projects depends on the initiative of the Missions and their host country counterparts.

That's the real significance of this kind of Workshop. If it works, it will really affect the Bureau's thinking about energy reforestation and environment and directly influence my decisions on the Bureau's programs in energy, forestry and the environment over the next several years.

We have assembled here in Nairobi some of the world's leading experts on energy, reforestation and the environment in Africa. We have also started a process of self-instruction, of learning the lessons about our successes and failures through the case studies that you have prepared. All of us should come away from this meeting with a better base of knowledge and understanding for dealing with the topics on our agenda.

Secondly, this Workshop is a means of coming to grips with a broad range of issues that confront the Bureau, and of generating programs to deal with them. We scheduled this meeting in December to allow time for Missions to consider what has been learned and to incorporate these ideas into the 1984 ABS program submissions due next May. In this connection, I invite your attention to the list of Workshop issues which the conference organizers have prepared in order to get the dialogue going. That list was prepared in AID/W and our people in the field will undoubtedly have others to add. Let's get them on the table and see if we can reach a consensus on how to address them.

In our discussions, I hope you will give attention to the question of private sector participation in our energy, forestry and environmental programs. And by "private sector" I do not mean only U.S. private investment or the involvement of African commercial and industrial sectors. In some cases it may be American private investment, but in others it may be the skills, energies and resources of the vast rural, village and urban populations of Africa who represent a great source of entrepreneurship. The initiative of these resources can play a role in addressing Africa's energy, forestry and environmental problems. Clearly, to do so means developing technologies, policies and approaches that are affordable, profitable and practical.

We expect a lively and spirited discussion of these issues and I will be very anxious to see the consensus report on Friday, the last day of our Workshop. Unfortunately, on that day I shall be in Somalia. Nevertheless, I want to emphasize the importance I attach to your report that will summarize your views and recommendations on the issues and on the Bureau's future work in energy, forestry and the environment. I

look upon this Workshop as the beginning of a process that will provide new impetus and dynamism to our work in these fields. I am looking to John Blumgart to bring back your views, and I assure you I will use them as a basis for action.

I wish you well in your labors and I look forward to receiving your report. Thank you.

AFR ENERGY, FORESTRY AND ENVIRONMENT PROGRAMS

OVERVIEW AND ISSUES

This paper was prepared for the Workshop on Energy, Forestry and Environment to outline the historical context of the Bureau for Africa's programs in these areas. It summarizes their current status, notes complementarities and differences with AID centrally-funded programs, and identifies issues which merit discussion and recommendation.

Program Origin

The origins of the Bureau's programs in energy and environment go back to an informal "planning group" that was set up in AFR/DS (the forerunner of AFR/DR) which attempted to look at some of the longer run issues of development in Africa. The group identified the interrelated problems of rural energy needs and environmental degradation as among the most serious facing African countries over the next two decades.

As a result the Bureau initiated two activities. The first involved a grant to Clark University to fund a series of pilot programs in several East and Southern African countries aimed at strengthening local capacity to deal with environmental problems. The second involved a grant to the Overseas Development Council (ODC) to prepare a concept paper on how the Bureau might begin to address Africa's rural energy needs. These initiatives took place against a background of growing concern in AID and in the Congress on environmental issues as a result of the 1969-1974 drought in Africa and the realization that more attention and resources should be devoted to the energy dimension of AID's "New Directions".

Renewable Energy

The ODC study, "Energy for the Villages of Africa", published in early 1977, noted that 85% of the 250 million people of sub-Sahara Africa "live out their lives (in rural areas) without more than occasionally being touched by modern energy". It noted that the "chief sources of energy for most of these people are human muscle power, wood, and the rays of the sun". It asked whether the tasks of these people might be lightened and their productivity increased by "technologies that are now on the shelf or emerging from the laboratory".

The report suggested an approach by which Africa policy makers and donors could try to determine "whether village-source energy systems warrant use on a wide scale" and, if so, how best to select appropriate technologies and what kind of support systems they would require. To answer these questions the report recommended a series of activities involving (a) the identification of tasks villagers wish to have performed by non-human energy, (b) evaluate the energy resources available (sun, wind, stream flows, wood, crop residues) for performing tasks, (c) install and operate appropriate devices and measure the technical performance of the technologies introduced, (d) evaluate

performance, local acceptance, cost, economic feasibility and maintenance and repair requirement of such hardware and (e) examination of how best to extend successful systems, including particularly the utilization of the private sector.

The report further recommended the training of African energy experts and the strengthening of African energy-related institutions. It also urged a stepped-up program of small-scale decentralized renewable energy research, both in the U.S. and, with AID support, in Africa.

Early Starts

The ODC report, which was circulated in both English and French versions, provided the initial impetus and direction to AFR's renewable energy program. In FY '78, projects were launched or designed in Mali, Senegal and Niger (initial emphasis was placed on the Sahel) which sought to apply the report's directions and methodology. For example, the project in Mali involves building up the institutional and technical capcbility of the Mali Solar Energy Laboratory while simultaneously carrying out village energy surveys in four ecological zones of the country to determine village energy priorities and resources. The survey results are meant to help guide the R.& D. work of the laboratory toward technologies relevant to the needs of its rural "clientele" and their financial and technical capabilities.

Forestry and Fuelwood

Along with the Bureau's increased emphasis on renewable energy, there was a growing concern with Africa's fuelwood/deforestation problem. Concurrently with a State/AID conference on the global dimensions of the problem, the Bureau sponsored in June, 1978 an Africa firewood workshop which sketched out the dramatic magnitude of the problem and urged a growing AFR emphasis in this area. It suggested in a message to the AFR missions the initiation of local fuelwood surveys as a means of designing government sponsored and village-initiated fuelwood projects.

The Bureau's concerns on Africa's fuelwood problem were replicated by the October 1978 report of the CILSS/Club du Sahel, "Energy in the Development Strategy of the Sahel". It pointed to the dominant position of fuelwood as a source of energy (80%-90% of total demand) and warned that the region would be largely desertified by the year 2000 if current trends persisted. The Sahel energy report, the work of the Forestry/Ecology team of the CILSS, as well as growing concern by Sahelian governments led to the initiation of a number of forestry and fuelwood projects in the Gambia, Mali, Senegal and Upper Volta.

A subsequent major potential impetus for expanding the Bureau's and other donor efforts in fuelwood and reforestation in Africa has been the designation of AID as the lead donor in this field among the informal grouping of "Cooperation for Development in Africa" (CDA) countries -- France, Belgium, the U.K., West Germany, Canada and the U.S. On the basis of agreed criteria, five African countries have been initially selected as candidates for expanded programs -- Somalia, Malawi, Senegal, Upper Volta and Burundi. Agreement has also been reached on a

process for comprehensively evaluating country requirements and resources and for coordinating donor actions at the country level. Much of the informational base for the CDA fuelwood/forestry initiative as well as its methodology can in part be traced to the results of the "Fuelwood and Renewable Energy Workshop" that the Bureau had convened in Paris in November, 1979 involving African and donor experts from over 20 countries and donor organizations.

Program Emphasis

Accordingly, as indicated in a program guidance message to the field in August, 1979 (AIDTO A-204), the Bureau has elected to "stress ways of meeting (African) energy needs in the areas of:

- cooking and heating by the rural and urban poor;
- water supply, grain grinding, irrigation, handicraft and other basic life functions."

The message supplemented the earlier ODC study by incorporating fuelwood production and conservation as a major AFR energy concern. It also laid great emphasis on a multi-disciplinary approach for assessing the economic feasibility and social acceptability of energy interventions and of rigorously evaluating results. It called for a continuing program of studies and analysis so that the Bureau could keep pace and deal more effectively with the evolving nature of Africa's energy problems. And it urged an expanded energy effort through (a) adding energy components to existing projects, (b) undertaking new projects, and (c) preparing national energy assessments.

The message explicitly downplayed attempting to deal with Africa's conventional energy problems caused by escalating oil prices. While it recognized the seriousness of the problem and its impact on the economies of the region, the Bureau emphasized fuelwood and renewable interventions because (a) they built on the Bureau's existing strengths and capacities in rural development, training and extension work, (b) they complemented and reinforced the Bureau's agricultural development efforts by addressing the environmental dimensions of declining agricultural productivity (e.g. erosion, river basin siltation, declining soil fertility) and (c) nearly all other major donors as well as private investment resources were becoming involved in providing assistance in the conventional energy area. Hence the Bureau's energy bias is based on a perception as to how it can most meaningfully and effectively apply its limited resources.

The approach is consistent with AID's "Energy Assistance Policy Paper" of January 1981 or the Administrator's energy guidance message of May 12, both of which recognize that energy programs, like other programs, should be tailored to regional and country specific circumstances and priorities. While both set forth a broad range of possible energy activities, including conventional, each also gives major attention to fuelwood and renewable energy concerns. The Administrator's emphasis on careful economic analysis of projects and replication through the private sector is particularly supportive of Bureau policy. Most

important, both messages urge a "significant" expansion in the Agency's energy-related activities.

Program Profile

As indicated in the attached table, AFR's energy programs have grown from annual obligations of $4.7 million in FY' 78 to $15.7 million in FY' 81 although they at present show a decline to $13.8 million in FY'82. The Bureau is presently financing or planning 24 renewable energy projects in 15 countries and 15 fuelwood and forestry projects in 12 countries. It is testing and/or demonstrating over 30 different renewable energy technologies in over 20 countries. See Table A for a tabulation of AFR's energy programs.

Illustrative of the Bureau's "second generation" of energy projects are the following examples:

Kenya: Expatriate and Kenyan consultants are undertaking village and urban energy surveys and a national energy assessment to develop a national energy plan aimed at reducing Kenyan dependance on imported fuels while accelerating the production and conservation of fuelwood. The project includes technical assistance to the Ministry of Energy and a fund for encouraging the development of promising, replicable technologies.

Lesotho: Here a renewable energy program has been set up within the Ministry of Rural Development to train village craftsmen in the fabrication of promising renewable energy technologies -- thatch insolation, solar grow holes, pedal-powered grain grinders, solar greenhouses. Trained craftsmen will return to the village to set up demonstration units aimed at widespread replication of appropriate applications. Attention will also be given to community-scale mini-hydro and biogas interventions.

Senegal: The Senegal fuelwood project involves the development of 3,000 hectares of rapid-growing trees in controlled areas of the Bandia Classified Forest to help meet the fuelwood and charcoal needs of the Dakar/Thies area. The project involves establishing a central nursery and the development of easily extendable fuelwood production systems. Research and evaluation will be conducted on nursery planning, clearing techniques, live fencing and agro-silvicultural systems.

AFR/S&T Relationships

In addition to its bilateral energy and fuelwood programs, AFR and its missions have access to the resources and expertise provided by the Office of Energy (S&T/SY) and the Office of Forestry, Environment and Natural Resources (S&T/FNR). AFR has made considerable use of both of these resources.

The Office of Energy

The Office of Energy's global programs for training LDC energy personnel in management and planning, in solar technologies, and in conventional

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energy disciplines are being widely used by AFR missions. The S&T/EY projects that support the VITA and Peace Corps renewable energy expertise and surveys have been invaluable in meeting the needs of the Bureau's projects in Mali, Senegal and Rwanda, for coordinating woodstove development in the Sahel and for providing a variety of appropriate technology services and advice to our missions. The S&T/EY photovoltaic demonstration project, managed by NASA, has initiated or will be launching pilot efforts in Upper Volta, Kenya, Zimbabwe and several other locations. The energy planning project has made possible preliminary national energy assessments in Togo, Liberia and Malawi (the latter in conjunction with the World Bank) and has initiated a collaborative energy planning and training exercise in the Sudan. The conventional energy technical assistance project has or will provide missions access to skills outside of the Bureau's main energy concerns, as discussed above. Senegal, Botswana and Kenya, among others, have requested assistance on such matters as lignite potential, coal surveys, and oil refinery analysis.

Collaboration with S&T/FNR in Fuelwood/Forestry

Collaboration with S&T/FNR in this field has been more limited, simply because FNR's forestry budget is more restricted. Of particular value has been the forest resources project, administered through a PASA with USDA, which has permitted the stationing of a long term regional Forestry Adviser in REDSO/EA, the provision of short-term consulting services, such as that recently made available to the Mission in Somalia, and the planning of closer collaboration between AID and the Peace Corps in forestry activities.

Environment and Natural Resource Management

In addition to programs in energy, fuelwood and forestry, the Bureau has encouraged and engaged in a major expansion of its work in environmental management concerns, broadly defined. Growing attention to problems of environmental degradation in the developing countries were initiated by the Agency in the min-1970's and Regulation 16 was issued to strengthen the environmental criteria by which AID's own projects were to be evaluated. Meanwhile, perceptions of the problem in Africa had been sharpened by the Sahelian drought, by the UNEP conference on desertification and, as noted at the beginning of this paper by the pioneering work being carried out in Tanzania, Kenya, Botswana and the Sudan under the grant to Clark University. This latter activity eventually led to the initiation of a major Environmental Training and Management project, backstopped by a consortium of universities, including Clark, and managed by AFR/RA. The Bureau's own capability to help its missions and their African clientele address environmental issues has been greatly enhanced by the stationing of Environmental Advisers at both of the REDSOs and the formation of an Environmental Unit in AFR/DR. The Bureau has also begun a series of "phase I" profiles conducted earlier (see below), for use in national environmental planning. Such profiles are underway in Zaire and Upper Volta and additional ones are planned for FY'82.

However, most significant of all is the extent to which the Bureau, on the initiative of its missions and their host governments, have become engaged in a broad range of projects addressing regional or country specific problems having major environmental or resource management implications. A recent in-house review of AFR's project portfolio showed that -- not counting reforestation and fuelwood activities -- the Bureau was implementing or well along in planning some 30 projects, all dealing with environmental or natural resource issues. See Table B for a tabulation of the Bureau's natural resource programs.

Illustrative of this portfolio is (a) the two regional remote sensing centers, in Kenya and Upper Volta, which are training Africans and providing technical assistance on measuring and evaluating ecological change, (b) natural resource inventories and land use planning projects are taking place and planned in Mauritania, Senegal, Mali, and parts of Niger, Upper Volta and Botswana, (c) natural resource management and planning projects (e.g. river basin studies, dune stabilization, regional integrated development) projects in Mauritania, Kenya, the Gambia, Niger, Somalia, Cape Verde, Botswana, Rwanda and Senegal. Thus the Bureau has become heavily engaged, through its bilateral programs, with pressing environmental and resource management issues which play such a leading role among Africa's development problems.

Collaboration with S&T/FNR on Environmental Matters

As in energy and forestry, the Bureau's work has been enhanced and assisted through collaboration with S&T/FNR. Of particular benefit have been the "Phase I" environmental profiles (desk studies) carried out with FNR funding by the Library of Congress and the University of Arizona. S&T/FNR has also (a) commissioned environment manuals for the design of irrigation and small scale rural development projects, (b) made available a directory of U.S. environmental study programs for trainees from the LDCs, (c) financed a study on the legal, regulatory and institutional aspects of environmental protection (using Ghana, Malaysia and the Sudan as two case examples), (d) assisted the Regional College of African Wildlife Management in Mweka, Tanzania, and (e) circulated a newsletter for AID environmental field staff. In addition, pilot remote sensing activities made possible by FNR funding are now leading to full scale natural resource assessments in Mauritania and Senegal.

The S&T Bureau is actively continuing this support to the Africa Bureau. AFR staff are working closely with them on ongoing projects which include: (a) a study of selected ecological problems in the humid tropics which will include a section on central Africa, (b) an examination of methods for developing natural resource inventories and environmental baseline studies and (c) a study on renewable resource scarcities which will focus on Africa, east of the Rift Valley.

PIDs have been developed, reviewed and recommended for further development on additional subjects of great use to Africa. One will supply high quality short-term, short-notice environmental expertise for non-project assistance, another will provide for environmental training, a third will give a grant to the U.S. Man and the Biosphere program

(MAB) to fund small ($50,000) research projects in developing countries. A fourth project will provide one African country with assistance to build its water resources management infrastructure.

The general thrust on environmental matters of the new S&I Bureau will be to create a portfolio which will include projects that can provide short-notice, short-term environmental expertise to missions, and to have projects which will conduct research to address perceived future environmental problems. They intend to be guided by the Regional Bureaus via the new Sectoral Council for Energy and Natural Resources.

Issues

The foregoing narrative raises a number of issues which the Workshop may wish to address. The following list is suggestive and by no means complete.

1. With overall AID budgets likely to be stable, or even declining (in real terms), how can the Bureau's energy programs (including fuelwood) be increased, as advocated in AID's policy paper and the Administrator's message? How can we improve on our currently unimpressive record of adding energy components to other projects (e.g. agriculture, housing, health)?

2. What are the prospects for increasing AID-financed energy activities in FY'84 and '85 (assuming program allocations for FY'83 are by now fairly well defined)? Do missions/host governments see energy (including fuelwood) as a rising priority which should be pursued even at the expense of foregoing the initiation of other programs?

3. Is the Bureau on the right track with respect to its emphasis on fuelwood and renewables? Should more attention be paid to energy planning and energy conservation (both fuelwood and conventional) activities as recommended in the draft "Energy Initiatives for Africa" project paper? Should the Bureau continue to look to S&T/EY for meeting mission requests in other conventional energy matters and in energy training?

4. Is the Bureau paying sufficient attention to the potential role of the private sector (African and U.S.) in designing its energy programs? If not, how should we go about improving our performance in this regard?

5. Is the Bureau giving sufficient attention to the implementation of its existing energy, forestry and natural resource programs? If not, what should be done to improve and accelerate implementation?

6. What about evaluation? Are we learning from our successes and failures? How can we disseminate this information more effectively to the field?

7. How can AID/W (AFR and S&T) more effectively backstop the field in the various programs which are the subject of the Workshop? Are there specific shortcomings in (a) design, (b) approval or (c) implementation of such programs which need to be identified? Are there specific shortages in staff skills which need to be rectified?

8. Is REDSO backstopping adequate? Are there ways in which it can be improved? Has the Bureau achieved the right "mix" in the allocation of functions between AID/W and the REDSOs? Should the REDSOs exercise approval authority for energy projects proposed by missions under the "Energy Initiatives for Africa" project?

9. Is the Bureau adequately utilizing the resources of the Peace Corps (and PVOs) in the design and implementation of its energy, forestry and environmental programs? Can this role be more precisely defined in terms of the most promising organizations and the types of functions they seem best equipped to carry out?

10. Is there a role for African regional organizations in Africa's energy, forestry and environmental programs? Can this role be more precisely defined in terms of the most promising organizations and the types of functions they seem best equipped to carry out?

11. Is coordination with other donors a problem and, if so, is it an AID or an African problem? What can or should AID do to increase the effectiveness of donor coordination?

Table A
Energy Project Figures

Project Number and Title		FY '78	FY '79	FY '80	FY '81	Estimated FY '82	Presently Projected FY'83	LOP
635-0205	The Gambia Reforestation		1,181					1,181
615-0205	Kenya Renewable Energy			3,482	1,318			4,800
625-0937	Mali Village Reforestation (AIP)			495				495
682-0205	Mauritania Renewable Resources Management	250	325	275	1,278	1,000	2,000**	10,675*
683-0230	Niger Forestry and Land Use Planning			332	576		800	1,151
685-0219	Senegal Fuelwood Production Project		1,400	700	730	300		3,133
685-0259	Senegal Fuelwood Production II(shelf)							
685-0243	Senegal AFRICARE Reforestation (OPG)			126				126
685-0247	Senegal Village Woodlots			211				211
686-0235	Upper Volta Forestry Ed and Development		525	1,350	3,458			4,469
625-0937.08	Upper Volta Village Forestry (AIP)			50				50
625-0937	Upper Volta Yatenga Agri-forestry Proposal (AIP)			56				56
SUBTOTAL		250	3,431	7,077	7,360	1,300	2,800	26,347

* Figures represent that portion of total funding estimated for fuelwood/energy.
** Figures represent a proposed amendment resulting in an extention and LOP noted.
Results of review should be known by end of 2nd quarter FY '82. Portion for energy not broken out of the proposed figures.

Table A
Energy Project Figures

Project Number and Title		FY '78	FY '79	FY '80	FY '81	Estimated FY '82	Presently Projected FY '83	LOP
633-0209	Botswana Renewable Energy Technology Project			725	1,000	1,500	500	3,725
625-0937.03	Cape Verde Renewable Energy			500				500
632-0206	Lesotho Renewable Energy Technology		1,600					1,600
698-0407.07	Liberia Mini-Hydro Electric Activity (IRT)	50			20			70
688-0217	Mali Renewable Energy	2,174			930	1,100	700	4,900
685-0202	Mali Operation Mil (Photovoltaic Pump)	220						220
688-0213	Mali Action Ble (PV Pump)	220						220
683-0235	Niger Solar Energy	500						500
698-0410.22	Rwanda Renewable/ Improved Traditional Energy (AIP)		488					488
625-0937	Senegal Renewable Energy (AIP)			300				300
685-0208	Senegal Bakel Crop Production	700						700
	SUBTOTAL	3,864	2,088	1,525	1,950	2,600	1,200	13,223

Table A
Energy Project Figures

Project Number and Title		FY '78	FY '79	FY '80	FY '81	Estimated FY '82	Presently Projected FY '83	LOP
698-0407. 09	Togo Rural Solar Technology Activity			50				50
698-0410. 13	Upper Volta Solar Energy Demonstration (AIP)	80						80
655-0005	Cape Verde SAL Desalination Power				450			3,595
660-0095	Zaire Rural Hydro-Electric Development						2,000	10,000
682-0223	Mauritania Alternative Energy Development						960	4,150
685-0246	Senegal Renewable Energy II					1,000	1,000	5,000
650-0041	Sudan Village Renewable Energy				1,000	2,355	1,200	4,600
698-0410	Tanzania Dodoma Rural Energy Development (AIP)					500		500
603-0013	Djibouti Energy Initiatives				2,000	2,000		4,000
698-0424	Africa Regional Energy Initiatives for Africa							16,000
						2,000		3,000
	SUBTOTAL	80		50	3,450	7,855	5,160	50,975

Table A
Energy Project Figures

Project Number and Title		FY '78	FY '79	FY '80	FY '81	Estimated FY '82	Presently Projected FY '83	LOP
698-0410.09	Burundi Alternative Energy-Peat (AIP)	490						490
695-0103	Burundi Alternative Energy-Peat II			2,000	2,000	1,106	2,000	8,000
650-0039	Sudan Petroleum Training			200				200
698-0410.35	Guinea Community Forestry School Tree Nursery (AIP)				497			500
657-0005	Guinea-Bissau * Forestry Project					500		3,200
682-0220	Mauritania Environmental Restoration*				500	500		3,500
	SUBTOTAL	490		2,200	2,997	2,106	2,000	15,890
	TOTALS	4,684	5,519	10,852	15,757	13,861	11,160	106,435

* Not all funds represent energy expenditure.

Table B
Natural Resources Projects Figures

Project Number and Title		FY '78	FY '79	FY '80	FY '81	FY '82	FY '83	LOP
655-0009	Cape Verde Watershed Management		1,000	1,457	2,057	1,765		6,210
682-0201	Mauritania Guidimaka Integrated Rural Development	800	1,096					3,696
	Amendment				1,643	1,000		2,805
682-0205	Mauritania Renewable Resources	1,000	1,300	1,100				4,678
	Amendment				1,278	1,000	2,000	5,997
686-0231	Seguenga Integrated Rural Development		1,000	1,000	1,356	1,600		4,956
625-0010	Sahel Regional Livestock and Mixed Agriculture			500				500
635-0202	The Gambia Soil and Water Management Unit		251		834	750	750	2,517
683-0226	Niger Rural Sector Human Resources Development		2,000	995	860	1,185		5,030
686-0221	Upper Volta Agricultural Human Resources Development	2,000	2,000	2,000		3,460		9,457
688-0205	Mali Land-Use Capability Inventory	2,200	669	400	1,725			4,678
	SUBTOTAL	6,000	9,316	7,452	9,783	10,760	2,750	50,524

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Table B
Natural Resources Projects Figures

Project Number and Title		FY '78	FY '79	FY '80	FY '81	FY '82	FY '83	LOP
698-0414	African Regional Remote Sensing (E.A.)		750	540	550	750	400	2,364
696-0117	Rwanda Rural Works					3,880		3,880
695-0105	Burundi, Bururi Forest						1,100	1,100
678-0420	African Regional Remote Sensing (W.A.)	700	1,000	500	235	1,000	400	2,290
683-0240	Niger Niamey Departmental Development, Phase II				5,704		3,000	13,582
683-0244	(PVO) Tapis Vert, Niger					300	350	650
683-0230	Niger Forestry and Land Use Planning				576		800	3,839
685-0233	Senegal Plan for Land Use and Development				1,000	1,000		2,000
686-0256	Upper Volta Environmental Sector Grant						1,000	25,000(est.)
621-0160	Tanzania-Village Environmental Improvement				500			500
649-0108	Somalia-Central Rangeland Development			3,366	3,680	3,600	3,050	14,944
	SUBTOTAL	700	1,700	4,406	12,245	10,530	10,100	70,149
	TOTAL							120,673

WORKSHOP REPORT

I. Preamble

Events of the past few years have created a perilous situation in Africa's energy, environment and forestry interaction. Petroleum price increases have caused balance of payment problems; drought and famine coupled with rapid population growth have caused serious environmental degradation. The result is that a number of nations now face political instability and financial and environmental collapse. To help clarify AID's role in dealing with these forces, the Assistant Administrator of the Bureau for Africa convened a workshop in Nairobi from 6 to 11 December 1981. The goals of the workshop were:

- to learn from field staff what issues seemed primary and how they should be addressed;
- to improve current information of designing and implementing projects in energy, forestry and environment;
- to present the Assistant Administrator with recommendations on how the Agency might proceed in the area of energy, forestry and the environment.

This report is a summation of the workshop's recommendations and priorities for action. A number of general principles emerged:

First, sentiment was unanimous that African energy and environment problems defy generalization. No single solution appears possible. Varieties of ecosystems, infrastructures, and resource bases require that individual policies and programs be developed for specific regions and even sub-national regions.

Second, energy issues and goals do not exist in isolation, but are part of the larger development process. Similarly the fuelwood need is part and parcel of the overall need for reforestation, resource management, and the tapping of entrepreneurial skill and financial incentives to increase wood production and manage forest resources more efficiently.

Third, participants clearly identified two key components: fossil fuel problems occuring primarily in urban areas, and the traditional fuel problems and environmental degradation occuring within both urban and rural areas.

Fourth, there are at least three components of a strategy to meet the energy problem:

- increased efficiency in the use of existing energy sources, be they commercial or traditional;
- increased production of energy, particularly in the area

of renewables and fuelwood;

- better natural resource planning and management.

Fifth, AID resources by themselves are far from adequate to solve the problem. If selectively and carefully invested they offer possibilities of providing leverage and testing ways to strengthen national institutions, improve production and use of forest and natural resources, expand the use of renewable energy technologies, conserve conventional energy resources, assist in energy analysis and policy planning and streamline procedures for AID action.

Sixth, given the nature of the energy problem, AID must think in a longer time period than it now does, both in formulating projects and in appraising project effectiveness. Whereas three to five years seems to be the accepted life cycle for planning present AID projects, a much longer period - 10 years or more - is often more appropriate to efforts in energy, forestry and the environment.

Seventh, the important issue of energy as related to agricultural and industrial production was raised, but the Workshop's already crowded agenda did not permit its discussion groups to make concrete recommendations on those issues.

Within the foregoing context, the Workshop advanced the following recommendations and priorities for action:

II. Institutional Considerations: Host Countries and AID

A. Host Countries

In virtually every country of Africa there is a recognized energy dilemma. Ministries, agencies or departments of energy have been newly created with all the incumbent problems of infancy. Further, the unique interface between energy, forestry and environment issues has placed special burdens on the new institutions to interact across sectoral and ministerial lines when action even within a new ministry is difficult.

Most African governments are just beginning to consider their energy needs, uses, resources and policies. Experienced staff, data availability, policy precedents, and planning models are, at best, scarce and at worst, nonexistent. Need exists in the short run for assistance to initiate policy planning and in the longer run to strengthen institutional capabilities to carry out independent analysis and planning of renewable and fossil fuels. Moreover, there is a need to develop plans which place energy in a broad context as well as within the overall guidelines of national development plans.

With these difficulties in mind, the Workshop recommended:

- That donors including AID, provide long and

short-term training, especially in areas of energy policy and planning, resource assessment and land use, energy technologies, energy efficiency analysis, agroforestry and natural resource management;

- That AID missions review national needs for short run assistance in policy and planning as well as longer run institutional needs.

- That planning not be confined to energy reports and assessments but that it lead to implementable project proposals.

- That policies be formulated and projects designed to take explicitly into account local institutional weaknesses by relying, wherever possible, on encouraging private sector initiatives and by placing the minimum burden on public agencies and extension services.

B. A.I.D.

To strengthen AID's ability to carry out effective energy activities, the Workshop recommended:

1. That adequate training be given to Mission officers so that they can understand and implement AID energy policy and programs.

2. That thorough evaluation be undertaken on past projects which impact on the broad fields of energy, forestry and environment and that AID/W disseminate information from these evaluations to USAIDs.

3. That help be provided to USAIDs in surveys of current and projected energy use and potential energy supply, both urban and rural, to assist in shaping sound programs.

4. That the energy implications and requirements of all projects be evaluated at the design stage.

5. That project review procedures be streamlined and a methodology established for rapid approval of projects that are of small dollar value or a proven technology.

6. That the Africa Bureau's Office of Development Resources strengthen its technical and management capacity as the principal backstop for AFR energy activities.

7. That USAIDs and AID/W organize themselves so as to

ensure the integration of agricultural, forestry and engineering capabilities to deal with the enhancement of wood supplies. Similar integration should be encouraged in the institutions of host country governments.

8. That REDSOs promising efforts at a multidisciplinary approach - which includes an initial preassessment of a country's energy problems within a total resource development context -- be encouraged.

9. That REDSO staff provide help to USAIDs in problem definition which integrates energy with forestry and resource management as well as other components in development sectors.

III. The Development and Management of Energy Resources

In considering issues and recommendations on the development and management of energy resources in Africa, the Workshop focused most attention on forestry and natural resources (including fuelwood), and on other renewable energy technologies. Issues relating to fossil fuels were considered, for the most part, in the context of energy conservation (see Section D, below).

A. Forestry and Natural Resource Management

The deterioration of the natural resource base in many African countries requires a substantial effort to improve their management and to rationalize their use by strategies specific to the needs of local populations.

Programs should include improved management of existing forest resources as well as agroforestry, afforestation and reforestation programs in urban and rural areas to increase the supply of both fuelwood and other forest products.

The gravity of the wood crisis urgently requires greater attention and concern by donors and African governments alike. There is an acute need on the part of African decision makers to become more aware of the problems of continued overgrazing, deforestation, soil erosion and environmental degradation, and to increase the capacity of African institutions to deal with them.

The long duration of forest development programs requires strategies to rationally manage and exploit existing forest resources. Concurrently, the identification and use of transitional energy resources -- such as "bridging fuels" that would serve as wood and charcoal substitutes -- and technologies that may buy time for the regeneration of these forest reserves, especially in Africa's semi-arid areas is needed. In addition, the growing numbers of urban woodfuel

and charcoal consumers requires that more attention be given to urban as well as rural fuel problems.

In particular the critical role of agroforestry should be stressed in areas where small farmers could begin to integrate agriculture with tree cultivation. Such initiatives could increase both the market possibilities of forest products and agricultural production while encouraging sound environmental practices. To facilitate the rapid adoption of agroforestry, the group recommends the following priorities for action:

1. That private establishments be encouraged to reproduce and distribute bush and tree seeds.

2. That action be taken to strengthen capabilities for rapid dissemination of information about seed sources and development of an African based "improved-tree" seed dissemination network.

3. That research and development be undertaken (1) to assess the relative importance of seed, seedlings and cuttings in forestry practice; (2) to assess alternative to monoculture, with particular attention to economic and social évaluation of agroforestry systems; (3) to assess appropriate technologies for forest management; (4) to assess the economic incentives to increase the production of forest products under a variety of land tenure pattern; (5) to identify and genetically improve promising fast growing exotic and indigenous tree species for fuelwood and other forest products.

4. That training of both agriculturalists, foresters, and other natural resource managers at all levels of their respective professional hierarchies, address the issues and problems of integrated land use management;

5. That AID encourage the development of small private nurseries in Africa. The efficient provision of seed, seedlings and cuttings for species which have already been proven could greatly help the process toward a positive transformation of the rural areas.

6. That AID include forestry and natural resource conservation considerations in future agricultural and river basin project designs and evaluations.

B. Renewable Energies

Given the rising costs of energy, attention has been focused over the last decade on renewable energies that would substantially reduce the recurrent costs of development projects. Although many technologies have been developed,

there has been little real progress to this end. The Workshop also noted that while the Bureau has been testing and demonstrating a wide range of technologies in many countries, very few of them appeared to be capable of widespread replication due to technical problems and excessive cost in relation to benefits, social acceptability, or to maintenance and repair problems which appear to be beyond the capacity of African institutions and entrepreneurs. In reviewing the role of renewable technologies, the Workshop participants felt that priority should be given to the following actions:

1. That the Africa Bureau's renewable energy technology programs be focused on the identification, introduction and dissemination of a limited number of proven technologies which hold the greatest commercial promise.*

2. That attention be paid to renewable technologies that will substantially increase agricultural output.

3. That the Bureau devote greater attention to the possibilities of mini-hydro power where such power would provide an alternative to diesel power and would be financially viable.

IV. Energy Conservation

A. Traditional Energy Conservation

Although there is considerable deforestation and consequent environmental degradation of the African landscape, this process is not only caused by the use of fuelwood by the rural population but also by overgrazing, demands for additional agricultural land and urban charcoal consumption. The continuous expansion of agriculture can be sustained only if a widespread application of agroforestry practice occurs. It is, however, possible to reduce consumption of charcoal by inbtroducing more efficient technologies. The Workshop therefore recommends the following technical assistance priorities:

1. That attention be focused on improved clay mound charcoal conversion in rural areas.

2. That manufacturing of improved wood and charcoal stoves in the urban and rural areas be rapidly undertaken as an entrepreneurial activity as a means

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* Although this was the predominant opinion of the Workshop, the view was also expressed that the Bureau should continue to support research and development of a broad range of renewable energy technologies.

to the threefold purpose of (1) benefiting the urban poor, (2) relieving the pressure of the rural environment and (3) serving as a focal point for demonstration effects throughout the country:

3. Other energy conservation technologies that hold promise of widespread dissemination within the urban and rural private sectors.

C. Increasing Conventional Energy Efficiency

Recent developments in increasing energy efficiency in the United States may be readily transferred to developing countries. While the Workshop did not have the time to give this topic sufficient consideration it recommends that this as an area in which AID may wish to be given additional emphasis.

Given the size of USAID energy budget in Africa, any intervention in the commercial sector must be strategically located. To this end, the Workshop suggested that technical assistance be considered for the following areas:

1. Conservation possibilities in the transport sector, especially in intra-urban transport;

2. Attention should be given to energy efficient building practices and, if possible strengthening of the local building codes;

3. Conservation in industry and public buildings be examined and fostered.

Some participants also noted that U.S. overseas missions were sometimes among the worst offenders of energy efficiency; rather they should serve as efficiency models and be demonstrations of what can be done.

V. Energy Initiatives for Africa Project Paper

The general consensus of the Workshop is that the Energy Initiatives for Africa Project can provide important and much needed support for the Africa Bureau's energy activities and should be redesigned to be responsive to the Workshop's recommendations. During the project's review it was recommended that more of the sub projects be identified prior to completion of the Project Paper and the administrative responsibilities of the AID Washington and field offices be clearly stated. Field offices will review the proposed project and telegram AID/W their views by Januray 31, 1982. Upon the resolution of the above, the Project Paper should be approved.

VI. Other Points of Note

In the general discussions during the conference, several points

were noted that participants felt were worthy of further attention. In particular, it was felt:

- That a follow-on meeting be held in approximately 12 months which would include AFR natural resources personnel and agricultural personnel. The Workshop would stress the agriculture-forestry interface as a means to address deforestation and environmental degradation problems.

- That more attention should be paid to the energy problems of the urban and periurban poor.

- That greater attention should be paid to sharing experience both within and between regions in Africa.

- That greater contact and exchange of information be sought with other bilateral and multilateral donor organizations.

- That a long-term strategy be established with the Peace Corps to facilitate local operations.

- That, as Washington always insists that advice from the field is the foundation upon which AID programs are built, these recommendations be seriously considered, as they represent the collective wisdom of the energy and environmental field personnel of the Bureau for Africa.

STRATEGY FOR ACTION

I. Introduction

Events of the past few years have created a perilous situation in Africa's energy, environment and forestry interaction. Petroleum price increases have caused balance of payment problems; drought and famine coupled with rapid population growth have caused serious environmental degradation. The result is that a number of nations now face political instability and financial and environmental collapse.

AID's role in dealing with these forces should be based on certain general principles:

First, African energy and environment problems defy generalization. No single solution appears practical. Varieties of ecosystems, infrastructures, and resource bases require that individual policies and programs be developed for specific regions and even sub-national regions.

Second, energy issues and goals do not exist in isolation, but are part of the larger development process. Similarly the fuelwood need is part and parcel of the overall need for reforestation resource management, and the tapping of entrepreneurial skill and financial incentives to increase wood production and to manage forest resources more efficiently.

Third, energy problems consist of two key components: fossil fuel problems which occur primarily in urban areas and make a direct impact on the modern sector; and the traditional fuel problems and environmental degradation occuring within both urban and rural areas. More attention should be given to the energy problems of the urban and periurban poor.

Fourth, a strategy to meet the energy problem should be based on four key elements:

- increased efficiency in the use of existing energy sources for productive uses,
- increased production of energy, particularly in the area of fuelwood and renewables:
- better natural resource planning and management;
- encouragement of U.S. and host country private sector involvement.

Fifth, AID resources by themselves are far from adequate to solve the problems. If selectively and carefully invested they offer possibilities of providing leverage and testing ways to strengthen national institutions, improve production and conservation of

forest and natural resources, expand the use of renewable energy technologies, conserve conventional energy resources, assist in energy analysis and policy planning and streamline procedures for AID action.

Sixth, given the nature of energy problems, AID must think in a longer time period than we now do, both in formulating projects and in appraising project effectiveness. Whereas three to five years seems now to be the accepted life cycle for planning and executing AID projects, a much longer period - 10 years or more - may be more appropriate to efforts in energy, forestry and the environment.

Seventh, energy as related to agricultural and industrial production is an important issue which the Agency ought to investigate.

II. Strategy

Within the foregoing context, AID's strategy for the development and management of energy resources should consist of action in the following areas:

A. Forestry and Natural Resource Management

African countries must improve their management and rationalize their natural resource use by strategies specific to the needs of local populations. Programs should include improved management of existing forest resources as well as agroforestry, afforestation and reforestation programs in urban and rural areas to increase the supply of both fuelwood and other forest products.

The long duration of forest development programs requires strategies to manage and rationally exploit existing forest resources. Concurrently, it requires the identification and use of transitional energy resources -- such as "bridging fuels" that would serve as wood and charcoal substitutes -- and technologies that may buy time for the regeneration of these forest reserves, especially in Africa's semi-arid areas. In addition, the growing numbers of urban woodfuel and charcoal consumers requires that more attention be given to urban as well as rural fuel problems.

In particular the critical role of agroforestry should be stressed in areas where small farmers could begin to integrate agriculture with tree cultivation. Such initiatives could increase both the market possibilities of forest products and agricultural production while encouraging sound environmental practices. To facilitate the rapid adoption of agroforestry, the following priorities for action are recommended:

1. That an assessment of the capabilities and status of forestry research in Africa be undertaken. Specific areas identified to reorient forestry research and

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development include:

- an investigation of alternatives to monoculture, with particulture attention to economic and social evaluation of agroforestry systems;

- empirical analysis of appropriate technologies for forest management;

- an investigation of economic incentives to increase the production of forest products under a variety of land tenure patterns;

- enhancing efforts to identify and genetically improve promising fast growing exotic and indigenous tree species for fuelwood and other forest products.

2. That action be taken to strengthen capabilities for rapid dissemination of information about seed sources and development of an African based "improved-tree" dissemination network.

3. That training of both agriculturalists, foresters, and other natural resource managers at all levels of their respective professional hierarchies, address the issues and problems of integrated land use management.

4. That AID encourage the development of small private nurseries in Africa.

5. That AID include forestry and natural resource conservation considerations in future agricultural and river basin project designs and evaluations.

B. Renewable Energies

Given the rising costs of energy, attention has been focused over the last decade on renewable energies that would substantially reduce the recurrent cost of development projects. Although many technologies have been developed, there has been little real progress to this end. While AID has been testing and demonstrating a wide range of technologies in many countries, very few of them appear to be capable of widespread replication due to technical problems, excessive costs in relation to benefits, social acceptability, or to maintenance and repair problems which appear to be beyond the capacity of African institutions and entrepreneurs. In reviewing the role of renewable technologies, priority should be given to the following actions:

1. That the Africa Bureau's renewable energy technology programs be focused primarily on the identification, introduction and dissemination of a limited number of proven technologies which hold the greatest commercial promise and the potential for contributing significantly to total national energy supplies.

2. That attention be paid to renewable technologies that will substantially increase agricultural production.

3. That the Bureau devote greater attention to the possibilities of mini-hydro power where such power would provide a financial viable alternative to diesel power.

C. Energy Efficiency and Conservation

Although there is considerable deforestation and consequent environmental degradation of the African landscape, this process is not only caused by the use of fuelwood by the rural population but also by overgrazing, demands for additional agricultural land and urban charcoal consumption. The continuous expansion of agriculture can be sustained only if a widespread application of agroforestry practice occurs. It is, however, possible to reduce consumption of charcoal by introducing more efficient technologies. The following technical assistance priorities are therefore recommended:

1. That attention be focused on improved clay mound charcoal conversion in rural areas.

2. That manufacturing of improved wood and charcoal stoves for the urban and rural areas be rapidly undertaken as an entrepreneurial activity as a means to the three fold purpose of (1) benefiting the urban poor, (2) relieving the pressure on the rural environment and (3) serving as a focal point for demonstration effects throughout the country;

3. Other energy conservation technologies that hold promise of widespread dissemination within the urban and rural private sectors.

D. Conventional Energy

Fossil fuels and other conventional energy resources continue to make a crucial contribution to the economic development of many African countries.

AID should give additional emphasis to conventional energy development particularly where sources exist in significant quantities. Given the size of AID's energy budget in Africa,

any intervention in the commercial sector must be strategically selected. AID can assist countries in the development and efficient utilization of their conventional energy potential by providing technical assistance and training in areas such as:

- policy and planning for conventional energy use;
- improving conservation and efficiency in the transportation, building and industrial production sectors;
- fuel substitution to conserve scarce domestic and imported fuels.
- programs for assisting fossil fuel development

E. Institution Building in Host Countries and A.I.D.

1. Host Countries

In virtually every country of Africa there is a recognized energy dilemma. Ministries, agencies or departments of energy have been newly created with all the incumbent problems of infancy. Further, the unique interface between energy, forestry and environment issues has placed special burdens on the new institutions to interact across sectoral and ministerial lines when action even within a new ministry is difficult.

Most African governments are just beginning to consider their energy needs, uses, resources and policies. Experienced staff, data availability, policy precedents, and planning models are, at best, scarce and at worst, nonexistent. Need exists in the short run for assistance to initiate policy planning and in the longer run to strengthen institutional capabilities to carry out independent analysis and planning of renewable and fossil fuels. Moreover, there is a need to develop plans which place energy in a broad context as well as within the overall guidelines of national development.

With these difficulties in mind, it is recommended:

- That donors including AID provide long- and short-term training, especially in areas of energy policy and planning, resource assessment and land use, energy technologies, energy efficient analysis, agroforestry and natural resource management;
- That AID missions review national needs for short run assistance in policy and planning as well as longer run institutional needs.

- That planning not be confined to energy reports and assessment but that it lead to implementable project proposals.

- That policies be formulated and projects designed to take explicitly into account local institutional weaknesses by relying, wherever possible, on encouraging private sector initiatives and by placing the minimum burden on public agencies and extension services.

2. A.I.D.

To strengthen AID's ability to carry out effective energy activities, it is recommended:

- That adequate training be given to Mission officers so that they can understand and implement AID energy policy and programs.

- That a thorough evaluation be undertaken of past projects which impact on the broad fields of energy, forestry and environment, and that AID/W disseminate information from these evaluations to USAIDs.

- That help be provided to USAIDs in surveys of current and projected energy use and potential energy supply, both urban and rural, to assist in shaping sound programs.

- That the energy implications and requirements of all projects be evaluated at the design stage.

RECOMMENDATIONS

The approach set forth in the previous section includes a series of suggestions and recommendations for guiding our future work in energy, forestry and the environment. Certain actions should be initiated in the near term to implement the strategy. We should evaluate our experience to date so as to target our future efforts in ways most likely to have maximum impact. We should place increased emphasis on better planning - so as to help LDCs better identify the problems to be solved and the programs required to do so.

We should strengthen our training programs (for Africans and for AID staff) because no projects can succeed without competent people to design and execute them.

Action should be taken now on the following fronts:

1. Evaluation: We need to examine our experience to date in renewable energy and fuelwood to improve program performance, sharpen our approach and select the most promising technologies that hold potential for widespread replication and maximum development impact.

   A working group should be convened -- composed of AFR energy officers, counterparts from the other regional and central bureaus and evaluation officers from AFR and PPC -- to examine the issues raised in the Workshop report and design an evaluation plan for assessing energy efforts in Africa including utilization of the Energy Initiatives for Africa project.

2. Planning: Workshop discussions stressed the importance of helping African governments evaluate their total energy, forestry and environmental situations to identify policy issues, institutional problems and measures for dealing with them, including encouraging a vigorous role by the private sector.

   Good projects require planning and planning requires data. In many countries, both planning and data are often weak. Country Environmental Profile studies are now getting underway in several countries. We can build on this process by expanding the studies to include a greater emphasis on the energy and forestry components to provide a more systematic basis for integrated resource planning and project identification. The Energy Initiatives for Africa(EIA) project now being designed in all likelihood will be providing substantial resources for this kind of energy planning and project development.

   Beyond the approach outlined above, we need to help host governments and the private sector strengthen their capacity to plan for the best use of their energy and forestry resources. The Workshop agreed that "one time" assessments were not sufficient. These should be complemented by technical assistance and other

efforts to help identify potential projects, mobilize indigenous private sector involvement in energy, and lead to the implementation of energy policy recommendations by both the public and private sectors. Implicit in these discussions was the conclusion that the Bureau for Africa should include planning assistance as part of its bilateral energy activities in Africa to supplement the resourses of the Bureau for Science and Technology to respond to African requests for energy planning assistance.

Once the EIA project is approved, we should communicate with our Missions regarding planning assistance and, on the basis of their replies, develop priorities as to African candidates for such assistance. Such priorities must, of course, take into consideration energy assessments and planning assistance being provided by other donors, especially the IBRD.

3. Training of Africans: Building African capacity through training was another dominant motif of the Workshop. Energy programs cannot succeed without Africans who can run them. The Workshop recommended stepped up long- and short-term training over a broad range of subjects, building and expanding AID's existing programs and taking into account those of other donors.

   The other Regional Bureaus and the Office of Energy also recognize that the evolution of energy activities during the past few years requires a redesign of training. To this end, AFR should (a) solicit mission views on training needs and priorities for energy, forestry and natural resources management, (b) set up a working group consisting of appropriate Africa Bureau and S&T staff and an energy training consultant to do an initial assessment of current and potential training activities and institutions which are particularly relevant to training requirements in Africa, (c) cooperate in S&T efforts to redesign the Agency's centrally-funded training programs. The output of the foregoing recommendations would be a report and recommendations on how the Bureau for Africa can more effectively address African training needs, taking note of training being conducted elsewhere by AID and by other donors.

4. AID Staff Development: Improved training opportunities for AID's own staff were also urged at the Workshop. M/PM's Training Division is in the process of designing an energy training program for AID staff and AFR is participating in this work. If all goes well, a short course should be held in the fall of 1982. We endorse this initiative. In addition, we urge increased support for short- and long-term training in the planning and management of natural resources for our agriculturalists, foresters and environmental officers so as to encourage a more integrated approach to land use planning within AFR.

5. Forestry Research and Forestry Sector Support: Dominant concerns among the forestry and natural resource participants at the Workshop were:

- the present inadequacy of forestry research, especially on fast growing tree and shrub species for fuelwood and other forest products; there is a need to reorient forestry research to be more closely associated with human needs.

- the need for research on alternatives to monocultures, especially agro-forestry systems and improved management of natural vegetation.

- the chronic shortage, for a variety of reasons, of high quality genetically improved tree seeds and plant materials to supply both AID and national replanting schemes.

- the importance of encouraging private entrepreneurship for the establishment of nurseries and the distribution of seedlings.

- the need for closer integration of forestry and agriculture.

While we are seeking new knowledge, it is vital that we use the considerable body that already exists. A start in this area would be to sponsor a specialized meeting to bring together experts, interested agencies and institutions to define in greater depth the forestry research problems noted by the Workshop and to recommend options which may be pursued to address them. In preparation for this meeting, We should commission an analysis of the status and needs of forestry research in Africa to determine those lines of research receiving insufficient attention and to identify what options might be chosen to strengthen forestry research in Africa.

The terms of reference for the analysis would take into consideration the global study on forestry research priorities being sponsored by the World Bank and FAO.

WORKSHOP EVALUATION *

All of the workshop participants were asked to complete the attached evaluation sheet before leaving Nairobi. Eighteen of the 40 USAID field attendees responded and a summary of their reactions are as follows:

All, but one respondent said that the workshop was a success; many were specific about what had made it so. Their comments shared some common threads: the participants felt challenged by the different approaches presented and felt that it was an inexpensive, effective way to expose new project managers to energy problems and solutions. Other participants qualified their enthusiasm by saying that the workshop was a good first step and that additional training efforts should follow. They felt that face to face contact by field personnel will help bring unity to energy strategy in Africa. Nearly all respondents complained that there was too much material and too little time. The one negative respondent felt that the agenda failed to flow and ought to have been thought out more topically.

The second question asked the participants how they would change the agenda of any subsequent workshops. The overwhelming response was that the workshop should be followed by other training workshops which would have narrower foci. Participants want to see one set of technologies dealt with at a time, i.e., forestry and agriculture, or one topic with related subtopics, such as: what are the essential preconditions for undertaking any energy project and/or a comparison of the opportunity costs of various technologies. Throughout the evaluations, participants expressed enthusiasm for small working group activities. They would like to see even more of these in follow-up workshops. A few respondents would like to see less consultant participation yet there appears to be contradicting opinions here. In response to other questions on the evaluation sheet, they said that the consultants were the most effective speakers. Other constructive suggestions from individuals were that we ought to include the politics of energy in our case studies, and that more field trips ought to have been planned with the appropriate technical presentations given on site.

The remaining three evaluation questions focused on the relative usefulness of sessions, topics and individual presentations. The respondents generally ignored the distinctions between the three separate categories, yet one can still generalize about what they found useful in the workshop. They rated the state-of-the-art presentations on specific technologies as the most highly relevant activity and Gene Ellis' "Energy Trade-offs in Africa" as the best single presentation. There was enthusiastic praise for many of the speakers. The participants appeared reluctant to single out parts of the program which they felt were irrelevant. Thirty percent wrote nothing at all in response to that question. Others felt that the sections on the environment could have been strengthened; that too much time was spent "preaching to the converted" during the first two days; that there was unnecessary duplication in the energy assessment section; that the economic analysis was too general and that the review of Energy Initiatives for Africa was premature and out of place at the workshop.

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* Summary of the Participants' Evaluation Forms.

In all, the evaluations were favorable; their suggestions were constructive and their criticism well taken. Many participants thanked AFR/DR for the workshop on their evaluation forms and said that as a result they thought they could perform more effectively in their jobs.

APPENDIX A

ENERGY ASSISTANCE POLICY PAPER *

I. Introduction

This paper sets forth AID energy assistance policy and describes, in very general terms, energy activities appropriate for AID financing. It should be read in the context of AID's overall "Strategy for a More Effective Bilateral Development Assistance Program."

Three objectives have been identified for U.S. Third World energy programs:

- to assure adequate energy supplies at reasonable prices to support continued world economic growth;
- to encourage developing countries to expand their own energy resources, both non-renewable and renewable, without increasing the risk of nuclear proliferation;
- to assist developing countries in overcoming energy-related constraints to their development.

The U.S. Government has consistently supported the expansion of energy programs for developing countries. Heads of State at the last three Economic Summits have supported and then reaffirmed a U.S.-sponsored initiative to increase assistance for such an expansion. Top Executive Branch officials have frequently stressed the importance of energy cooperation with developing countries, and the United States has strongly supported the expansion of the World Bank's energy program. The President has directed AID and ACTION/Peace Corps to give high priority to "developing integrated projects for reforestation, more efficient fuelwood use, and alternative energy sources." IDCA has identified energy as one of its sectoral priorities. And the Congress has added a number of provisions to the Foreign Assistance Act stressing the importance of energy activities for developing countries.

II. The Third World Energy Problem

Third World energy problems stem from depletion of traditional

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Agency for International Development, January 1981.

fuels, on the one hand, and a lack of developed conventional sources and inability to pay for imported fuels, on the other. Too frequently energy in Thirld World countries is equated with commercial (often imported) energy: oil for transport fuel and heating; kerosene for cooking and lighting; and oil, gas, coal, and hydropower for electricity generation. Yet energy also includes traditional fuels: fuelwood, charcoal, dung, and crop residues. Traditional fuels, particularly in rural areas, supply the major share of total energy in most AID-recipient countries and 80-90 percent of the energy used in some of the poorest countries.

While traditional and commercial energy problems are separately identifiable, there is also considerable interdependence between them. The demand for fuelwood in the cities is a major cause of pressure on many traditional fuel supplies in rural areas. Kerosene and natural gas for cooking, if widely available at affordable cost, could ease the demand for traditional fuels, yet their cost rises with the price of oil. Diesel oil for transport fuel is an essential cog in the transportation systems that support rural development. The energy implications of alternative development strategies and policies, affecting prices, production, conservation, and technology related to both traditional and commercial energy, carry important consequences for the incomes and well-being of the poor.

A. Traditional Renewable Fuels

As they have been for centuries, wood and charcoal fuels are today the main source of energy for household uses (cooking and heating) in developing countries. The World Bank estimates that in rural areas of Latin America, the Middle East, Asia, and Africa, only 12 percent of the population relies on commercial energy for cooking. Kerosene and natural gas are widely used in countries with a sizable middle class, where these fuels are subsidized or where charcoal and fuelwood are inadequate. Even in urban areas, the majority of the poor depend on traditional fuels for cooking and heating.

Deforestation is occurring rapidly in many countries, because of the increasing population's search for new agricultural land and domestic energy sources. Developing countries face a projected loss of 40 percent of their forest resources between 1978 and 2000. Whereas 10-15 kilometers is the most anyone can regularly walk to collect fuelwood, there is today virtually no wood within 70 kilometers of Niamey, Niger or Ouagadougou, Upper Volta. At the current deforestation rate, physically accessible forests would disappear altogether by 2020.

Even assuming both significant savings from more efficient stoves and considerable substitution of new sources of energy for fuelwood, recent World Bank analysis indicates that forestation activities must be increased worldwide by a factor of five -- and in Africa by a factor of fifteen -- in order to

meet projected demand. The sooner the problem is attacked, the lower the cost of effective action through balanced production and use rather than wholesale reforestation.

Rapidly escalating fossil fuel prices make a widespread solution through substitution by kerosene or natural gas highly improbable. Rather, the scarcity of fuelwood forces the poor to switch to the available alternatives of dung and crop residues. This switch deprives the land of top-soil and nutrients, thereby encouraging soil erosion and resulting in a decline in crop yield per unit of land. The World Bank estimates that by the year 2000 Nepal, for example, will lose an estimated one million tons of grain production directly attributable to this loss of natural fertilizer caused by the shortage of fuelwood. Thus, adequate fuelwood supply is critical for food production, as well as for energy.

B. Fossil Fuels and Hydroelectricity

Oil is the main source of commercial energy and largest single import in most developing countries. Forty-eight of the seventy-four oil-importing developing countries surveyed by the World Bank now depend on oil for 90 percent of their commercial energy requirements -- a dependency attributable to oil's flexibility as an energy source and its low cost until 1973. Transportation, industry, and modern agriculture are all dependent on oil.

Coal and natural gas have not been significant resources for most Third World countries, although many are now making efforts to exploit these resources. In some countries, hydropower is an important energy source. Few AID-assisted countries have large enough electrical grids to make nuclear power an economic proposition.

The post-1973 revolution in energy prices has created major alterations in the economic situation of the developing countries. The key effect is on the terms of trade: they must now give up more of their resources to buy a unit of imported energy than before. This poses three major issues, among others: (1) How will developing economies -- and national development plans -- adjust to higher energy prices? (2) Can enough external capital be obtained to cover balance of payments requirements? and (3) Will countries have continued access to energy supplies?

Economic adjustments to higher energy costs take time; moreover, they are politically and economically difficult and potentially disruptive to the development process. Following both the 1973 and 1979 oil price increases, developing countries borrowed heavily to finance continued levels of imports, causing a rapid increase in

their balance of payments deficits. The current account deficits of the oil-importing developing countries -- gradually reduced in 1976 and 1977 from the peak of 1975 -- again rose in 1978 to $24 billion. Deficits are now estimated to have been $43 billion in 1979 and are projected to reach $61 billion in 1980.

This borrowing by developing countries, much of it from private sources on commercial terms, has caused a dramatic rise in debt servicing requirements. Between 1973 and 1978 oil-importing developing countries' external debt rose from $68 billion to $187 billion, while their annual debt service requirements rose from $8 billion to $28 billion. Some developing countries will find it difficult to continue borrowing on the private market. Adjustments in their economies in the coming decade will be required.

The internal adjustments required by higher energy costs raise difficult policy choices. Commercial energy -- unless subsidized -- is often beyond the means of the poor. Subsidies, however, create distortions in resource allocation and generate large budget, and usually also foreign exchange, costs to the government. Developing countries are rethinking kerosene subsidies and possible alternatives. India, for example, is encouraging the production of fuelwood to substitute for kerosene, saving petroleum expenditures for higher value uses.

Access to supplies is also a concern. The 1973 embargo and the disruptions in 1979 and 1980 due to the Iran Revolution and the war between Iran and Iraq illustrated the tenuous nature of the international supply system. In 1979, for example, several countries suffered shortages; the lack of diesel fuel grounded half of Thailand's fishing fleet, halted irrigation pumping in India, and threatened Kenya's truck transport system.

On the positive side, there may be great potential for alleviating both sets of problems during the next 10 years. For example, fossil fuel exploration in the oil-importing developing countries remain low in comparison with other regions despite large sedimentary basin areas about which little is known. There is tremendous scope for increased use of hydroelectricity, since less than 10 percent of the potential has been developed. New and renewable energy technologies are also promising. Many of these are most appropriate in rural areas to meed basic needs, while otners such as alcohol fuels will have a direct impact on demand for imported energy. The loss of tropical forests can be much alleviated by improved resource management and by more efficient use of fuelwood. On the energy demand side, significant gains can be made in energy

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conservation and inter-fuel substitution. The World Bank estimates that up to 15 percent reductions in total LDC demand could be achieved by 1990, without sacrificing economic growth.

III. AID Energy Policy and Programs

AID has two basic policy goals in the energy area: (1) to ease the immediate energy constraints to development in developing countries, and (2) to help those countries make the difficult transition to a mix of energy sources that will sustain their economies in the future.

In achieving these goals, several things should be kept in mind. The first concerns the relationship of energy assistance activities to the Agency's bilateral development assistance strategy. The severity of the energy crisis and its impact on economic performance can be so great as to threaten the very capacity of many countries to succeed in the implementation of a development strategy of any kind. Thus, AID programs must be sensitive to the range of energy activities -- involving commercial energy as well as traditional fuels -- that affect development prospects.

More rapid development of the energy potential of these countries is impeded by a variety of technical and fianancial problems. These include:

- Lack of basic resource knowledge
- Lack of adequately trained personnel
- Lack of appropriate technology
- Lack of comprehensive energy planning and management
- Lack of sufficient financial resources

Overcoming these obstacles will require the combined efforts of donor governments, the private sector, and the governments of developing countries themselves. Not every aspect of the energy problem requires U.S. Government involvement or official financial assistance. AID development assistance for energy should complement rather than substitute for the resources available from other sources.

An additional consideration that should be kept in mind is that AID's program in energy, as in other fields, should be implemented in recognition of both resource and staffing constraints. Program concentration should be in those areas where AID's flexibility and capacity give the Agency a comparative advantage vis-a-vis multilateral development banks and other donor programs. In most development assistance programs, AID does not expect to provide capital assistance except for fuelwood and small hydropower and to a limited extent for other renewable energy activities.

With these considerations in mind, AID's energy program should:

- Support a wide range of activities, primarily technical assistance, tailored to the specific needs of countries in coping with the impact of petroleum price increases and the depletion of traditional renewable fuels, and beginning the long-term adjustment to an era of expansive energy and fossil fuel scarcity. AID expects that its programs will be giving major attention to renewable energy sources, especially fuelwood.

- Promote least-cost energy alternatives selected on the basis of life-cycle cost calculations (total cost of the technology over its useful life).

- Stress coordination with other U.S. agencies, bilateral donors, the World Bank and other multilateral assistance organizations, and the private sector.

- Reflect the importance of energy as an integral element in AID's various sector activities -- rural and urban -- in support of equitable growth.

- Emphasize those areas in which AID has special competence and experience: analysis and planning assistance, including project preparation and feasibility studies; training and institution-building; and site testing, demonstration, and evaluation of technologies.

This guidance should be implemented flexibly. In different countries or regions, local problems, AID program objectives, and contributions by others will dictate different mixes. A broader program that includes capital investments outside the areas of primary emphasis may be justified in certain cases, e.g., in major Economic Support Fund programs or in countries with a strong and demonstrable commitment to equitable development. Ultimately, AID's energy activities must depend on the particular country's situation, on AID's overall program goals in that country, and on the degree of creativity that AID staff can bring to bear.

A. AID Energy Programs

Consistent with these broad policy considerations, AID will carry out energy programs in the following areas:

1. Energy Analysis and Planning

A country's energy plans must be based on its own particular mix of resources and pattern of development. Yet most Third World countries have not yet examined their energy needs, uses, resources, and policies in a comprehensive and systematic manner.

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Basic information on energy resources is essential for the expansion of indigenous energy production through informed decisions on energy supplies, needs, and technologies, as well as energy conservation. Existing data bases for effective planning often are poor, especially with respect to energy use in rural areas. Even in countries that have carried out extensive economic planning, the sharp increases in the price of energy since 1973 may necessitate a reevaluation of the energy systems that support their development plans, as well as possible adjustments in the plans themselves.

Technical assistance can play an important role in developing country energy resource analysis and planning, by supporting or contributing to comprehensive energy studies, geological and geophysical surveys for conventional fuel sources, renewable resource assessments, energy demand analyses, the formulation of national energy strategies and policies, and studies of particular energy subsectors. Technical assistance can also increase public and private sector capabilities to analyze the benefits and costs of the variety of energy activities, as well as presenting options for development strategies and investment priorities in different time frames. AID should be prepared to provide technical assistance in those areas where the United States has substantial expertise that is applicable to, or could be organized to address, Third World energy analysis and planning problems.

2. Energy Training and Institutional Development

The establishment of indigenous technical and institutional capability to address energy problems is a high priority for all Third World countries. Experience in agriculture, population, and other assistance programs has shown the value of significant efforts in training and institutional development.

Designing and pursuing viable energy strategies requires a wide range of skills at various levels, in such areas as energy planning, project management, geology, engineering, environmental analysis, economic and social science disciplines, and energy equipment operation and maintenance. The social, economic, and cultural aspects of energy programs are as important as the technical aspects. AID training programs, both centrally and regionally funded, should be capable of responding to the need for training people in renewable and conventional energy and include both academic and in-service arrangements. Particular attention should be paid to programs implemented in the Third World, as well as in the United States, and might cover arrangements between U.S. institutes, laboratories, or universities on the one

hand, and individual developing country or regional institutions on the other.

Institutions to establish, finance, manage, and operate energy programs in developing countries. Assistance is needed at the national level to assure that the institutions and trained people are in place to develop a national energy plan and coordinate its implementation. Developing countries must also have regional and local capability to give life to national plans or to implement region-specific activities. AID's programs should recognize and reinforce the role of the developing country private sector (manufacturing, credit, rural cooperatives) in supporting dissemination of proven new technologies.

3. Site Testing, Demonstration, and Evaluation of New Energy Technologies

Prospective "new" technologies from both renewable and non-renewable sources stretch across the entire spectrum of energy needs. Among others, they include solar hot water heaters, photovoltaic pumps, wind pumps and generators, bio-gas digestors, ethanol and methanol production, small scale hydropower, and utilization of coal-oil mixtures. These technologies are in different stages of development and application. Technology assessments are needed to match energy needs in developing countries with prospective technologies and to establish priorities for U.S. Government research, development, demonstration, and investment for developing country applications.

The United States is spending several billion dollars a year to develop and demonstrate energy technologies aimed at meeting our own domestic energy requirements. Most of these technologies have attractive applications in developing countries, either in their present form or with some modifications. A systematic review and analysis of U.S. research and development is required to identify and adapt these systems for potential developing country use.

Renewable technologies are cost-effective today vis-a-vis petroleum-dependent technologies for some applications in developing countries. Further, if present research and development reduces their cost while oil prices continue to rise, renewable technologies will be more cost-effective. Widespread adoption of new technologies will not occur, however, irrespective of cost comparisons, unless the technologies have been proven effective from technical and social as well as economic perspectives in actual developing country settings.

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AID should support the site testing and demonstration of potentially attractive technologies that are ready for application and careful evaluation. With the strengthening of developing country capability in energy technology and a well-structured analysis of applications, developing country specialists and institutions can learn which technologies are appropriate for each individual setting and can formulate programs for their widespread utilization. AID should coordinate site testing and evaluation programs with other assistance agencies and developing countries to expand the information base on new technologies.

4. Increasing Energy Supplies

Developing countries must increase the amount and the efficiency of energy use in both commercial and traditional fuels to support their development efforts. AID has identified six forms of energy in which important progress can be made where AID can make a contribution: (1) fuelwood; (2) hydropower; (3) new renewable energy technologies, such as direct solar, wind, and biomass conversion; (4) oil and gas; (5) coal; and (6) energy efficiency improvements (which are functionally equivalent to a new source of supply). In addition, in selected countries AID may provide technical assistance in the development of geothermal or oil-shale resources.

AID will devote major attention to fuelwood production, both directly and by supporting multiple-use forest management activities that preserve and enhance forest resources. Used primarily for domestic cooking and heating, fuelwood has received considerable attention because of the high potential pay-off of fuelwood and forestry programs. Returns include (a) substitution for expensive imported kerosene (India estimates rural use at 3 liters/household/month or about 9 gallons/year), (b) reduced deforestation, with subsequent control of erosion, siltation, and flooding, and (c) continued use of organic fertilizers (dung, crop residues) to increase food production rather than as cooking and heating fuel. Considerable time and money must be devoted to designing fuelwood and forestry activities, because the economic, social, and political issues, along with the technical aspects, are critical, yet are still not very well defined, much less understood. Production possibilities include fuelwood plantations serving primarily urban areas and social forestry projects (e.g. supplying fuelwood, small timber, and minor forest products to the rural population) such as those now being implemented in India, Nepal, and Sri Lanka.

AID's emphasis here will be on experimental projects, village or family woodlots, social forestry projects, and

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multiple-use forest management, where these activities are appropriate. AID will look initially to the multilateral development banks for most of the financing of large-scale fuelwood plantations, but stands prepared to provide technical assistance for these activities. In light of the importance of fuelwood and forestry to rural development and the well-being of the poor, however, AID will consider capital assistance for fuelwood and forestry activities when other sources of financing are not available.

In the field of hydropower, AID expects the multilateral development banks to finance the large capital costs of conventional schemes. In particular countries or regions AID can play an important role by conducting basic surveys and helping countries formulate comprehensive plans to develop large hydropower projects. The banks are not generally involved in the development of medium- and small-scale hydropower (up to 10 megawatts), which could provide decentralized electricity and feed into national or regional grids. With some systems already less expensive than fossil fuels in rural locations, and with escalating fuel prices making small hydropower even more competitive, AID will consider assistance for these smaller hydro projects.

AID will also rely heavily on the multilateral development banks, other assistance agencies, and the private sector to finance energy production from new renewable sources (e.g., biomass conversion, direct solar, wind) when the technologies and their applications have been proven. As already suggested, however, there will be many opportunities for AID to provide technical assistance for testing and demonstration of new technologies, training, institution-building, and planning.

In the near to medium term, fossil fuels will continue to be a critical commercial energy source for both industrialized and developing countries. In fact, if they are successful in promoting economic growth, most developing countries will need to increase their relative reliance on these fuels while they begin to search for long-term replacements. Large tracts of unexplored, or poorly explored, sedimentary basins exist throughout the Third World, and a recent World Bank study estimates that production from these countries could increase from 2.6 million barrels per day now to 5.9 million barrels or more per day by 1990.

The private sector will be a primary source of capital and expertise to exploit fossil fuels. In some developing countries, private investment has been impeded by corporate fears of expropriation or high taxation,

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lack of potential for exportable surplus, and musunderstanding and mistrust between the host government and the corporation. The World Bank's "Program to Accelerate Petroleum Production in the Developing Countries" is intended to help overcome these problems, as well as to supplement private resources. AID's role in the fossil fuel area -- oil, gas, coal -- will take the form of technical assistance for training and institutional development, policy advice, and financing of some geological and geophysical studies in coordination with other assistance agencies.

Increasing energy efficiency in developing countries is an important but neglected "source" of new energy. Because present energy practices evolved in an era of cheap energy, and because little attention has been paid to the design of efficient energy systems, large returns can now be expected from effective conservation practices. AID will support programs to develop and promote improved cooking stoves, more efficient kerosene stoves and lamps, and more efficient charcoal manufacturing techniques. AID will also provide resources for programs to analyze and promote modern sector energy savings in industry, transportation, building, and electric power generation and distribution, in addition to household use.

5. Rural Electrification

In the past, AID has provided considerable assistance for rural electrification. The multilateral development banks also have been financing rural electrification projects. Future plans for assistance for rural electrification should take into account (1) the implications of national rural electrification plans for energy supply (particularly as they relate to oil imports); (2) evidence of the benefits from previous rural electrification projects (degree of encouragement of industry, increased irrigation, lessening of urban migration, improved income distribution, etc.); (3) the cost of electricity from a central grid when compared with decentralized systems, both conventional and non-conventional, over the life of the investment, assuming realistic estimates of future fossil-fuel prices; and (4) the relative benefits of rural electrification compared to foregone planning assistance, site testing, fuelwood activities, and other rural development programs.

Department of State

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FOR AID MISSION DIRECTORS AND AID REPRESENTATIVES

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TAGS:

SUBJECT: FY 1983 PROGRAM AND BUDGET GUIDANCE - ENERGY

1. I HAVE REVIEWED A.I.D.'S ENERGY POLICY AND HAVE COME TO A NUMBER OF CONCLUSIONS THAT I WOULD LIKE TO COMMUNICATE TO YOU FOR YOUR USE IN PREPARING YOUR ANNUAL BUDGET SUBMISSIONS. THIS MESSAGE COMPLEMENTS THE ENERGY ASSISTANCE POLICY PAPER ISSUED BY A.I.D. IN JANUARY (ADDITIONAL COPIES OF WHICH ARE BEING POUCHED TO YOU) AND REGIONAL BUREAU GUIDANCE.

2. AS YOU KNOW, THE ENERGY CRISIS FOR THE DEVELOPING WORLD HAS TWO MAJOR DIMENSIONS. FIRST, OIL-IMPORTING DEVELOPING COUNTRIES HAVE ENCOUNTERED SERIOUS PROBLEMS IN ADJUSTING TO THE PETROLEUM PRICE INCREASES THAT HAVE BEEN IMPOSED BY THE OPEC COUNTRIES IN THE YEARS SINCE 1973. IN MANY CASES, THE COST OF ENERGY HAS BECOME A FUNDAMENTAL CONSTRAINT TO THE OVERALL DEVELOPMENT PROCESS. IN THEIR EFFORTS TO COPE, COUNTRIES HAVE HAD TO REDUCE INVESTMENTS IN FUTURE ECONOMIC GROWTH, CUT BACK SOCIAL PROGRAMS OF BENEFIT TO THE POOR, AND GO MORE DEEPLY INTO DEBT. SECOND, DEMAND FOR TRADITIONAL FUELS--FUEL-WOOD, CHARCOAL, CROP RESIDUES AND ANIMAL WASTES--IS OUTSTRIPPING NATURAL REGROWTH AND REFORESTATION EFFORTS, INTENSIFYING PROBLEMS OF DEFORESTATION, DESERTIFICATION, SOIL LOSS, AND WATERWAY SILTATION.

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3. THE ENERGY CRISIS IN MANY AID-ASSISTED COUNTRIES IS SEVERE. MANY KEY U.S. INTERESTS--IN PROMOTING EQUITABLE DEVELOPMENT, INCREASING WORLD ENERGY SUPPLIES, EASING STRAINS ON THE INTERNATIONAL FINANCIAL SYSTEM, AND DRAWING UPON THE TECHNICAL SKILLS OF THE U.S. PRIVATE SECTOR--CAN BE SERVED BY EFFORTS TO AMELIORATE THAT CRISIS THROUGH INCREASED SUPPLY AND IMPROVED ENERGY EFFICIENCY. THE AGENCY SHOULD, THEREFORE, INCREASE SIGNIFICANTLY THE TOTAL LEVEL OF FUNDING DEVOTED TO ENERGY-RELATED ACTIVITIES IN THE YEARS TO COME.

4. THE CHARACTER OF ENERGY PROBLEMS, AND MEANS AVAILABLE TO MANAGE THEM, VARY GREATLY FROM COUNTRY TO COUNTRY. ACCORDINGLY, OUR RESPONSE SHOULD BE CAREFULLY TAILORED TO THE NEEDS OF INDIVIDUAL RECIPIENT NATIONS. IN SOME CASES WHERE ENERGY PROBLEMS ARE RELATIVELY MINOR, OR THERE IS LIMITED SCOPE FOR SIGNIFICANT IMPROVEMENTS IN THE NATION'S ENERGY BALANCE, THERE MAY BE LITTLE NEED FOR INCREASED ASSISTANCE IN THIS SECTOR. WHERE ENERGY PROBLEMS ARE SEVERE, OR THERE IS GREAT SCOPE FOR IMPROVED ENERGY SUPPLY, HOWEVER, AID SHOULD BE ACTIVELY INVOLVED.

5. SPECIFIC PROJECTS SHOULD BE BASED ON A CAREFUL EVALUATION OF THE OPPORTUNITIES AVAILABLE TO HAVE THE MOST FAR REACHING AND COST EFFECTIVE IMPACT ON ENERGY AND ENERGY-RELATED DEVELOPMENT PROBLEMS FACING INDIVIDUAL GOVERNMENTS. DEPENDING ON THE CASE, THIS MIGHT MEAN EMPHASIZING FUEL-WOOD PRODUCTION TO MEET THE DEMAND FOR COOKING AND HEATING FUELS, WORKING ON NEW ENERGY TECHNOLOGIES, IMPROVING ENERGY POLICY AND PLANNING CAPABILITY, TRAINING AND STRENGTHENING INSTITUTIONS, INCREASING THE EFFICIENCY OF ENERGY USE IN HOUSEHOLDS OR IN INDUSTRY OR TRANSPORT, IDENTIFYING OPPORTUNITIES FOR THE DEVELOPMENTOF INDIGENOUS FOSSIL FUELS, OR FINANCING PROJECT PREPARATION AND FEASIBILITY STUDIES. THE KEY VARIABLE IS THE DEGREETO WHICH ENERGY AVAILABILITY AND COST POSE A FUNDAMENTAL THREAT TO ECONOMIC DEVELOPMENT AND TO THE WELFARE OF THE POOR, AND THE DEGREE TO WHICH FOREIGN ASSISTANCE CAN BE CATALYTIC IN OVERCOMING THIS CONSTRAINT.

6. GENERALLY SPEAKING, WE SHOULD PROMOTE THE LEAST COSTLY ENERGY ALTERNATIVES AVAILABLE, AND THESE SHOULD BE SELECTED ON THE BASIS OF LIFE-CYCLE COST CALCULATIONS. WE SHOULD ALSO CONTINUE TO STRESS TECHNICAL ASSISTANCE IN OUR PROJECTS AND SHOULD ENCOURAGE THE INVOLVEMENT OF THE PRIVATE SECTOR, BOTH U.S. AND FOREIGN. FINALLY, ENERGY ASSISTANCE SHOULD BE CONDUCTED WHEREVER POSSIBLE IN CLOSE COORDINATION WITH OTHER U.S. AGENCIES, BILATERAL DONORS, THE WORLD BANK, AND OTHER MULTILATERAL ORGANIZATIONS.

7. A COMMITMENT TO INCREASE SIGNIFICANTLY OUR ENERGY ASSISTANCE ACTIVITIES ALSO HAS IMPLICATIONS FOR AGENCY STAFFING AND CONTRACTING. WITHIN PRESCRIBED DIRECT HIRE AND PSC CEILINGS, I EXPECT AID/W AND THOSE MISSIONS THAT PLAN SUSTAINED ACTIVITY IN THIS SECTOR, WHETHER IN RENEWABLE OR IN CONVENTIONAL ENERGY, TO TAKE STEPS TO ACQUIRE PERSONNEL WITH THE SKILLS NECESSARY TO DESIGN AND MANAGE PROJECTS AND TO ANALYZE THE ECONOMIC AND SOCIAL IMPACTS OF ALTERNATIVE ENERGY ASSISTANCE PROGRAMS. OVER THE COMING MONTHS, WE WILL BE WORKING HERE IN WASHINGTON TO INCREASE OUR CAPACITY TO PROVIDE ANY ASSISTANCE YOU MAY NEED IN OUTYEAR PLANNING FOR AN ENHANCED LEVEL OF PROJECT ACTIVITY IN ENERGY. HAIG

Position Paper

for

U.S. Delegation to UN Conference on New and Renewable Sources of Energy

Bilateral Assistance for New and Renewable Sources of Energy

Problem: To describe the U.S. policy on bilateral assistance for New and Renewable Sources of Energy.

Relative Importance to the U.S.: The U.S. is encouraging the developing countries to expand the use of their own renewable energy resources and maximize energy efficiency, thus supporting their development aspirations while expanding world energy supplies. The full utilization of new and renewable sources of energy can made an important contribution to supporting continued world economic growth, as more applications using these sources become economically viable.

U.S. Position: The U.S. position is based on AID's energy assistance policy paper and the Energy Policy Cable signed by the AID Administrator May 12, 1981, which states, inter alia, that: "The Agency should increase significantly the total level of funding devoted to energy-related activities in the years to come." The bilateral assistance program gives significant attention to new and renewable sources of energy, and accordingly expects a substantial increase in funding for these activities as the overall program expands.

Background: U.S. bilateral assistance energy programs reflect a recognition of the energy problems facing developing countries characterized by separate by related dimensions--dependence on imported oil, and inadequate fuelwood supplies to meet domestic demand. AID, the implementing Agency for U.S. assistance, is tailoring programs to individual country requirements and characteristics, consistent with each mission's program objectives and areas where AID programs can act as a catalyst to investment. These orograms will address not only renewable technologies but the use of non-renewable resources not being exploited, and the more effective and efficient use of all energy forms. In addition, as projects are developed, AID will emphasize the importance of energy as a critical factor in achieving development goals in food production, employment, and the environment. The Trade and Development Program (TDP) will provide some additional assistance

by facilitating the transfer of U.S. energy technology through grant-financing of project planning services.

Discussion: AID programs are expected to concentrate on technical assistance in the following areas:

-- analysis of needs, uses, resources and policies;
-- training and institutional development;
-- site testing, demonstration, and evaluation of new technologies;
-- increasing energy supplies, both conventional and renewable, with significant attention to fuelwood activities.

In most development assistance programs, AID does not expect to provide capital assistance except for fuelwood and small hydropower projects and to a limited extent for other renewable enrgy technologies.

The TDP program will finance pre-feasibility and feasibility studies, technology workshops and technology orientation visists to the United States.

U.S. assistance in the areas mentioned above is intended to help create the conditions for private investment in new and renewable sources of energy as these technologies become economically viable. The U.S. expects that the private sector will provide the primary financing for production of renewable energy just as the private sector does for fossil fuels in most developing countries. In areas where public investment is appropriate, multilateral sources of financing are expected to provide the major share of capital assistance.

In the conduct of its programs, the U.S. will encourage involvement of the private sector, and coordination and information exchange with other donors, the World Bank and other multilateral organizations.

As the negotiations on the UNCURSE plan of action move forward, proposals may be tabled for increased training, energy assessment and research and development on (i) tree species and varieties and (ii) new and renewable technologies that are projected to be cost-effective within the next decade. These areas coincide with AID's program interest. The U.S. would be willing to consider initiatives for establishing bilateral and international coordination in these areas, subject to the availability of funds. In areas where AID has particular interest and capacity, AID may wish to take a lead coordinating role. The U.S. would prefer that international coordination be led by organizations such as the World Bank or FAO.

AID's energy program budget as presented to the Congress for FY 82 is as follow:

	($ Millions)		
	FY 80	FY 81	FY 82
DEVELOPMENT ASSISTANCE			
Renewables (Excluding fuelwoods)	11.9	30.2	40.0
Fuelwood	11.3	8.6	37.6
Fossil Fuels	4.7	13.7	15.6
Subtotal	27.9	52.5	93.2
Power Generation & Distribution	19.8	25.8	.3
Total Development Assistance	47.7	78.3	93.5

ECONOMIC SUPPORT FUND

In addition to AID's programs, the Trade and Development Program provides small amounts of assistance for developing countries to promote renewable energy technologies.

July 1981

APPENDIX D

PROGRAMS AND PROJECTS OF THE OFFICE OF ENERGY

I. Background

The Office of Energy (S&T/EY) is constituted of eight professionals with background in energy policy, conventional and renewable energy technologies, and energy program management. The budget for FY 1982 is $9.65 million. At present, $9.65 million is projected for FY 1983. The Office of Energy is a component of the Agency Directorate for Energy and Natural Resources. This centrally-funded program resource is available to Regional Bureaus, Missions and AID Affairs Officers.

The Office of Energy seeks to ease LDC energy constraints to development and assist them to make the difficult transition to the new mix of energy sources required to sustain their economies. Toward this end, LDCs are assisted in using available energy more efficiently while conserving it where possible, in increasing energy supplies employing both conventional and alternative indigenous resources, and in minimizing costs associated with scarce, expensive imported fuels. The Office of Energy offers the following types of assistance:

- General Technical Services. Technical reviews and evaluations; support for workshops, conference and seminars; coordination among donors and technical agencies; provision of institutional and individual expertise for design, implementation and evaluation of projects.

- Energy Planning. Assistance to LDCs in formulating national energy policies and strategies; analyzing demand by sector; selection of energy conversion technologies, provision of on-site training in survey and planning techniques.

- Energy Training and Institutional Development. Training of LDC planners, decision-makers and mid-level technical personnel; consultation on institutional development plans.

- Increasing Energy Supplies. Help LDCs to explore, develop and market indigenous oil, natural gas and coal resources through technical assistance and training; accelerate the LDC shift to non-conventional energy sources where appropriate through site-testing, demonstration and evaluation of new energy conversion technologies; conduct national resource reconnaissance surveys where indicated; promote low-cost, small-scale energy conversion technologies; expand supplies of

fuelwood and charcoal; promote more effective use of bioresources.

II. Enhancing the Private Sector Potential of Energy

Energy lends itself to the involvement of developing country and U.S. private enterprise. The Office of Energy actively seeks substantially greater private sector support for development of energy in LDCs through the following activities, among others:

- To enroll young executives of U.S. energy industries (at the expense of their corporations) in the Energy Management Training Course at Stony Brook. This will expand contacts with U.S. industry by LDC participants and provide new relationships for the U.S. private sector with LDC energy officials in decision-making positions.

- To promote U.S. photovoltaic products in Third World applications through the five-year research applications project in photovoltaic technology with the NASA/Lewis Research Center. The project is providing test data on innovative applications of photovoltaic (solar cell) arrays in LDCs which require small amounts of electricity at relatively high cost, e.g. in rural clinics, education and communication projects.

- To refer to the Trade and Development Program opportunities for the sale of U.S. technical services and products in energy.

- To supply U.S. companies and technical consulting firms with background about A.I.D. energy programs and LDC needs and interests upon request.

- To tap private sector expertise wherever possible in project design and development. For example, the Office of Energy has a major contract with Bechtel National Corporation to provide technical services in development of coal, natural gas, oil and geothermal resources in developing countries.

III. Office of Energy Programs

The following program areas are being carried out by the Office of Energy.

A. Technical Assistance

1. Energy Planning Assistance

Purpose: To enable LDC policy makers to carry out

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effective long-term energy planning within the context of national economic development plans.

Resources Available: Country-level planning efforts are assisted by individuals or teams with sound LDC energy planning and research experience. Efforts focus on analyzing the feasibility of specific interventions, capital investments in developing resources programs, selection of technologies for increasing energy supplies and energy conservation. Activities may include institution-building, joint planning with assistance from teams contracted by S&T/EY or Missions, and analysis of critical policy issues such as energy pricing, incentives to implement strategies, and social economic impact assessments of proposed strategies. Assistance in developing a supporting data base can be provided. In-country and U.S. training activities can be designed to advance national energy plans.

Experience: Country-level energy planning activities have been conducted in Tunisia, Morocco, Guyana, Togo, Malawi, Sudan, Kenya, and Liberia. Energy-based economic and policy studies carried out by Resources for the Future. A workshop on energy survey methodologies was conducted by the National Academy of Sciences, funded by the Office of Energy.

Funding: FY 1981: $2.3 million; FY 1982: $1 million. Life of Project: $10 million projected for Phase II.

Contractors: Include Energy Development/International; Ferguson/Bryan; Energy and Environmental Engineering, Inc., Development Sciences, Inc., and International Science and Technology Institute.

Project Officers: Pamela L. Baldwin, Patricia Koshel

2. Energy Technical Services

Purpose: To provide short-term scientific and engineering experts in response to field and LDC requests for assistance in energy planning and program development, selection, transfer and adaptation of energy technologies, and assessment/evaluation.

Resources Available: A wide range of services is available under an Office of Energy RSSA with the Department of Energy. Technical staff from DOE and all the National Energy Laboratories [e.g. Brookhaven, Argonne, Oak Ridge, Los Alamos, Idaho, Lawrence Berkeley and the Solar Energy Research Institute (SERI)], can be made available on short notice without lengthy contract delays for assignments in LDCs. Services include technical consultation, choice of technology and

equipment, management guidance, evaluation, and applied research.

Experience: Helping Indonesia establish a national energy laboratory, the Sudan Petroleum Administration to design an energy training program, Senegal to design a solar energy water pumping project, Morocco to plan a Renewable Energy Institute at Marrakech, and the Caribbean Regional Technical Office at Barbados to consult on renewable energy projects in the ten countries it covers.

Funding: FY 1981: $400,000; FY 1982: $200,000. Reserves from previous year obligations and paybacks from Mission projects. Missions are urged to use this resource as a revolving fund, replenishing it as funds become available.

Project Officer: Shirley Toth

3. Conventional Energy Technical Assistance

Purpose: To assist developing countries identify and assess potential indigenous resources of coal, oil and natural gas.

Resources Available: High-level, experienced technical personnel to assist LDCs in exploring, extracting, producing and marketing existing or newly discovered sources of conventional energy. Production possibilities of known reserves will be evaluated on request. Where new resources are indicated, assistance can be supplied for their systematic exploration, using seismic and other geophysical survey techniques, geochemical studies and, where relevant, application of satellite and aircraft sensing imagery and photography.

Methodology: An Office of Energy specialist in conventional energy visits the developing country at Mission request to discuss requirements with indigenous officials and visit local sites and facilities. Once suggested activities are defined, a scope of work is prepared with the Mission. Existing contractor resources (Bechtel, USGS) or new contract expertise can be arranged for implementation.

Experience: CY 1981 was the initial year of conventional energy assistance. Bechtel National, Inc. the primary contractor, is assisting Sudan with recommendations to upgrade the Blue Nile Power Grid, Morocco and Ecuador in planning for use of fossil fuel resources, and Bangladesh for development of natural gas and coal resources. At the request of the Department of State, a U.S. Geological Survey research vessel is making a geophysical survey of

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a number of countries in the South Pacific to identify potential off-shore petroleum resources.

Funding: FY 1981: $1.7 million; FY 1982: $2.95 million.

Project Officer: Charles Bliss

4. Bioenergy Systems and Technology

Purpose: To promote development of cost-effective bioenergy production systems with the aim of increasing fuel supplies of biological origin in LDCs. The goal is to increase effectiveness of existing bioresources and development of new resources.

Resources Available: A core group of four full-time U.S. Forest Service experts to assist LDCs with bioresource assessments and design of bioenergy production systems. The latter includes capabilities in selection of conversion technologies and cultivation systems, species improvement, and marketing techniques. The core group is supplemented by other specialists from USFS or USDA and through use of outside experts as required. Demonstration and evaluation of new biomass conversion technologies can be arranged.

Experience: Biomass prefeasibility studies have been conducted in Panama, Guyana, Morocco, Costa Rica, Indonesia and Ecuador. State-of-the-art appraisals have been produced in areas such as combustion systems for agricultural and forest residues, methane fermentation of woody biomass, ethanol from sugar crops, and heat engines fueled from biomass. A bioenergy handbook with detailed technical data and specifications has been published for missions and host countries.

Funding: FY 1981: $1 million; FY 1982: $1 million.

Project Officer: W. Paul Weatherly

5. Small Decentralized Waterpower

Purpose: To assist LDCs identify, design, construct and operate small-scale, decentralized hydroelectric power systems to help ease energy barriers to development by increasing the supply of renewable energy.

Resources Available: A full-time staff of six professionals in the National Rural Electric Cooperative Association, a group of independent U.S. utility associations with extensive experience in small waterpower and rural electrification. Assistance can be supplied in national surveys, prefeasibility and

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feasibility studies: design and installation of hydropower; preparation of local demand forecasts and investment/operating cost estimates; analyses of financial, economic, sociological and environmental aspects of projects; and training for LDC planners and engineers in this field. NRECA taps expertise from its member associations of external consultants to study specific aspects of projects, e.g. civil works, hydrology, and electrical engineering including turbine and generator specifications and distribution systems. Other resources such as experienced hydraulic and electrical engineers from the Tennessee Valley Authority, are also available.

Experience: Assistance to 12 AID countries ranging as follows: preparing work scopes and project papers, country-wide hydropower surveys, prefeasibility studies, preliminary engineering, technical advisory services. In some countries NRECA engineers have recommended restoration of abandoned hydro sites at a fraction of the cost of new installations. NRECA has conducted regional workshops in Quito, Abidjan and Bangkok, involving a total of more than 150 participants from about 50 countries.

Funding: FY 1981: $1 million; FY 1982: $800,000.

Project Manager: William Eilers

B. Education and Training

1. Energy Management Training

Purpose: To develop LDC participant skills in energy planning and management, including familiarization with technical options associated with energy production and conversion and an understanding of the financial needs and institutional constraints involved in various development strategies.

Resources Available: A seven-week course offered in March and September each year at the Institute for Energy Research of the State University of New York at Stony Brook, Long Island, 60 miles east on New York City. The course is offered in conjunction with the National Center for Analysis of Energy Systems of the Brookhaven National Laboratory. Designed for middle to upper level LDC management specialists in energy planning or administrative institutions, preferably those with technical training and professional experience in an energy-related activity who have moved into energy management. The seven-week course is supplemented with a one-week field trip.

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Course Curriculum:

- Rationale for Energy Planning. Importance and benefits of national energy planning. Relationship to development planning.

- Defining the current situation. Energy information, data needs, and sources, energy modeling techniques; energy assessments, sectoral energy use and measurement; energy demand forecasting; resource evaluation.

- Identification of Policy Options. Role of assessments and applying results, energy supply planning, expanding conventional and renewable resources, industrial energy conservation.

- Program and Project Evaluation. Project evaluation, analysis of economic impact models, introduction to pricing structures and policies, capital planning and budgeting under uncertainty, and application of financial investment and analysis.

Experience: Since 1978 some 200 LDC participants from energy ministries, economic planning staffs, central banks, donor agencies, public utilities and refineries from over 50 countries have attended the course.

Expenses: Tuition, housing, one-week field trip, medical insurance, and a cash allowance to cover meals, laundry and miscellaneous expenses are covered from the S&T/EY contract which funds the program. International air travel, in-transit lodging, meals and ground travel connections to and from Stony Brook and the participant's home country, or the Mission. Participants are not authorized to bring family members with them during the session.

Funding: FY 1981: $650,000; FY 1982: $0.

Project Manager: Shirley Toth

2. Training Program in Alternative Energy Technology

Purpose: To provide short-term training in non-conventional energy conversion technologies, emphasizing small-scale, renewable energy resources, with the objective of strengthening LDC institutional capabilities in this field.

Resources Available: A 15-week course for 40 participants offered twice each year at the Solar Energy and Energy Conversion Laboratory, School of Engineering,

University of Florida at Gainesville. Includes lectures, seminars, laboratory sessions, shop fabrication of equipment, a specialized research project, and about two weeks of field trips. Participants gain knowledge to design, construct and evaluate systems based on alternative energy technologies. Required: a university degree or equivalent in engineering or the physical sciences; at least two years experience in an energy-related field; English competency, and nomination from a sponsoring agency.

Course Curriculum: Topics include: an overview of global energy, resource assessments of solar, biomass, wind, hydropower, and geothermal energies; flat plate solar collectors; concentrating collectors and photovoltaic conversion; refrigeration and food preservation; fuels from biomass; energy conservation; economics and financing of alternative energy systems; and sociological implications of energy technology transfer.

Expenses: Full tuition, lab expenses, field trips, housing, weekly living allowance and miscellaneous costs are provided through the S&T/EY cooperative agreement with the University of Florida. International air travel and in-transit costs to and from Gainesville must be covered by the participant, his or her employer, host government or other sources. Estimated value: $15,000 for the 15-week session.

Funding: FY 1981: $40,000; FY 1982: $900,000 (tentative).

Project Manager: Shirley Toth

3. Conventional Energy Training

Purpose: To provide LDC personnel with the scientific knowledge and skills in engineering, planning and management required to explore, develop and administer national programs to use indigenous conventional energy resources. (Conventional energy is defined to include oil, natural gas, coal, large hydropower, shale oil, tar sands and geothermal.)

Resources Available: About 100 LDC participants each year are offered up to two years graduate education at U.S. universities of internships in U.S. research institutes of industry which are designed to provide practical engineering, management, and analytical experience in conventional energy specialties. Typical fields of study include: geology and geophysics, (coal, oil, gas, oil shale, and geothermal resources), petroleum engineering (reservoir management, refining, enhanced oil

recovery), coal mining engineering and coal use (beneficiation, liquification and gasification), electrical engineering (power production, conversion, rural electrification, distribution, load management), energy resource planning and management (economics, law and policy analysis, demand forecasting and conservation), civil engineering (hydropower, geothermal, and other conventional resources), mechanical engineering (boilers, cogeneration, and conservation), and chemistry and chemical engineering (petroleum refining, petrochemical production.) Required: university degree in an appropriate field, speak and read English, acceptable Graduate Record Examination.

Experience: The Conventional Energy Training Project is administered by the Institute for International Education, with scientific guidance from the American Society for Engineering Education and the Accreditations Board for Engineering and Technology. The first 41 participants are in training at 14 U.S. universities in fields which include petroleum engineering, geophysical engineering, chemical and electrical engineering, geology, energy technology policy studies, and mineral economics. Fourteen individuals attended a four-month petroleum management course offered by the Arthur D. Little, Inc. Management Education Institute. One attended Westinghouse Corporation's two-month course on power systems.

Expenses: Tuition, fees and related educational costs, travel within the U.S., an orientation program, some English language training if required, a living allowance, books and supplies, a thesis allowance, and health insurance for the participant are provided from S&T/EY funding to IIE. International travel is generally arranged and paid for by the candidate's government. Nominees must have guaranteed future employment in a field that will benefit from the training received.

Funding: FY 1981: $2.525 million; FY 1982: $2.5 million

Project Manager: Pamela Baldwin

C. Assistance to Rural Energy Activities

1. Low-Cost Energy Technology for the Rural Poor
Purpose: In promoting the use of small-scale, low-cost appropriate energy technology in less developed countries through volunteer technical assistance.

Resources Available: Information, technical assistance, and small grants are available through Volunteers in Technical Assistance (VITA) to develop, demonstrate and

apply rural energy technologies, with a focus on rural regions. The scope of technologies includes among others improved, low-priced wood stoves, firewood and charcoal technologies, wind-powered pumps, biogas digesters, wind power generators, etc. U.S. scientists and engineers are enlisted as volunteers to visit LDCs or supply technical advice through correspondence to LDC counterparts or village workers. Energy manuals are published, a rapid energy information network is being established, and in-country training programs are organized. The role of women in applying appropriate technology is stressed.

Experience: Progress to date. VITA has compiled a substantial amount of diverse energy material and has published a number of manuals. VITA personnel and consultants have visited over 20 missions. About 75 small grants averaging $7500 have been awarded to underwrite activities such as wind turbines, solar greenhouses, crop driers, testing of solar refrigerators and experiments with new types of energy conserving building materials.

Funding: FY 1981 $1.325; FY 1982: $.800 million.

Project Manager: Ray Roan

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APPENDIX E

Goal and Strategies of S&T/FNR

1. Goal: The goal of the Office is to support the Agency's operational program by helping the developing clientele countries address their problems of forestry development and environmental and natural resource deterioration and by assisting the LDCs manage their natural resource endowment for productive use, including forest and related woodlands and grasslands and water, wildlife, watersheds, coastal zones, minerals, and other resources essential for their economic growth and well-being.

2. Strategies: The Office's major focus is on operational field programs, and it will use its resources to increase the effectiveness and efficiency of these programs. To the extent possible, it will make the specialist skills in the Office available to the Regional Bureaus and the Missions either from its direct-hire staff or from the extended human resource and institutional support put in place through its project activities and other linkages.

The project and non-project activities of the Office will be fashioned to satsify:

a. basic and continuing needs of our field Missions and their host countries.

b. innovative initiatives whose purpose will be to generat new information and new applications to advance the state-of-the-art.

An important element of the Office strategy deals with the manner in which the Office's activities are designed to make them relevant to Regional Bureau, Mission and host country needs. This is accomplished through two interbureau groups whose membership includes Regional Bureau, PPC and S&T Bureau personnel with competence in forestry, environment and natural resources. They are the Committee on Environment and Development and the Forest Resources Group. In addition, the Office routinely clears all project initiatives with appropriate offices in the S&T Bureau, such as the Offices of Agriculture, Energy, and Rural Development, to assure that redundancy is avoided and compatibility is achieved.

Each project will have its unique mode characteristics. The array that the Office will emphasize includes: technical asistance; planning assistance; linkages with internal and external organizations; information aggregation and dissemination; applied research; institution building; and training.

3. Rationale: The first priority in implementing the Office Strategy is to assure that we address the basic and continuing needs of the Missions and their clientele. As you will note from our ongoing and planned projects, we are putting in place activities that satisfy this demand. To the extent that funding permits, we then venture into innovative initiatives in order to advance the knowledge base in the various disciplines that make up forestry, environment and natural resources.

Office Portfolio

1. Legislative Mandate: AID Program investments in forestry, environment and natural resources have been growing significantly starting with the late seventies and into the eighties. In FY 1978 the Agency obligated $13 million; and its original FY 1982 request, now revised downward, amounted to $153 million reflecting an elevenfold rise since FY 1978. They were in part prompted by the 1972 United Nations Conference on the Human Environment (Stockholm, Sweden), the 1977 UN Water Conference (Mar del Plata, Argentina) and the 1977 UN Conference on Desertification (Nairobi, Kenya). The series of legislative changes in the Foreign Assistance Act of 1961 giving prominent attention to this area include: Sec. 118(1977), Sec. 102(1978), Sec. 103(1978), Sec. 118(1978), Sec. 119(1978), Sec. 119(1979) and Sec. 103(1979).

These amendments direct the Agency to improve the capability of the LDCs to protect and manage their environment and natural resources upon which depend their economic growth and well-being, especially that of the poor. Forestry and soil conservation are to receive special attention. Concern for the impact on the environment of AID's program was singled out, thus requiring environmental assessments. Attention was directed to the potential for renewable energy sources for rural areas including research on the use of wood. Finally, the most explicit authorization was given to AID to provide bilateral assistance to deal with forest resource depletion and associated soil and water resource deterioration.

The translation of growing worldwide attention to environmental and natural resources problems and the legislative directions into internal AID program guidance was accomplished by the issuance of 3 Policy Determinations (PD): PD-57 of January 12, 1973 - Selected Aspects of Science and Technology; PD-63 of August 1, 1975 - Environmental Aspects of Development Assistance; and PD-14 of April 15, 1981 - AID Forestry Programs and Policies.

2. Establishment of the Office: In June 1980, the Assistant Administrator of the Development Support Bureau requested the views of the Agency's Senior Staff on the creation of a new Office of Forestry, Environment and Natural Resources. He argued that AID's growing investment in this area, especially in forestry, required centrally funded support which was not available at that time. The review of the predecessor Office's program (the Office of Science and Technology) during the FY 1982 ABS cycle provided the principal forum for Agency comment on the proposed reorganization. There was agreement that a centrally funded and managed portfolio and technical staff support were needed in forestry, environment and natural resources.

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The new Office was formally approved on January 8, 1981 with a two division structure (Forestry and Environment and Natural Resources) and a staff of fifteen full-time, including 2 IPAs, and 5 part-time personnel. (Attachment 1 shows the presently authorized Office staff of 11 full-time personnel. The authorization for IPAs and part-time staff is yet to be resolved.)

3. Ongoing and Planned Office Projects: The Office's project activities are divided into two categories to show those projects that respond to satisfying the Missions' basic and continuing needs and providing innovative initiatives. The list is long (11 projects) and, therefore, on its face is misleading.

Of the four ongoing projects, two are terminating during the first half of this fiscal year (FY 1982). The Environment and Natural Resources: Expanded Information Base and the Forest Resources Management projects will continue.

The planned projects on the list reflect the formerly approved FY 1982 OYB at $3,250,000 and an FY 1983 current level of $3,500,000. The project sheets in Attachment 2 describe the 11 projects on the list. However, given the reduced level we have been asked to work with, a significant reprogramming of our funds will be required. We demonstrate the impact of this cut in the section on constraints.

Basic and Continuing Needs

Title: Environmental Training & Grants/Environmental Field Support (ongoing)
Implementation: Department of State
Project Manager: Molly Kux
LOP: $1,180 - 5 years (77-82)

Provides information (e.g., 45 country environmental profiles), guidance (e.g., environmental guidelines for irrigation), and training courses (e.g., watershed management) for AID-LDC personnel.

Title: Environment and Natural Resources: Expanded Information Base (ongoing)
Implementation: National Park Service
Project Manager: Molly Kux
LOP: $2,260 - 5 years (79-83)

Prepares and disseminates review papers, case studies and guidelines for development planners working in different biogeographic areas, such as the humid tropics, arid zones, grasslands and rangelands on natural resources management.

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Title: Forest Resources Management (ongoing)
Implementation: Forest Service and Peace Corps
Project Manager: Dan Deely
LOP: $3,700 - 5 years (80-84)

Provides technical experts to assist LDCs on forestry and forestry-related activities and funds joint PC-AID collaboration in forestry activities.

Title: Environmental Planning and Management (planned 82)
Implementation: International Institute for Environment and Development
Project Manager: Ming Ivory
LOP: $1,850 - 4 years (82-85)

Assists LDCs to develop environmental protection and natural resources management institutions and improve legislation and administrative structures through advisory services.

Title: Natural Resources Management Training (planned 82)
Implementation: USDA or Department of State (MAB)
Project Manager: Caldwell Hahn
LOP: $1,500 - 5 years (82-86)

Provides training to LDC planners, economists, scientists and technicians through short technical and management courses on forestry, renewable natural resources and environmental protection issues.

Innovative Initiatives

Title: Remote Sensing for Agriculture (ongoing)
Implementation: USDA
Project Manager: Charles Paul
LOP: $1,400 - 4 years (79-82)

Provides technical assistance in interpreting LANDSAT satellite imagery and air photos to identify various cropping patterns. Surveys of sample fields produce a crop reporting system for LDC use.

Title: Tree Seed Production
Implementation: Industrial Council for Development (ICD)
Project Manager: Dan Deely
LOP: $220 - 1 year (82)

Examines the feasibility of providing support to private enterprise and public agencies to expand production of tree seed and plant material required for AID and LDC-sponsored reforestation and fuelwood production projects.

Title: Man and the Biosphere (MAB) II (planned 82)
Implementation: Department of State (MAB)
Project Manager: William Roseborough
LOP: $2,000 - 6 years (82-87)

Provides research grants averaging about $50,000 to U.S.-LDC investigators to address problems relevant to AID needs in marine and terrestrial environment problems.

Title: Forestry Sector Development (planned 82)
Implementation: Resources for the Future/Society of American Foresters, UNIFOR, Industrial Council for Development (ICD)
Project Manager: David Joslyn
LOP: $6,000 - 7 years (82-88)

Provides opportunities for more effective mobilization of local, national and international financial and human resources from private and public sectors to insure sustained growth of forestry sector. Main emphasis will be on forestry sector policy planning, reforestation of degraded sites, private sector involvement and creation of international forestry research network.

Title: Water Resources Assessment and Management (planned 82)
Implementation: Dames and Moore, Woodward Clyde, Spectral Data, University of Wisconsin
Project Manager: Charles Withington
LOP: $4,000 - 7 years (82-88)

Trains developing country hydrologists to better assess and manage their water endowment; prepares water resources atlases and provides other know-how to facilitate prediction of groundwater locations, such as photogeology using LANDSAT imagery and aircraft photography.

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Title: Coastal Resources Management (planned 83)
Implementation: NOAA/University
Project Manager: William Roseborough
LOP: $2,500 - 5 years (83-87)

Investigates and determines major causes of environmental problems along coastal areas and uses this knowledge to influence LDC policies and programs to protect these vital areas subject to continuing degradation.

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APPENDIX F

POLICY DETERMINATION 74

A.I.D. FORESTRY PROGRAMS AND POLICIES

I. The Importance of Forestry in Developing Countries

Forests, woodlands, and grasslands provide food, forage, fuel, shelter, commercial products, and income and employment opportunities. These material benefits are critical in enabling rural populations in developing countries to meet their basic needs. Forests also provide important environmental benefits to society at large. They perform protective functions by regulating waterflow and preventing flooding; influence both the quality and quantity of usable water for agriculture, industry, livestock, and human consumption; provide habitats for wildlife; preserve a vast genetic reservoir of plant and animal life; help minimize soil erosion and soil resource depletion; influence local climate and meteorological phenomena as well as stabilizing global climate; and make recreational, educational, and scientific contributions to the entire population and succeeding generations.

Current rates of deforestation threaten the continued realization of these benefits. Unsustainable levels of forest use must be replaced by those which can be sustained. Fuelwood needs and the expansion of agriculture into forest areas are currently responsible for a significant part of the forest depletion. Yet it has been estimated that, by the year 2000, at least 250 million people will be without fuelwood to meet their minimum cooking and heating needs. People will be forced to increase their use of animal dung and crop residues, thereby decreasing their crop yields and providing further impetus to extending cultivation into forested lands. Thus, the long term prospects for growth in agriculture are also significantly threatened by the continued depletion of tropical forests. An allocation of development resources that is both adequate and appropriate to address the deep-rooted causes of deforestation is needed.

II. The Need for Forestry Programs

A.I.D. fully recognizes the importance of forestry as a key component of environmental and ecological systems and the overwhelming evidence that "...the accelerating loss of forests and tree cover in developing countries undermines and offsets efforts to improve agricultural production and nutrition and otherwise to meet the basic human needs of the poor."[1] A.I.D. also recognizes that few developing countries have the requisite knowledge or the development resources to carry out the wide-ranging programs required to stabilize forest use and to increase forest benefits. A.I.D. will therefore provide assistance to developing countries for a range of forestry programs.

Among the forestry programs which currently require assistance are those which seek to:

- Ensure that the production and harvest of fuelwood and timber is carried out on a sustained yield basis.
- Integrate the production of trees and tree crops into agricultural systems, that is, encourage agro-forestry approaches.
- Direct the clearing of forest cover or conversion of forest lands to other uses in ways which are consistent with land use capability.
- Reforest, afforest, or encourage the natural regeneration of lands not currently supporting any forest cover — to help balance conversion and transformation losses that will occur as forest lands are inevitably converted to other uses.
- Restore the productivity of degraded watersheds and depleted soils.
- Develop communities' capabilities to initiate and undertake forestry and forestry-related activities in their own behalf.
- Protect forests and set aside certain ecological areas for protection of plant and animal species.

1. Foreign Assistance Act of 1961, Section 103(b).

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In designing and funding such programs, both A.I.D. and host governments will be confronted with a number of hard political and economic decisions. Immediate benefits from forestry -- for timber, fuelwood, fodder -- must be balanced against long term needs -- for soil fertility, genetic resources, watershed protection, ecological diversity, wildlife habitat, future commercial development, tourism, and recreation. Land required for agricultural expansion in the short term may also compete with the need to maintain or create adequate areas of forest cover. Further, the successful implementation of these programs will require rural populations to participate in these decisions. Households, for example, will have to choose between satisfying pressing daily needs for fuel and food in the short term and investing additional labor and resources in the nurturing of new forest growth for future returns.

This policy determination sets out A.I.D.'s position on addressing forestry concerns in the context of its overall development objectives.

III. Forestry in the Context of Equitable Growth

A.I.D. has endorsed a strategy for U.S. bilateral development assistance which endeavors to support developing countries in their efforts to satisfy, through sustained and equitable economic growth, the basic human needs of their populations. Major elements of this strategy include: (1) assisting the poor to increase their incomes -- through raising their productivity and access to productive resources as well as expanding their opportunities for productive employment, and (2) increasing the availability of and access to goods and services required to meet these basic needs.

There is evidence in many developing countries that unsustainable uses of forest resources are already having widespread adverse effects. Such effects are being felt by consumers who need fuelwood to cook their food, farmers who require assured supplies of water for their crops and protection against erosion for their fields, builders who rely on timbers to construct shelters, and workers who depend on jobs in forest-related industries for their livelihoods.

The tendency in forestry programs, as in many agricultural development efforts, has been to direct available resources to the most fertile and productive areas. It should be recognized, however that people with little social, cultural, or economic standing are often forced to subsist on the most marginal and fragile forest lands. These lands require both greater knowledge and substantial economic investments to sustain productivity. Yet those who live in them often have least access to such resources and find special difficulty in controlling the problems begun when the forest and vegetation cover is removed.

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Without directed action to alter the allocation of development resources to marginal as well as more productive areas and to generate the knowledge needed to maintain deforested lands in productive use, inequities are likely to increase and to constrain significantly the prospects for sustained, equitable agricultural growth. These inequities and constraints will undoubtedly have broad ecological, social, and political ramifications.

IV. A.I.D. Forestry Policy

A.I.D. forestry policy includes the following elements:

1. A.I.D. will provide assistance in support of forestry and forestry-related activities. The assistance -- both technical and financial -- may be narrowly focussed (as in a reforestation activity in a single region in a single country) or it may be global in emphasis (as in support of a worldwide program of forest resources inventories).

2. A.I.D. recognizes that forestry activities may be an important instrument of rural income and employment generation. Forestry activities are thus to be seen as complementary to the Agency's broader rural development objectives. One implication of this is that in areas where underemployment is significant, labor-intensive approaches to forestry activities should be adopted.

3. Forestry program objectives supported by A.I.D. assistance may be broadly defined (as in supporting the intensification of permanent agriculture opportunities to prevent further encroachment on forested lands) or they may be narrowly specified (as in establishing a given number of tree nurseries to provide planting materials for community forestry).

4. A.I.D. recognizes that forests have multiple uses. For example, forestry (or agro-forestry) programs may be an appropriate approach for providing assistance to improve and restore the agricultural productivity of degraded watersheds and depleted soils.

5. In providing forestry assistance, A.I.D. will rely on normal project preparation procedures to indicate social, economic, and technical feasibility and to establish pragmatic project design. Popular participation of the prospective beneficiaries will be intrinsic to project preparation and implementation.

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Community and participant needs, interests, and capacities must be recognized and understood. The roles of local institutions, particularly those that manage the allocation and use of land, should be given major weight in project design and implementation.

6. In addition to bilateral support, A.I.D. will provide forestry assistance in collaboration with other donors, the U.N. specialized agencies, other U.S. Government agencies, U.S. land grant institutions, and private voluntary organizations.

7. A.I.D. will rely on Mission identification of country needs and forestry project opportunities, on host country initiatives, and on international or regional organizations' analyses to determine relative priorities and emphases in its forestry assistance efforts.

8. The U.S. Government is prepared to provide food aid as appropriate to support forestry objectives. Such assistance may be provided where forestry activities are essential to sustaining the productive capacity of agriculture in the long term but will involve a reduction in food supplies in the short run or where food for work approaches are indicated. In the latter case, the impact on local food production incentives must be taken into account.

This policy determination clearly establishes that A.I.D. is prepared to offer support to developing countries to assist them in addressing the broad range of problems associated with deforestation. The task will require resources far beyond the capacity of A.I.D. to provide. Thus, it is essential that A.I.D.'s bilateral assistance be associated with the mobilization of community and national resources within the host country itself. The political and financial commitment of the host country to altering unsustainable forest resource use patterns must be supported by the similar commitment of the rural population if A.I.D.'s support is to be effective. Complementary assistance from other donor groups and organizations will also be important, and collaborative opportunities should be explored wherever possible.

Because of the diversity of problems, resources, awareness, and commitment among developing countries, this policy determination does not attempt to delineate precisely the types of programs which A.I.D. will support in all cases. Any one of several areas of activity may be appropriate starting points for policy implementation and program development:

- Analysis, planning, and policy formulation (including natural resource inventories and land use assessments, land capability classification, evaluation of tenure law and its application).

- Institution-building for natural resource management and conservation (including training, management systems, and establishment of service support institutions).

- Incorporation of forestry activities into agricultural and rural development programs.

- Afforestation or reforestation, and protection of natural or induced vegetation.

- Appropriate or alternative energy analysis.

- Action programs for technology transfer and exchange, including extension and community liaison.

- Development of the scientific knowledge base and applied forestry research.

It should be emphasized that A.I.D.'s program of assistance in forestry will encompass program and policy options well beyond the narrow bounds of tree planting. Programs that assist developing countries to improve their capacity for making sound forestry and related land and natural resource use decisions normally will be conducive to creating sustainable and productive land use patterns in the long term.

Further, it should be stressed that few social and economic benefits of projects in natural resource conservation, preservation, and management will be realized in the short term. Some programs in forestry can be accomplished relatively quickly (assessment of resources, use rates, and causes of deforestation), but the development of programs to meet other objectives (training, controlling use rates) will require a decade or more before success can be expected, much less achieved. This should not deter A.I.D. from undertaking such activities.

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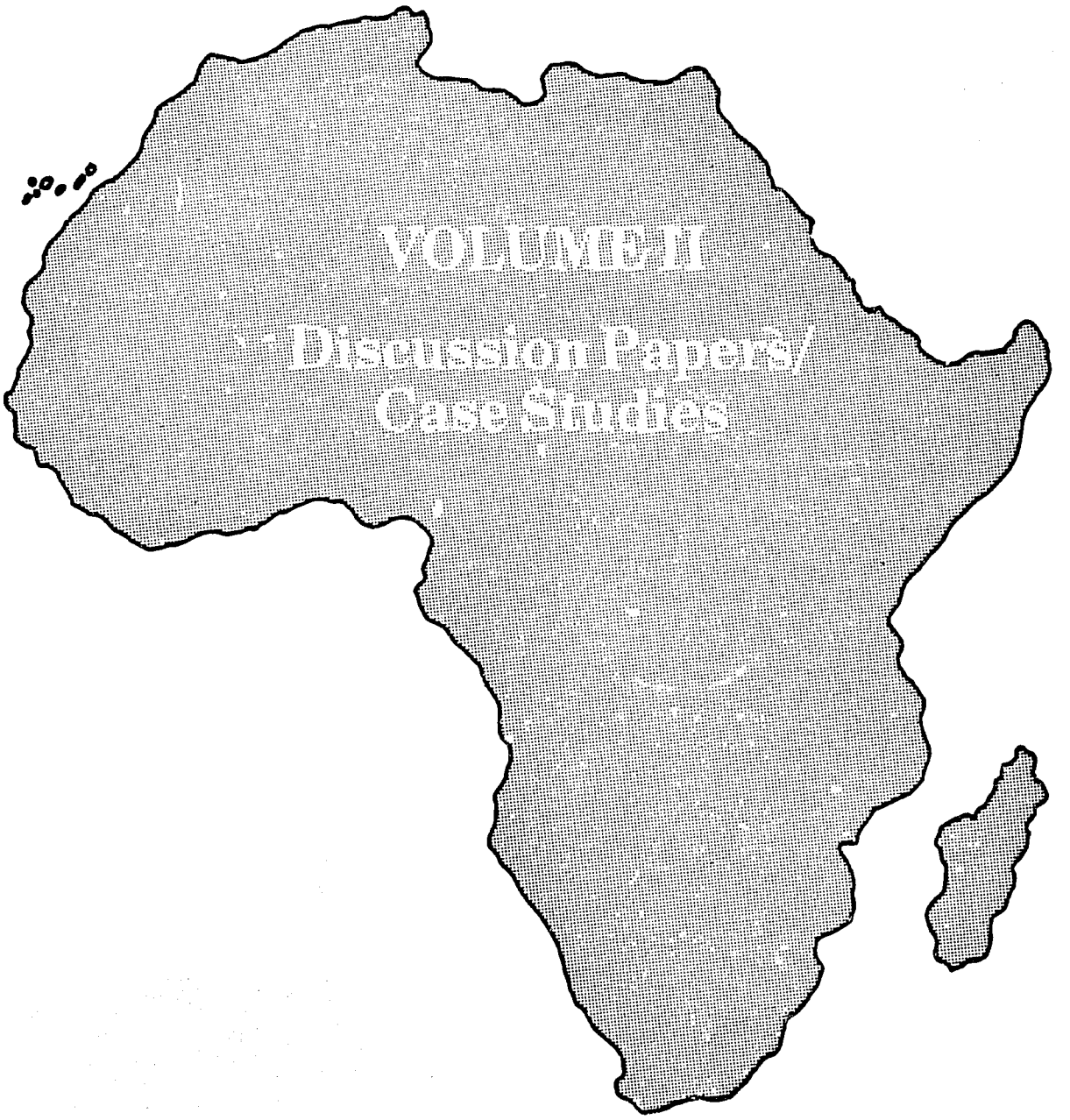
Proceedings of Workshop on Energy, Forestry and Environment



Bureau for Africa
Agency for International Development

April 1982

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Proceedings of
Workshop on Energy, Forestry and Environment

Volume: I Workshop Summary

Volume I includes the Workshop Report as prepared by the participants, a strategy for action and recommendations to the Assistant Administrator of the Bureau for Africa for implementing the strategy. In addition, there is information on the history of the Bureau for Africa's energy, forestry and environment programs.

Volume II: Discussion Papers/Case Studies

Volume II includes the 41 discussion papers and case studies which were prepared for the workshop.

Volume III: Country Energy Papers

Volume III includes the energy profiles of 21 African countries. The papers were prepared by energy, forestry and environmental officers of AID field offices.

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PREFACE

The discussion papers and case studies appearing in this volume were prepared for the Workshop on Energy, Forestry and Environment held in Nairobi during December 6 - 11, 1981. One of the goals of the Workshop was to improve the current information on designing and implementing projects in energy, forestry and environment and to stimulate the programming of projects in these areas.

Papers were presented on the world energy situation and its impact on the third world, particularly Africa. In response to what AID's role might be in helping African countries to alleviate this worsening situation, emphasis was given to the role of energy assessments, forestry and natural resource protection and management. In order to encourage the Workshop participants to think in planning and implementation terms, there were discussions on economic, social and technical approaches to project design and a review of energy technology project possibilities. In small working groups, case studies were discussed on AID's experience in reforestation, natural resource management and renewable energy technologies.

The authors of these papers and case studies are the energy, forestry and environmental officers from AID field Missions and other specialists, expatriates and Africans, who were asked to deliver papers at the workshop. Editorial changes have been kept to a minimum to maintain the integrity of the papers and preserve the writing styles of the authors.

VI. Implications for A.I.D. Staffing

This policy on forestry could have significant staffing implications for A.I.D. The corollary to the development of new activities in forestry is an increase in staff having forestry and related interdisciplinary backgrounds. Many of the constraints to improved forestry management lie in the purview of agriculture, political science, economics, law, social organization, and informal education, as well as in the technology of forestry. The Agency currently has few foresters on its direct-hire roster. Mechanisms for supplementing and increasing forestry and related skills in A.I.D. need to be addressed, within the context of continuing limitations on staff resources, in order to enhance the effectiveness of A.I.D.'s forestry efforts.

Approved: [illegible]

Date: April 15, 81

Indeed, where conditions of deforestation are most urgent, A.I.D. may wish to exercise considerable bilateral initiative in undertaking and supporting forestry-specific programs.

V. Implications of A.I.D. Forestry Policy for Assistance in Other Sectors

A.I.D.'s policy on forestry complements policy in other sectors. Indeed, strengthening the support for forestry-related activities should increase the potential for achieving objectives in other sectors in which A.I.D. provides assistance.

1. Environment and Natural Resources: A.I.D.'s Policy Determination on "Environmental Aspects of Development Assistance" (PD 63) and the procedural requirements contained in A.I.D. Regulation 16 (22 CFR, Part 216) direct the Agency to take forest values into account in the design of projects requiring A.I.D. assistnce. Better understanding and measurement of both benefits and adverse impacts should flow from increased activity in forestry programs.

2. Agriculture and Rural Development: The provision of support for the development of agro-forestry programs and other alternatives to unsustainable patterns of shifting cultivation should help to support and encourage a sustainable and sound balance between agricultural, range and livestock, and forest land use alternatives in developing countries. By developing alternative fuel supplies, fuelwood programs should benefit agriculture by increasing availability of dung and crop residues for soil enrichment. By developing forest-based income and employment opportunities, rural growth will be fostered.

3. Energy: The increased production of fuelwood supplies through the establishment of tree planations has already been adopted as an objective of A.I.D.'s energy policy. Thus, through direct production programs as well as through conservation of other energy sources (e.g., protection of watersheds above hydroelectric dams), forestry activities will play a key role in suppporting the achievement of A.I.D.'s energy objectives.

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PROCEEDINGS OF
WORKSHOP ON ENERGY, FORESTRY AND ENVIRONMENT

VOLUME II: DISCUSSION PAPERS/CASE STUDIES

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WORLD ENERGY AND THE DEVELOPING COUNTRIES

James W. Howe*

I. World Energy

A. Oil and Gas

Together they supply nearly three quarters of world commercial energy. Known reserves of oil are enough to last 35 years at present level of use. New discoveries are expected to more than double this. But the initial problem is not when we run completely out but when oil production will peak and then turn down. The demand curve for oil has been the key factor in determining the production curve. If production peaks soon after the year 2000, that curve will turn down no matter what the demand for oil. Therefore, the consumption curve will have to be forced down to match supply and that could be a world trauma without peacetime precedent. Earlier, experts thought production would peak around 2000. Because demand (and therefore production) is lower than expected, the production peak may occur later -- perhaps after the year 2010. However, in the interim, political turmoil may cause oil shortages. The Iranian revolution and war with Iraq cut oil supply only 2½ MBD but that was enough to drive prices up 143%. 1/

Gas will probably outlast oil, peak later, and become more important. It is more expensive to transport than oil. It is likely that some industries will come to where gas exists rather than vice versa, but gas will never be as important as oil in international trade.

B. Coal

World reserves are huge; coal could last 700 years at current rates -- less if coal consumption increased.

Problems: Reliability of supply (labor/management problems); high concentration of reserves and inadequacy of transport; air pollution; acid rain; threat of CO_2 increasing creating "greenhouse effect" on earth and changing the climate. Prognosis: coal will become more important, but it won't fill the gap left by oil, especially in international trade.

C. Nuclear

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* President International Renewable Energy Services; former Director, International Programs, SERI.

Outside USSR, France and Japan nuclear is about dead in its tracks. Problems: (1) fear of major accident (core melt or perforation), (2) fear of diversion of fuel to military or terrorism -- especially if we go to breeder reactors which produce plutonium, (3) if we do not convert to the breeder, fuel supplies will not last long, (4) fear of damage to posterity from waste storage; and (5) cost. Additional problems for LDCs: their grids are not big enough. Prognosis: Not much global relief to the energy supply problem. No direct benefit to LDC's except for a handful with large grids -- none in Africa south of the Sahara.

D. Conservation

Define it: not austerity but efficiency. In the U.S., SERI says energy use can drop from 75 to 65 quads by the year 2000. This is the most cost effective option in the short and medium term. One sees the beginnings of a real success story in OECD countries: growth in energy use is down from 5.2% p.a. in 1960-73 to 1.3% in 73-79. About ½ is due to slowed economies but nearly ½ is due to improved efficiency. In 1980, OECD energy use fell by 3.2% while GDP grew nearly 1%. OECD is beginning to de-link oil from growth. Relative to GDP, oil use is down nearly 20% since 1973 and the surface of possible savings has barely been scratched. 2/

E. New and Renewable Sources of Energy

Two U.S. studies (President Carter's Domestic Policy Review and SERI's study) say that by the year 2000, 20% to 30% of total energy (reduced from 75 to 65 quads through efficiency) can come from these sources: hydro, sunshine, wind, bio, geothermal. In the modern sector of developing countries the goal should be at least as high. 3/

II. Energy in the Third World

A. Third World Position in the World Energy Scene

They produce about half of world oil and gas; 4/ consume 15% of oil; 5/ oil use is increasing at 6.5% p.a.; 6/ and will be 30% of the world total by 2000. 7/

B. Energy Characteristics in Oil Importing Developing Countries (OIDCs)

1. Low level of consumption of commercial energy. U.S. per capita average is: 1000 times that of Nepal; 800 for Upper Volta; and 25 for India. An American uses more in a day than the average person of the Third World uses in a year.

2. Consumption of commercial energy is increasing rapidly as noted above.

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3. High level of production and consumption of traditional energy: in Africa, fuelwood consumption as a percentage of total energy ranges from 63% in Senegal to 94% in Tanzania. 8/

4. Unequal distribution in modern energy use in the Third World. (e.g. Abidjan used more than 1/3 of all the electric energy used in the entire CEAO/CILSS region; more than 60% of that in Ivory Coast.) 9/

5. Energy is used inefficiently -- as we shall see below.

6. These countries are hit hard by oil price increases. For example, 57% of Kenya's export earnings in 1980 went to pay for oil imports. 10/ OIDCs' balance of payments deficit reached $46 billion in 1979, $67 billion in 1980 and $73 billion in 1981. 11/ These statistics fail to describe the human side of the impact: lost jobs, further malnutrition, accelerated deforestation, etc.

7. Dependence on outsiders for technology to cut oil imports, find and produce oil, gas, and coal and development of renewable energy.

8. Under-exploited energy. In Africa there is moderate to good potential for oil, gas, and coal and excellent potential for hydro. Also, there are good prospects for renewable energy resources.

Prospects for the Rest of the Century in OIDCs -- Unless Trends Change

1. Increased oil import bill.

2. Continued deforestation.

3. Slowed growth.

4. Not many people will have access to modern energy.

III. OIDC Options

A. Basic Ques

How far and how fast should LDCs permit their economies to become dependent on oil? The dilemma is that if they slam on their brakes, it will hurt development now, since other technologies are not ready to take the place of oil, but if they hit the oil accelerator, they will be in trouble when oil prices skyrocket. Is there an option to touch the oil brakes gently and selectively? Within the framework of this dilemma their options are to:

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B. Develop their own conventional energy: coal, oil and gas

C. Improve the efficiency of oil use

1. In the Modern Sector: Re-think the urban layout and transport systems. Make modern buildings more efficient; same for industry. The South has a better chance to improve rapidly and inexpensively than the North because its infrastructure is not locked in place.

2. In the Traditional Sector: Most importantly more efficient use of wood.

D. Develop Renewable Energy

Solar powered systems: sunshine, wind, hydro, photosynthesis; plus non-solar tides and geothermal. There are four characteristics of renewable energy:

1. Abundance: 10,000 times as much as all conventional energy consumption.

2. Mostly decentralized: No problem of building a grid. The energy is already out in rural areas where the people are.

3. Cost: Capital costs are high, but some trends are good. No fuel cost, the more we use, the cheaper and better it is.

4. Manageable environmental problems.

Two objections are often heard regarding modern renewable technology:

1. First: LDCs should stick to wood which is fundamental and not waste time on new and chancy hardware. Answer: Fuelwood depletion is a severe problem and will never help those countries develop -- it will only keep them from deteriorating.

2. Second: New and renewable energy (NRSE) is just another passing fad inflicted on the South by the North. Answer: Some kinds of NRSE equipment will fail. But electricity and other forms of mechanical power are not passing fads, they are essential for development. Development is not possible without them. Human and animal muscle, and wood are not adequate energy forms for development.

IV. <u>Donor Option and Areas for Action</u>

A. Every Donor has Two Constraints

1. What the host government invites him to do, and

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2. What the donor's own rules permit.

Within these constraints there are many options:

B. Comprehensive Energy Planning

Help each country, using existing data, to review its options and select lines of action. Provide advisors on general energy strategy.

C. Develop Better Basic Information

Develop better basic information: (to refine and improve the comprehensive plan).

1. Resource assessment: wind, sunshine, bio, small-hydro. Coal, oil and gas are different; usually best done by private enterprise.

2. Data on energy use patterns in transport, industry, buildings, agriculture, domestic.

D. Develop Conventional Energy

Technical aid in production, distribution and use of coal. Train experts in oil, coal and shale to deal with foreign oil companies.

E. Renewable

1. Detailed resource assessment to find test sites.

2. Testing a variety of equipment.

3. Training and institution building.

4. Setting up networks to gather evidence on the performance of renewable energy.

F. Improved Energy Efficiency

1. Educate: sponsor scholarly work. See that it gets published; run seminars to spread the word.

2. Technical Advice: in industry; in urban planning; in buildings; in transport: in electricity production and distribution.

3. Help get conservation capability built into private sector; help establish energy audit firms.

V. <u>Summary and Conclusions</u>

A. We are facing an unprecedented transition from oil to its

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successors.

B. Conventional successors (gas, nuclear, coal) give us more time to make the transition but cannot fully take the place of oil.

C. LDCs have special problems; i.e. crushing oil bill; environmental devastation -- especially deforestation.

D. LDCs have an abundance of energy to take the place of oil.

E. LDCs have a special opportunity to improve energy efficiency -- better than that in the North because LDCs are still designing their urban, industrial buildings, and transport infrastructure.

F. Donors have many opportunities to make critical inputs.

G. Without action now, the OIDCs will be in a critical situation when the oil runs short and prices skyrocket again.

With action now the transition can be made to an era of energy abundance that will open the way for sustained development. There is time. But there is no time to waste.

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ENERGY ISSUES IN AFRICA

W.N. Mbote *

I. Overview of Africa's Energy Scene

Compared to countries in other continents, most African countries are well endowed with energy resources. However, while a number of them such as Nigeria and Libya are net exporters of energy, most others are net importers. Consequently, the majority of the African countries are directly confronted with energy concerns which affect the rest of the world.

Although I have not come across any official forecasting figure for energy demand covering the African continent, it is generally estimated that the annual demand is growing fast and will be about double before the year 2000. Gigantic efforts must therefore be made in order to double the current energy production. This means that unprecedented levels of financing and technical and environmental problems would have to be overcome in a relatively short period of time. Failure to do so will spell enormous difficulties to the economies of most African countries.

It is with this background that I would like to introduce to you what I consider as key energy issues facing most of the African countries and perhaps all other countries of the world. In doing so, I shall give specific examples based on the situation in Kenya.

II. Key Energy Issues

As stated earlier, Africa's indigenous energy resources are believed to be abundant to meet her future requirements. However, in order to develop these resources, there is an urgent need for each African Government to adopt energy plans based on the policy of self-reliance which inter alia should consist of the following main points:

- Full exploitation of hydropower resources including mini-hydro
- Extensive exploration and development of new oil and gas fields
- Full exploration and development of coal resources
- Development of nuclear power stations

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- Introduction of commercial and domestic fuelwood plantations
- Utilization of biogas and other vegetable fuels
- Improved utilization of renewable energy resources such as solar, wind, geothermal, tides, etc.
- Energy conservation

III. Hydropower

Where rivers and streams exist, particularly in Africa south of the Sahara, hydropower generation accounts for approximately 80% of the total electricity supply. Hydropower is also used for running water mills, grinding cereals, hydraulic rams, for water supply and irrigation in rural areas.

There still exists in Africa vast hydropower which is currently untapped. In Kenya for instance, the main hydroelectric potential is concentrated on River Tana with an estimated potential of 15,000 Gwh/year. Out of this, 4000-5000 Gwh/year (i.e. between 500-600 Mw) can be economically exploited. With the commissioning of the Masinga Reservoir, the total installed capacity will be 450 Mw. Exploration for other hydropower potential, including mini-hydros, is being carried out under the auspices of the Ministry of Energy. In total, the hydropower potential of Kenya is estimated at 1200 Mw out of which 750 Mw can be economically harnessed at todays market prices.

There is little doubt that in Africa, there will be a continuing and expanding requirement for large and small hydroelectric stations to feed urban, industrial and rural loads and thereby assist in displacing reliance on hydrocarbon fuels. In Kenya, the growth rate of the demand for electricity is 8% per annum and is expected to continue through the year 2000. This implies that the total hydropower potential, if harnessed exclusively for generation of electricity, will hardly meet Kenya's electricity demand by the year 1993.

IV. Oil and Gas

While a few countries in Africa have already discovered and developed oil and gas fields and are producing surplus oil and gas, most others depend on imported hydrocarbon fuels. Since the 1973/74 oil crisis, the international economic order has undergone a series of recessions which coupled with inflation have led to escalation in prices of manufactured goods. Most African countries, being net importers of energy and production technology, have been adversely affected. As a result, most African countries are spending a large part of their earnings from exports to finance the importation of petroleum fuels. In 1979 for example, Kenya spent 37% of her export earnings on oil imports.

The land mass of some of the African countries are known to possess geological and geophysical characteristics capable of having reservoirs of oil and gas. There is need for these countries to participate in more comprehensive and intentive exploration for hydrocarbons through fiscal and administrative policies. The exploration for hydrocarbon resources and their exploitation are highly technical and expensive. Both these technology and finances are lacking in these countries and therefore developed countries and their appropriate institutions should assist.

Exploration for oil in Kenya, especially in the Northeastern and Coast Provinces, has been going on for many years and is still proceeding. There is, however, need for the Government to simplify the licensing and other administrative procedures and to become more directly involved in oil exploration to ensure quicker results.

V. Coal

The known coal deposits in the world are estimated to be many times more than oil. Some African countries are already known to have substantial coal deposits and some are even exploiting them. With more exploration, other African countries should discover coal.

Being importers of technology, most industries in Africa cannot run on coal. Since coal as a source of commercial energy is destined to play a major role in future, and taking into account the environmental impacts of using coal, African countries would be well advised to start utilizing coal for powering industries in an effort to alleviate dependence on expensive oil. At least one company in Kenya M/S Portland Cement Ltd is changing from using fuel oil to using coal. Others should follow this example.

VI. Nuclear Energy

It is recognized that the issue of nuclear power is internationally highly sensitive. In spite of this, the fact remains that in order to meet the ever rising demand for electrical power in most African as well as many other developing countries, the use of nuclear power as a source of electricity is the only viable alternative.

At the present rate of growth for electricity demand in Kenya (8%) all hydropower potential small and large - will have to be fully developed by the year 2000. A small quantity of geothermal power will also be available. Then what? To enable Kenya's economy to continue growing, there is a need to start considering the introduction of nuclear energy now since the commissioning of a nuclear plant requires substantial lead time, particularly in designing, constructing and training of necessary manpower.

The present day cost of a nuclear plant (say 200-400 Mw) might be considered astronomical. But in the long run, nuclear power might be the only reliable source of electric energy capable of sustaining most economies in Africa.

VII. Fuelwood

At present, fuelwood and charcoal are the mos important energy sources for the majority of Africans. In Kenya, it accounts for about 75% of the country's energy requirements (both commercial and domestic).

Being an indigenous energy resource which is renewable and easy to handle, the future of fuelwood and charcoal should and in deed must be guaranteed. Recent studies in Kenya indicate that the current annual consumption of fuelwood is of the order of 30 million m^3 (approximately 22 million tons of air-dry wood). This is about 7 million tons of oil equivalent. Thus in terms of foreign exchange, use of fuelwood is saving Kenya an estimated 200 million pounds per year.

But if the present fuelwood use pattern in Kenya continues, the demand for fuelwood by the year 2000 will be about 55 million m^3. Already the trees are being depleted and there are insufficient stocks to meet the current needs on a sustainable basis. If nothing is done to arrest the situation, the country's forests will diminish rapidly, adversely affecting water flow, dam life, agricultural production, local climate and will make it extremely expensive and difficult for the rural communities to obtain cheap energy for their normal requirements.

It is gratifying to note that during the opening of the Masinga Reservoir, His Excellency President Moi urged all Kenyans to continue planting trees at every possible site not only in order to conserve soil and protect dams but also to provide fuelwood. This Presidential call must be heeded.

VIII. Biogas and other Vegetable Fuels

Most African economies have agriculture as one of their main basis. There is therefore abundant organic wastes from agro-industries (i.e., coffee, coconut, sugarcane, forestry, livestock, etc.)

Biogas production technologies are well developed in countries such as India and China. These technologies could easily be adopted in the African countries and could reduce reliance on fuelwood in rural areas.

The technology for producing ethanol from sugarcane, maize, and cassava for straight use or for mixing with motor gasoline is well known, particularly in Brazil and USA. The possibility for extracting vegetable oils which could be used for replacing or mixing with diesel also exists. There is need, however, for more research and development into these areas in order to improve the known technologies and to develop new ones which are appropriate to the African conditions.

In Kenya, the Government is promoting and fostering use of biogas as an alternative fuel in the rural areas and is encouraging

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production of ethanol from sugarcane or molasses for mixing with motor gasolines.

IX. Solar and Wind Energy

In Africa, the solar and wind energy are abundant and renewable. They have been used throughout history to perform various functions. It is estimated that one square meter of space in tropical Africa can produce 1 kw.

Solar energy, for instance, is widely used for crop drying, cloth drying, etc. There is ample scope for its use in water pumping, water heating, generation of electricity and so on. However, there is need to improve solar energy technology and make it readily available. Depending on availability of appropriate technology, solar power has enormous application in Africa.

Wind energy applications are many and several technologies appear promising. Wind mills can be used for water pumping and for generating electric power to operate remote unmanned instruments. It could also be used to generate electricity for remote communities isolated from the grid or for driving large wind turbines for grid-connected generation.

X. Geothermal

Geothermal power although not widely distributed is available in some African countries. In Kenya, geothermal areas are mostly located within the great Rift Valley. At Olkaria near Naivasha, the geothermal field has been proven to be a large one. Based on exploration data and certain geological assumptions, the estimated geothermal energy potential at Olkaria field is between 170 to 500 Mw available over a period of 25 years.

The development of the Olkaria geothermal field is in progress and already over 15 Mw of electricity is available.

XI. Energy Conservation

Along with the development of various energy resources, energy conservation and increased efficiency should be key features of the energy strategies of each African Government. Special emphasis should be placed on oil and wood conservation.

Energy conservation programs should encompass: information dissemination to promote increasing awareness, direct government grants or other incentives to remove capital barriers or to increase rates of return, taxation measures, regulation, removal of disincentives to efficiency, research and development, technology demonstration and in-house examples.

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XII. Training in Energy Planning

The importance and necessity of national energy planning particularly in developing countries as a guide to energy policy decisions has not as yet been fully recognized. National planning agencies, ministries of petroleum energy, electricity and finance as well as the international financial institutions concerned with energy development must realize the need for systematic and comprehensive energy planning as an essential component of overall economic planning.

Concomittant with the need for energy planning should be the recognition of the paucity of trained energy planners. Steps should therefore be taken at both national and international levels to develop training institutions for energy planners who can adequately undertake to solve the key energy issues such as those outlined above.

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ISSUES IN AFRICAN ENERGY DEVELOPMENT: ON TEACHING HOW TO FISH...

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In the months since the present AID administrator, M. Peter McPherson, has taken office, AID has heard much of the paradigm of 'teaching how to fish', a paradigm many of us first learned as Peace Corps Volunteers. In addition, we have heard of the need to 'build institutions', to place 'technology transfers' ahead of mere 'resource transfers', and to unleash the powers of private enterprise. These initiatives have been the 'top-down' initiatives of AID, the directives of those setting strategy. In this paper, I will explore briefly the 'bottom-up' initiatives, those which would seem to stem from the logic of energy development in the African context. I will first explore what would seem to be required in the way of a general strategy for energy development in Africa, and then move on to explore the implications of this strategy, in terms of the manner in which projects are analyzed, the types of projects undertaken, and in the use of organizations such as the Peace Corps and Private Voluntary Organizations of which the Administrator has committed the agency to make more use. What should culminate from this discussion is some sense of the field and the bureaucratic perception thereof, and a short list of major issues and suggested strategies for approaching those issues.

One major and pressing issue is how to address the problem of fuelwood shortages which afflict urban and rural sectors alike, and it is in this context that I would like to address the issue of a general strategy. The elements of this dilemma are clear.

1. The plantings needed to meet future demands are far in excess of actual plantings:

   ... To meet future rural and urban needs, annual fuelwood planting will need to be increased by about 15 times over current levels -- nearly one million hectares (2.5 m. acres) of new fuelwood plantings a year -- for twenty years. This level assumes that up to a fourth of future fuelwood demand will be met by conservation or ... alternative fuels (1).

   ... the amounts (of resources) devoted to establishing fuelwood supply plantations of any significant size is negligible (2).

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2. Indigenous governments cannot be expected to meet the need. ... African governments will obviously not have the ... funds from their own resources to pay for programs of this size (3).

3. Institutional capabilities for carrying out such programs are lacking: In many countries, the necessary national cadres of foresters and/or extension agents simply do not exist... transportation and other logistic support is often lacking (4).

   A recent case history from a Koudougou (Upper Volta) regional development project, assisted by FAO/UNDP funds, illustrates the fact that, without manpower, transport and gasoline, foresters, however well motivated, cannot be expected to service and supervise even small-scale planting programs successfully (5).

4. Attempt to regulate access has generally failed. With the notable exceptions of the conservation and reforestation drives in China and the Republic of Korea, most national and local government efforts to regulate access to fuelwood-producing lands, covering the spectrum from simple legislation to police-type patrols, have been ineffective (6).

   An added difficulty has been the alienation of local populations from forestry cadres who have been placed in policing roles, making cooperation in other initiatives less likely.

5. Costs of current attempts have been high and variable. ... current costs per planted hectare are quite high, but they also vary widely. Sahel (CILSS) is using an illustrative average of $725/hectare, for village woodlots based on recent field experience... The World Bank's proposed 5-year planting averages $765/hectare in East Africa and over $850/hectare in West Africa (7).

The above-cited source noted that a large-scale multi-purpose reforestation project in Algeria had reported costs of about $300/hectare. Alas, a field study by Fred Weber revealed that:

> labor costs per hectare alone would amount to $1080 per hectare...
>
> The World Food Programme Estimates the overall cost per hectare of reforestation as $1,600 (8).

In Brazil, on the other hand,

> ... the government chose to develop plantations rather than follow the path of community forestry. The price has been extraordinarily high. The public subsidy alone has ranged from $500 to $820 per acre (roughly, from $1,235 to $2,025 per

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hectare), and total costs give the plantation project the dubious distinction of being one of the most costly man-made forests in the world (9).

In this context it is notable that two AID experts, asked separately which donor-supported forestry projects would be able to pay for themselves, unsubsidized, in the marketplace, both answered succintly, "None."

The conclusions which have been come to are that "... the bottom line is that there must be massive fuelwood planting programs... (10)"

One wonders if a more logical conclusion would not be that we simply not get there from here, that in a situation where governments are without resources, where skilled personnel are not available, where donors are increasingly constrained, and where marginal costs are high and rising, a strategy based on 'more of the same' is doomed to failure.

Given the sheer magnitude of the task and the inadequacy of the public resources which can be mounted, there is need for a strategy which will mobilize resources on a wider scale. What is needed are responses which can and will be replicated.

An example of the potential of small inputs widely replicated is the jiko stove, or a metal stove of the Southeast Asian variety lined with clay. In Tanzanian tests, this stove design proved twice as efficient in burning charcoal as the traditional variety (11). The stove is quite cheap to make, and, given even a fraction of the cited savings, highly profitable to make and buy. Such an innovation is, in short, CONTAGIOUS -- there is reason for believing that others would seek to produce and disseminate the stoves with no donor inputs save the idea.

Another innovation is the improved charcoal conversion techniques (based on upgrading the traditional pile method) introduced by Ed Karsch in West Africa. This improved mound layout normally results in substantially higher yields with very little capital outlay. The ensuing higher profits lead to ready acceptance of the technique, and there is reason to hope for rapid CONTAGION and dissemination.

It is important to realize the potential in such small innovations. A household survey of Monrovia, Liberia, for example, reveals that 73 percent of the households use charcoal for cooking -- a not atypical result. Taking the lowest difference found in a number of measured trials, spreading the improved mound technology to the charcoal industry feeding Monrovia would be the equivalent of planting and maintaining a forest of about 23,500 hectares. If, in addition, improved charcoal stoves resulted in 25 percent energy savings, the savings would be the equivalent of a maintained plantation of over 40,000 hectares.

Caveats are in order. We are not assured of the level of gains in either technology. Nor are we assured that the total sector could be penetrated with the innovations. The point is, however, that large impacts can be had for relatively little effort and costs, if we can

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find replicable, CONTAGIOUS technologies. The benefit-cost ratios of projects introducing such technologies should reflect their potential for wide-spread replicability and mobilization of resources -- a point to which we shall return below.

In passing, it should be noted that we should not expect, nor depend upon, a succession of technological 'quick fixes.' As a BOSTID study noted, "With the exception of a few devices (for example, homemade windmills, solar driers) there are no cheap alternative technologies of significance for either industrialized or developing nations, and there probably will not be any in the near future (12)." Rather, we should search for technologies and institutions which conserve on our scarce publicity mobilized resources, and yield maximum impact. The example of the development of the Addis Ababa eucalyptus forest at the turn of the century is illustrative of how a serious fuelwood shortage was corrected with but a modest input of governmental resources.

Development of the Addis Ababa Forest (13)

The decision of Emperor Menelik to site a permanent capital to be named Addis Ababa at Finfini at the close of the 19th century placed extreme pressure on local forest supplies, so much so that it was thought that the capital would have to be relocated (14). A variety of laws forbidding the cutting or burning of trees without permission, and ordering replanting to replace trees cut down went unheeded and unenforced (15). By 1901, travellers approaching Addis Ababa had to do without wood for several days before reaching the capital, so scarce was wood (16).

Around 1894-1895 Europeans brought in a wide range of seedlings for plantings, including 26 varieties of eucalyptus. Menelik through his support behind this introduction by exempting from taxation lands planted in trees, and by distributing young plants at nominal prices (17). By 1899 a writer noted that owners of several hectares were planting their lands with eucalyptus in hopes of high profits, and that many houses and roads were rapidly becoming surrounded by forests (18). When in 1913 the newly created Ministry of Agriculture tried to order the trees uprooted (in the belief that they dried up water supplies), the proclamation went unheeded (19). By around 1920, Addis Ababa resembled a forest, and the wood shortage had been eased. At the time of the Italian invasion, the size of the urban forest was estimated to be not less than 4,000 hectares (20). By 1957, aerial photography put the forest size at 7900 hectares; by 1964, 10,400 hectares (21), roughly keeping pace with population growth.

There are important lessons to be learned from the Addis Ababa example:

1. Firstly, it is an example of the type of foreign aid project pressed for by AID's Administrator, M. Peter McPherson. Rather than being merely a 'resource transfer,' the extremely limited aid of the foreign donors was 'technology transfer.' Rather than 'catching fish' for the recipients, the donors concentrated on 'teaching how to fish.' There was no

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long-term dependency; indeed, historians have been hard put to pin down who introduced the successful species.

2. A second, related, point is that the 'foreign aid' would appear to be a necessary ingredient. The large number of varieties introduced were all exotic to Ethiopia; the transport costs were high relative to any hopes for private return; and institutionalization took several decades.

3. Thirdly, in contrast to modern forestry projects, there were no long-term governmental inputs required. By the 1960's, the Forestry Research Institute had still not included the eucalyptus in research plans because it was a 'plantation' tree. Indeed, as noted above, the industry grew despite government attempts to eradicate it!

4. Fourthly, the forest was an urban forest! While the urban forest expanded, the countryside remained denuded. Jane Jacob's, The Economy of Cities, presents a convincing case that cities developed agriculture first, and exported it later to rural areas. On the demand side, there is the urban market. On the supply side, the information and techniques from abroad arrived first in the urban areas. And location in the urban areas minimized transport (and energy) costs. Perhaps most importantly, the ofttimes perverse incentives of the rural countryside (arising from the nature of the land tenure systems) were avoided, and replaced with the positive incentives of the marketplace.

5. Fifthly, many of the elements of the system are wrong from the 'scientific' point of view, but as one writer noted, "It may be all wrong scientifically -- but it works." The stems are 'neither pruned nor stripped of leaves, 'and' from a forestry perspective, the plants are doomed (22).' The seedlings are planted at a density of 40,000 to 100,000 seedlings per hectare, whereas a textbook forester would say 10,000 per hectare were too many. But the crude techniques have proven enduring and economical, whereas the textbook techniques a research and development institute might have suggested (had there been one) might not have been either.

6. Sixthly, the economy of resource use must be emphasized. No only did the system require no 'manpower, transport and gasoline' for supervision, but a large amount of the wood was carried to market on people's backs, with women walking as far as 14 kilometers from the town center to purchase fuel from woodcutters and retail it in the city. Of that which was trucked, the majority was informally transported on top of contracted loads. It is doubtful that a planner would have dared devise a system requiring the bulk of forest products to be carried to market on pack animals and the backs of women, but the system provided large-scale employment, and competed in the marketplace with alternatives.

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7. Lastly, the very viability of the system should be noted. Despite enemy invasion, despite benign neglect by government, in one of the poorest and least literate economies in the world, with one of the least able governments in the world, the industry endured.

POINT: There is no hope whatsoever that our efforts in reforestation, whether in plantations, village or individual woodlots, will be adequate. Our funds will suffice at best to reach a tiny fraction of the necessary. If there is to be a solution, it will come through the efforts of the indigenous governments and the indigenous private sectors. Given the limitations of the governments, in terms of expertise, administrative and managerial talent and, most especially, finances available, the solution must most assuredly come from the response of the private sector. The focus of our efforts must be to complement and draw out the private sector's resources, and not to compete with highly-subsidized, non-replicable efforts.

If the general point is that we must attempt to focus on replicable, contagious technologies and institutions, the particular one is that we can design efforts in this particular sector to do so, by subcontracting out the production of seedlings and mini-plantations, by promoting the urban market and providing tax relief, expertise and technological backup, by subsidizing research in exotic and domestic species.

If the logic of the above argument is accepted, there are implications for the manner in which donor agencies conduct project analysis, for in the types of projects funded, and for the general approach we have taken to the energy problem. First of all, the above argument, with its emphasis upon replicability and spread (or dynamic) effects, casts doubt on the current emphasis on social benefits and costs in project analysis. It has increasingly become the practice among donor agencies to shadow price a number of inputs and outputs (most especially domestic unskilled labor and foreign exchange) when conducting project analysis -- to determine the 'social' benefits and costs with an economic analysis, as opposed to a 'financial' analysis which uses market prices. In addition, project analysts have tried to weigh a number of intangible and non-quantifiable benefits. While it has been recognized that replicability and spread effects are issues of importance, the difficulty in documenting these benefits ex ante has led to little consideration being given them in practice. These benefits may, however, dwarf social benefits by comparison. And these benefits, which accrue when projects are replicated by contagion, will not accrue unless projects are financially viable. There is reason, in short, for weighing projects according to their financial, as opposed to economic, viability.

The argument for letting viability in the marketplace be the major criterion becomes the stronger when we note that there is a tendency amongst planners to overstate benefits and to understate costs when there is no check on their behavior.

POINT: An attempt to focus on projects which were replicable and contagious would mean that we would favor such projects over 'welfare'

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projects and what I would call 'Buck Rogers' projects. Projects which are essentially 'welfare' projects, whose initial cost could not and would not be borne by the community of beneficiaries, or even by the government, and which neither we nor they can afford to give to all citizenry, are poor projects. Projects which could and would be paid for by the beneficiaries would be replicable and perhaps contagious, and would deliver benefits to a much larger population. These offsetting replicability benefits need to be weighed against the social benefits and externalities of the localized welfare project.

A project like the IRTP minihydro project in Liberia, for example, is undesirable not only because it is quite administration-intensive; the primary problem is that even if it can be successfully set up and maintained (both issues about which there is considerable doubt), it will have such a large welfare component that it cannot be widely replicated. For public projects whose products cannot be readily marketed, or for which there are externalities in the form of social benefits, technologies which require less subsidization per capita are both more equitable and more useful in mobilizing the populace into contributing labor and savings (23).

As a number of internal and external economic analyses have shown, and as several AID economists have related to me, there is simply no way to economically justify some 'Buck Rogers' technologies at present (24). Often the photovoltaic pumps are justified by noting that solar cell prices are expected tc fall dramatically over the coming decade. But as the French study points out, even if the solar cells were free, diesel would prove more cost-effective in the foreseeable future (25). 'Demonstrations' of such technology prove little more than that everyone enjoys a free lunch, and that AID has the capacity to fly NASA engineers virtually anywhere to make repairs.

Just as we can have added impact by concentrating on replicable, contagious activities, we can have added impact (and save energy!) if we can manage to do our activities only once. In the energy field, we have had difficulties in maintaining our efforts, for both technological and institutional reasons. Interviews in Liberia revealed that about two thirds of the water pumps were out of commission at any one time. In Tunisia, an evaluation of CARE water projects in 1980 found that about 75% of the project sites were not producing potable water, and that only 50% of the sites were operational (26). In Tanzania, another evaluation found a number of diesel and windmill/diesel systems did not function for lack of diesel fuel and parts (27). In Mali, 35 water-pumping windmills were installed between 1956 and 1958; by 1959, none were working. A European organization, ELAF, was contracted to provide maintenance; by the mid-60's, after maintenance duties were transferred, none were working (28). In Ethiopia, AID put in over 100 windmills; by the late 60's, few if any were working. An AID analysis estimates that 35 to 50 percent of rural water projects are not functioning 3-5 years later (29). With regards to windmills, the primary difficulty would appear to be institutional -- it has proven to be difficult to organize public institutions which can and do carry out the needed maintenance, and difficult to organize community organizations which can carry out those functions. In the case of water

pumps, at least in West Africa, the technology has been such as to exclude local production of parts, leaving localities at the mercy of government agencies of limited capacity. More than one expert has argued that the result of installing caps and pumps (which promptly break down) has been to reduce the supply of potable water! In Liberia, leading experts argued that a water supply program focusing on hand-dug wells and pails would be less costly, spread faster, stir local initiative more, and provide more potable water than the current drilling program, which has some of the highest drilling costs in the world (30).

In some cases, maintenance can be made more likely by institutional changes -- in Senegal, a forestry project achieved a 3 year tree survival rate of almost 100% by paying farmers a small fee each year for each surviving tree (31). In others, emphasis upon either simpler technology or upon the development of a maintenance industry (e.g. Kumasi, Ghana, where the Technological Consultancy Centre has started to develop the capacity to teach firms how to cast parts, the essential 'missing link' in developing a spare parts industry for water pumps) will increase maintainability. In any case, consideration of the maintenance aspect is crucial both to the choice of technology and to the design of a replicable, contagious program.

Finally, recognizing that "the likelihood of a replicable panacea... is low (32)," and that each technology, each enterprise, each community organization, will require testing, experimentation, and, perhaps initially, locally-based advice and aid, we must in so doing recognize the important role which the Peace Corps and Private Voluntary Organizations can play. As Emmy Simmons has noted of fuelwood programs:

> The reforestation effort is never going to be achieved by a top-down approach. It is going to require thousands upon thousands of community-based fuelwood efforts -- the kind of approach that Peace Corps Volunteers, working with villagers and host country officials and backed by AID resources, are uniquely suited to handle (33).

She goes on to note that successful collaboration depends upon AID's ability to develop means for rapidly making small grants available -- grants similar to the Improved Rural Technology Project funds or to the Ambassador's Self-Help Fund (34). It is these two issues which must be dealt with -- the role of the PCVs/PVOs, and how best to fund and support that role.

Private Voluntary Organization participation has been found desirable because of their ability to have low-cost administration, to decentralize, and to have grass-roots organization and support. As well, they are ideologically attractive and have wide-spread political support, so that even in the face of drastic budget cuts which may severely hamper PVO/PCV efforts (e.g., the proposed cut by 50% in the IRTP budget), there is still a call for increased PCV/PVO involvement. There is nevertheless reason for taking a critical look at PVO/PCV performance.

First, there is the issue of performance. In 1979, a report was made to the Office of Private and Voluntary Cooperation of AID on the developmental impacts of 17 projects in Niger and Kenya (35). All the projects were self-selected by the PVOs carrying the projects out. In a relatively ignored Table of the report, the researchers attempted to construct the ratio of net benefits to costs for the projects (all of which were designed as development, as opposed to welfare, projects; all of which were expected to 'pay off'). Two projects had more net benefits than costs; fifteen returned less than $.78 on the dollar, six returned less than $.10 on the dollar. I would hope that few present would be so sanguine as the writers of the report, who concluded:

> ... all projects in the sample could be credited with generating at least some positive benefits for the participating populations. This in itself is an encouraging finding (36).

Both this study and an AID study of PVOs in Bangladesh found that "systematic and diagnostic evaluations were the exception, not the rule" (37) while the Bangladeshi study found that "few if any show promise of becoming Bangladeshi, self-sufficient, viable, continuing development activities (38). The AID-supported projects were found to offer little if any replicability.

A review of PCV-related energy projects in Mali, Liberia and Ghana this year revealed that a large number of different ideas were being tried, but that in some cases highly uneconomic projects requiring high levels of subsidization and with little chance of replicability were being undertaken, while highly economic projects had yet to be widely publicized or replicated. While some Peace Corps-related projects were receiving AID Improved Rural Technology Project funding, it was notable that Peace Corps officials were greatly upset over the lengthy delays experienced in obtaining funding, AID mission officials were equally upset at the perceived inabilities of both the contractors and AID/Washington to act with clarity, intelligence and dispatch, and external economic and technological experts were upset that projects offering little chance of success and replicability were being highly subsidized.

These disparate remarks have a focus. The system by which PCV/PVOs can submit proposals for small amounts of funding (i.e., the IRTP) has led to poor proposals being submitted by groups who have little expertise in analyzing and evaluating technologies. It has led to inordinate mission time being spent on relatively small projects. Because of the paucity of proposals, it has led to even poor proposals being accepted. It has not led to evaluation and replication, but the attempt to improve poor proposals has led to the usual loss of time at mission and Washington levels. This is an issue that must be dealt with if AID is to make full use of the excellent characteristics these voluntary groups offer.

The simplest approach would be to attempt to identify a number of energy technologies which do seem to be replicable and contagious, to evaluate a number of such projects thoroughly, and to construct prototypes, complete with economic and environmental justifications, which would have pre-approval for IRTP-type funding (subject only to the normal

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monitoring of accounts and post-evaluation). This would provide PCV/PVOs with services they currently need and cannot perform, while providing an incentive to cluster activities in replicable, viable areas. The lag time and frustration would also be reduced, and PCV/PVO efforts could be concentrated on problems related to implementation. Mission time spent on such projects would be greatly reduced, and Washington time spent on field evaluation and the construction of prototypes.

Conclusions

Given the magnitude of the energy problems in Africa, and the paucity of our resources, we are forced to focus on how we can multiply the effects of our efforts. To concentrate on the transfer of resources is manifestly futile, but if we can 'teach how to fish', if we can devise replicable, contagious activities and institutions, even a relatively small input (as in the efforts of the foreign missions in Addis Ababa at the turn of the century) can have far-reaching effects. If, on the other hand, our efforts cannot even be maintained, the sands of time will erode even what we contribute.

Just as our efforts should be concentrated on 'energizing' the private sector by providing key technological and managerial inputs, we should seek to be as responsive as possible to the initiatives of the voluntary organizations, while providing vital expertise and direction.

Baldly and briefly stated, these comments are so general as to be both glib and trite. The catch, of course, is to give them substance in a specific energy plan and strategy, with specific technologies and organizations. And that, I say with some relief, is <u>your</u> task.

In closing, however, I will implore you to address the question seriously, and to seek a solution which, like Addis Ababa's forests, will endure. It is easy, I assert, to 'fake' good energy planning, and important not to. Let us for a moment consider a typical (admittedly strawman) approach to developing an energy policy for an LDC. Such an approach to developing an energy policy for an LDC. Such an approach might be characterized by (1) an energy survey or set of surveys, (2) the establishment of a R&D facility, (3) the development of an overall plan (often by a contract team), and (4) the funding of a project to initiate implementation of part or all of the overall plan. Such an approach seems manifestly sound (and safe), but I think it is crucial to question the utility of this approach.

Peace Corps and AID officials, PCVs and others in Mali expressed doubt that the information collected in village surveys was worth the effort; technicians there found the material collected for the most part worthless, and there was a real problem with information overload. Tom Graham found people exhausted with surveys in Swaziland, with few able to see much connection between surveys and subsequent action program (39). In North Cameroon, he found the surveys to be quite expensive, with there being little control over the sheer bulk of information collected (40). One might question as well whether a general survey

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which seeks to incorporate a number of issues and topics is really of much use, and whether the supposed economies of scale are not spurious.

There are, similarly, several reasons to worry about 'institution-building' in the form of R&D institutions. Such institutions, whether in agricultural implements research in Columbia and Mali, or appropriate technology research in Kenya, or energy research in Mali, have poor track records in developing prototypes which actually achieve mass marketing. The institutes tend to have a technician's orientation, and evidence is growing that such measures may do quite poorly in determining the usefulness of innovations in the field, both for reasons of economics and performance. Dr. Timothy Wood of VITA, testing woodstoves in Upper Volta, has found that "laboratory testing cannot accurately predict stove performance under actual use conditions, and it cannot provide a universal efficiency rating for any woodburning stove (41)."

There may be equally good reason to be concerned about overall plans and assessments. Firstly, there is the problem of duplication of efforts. There is a striking similarity between the materials provided by contract teams for various countries in Africa. One wonders if an excellent document -- say, the Kenya one, could not be used in toto elsewhere with little loss (except monies lost by contractors). Secondly, with regards plans, one is struck by how often they amount to nothing. As Emmy Simmons observed:

> AID's experience in Tunisia with a water shed planning and marginal land project, carried out between 1959 and 1967, illustrates the limitation which are posed when the commitment of the host country government to implementing scientific plans is not secured. Twenty-nine person-years of technical assistance were provided between 1963 and 1967. Soils and range surveys were carried out and conservation plans for the 157,000 has. Oued Marguellil watershed in central Tunisia were drawn up. Yet the single achievement of the project appears to have been a series of soil maps and an unimplemented watershed management plan (42).'

Planning, almost by definition, is oriented towards being comprehensive, towards being holistic. Yet to do so it must incorporate actors and institutions whose actions cannot be predicted, much less controlled. Ironically, one nursery started by one Ethiopian peasant which makes a profit has a greater impact (and a more predictable one, I would argue) that a 'holistic' plan by experts for an entire watershed.

To cap off this disastrous (but comprehensive) hypothetical energy strategy, the energy projects undertaken would be expensive, subsidized, non-replicable, and non-contagious; the contract team would have managed to write itself into the project; and, as a sop to renewable energy, the IRTP funds would have been used to provide a few photo-voltaic pumps or biomass experiments, high-cost and non-replicable, at a few research stations and institutes of higher learning, there to be used to astonish and placate visiting firemen.

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The 'strawman', of course, is entirely hypothetical... but it provides a target to avoid, lest we, as developers, find ourselves in the position of King Ozymandias, of whom Shelley wrote that a stranger found his visage in the desert, with the inscription:

> "My name is Ozymandias, King of Kings:
> Look on my works, ye Might, and Despair!"

And, Shelley wrote on:

> "Nothing beside remains. Round the decay
> of that colossal wreck, boundless and bare
> The lone and level sands stretch far away."

Yet Addis Ababa's forests survive.

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11. See Firewood Crops, Appendix 1, p. 170.

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14. R. Pankhurst, p. 707.

15. Ibid., p. 246.

16. Ibid., p. 705.

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17. Ibid., p. 246.

18. Ibid.

19. Ibid.

20. Horvath, p. 15.

21. Ibid., p.16.

22. FIREWOOD CROPS, p. 180.

23. Barbara Liesch has related two such examples from Ghana, where villagers were refused electricity on the grounds that the government did not have transformers. The village promptly purchased a transformer. Also, the town of Okarase was told they could have water pipe only if a four mile trench were dug for it. They did so, and received the water pipe. In such cases, the donor achieves a multiplier effect and may elicit contagious behavior, as other groups mobilize in order to obtain goods and services. The strength of the contagion effect is apt to be inversely related to the amount of subsidization, and there is the strong possibility that high levels of subsidization of public goods and services for a limited part of the population will in fact retard mobilization of goods and services by the rest of the population, because they see more gain in developing political contacts for welfare than in developing themselves or because they see provision of the good or service as the responsibility of others.

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INVESTING IN AFRICAN RESOURCE DEVELOPMENT

Dr. Carol Sakoian*

I have been asked to discuss what private international companies look for when they consider natural resource exploration and development in Africa; how companies become interested in a particular country; and how this interest eventually becomes an exploration/production contract.

By way of introduction, Conoco Inc., which recently merged with DuPont, is the ninth largest oil company in the United States. The company has oil, gas, coal, mineral and chemical operations in 24 countries.

Conoco has 30 years of exploration experience in Africa. It has been producing oil in Libya since 1962 and has an active exploration program in Egypt. It has explored in Chad and several other African states. Conoco's mineral division has uranium holdings in Niger and has investigated coal production on the continent.

Let me preface this presentation by saying that oil companies have learned that the success of any international venture is directly related to the company's ability to deal realistically and effectively with host governments. The broad objectives that companies seek in these relationships are: fairness; mutual benefits (without this no contract can last); reasonable political stability; and contractual consistency.

Commercial relationships between international oil companies and host governments get started in several ways. In some instances, the company will approach the host government if it believes the country has geological potential. The potential would probably have been identified by the firms' advance exploration department, which is made up of geologists and geophysicists who use a wide variety of sophisticated techniques to identify areas of high geological prospectivity.

Sometimes one company will invite another company to join an exploration venture through a farm in. This helps spread the risk. It also occurs when the first company does not have the resources, or does not want to explore all of the acreage it has been awarded.

Third, the host government may contract companies to offer areas for exploration. Governments do this by direct telexes, through oil industry publications and occasionally through the U.S. Department of Commerce.

What do companies look for? Obviously, the first and foremost requirement in geological potential. This can be demonstrated by the host government through existing geological data which is sometimes

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found in the archives of former colonial powers or from seismic surveys commissioned by the host government. Companies often buy this data package as a preliminary step to applying for exploration acreage.

After geology, the next important factor is the terms for exploration and production offered by the host country. Some kind of a modern petroleum law or model contract is a positive factor. Where this does not yet exist, companies will sometimes work with the government to formulate an administrative framework that both sides can live with. Here, the company must intelligently assess the country's objectives and educate the government so that it clearly understands the mission and objectives of a private company. Any steps a government can take to reduce the red tape involved in obtaining exploration/production contracts is a plus.

What factors does a company consider when analyzing whether to develop a hydrocarbon discovery? Very briefly, this is project economics. You measure how much oil and gas you think you've found (and this is never 100% certain); how long its going to take to develop, how much it will cost; and what the host government's share will be, against what you think your share will be worth on the market over the life of the field.

Companies also look at political risk. This is not simply whether or not the existing government will stay in power. The real question is how likely are the terms and conditions under which the company made its investment decision going to last. The company must look at more than the government's intentions.... What economic and social pressures might lead a host government to modify the original terms?

The overriding issue for a company is that it obtain an adequate return on capital. Not just a profit -- but a better return than if it did something else with the money. Companies also need profits to maintain the credit ratings necessary to borrow on high cost projects and to reinvest in further exploration. Finally, firms must use the profits where they find oil to help pay for all the places where they do not. As the risks of exploration become greater, the cost of failure even higher, companies must spread the risk and be involved in several areas simultaneously in hope that their successes will compensate for their failures. I do not need to tell you that this is a very difficult concept for governments to accept.

On the government side, of course, is the fear that it will be taken advantage of by the company. Although governments are becoming more technically competent, they still feel at a distinct disadvantage. For example, most exploration contracts require that the company report geological data to the local expertise necessary to interpret the data.

For assistance, host governments new to the international oil business can turn to the World Bank, the U.N. Centre on Natural Resources, and professional consultants. Outside sources can be helpful, but not always. For example, some oil producing countries which have already reached the stage of large proven reserves may offer assistance but unintentionally mislead those just entering the field into seeking terms which are unrealistic.

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Let me conclude this presentation by touching upon the possible role of AID in the area of oil exploration and production, commercial opportunities of interest to large international companies should, and will, be identified by the companies themselves. It seems to me that AID is playing a key role in a very different and important domain. While there may be opportunities for training energy economists/planners or for infrastructure building in host countries that would indirectly benefit large international companies, I would hate to see your good work distracted or diluted by tasks that can and should be done by the private sector.

SECTION II

THE ROLE OF NATIONAL ENERGY ASSESSMENTS AND CONVENTIONAL ENERGY PLANNING

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PERSPECTIVES ON ENERGY PLANNING IN AFRICA

Asif M. Shaikh*

I. Overview

Working on the premise that most of what I say here today will be forgotten virtually as it is said, I would like to start by stressing the central points which should be remembered. They are not points about the substance of energy planning, but rather about its context and its inherent limitations. Only by understanding these can we approach the task of energy planning with the appropriate humility.

- Energy planning is a process, not an event. Energy assessment is a component, usually an early component, of that process.

- Energy problems are part of a larger set of problems. Energy scarcity is only one of several factors which impedes economic growth and development. It is an important factor and certainly these days it is a fashionable one. But it is seldom the most important impediment to development.

- Finding solutions to energy problems will not necessarily solve the underlying problems we are trying to affect, whether they be balance of payments deficits, underutilization of industrial or agricultural capacity, deforestation or others. There is an urgent need for integrated solutions if we are to avoid having advances in energy frustrated by bottlenecks elsewhere.

- There is no standard format for energy planning or assessment. The scope, depth and analytical framework for energy planning must depend on the individual circumstances of each country. The most important determinant should be a country's longer term capacity to sustain the energy planning process set in motion.

- There is, however, a fairly clear set of objectives associated with all rational energy planning excercises: to understand the energy system (flows), to establish overall priorities in energy, and to focus the limited resources available on high priority areas.

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II. The Energy Situation in Africa

There is no need to review the entire African energy context at this time. A number of excellent presentations have already set the stage. We can focus on the two sets of urgent problems which clearly stand out throughout sub-Saharan Africa: the fuelwood problem, and the high recurrent cost of fossil fuel imports.

A. Fuelwood

The majority of the population in virtually all of Black Africa relies on fuelwood or charcoal to meet the bulk of their energy needs; in most countries, that majority is between 60 to 90% of the total population. Yet a number of nations face serious deforestation both around urban centers and in rural areas. This deforestation not only makes fuelwood increasingly inaccessible (either physically or financially) to the poor majority, it also threatens the very viability of rural production systems by reducing soil fertility increasing the loss of topsoil, creating greater threats of flooding, accelerating the process of "desertification" and, in some cases, even fostering adverse climatic change.

Wood energy demand is, however, only one amongst many causes of deforestation. Other equally important causes include:

- land clearing for human settlement
- land clearing for agricultural use
- poor land management in agriculture and herding
- poor crop rotation practices
- inefficient charcoal production techniques
- overgrazing
- lumber and other non-energy wood demand
- poor watershed management
- commercial forest exploitation

Reducing energy demand's contribution to deforestation is important and can create sizable incremental benefits. However, it will not always halt continued forest degradation; it will seldom reverse deforestation, and it will almost never - by itself - solve the deforestation problem.

The deforestation issue is, in fact, a set of issues. We reach the ironical conclusion that even if we successfully end energy demand's contribution to deforestation, we will not necessarily solve the problem of the inaccessibility of wood energy to the rural and urban poor majority. To address wood energy needs, we must eventually confront the issue of integrated land use management.

B. Imported Energy

A very large number of African countries lacking in sizable mineral, fossil or other natural resources face a severe balance of payments crisis. In several countries, petroleum imports alone drain 30-50% of foreign exchange earnings from exports. Energy prices have risen much faster than export revenues since 1973, and over the long run they will probably continue to do so.

Balance of payments deficits have drained foreign exchange reserves, have caused acute scarcity of precious investment capital and have held long-term development objectives hostage to the criterion of foreign exchange savings. In countries such as Sudan, Kenya and Somalia, amongst others, they threaten the continued financial viability of the nation-state itself.

But here again, energy imports are only one contributor to balance of payments deficits and poor economic performance. Other important factors include:

- overly ambitious investment plans
- inadequate infrastructure support
- technical problems in production
- inadequate management capability
- fluctuating export commodity prices and, importantly
- a very high import intensity of growth

On the last point, it is important to understand that most African economies have demonstrated an extremely high propensity to import all types of goods - including consumption goods, luxuries and non-energy intermediate goods - in the process of economic growth.

As with the deforestation issue, relieving the energy burdens on the balance of payments and the economy as a whole will make an important incremental contribution. But it will not solve the problem. The relative emphasis on solving the energy problem as against others bottlenecks should depend, on a case-by-case basis, on an understanding of the interrelationships between a number of factors.

An excellent example is afforded by a recent analysis E/DI performed as part of the National Energy Planning Assistance Project in the Sudan. Sudanese industry suffers from very low plant capacity utilization levels - typically on the order of 25-30%. Unreliable supplies of electricity and of petroleum products are important contributors to frequent plant shutdowns and low operating levels. However, the analysis determined that even complete elimination of these two energy bottlenecks would - in many industries - have only a negligible impact on improving capacity utilization. Why? Because a number of other obstacles would persist and would

frustrate only potential gains from improved energy supply reliability. Such obstacles include poor management, unreliable raw materials supply, transport bottlenecks, and shortage of spare parts. Clearly, in this case - which is not at all unrepresentative - unresolving the energy problem in isolation is not only inadequate, it is inefficient.

The mandate of energy planning in Africa then is to place energy in its proper context, and to coordinate energy solutions with realistic development solutions throughout the economy.

III. Energy Planning and Energy Assessment

A. Energy Planning

"Planning" is a peculiar term to have to use in the context of African energy problems. It carries the implication that you can "plan" energy developments and somehow control them. That implication is blatantly false. Most energy institutions in Africa must struggle even to influence the energy future. "Control" or anything vaguely resembling it, is simply not in the cards. The development process in Africa has, if anything been convulsive and often chaotic - both constructively and destructively. Let us therefore, despel any illusion that energy planning will allow controlled energy development. Planning institutions can, however, look ahead. They can plan public responses to events beyond their control, they can plan certain policies, they can establish targets and, if fortunate, they can favorably influence (or cease to unfavorably influence) the future path of energy use and production. The issue is whether or not this limited degree of influence can be exerted in a way which fosters economic development. In principle, it can be, and its potential benefits can be considerable. The purpose of planning is merely to make what positive contribution it can and to remove or avoid potentially negative public sector policies, no more and no less.

B. A Goal-Oriented Process

Energy planning is a goal-oriented process. The emphasis must necessarily be on the word process, because there are no quick-fix, one-time solution to the energy problems African countries face. Therefore, energy planning, its methodologies and its objectives must be consonant with the capacities of the specific African energy planning institutions, and especially with their long-term human and financial resources. They, after all, will be charged with carrying the process through in the years to come.

Energy planning must be goal-oriented if it is to actually affect energy problems. Specific solutions must be implemented, whether they take the form of policy measures

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(price structure, taxation, incentives, etc.) investments (in conservation, renewables, resource development, etc.) or coordination (avoiding energy intensive development paths, for example).

C. An Energy Planning Sequence

What, conceptually, is the substance of the energy planning process? Figure 1 provides a set of conceptual steps in the process.

The first step is to clarify and understand how the energy system actually works. How much energy is used, how much is produced, where and how is it used and what is its relation to economic activity - both present and future.

The second step is to develop the highest priority areas for influencing the energy system. Priorities must be established both in the context of having the maximum beneficial impact (absolutely and relative to the resources to be committed) and in the context of the likelihood of success. Trying to solve the most important energy problems can only be a high policy priority if we can think of measures which have some chance of succeeding in that area.

Implementation of priority solutions, the third step, does not, of course, occur at a single point in time, but is ongoing. Conceptually, the highest priority solutions should receive priority access to the scarce financial, human and institutional resources needed to implement them. All resources have opportunity costs. When investment capital is as scarce as it is in most African nations, piecemeal efforts are extremely wasteful. One of the most serious charges made against all donor agencies involved in energy in Africa is that there has tended to be a project orientation rather than a systems orientation. Throughout Africa we see examples of very costly pilot projects, which, even if successful and successfully replicated, would lead to negligeable energy system impacts, even as much more urgent needs go unfilled.

The next three steps - "follow-up", "repeat at next level of priority" and "update", are self explanatory, and merely underscore the ongoing nature of the process.

To repeat, these conceptual steps will not occur in order at discrete points in time, but rather will be recurrent parts of the energy planning process.

D. Energy Assessment

What is an energy assessment? It is an early information gathering, organizing and analysis component of the energy planning process. Relating it back to the sequence in Figure 1, an energy assessment is an important tool for achieving

steps 1 and 2, and for establishing the procedures for step 6.

Figure 2 provides a diagrammatic outline of the major steps of a "full-blown" national energy assessment. It is intended to show all of the activities which can occur as part of an overall assessment. It must be emphasized that the extent to which these generic steps are carried out depends entirely on the specific needs and capacities of the country for which the assessment is being done. The level of detail can vary greatly according to the availability and reliability of data, the ability to act upon the information gathered and the urgency of the need to act in certain clear priority areas. For example, in the National Energy Planning/Assessment Project in Somalia, we have found it of little value to gather detailed plant-specific energy use data for industry. The industrial sector is very small, it is dispersed and it has little managerial or financial capacity with which to improve its energy efficiency and its importance pales by comparison with the forestry, transport and other sectors. On the other hand, in a number of more complex economies, such as the Dominican Republic, Tunisia, Indonesia, Kenya & even Sudan, plant-specific energy data has been very important in developing national energy strategies.

The extent to which an energy assessment is of long-term value to the host country can be strongly influenced by its success in orienting itself awat from simple providing outputs ("energy supply-demand balances", "energy projections", "energy strategies" and so on) and towards contributing to the ongoing planning effort. In this context, the hidden agenda of an assessment is to:

- Create a framework for future energy sector data gathering, monitoring and analysis.
- Provide a focal point around which to define institutional responsibilities in energy policy-making and to build national staff capability.
- Build a consensus amongst various public and private sector actors as to the current energy situation, future prospects and the priority needs in energy policy and energy investment.

IV. Alternative Approaches to National Energy Assessment

A number of donor agencies have funded various forms of rational energy assessments in Africa. There include USAID, the World Bank, the U.N. Development Programme, and other bilateral and multilateral donors. At present, USAID and the World Bank are the most active agencies in this area.

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I would like to spend a few moments briefly contrasting three very different approaches to national energy assessment in Africa. There is no value judgement implicit in this comparison. The diversity of African energy systems means that each approach can best be judged on a country-specific basis. The approaches considered are of the U.S. Department of Energy (DOE), the World Bank and USAID.

A. U.S. Department of Energy

The DOE's assessment activities began in the early years following the 1973-1974 energy crisis. That period was characterized by a very limited understanding, anywhere in the world, of developing country energy systems and energy/economic interactions. Consequently, the focus of the DOE assessments was as much research/analytic as it was policy-oriented. That is, what was learned in a given country was as valuable for its contribution to general knowledge about LDC energy as it was for its clarification of that country's energy problems. The first DOE assessments were performed in Egypt and Peru, and subsequent assessments were carried out in Portugal, Argentina and South Korea.

The analytic methodologies available in the early years were drawn heavily from existing methodologies which were designed for developed country energy systems. The early DOE assessments have frequently been criticized for seeking much more detailed information on energy use and energy/economic interactions than is reasonable to expect in LDC's. We are all aware that this kind of disjunction between data needs and data sources leads to elaborate "estimation" exercises, and much valuable analytic effort was devoted to this task. The danger in such practice is that the sum of the micro estimations is not always consistent with the macro picture, and the reliability of even the more aggregated numbers is subject to question.

The DOE efforts tended to use large teams - typically $750,000 to $1,000,000 was spent in a relatively short time span-and gave little attention to building local institutional capability.

For these reasons, the impact of the DOE assessments on the development of viable energy policies has been very small - with the possible exceptions of Portugal and South Korea - both of which had relatively strong indigenous institutional capabilities.

B. World Bank

World Bank is currently involved i two types of energy assessments:

- a series of small-scale assessments in 60

developing countries

- larger assessments in the $200-$400 thousand range lasting one or more years.

To date, only three larger assessments have been performed in Somalia, Gambia and Panama. These are viewed as strictly exceptional, and no new ones are now on the horizons. Accordingly we will focus on the first category of Bank assessments.

The small-scale assessments are funded by the U.N. Development Programme, with the Bank serving as the executing agency. Typically, the efforts involve three to six person months and are performed largely by teams of Bank experts spending three to four weeks in-country and preparing a report in Washington.

The Bank views this kind of energy assessment as a diagnostic, not as a technical assistance project. There is no attempt at institution building and the assessment is not normally "housed" within any specific government agency. Methodologically, the assessments are quite straightforward. They are generally limited to preparation of energy supply-demand balances and discussion of issues such as energy pricing, energy/economic interactions, efficiency improvement, resource development and sector performance in electricity, petroleum refining and the like.

Of the 60 assessments planned, only about 15-18 have been done or are already in progress. These include Barbados, Bangladesh, Kenya, Zimbabwe, Zambia, Burundi, Rwanda, Thailand, Sri Lanka, Indonesia and Malawi.

The mandate of the World Bank energy assessments is very clear as regards their sectoral emphasis: they attempt to create "a maximum favorable impact on the balance of payments in the shortest possible time" according to the energy assessments department. Attention is focussed on projects which will have an impact before 1986/87.

The terms of the mandate reinforce the tendency to favor commercial and conventional fuels over traditional and renewable sources of energy. In the first place, traditional fuels have little direct impact on the balance of payments; in the second place, both traditional fuels and many renewable technologies require lead times of five to ten years before large-scale impacts can be felt. Because it is one of the key outcomes of Bank energy assessment to identify urgent energy investment projects, the commercial and conventional focus extends beyond analysis and into the actual allocation of project resources.

C. USAID

The AID energy assessment activities are carried out largely through the Office of Energy. The Office of Energys is not an energy assessment program, but rather an energy planning assistance program. Long- and medium-term energy planning projects (ranging from about $100 - $700 thousand) have been or are being performed in Sudan, Dominican Republic, Indonesia, Morocco, Tunisia, Togo, Malawi, Guyana and Liberia.

In direct contrast to the World Bank approach, AID's program is based on no standard format, scope or methodologies. It emphasizes "tailor-made" approaches to suit the specific capabilities and needs of host countries.

The three principles which underlie the AID program approach are:

- Institution building, in the recognition that energy planning is a long-term process, and that it is host-country institutions rather than AID or its contractors who will be responsible for energy development and policy.

- An implicit longer term committment to the energy planning and technical assistance effort until useful results are obtained. Particular stress is laid on the role of a resident long term energy advisor.

- An action orientation, which focuses on using energy planning as leverage for energy investment.

Several of the larger AID projects have included relatively detailed assessments covering supply-demand balances, detailed sectoral studies, energy/economic projections, analyses of conservation, and renewables potential, pricing analysis, energy information systems and formal and on-the-job training of energy personnel.

V. A Balanced Approach to National Energy Planning

It is a peculiarity of the situation we are in that the term "national energy planning" more often than not refers to planning for commercial and conventional fuels, while the traditional fuels that constitute the bulk of the national energy used are often ignored at the national level. At the same time, we find that throughout Africa rural energy initiatives have been undertaken with little or no attention to their macroeconomic or system-wide prospects.

There are several important biases in national energy planning against adequate treatment of rural energy problems.

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- The institutional bias: without question, the major of energy planning decision-makers in African governments are more immediately concerned with the commercial energy/balance of payments problem than with rural energy. Foreign exchange scarcity threatens the entire modern sector edifice; petroleum shortage and electricity cutbacks are felt most acutely in urban areas, amongst the most politicized socio-economic groups.

- The time-frame bias: rural energy problems need to be addressed with a much longer time grame than for most urban/commercial energy problems. Trees take a long time to grow, and the spread of small-scale technologies will probably take even longer. There is a bias amongst government ministries and foreign donors for shorter term payoffs, both because of the urgency of short term needs, and because of a reluctance by donors to commit to truly long-term programs.

- The simplicity bias: rural energy analysis is quite simply, more difficult than urban/commercial energy analysis. Rural energy in non-monetarized subsistence economies is heavily linked to rural development as a whole. There are few readily obvious "generic" solutions which can be applied without a detailed understanding of the specific rural environment.

- The data bias: not only is rural energy data more difficult to obtain and much less reliable than data on commercial fuels supply-demand balances, it is not always clear what should be down with it at a national level. In indigenous forest products use, supply is always equal to demand, by definition. It makes little difference to know that per capita wood consumption is 1 metric ton per year vs. 0.6 MT/yr if we do not know the sustainable forest yields. Even then, wood supply potential is very geographically localized, sustainable yields are tied to a host of environmental and demographic factors, and so on. In short the term "supply-demand balance" becomes a very complex and ambiguous statement for fuelwood.

  Yet there is in national assessments a distinct need for data which can be added or multiplied by and otherwise integrated with the remainder of national energy data.

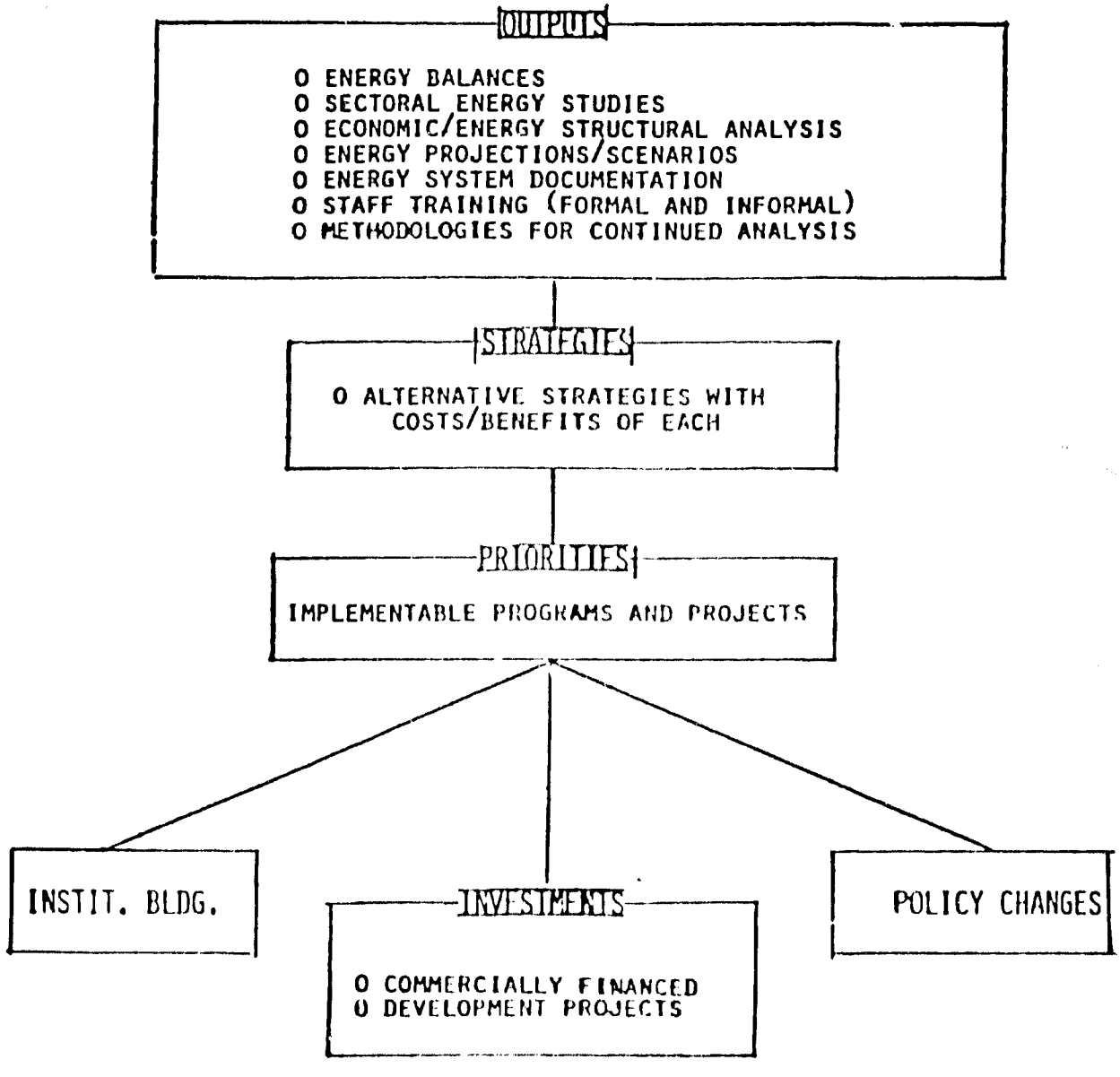
Despite these problems it is crucial to Africa's energy future to bring rural energy concerns to the forefront of national energy planning, and at the same time, to introduce into rural energy projects a greater sense of the urgency of system-wide solutions affecting large numbers of rural households.

VI Outcomes of Energy Planning and Assessments

I have talked about energy planning and assessments energy planning

must lead to something if it is to be useful. It is insufficient to say to developing nations " you have an energy problem and we will write you a report telling you how serious it is." Figure ___ diagrammatically illustrates the flow of outcomes of a national energy assessment, terminating in the three most important next steps: institution building, policy changes and energy investment.

OUTCOMES OF NATIONAL ENERGY ASSESSMENT



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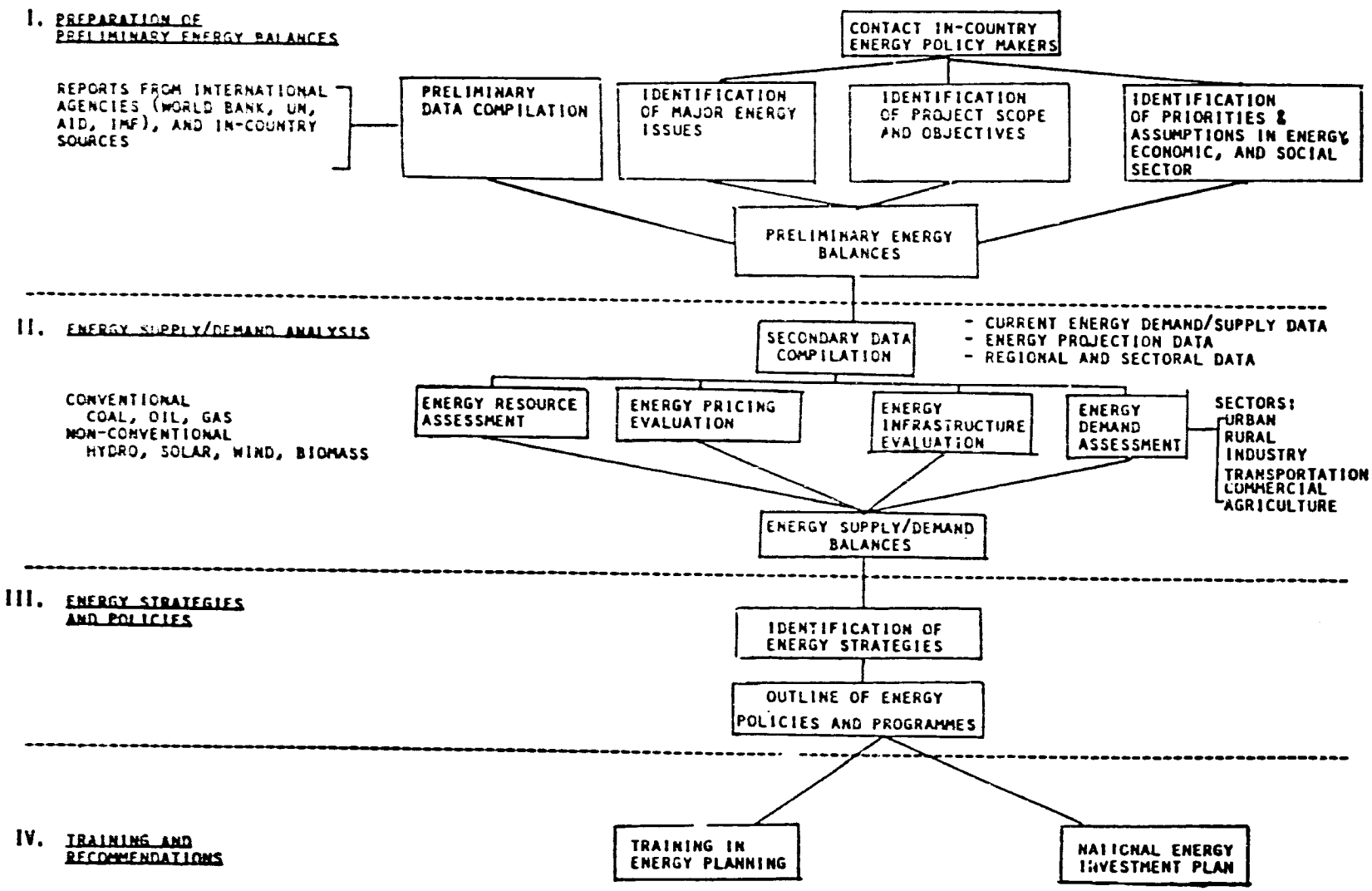
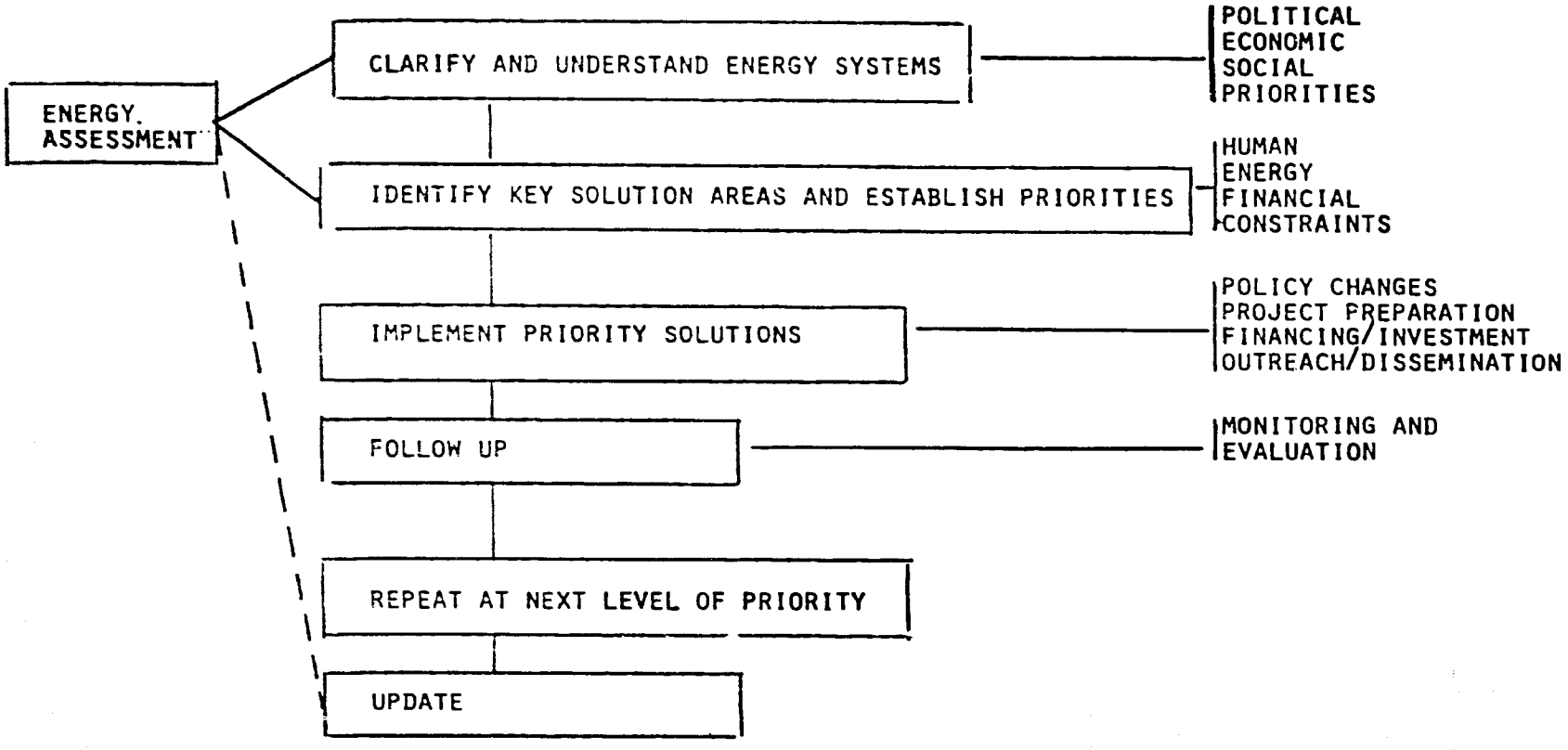
STEPS IN NATIONAL ENERGY ASSESSMENT



AN ENERGY PLANNING SEQUENCE



CAPITAL NEEDS AND THE IMPACT OF CAPITAL ON ENERGY PLANNING IN AFRICA

Colin Carter*

The connection between energy consumption and industrial activity is fairly obvious, as the industrial revolution entailed the use of alternatives to muscle power, particularly the use of fossil fuels. Since the industrial revolution was responsible for the current standard of living in the developed countries, it is presumed that the same route, or at least a similar route, should be followed by the developing world to achieve a comparable living standard. The route, if followed, may also bring with it much of the social turmoil that occurred in the developed countries through the last century. However, it is also a probability that much of this turmoil could be alleviated with help from the industrialized countries. We are assuming that there will be a growth in consumption of energy, both in total and on a per capita basis, by the African states; this growth in consumption being a necessary part of a growth in the economies of these states. I am going to discuss production, exports and costs of energy both capital and operation over the next 10 years. Using this as a basis, the expected capital needs can be derived and I will cover our estimates of the approximate capital expenditures. This will be followed by a review of potential sources. I will close by attempting to cover the myriad factors that a Bank considers when contemplating a loan for use in an African energy project.

First, let's review some history.

ENERGY CONSUMPTION - AFRICA 1970-1979

	1970	1979	GROWTH % P.A.
Total Consumption (Quads BTUs)	3.1	5.4	+ 6.4
Consumption 1/ (Quads BTUs)	1.6	3.4	+ 8.6
Per Capita (MM BTUs/Year)	8.1	11.2	+ 3.8
Per Capita 1/ (MM BTUs/Year)	4.5	7.5	+ 5.8
GDP 1/ (Billion $)	65	126	7.6 2/
GDP Per Capita	181	276	4.8 3/

1. Excluding South Africa
2. About 1% increase in real terms
3. About 1.8% decline in real terms

These figures are enough to lead to much concern. Since 1970, however, at least nine states representing nearly 20% of the population of Africa

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have shown a decline in energy consumption per capita.

STATES THAT HAVE SHOWN DECLINES IN PER CAPITA CONSUMPTION

CONGO	UGANDA
GHANA	TANZANIA
LIBERIA	ZAMBIA
MOZAMBIQUE	ZIMBABWE
SUDAN	

All of these states have suffered significant levels of internal problems that may have caused this decline, and these problems have also contributed to the poor economic performance of the region. Nothing in the numbers we have seen makes us believe that real economic growth for Africa is impossible in the next decade, and we also believe that energy consumption in some form will grow with it. Since the developments occurring will tend to be basic, we anticipate that for Africa energy consumption, growth will parallel growth in G.D.P.

ENERGY & ECONOMIC ASSUMPTIONS FOR AFRICA

ECONOMIC GROWTH 1980-1990	4.0% P.A. REAL
ENERGY CONSUMPTION 1980-1990	4.0% P.A. REAL
ENERGY CONSUMPTION 1980	7.0 QUADS
APPROX. G.D.P. - 1980 $	142 BILLION
BTUs PER G.D.P. $	49×10^6
ENERGY CONSUMPTION 1990	10.25 QUADS
G.D.P. - 1980 $	210 BILLION
BTUs PER GDP $	49×10^6

These are, of course, gross generalizations, and in fact would not imply any noticeable change in the per capita G.D.P. or energy consumption if the population growth of the last 5 years or so is continued. However, this does give a base against which capital investment can be estimated.

Having looked at energy consumption briefly, let's look at production of energy.

AFRICAN ENERGY PRODUCTION
(QUADS)

	1970	1979	1980	1990(est)
HYDRO/UNCONV.	0.1	0.4	0.7	1.3
COAL	1.4	2.1	2.5	4.4
GAS	0.05	0.7	1.3	3.5
OIL	11.1	12.4	11.9	16.1
NUCLEAR	--	--	--	--
TOTAL	12.65	15.6	16.4	25.3

Since oil production exceeds the continent's total energy consumption of 7 Quads in 1980 and the forecast 10.25 Quads in 1990, the obvious fact emerges that Africa is a major net exporter of energy, particularly oil.

We are assuming that consumption by the whole continent will have increased by 3.25 Quads in 1990 compared with 1980. Now, it is possible that this could be met with current production, and Africa would still have an exportable surplus. However, without investment, existing production declines, and the loss of foreign currency associated with the reduction in export would also be unacceptable. We have assumed that energy "export" will, in fact, rise by 5.7 Quads. This "export" is assumed to be made up as shown below.

ENERGY EXPORTS - AFRICA
(QUADS/YEAR)

	1980			1990		
	PRODUCTION	CONS.	EXPORT	PROD.	CONS.	EXPORT
HYDRO	0.7	0.7	--	1.3	1.3	--
COAL	2.5	2.1	0.4	4.4	3.8	0.6
GAS	1.3	0.8	0.5	3.5	1.4	2.1
OIL	13.1	3.4	9.7	16.1	3.7	12.4
NUCLEAR	--	--	--	--	--	--
TOTAL	17.6	7.0	1.06	25.3	10.2	15.1

Coal exports, all from South Africa, will be around 115 million tons/year by 1990. Oil exports will be at a net of around 5.8 million barrels per day in 1990 compared with around 4 million in 1980, and gas will be about 2.0 TCF/year. The oil will probably be from the following source states.

POSSIBLE MAKE-UP OF AFRICAN OIL EXPORTS - 1990
(MMB/D)

	1990
ALGERIA	0.8
LIBYA	1.6
NIGERIA	1.9
EGYPT	0.7
OTHER	0.8

The gas is assumed to be from Algeria, Nigeria and Cameroon.

Having set the basic production and export background that we are assuming develops over the decade, I would like to discuss our cost assumptions. I must emphasize that these are only approximate -- of the rule of thumb type. However, in many ways this makes them more valuable since they of general.

First, let's look at hydropower. This is an area where generalization is, perhaps, most dangerous, but an approximate figure in 1980 dollars would be $2,000 per installed kilowatt of capacity. Operating costs would be around $2 to $3 per year per kilowatt. Our assumption of an increase in hydropower production is equivalent to about 1.6 gigawatts of capacity costing about $3.2 billion in 1980 dollars.

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Coal costs will be almost entirely associated with distribution and consumption, since much of the production capacity is already in place. Even if all the increased production was from new mines, the capital cost would be only $4-6 billion (1980) over the decade, using an average cost of about $50 per annual ton of production capacity.

Gas production cost also varies, and when looking at these numbers, don't forget they are costs to produce, not distribute to the consumer. It is also difficult to separate the capital cost of gas discovery from that of oil, and we use a rough figure of $12,000 per daily barrel of production capacity, around $33 per barrel of oil produced per year or about $5.67 per million BTUs produced annually. In each case, the costs are in 1980 constant dollars.

This enables us to put together a rough summary of the capital needed to meet the energy picture developed. Please bear in mind that I am verifying my rules of thumb rather than developing out forecast. The projections of capital expenditure we make are made on a more detailed basis, but these generalizations will help to assess possible variations from the general pattern.

APPROXIMATE CAPITAL NEEDS FOR AFRICAN ENERGY PRODUCTION PROJECTS
1980-1990

FUEL	"ADDED CAPACITY"	1980 COST BILLION $	APPROX.CUR.COST BILL.$
HYDRO	4.6×10^6 KW	3.2	5.1
COAL	8.6×10^6 TONS	6.0	9.0
OIL	2×10^6 BBL/D 1/	48.0	77.0
GAS	1×10^6 BBL/D	24.0	38.0
		81.4	128.8

1/ Including investment to "replace" oil production capacity lost by standard depletion.

This shows a current dollar investment in oil and gas production of $105 billion, $77 + $38, compared with our published forecast of $72.8 billion for drilling and $30.8 billion for other E and P costs for Africa.

This investment is only for production. In addition, the investment to process and distribute, including movement to export sites, the consumption of these energy orms has to be considered. In order to do this, we must have an approximate assessment of the "type" of energy that will be consumed. We have already shown our estimate of primary energy consumption, and here I have shown this in the form of a sectoral consumption pattern for 1980 and 1990.

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ENERGY - SECTORAL CONSUMPTION 1980
(QUADS/YEAR)

	TRANSPORTATION	RESIDENTIAL/COMM.	INDUSTRIAL	TOTAL
OIL	1.5	0.2	0.8	2.5
GAS	--	0.1	0.4	0.5
COAL	0.1	--	1.3	1.4
ELECTRICITY	0.4	0.6	1.6	2.6*
TOTAL	2.0	0.9	4.1	7.0

	OIL	GAS	COAL	HYDRO/NUCLEAR	TOTAL
*ELECTRICITY	0.9	0.3	0.7	0.7	2.6

ENERGY - SECTORAL CONSUMPTION 1990
(QUADS/YEAR)

	TRANSPORTATION	RESIDENTIAL/COMM.	INDUSTRIAL	TOTAL
OIL	2.1	0.3	0.6	3.0
GAS	--	0.3	0.5	0.8
COAL	--	--	1.0	1.0
ELECTRICITY	1.1	1.3	3.0	5.4*
TOTAL	3.2	1.9	5.1	10.2

	OIL	GAS	COAL	HYDRO/NUCLEAR	TOTAL
*ELECTRICITY	0.7	0.6	2.8	1.3	5.4

This is an approximate breakdown, but it does give a basis for assessing additional capital expenditures. The first area to cover is the processing and distribution of oil. In this case, the cost of this step to yield electric power generation fuel can be considered as nil. In fact it is, in one sense at least, negative, since power generation requires heavy fuel that we believe will be in surplus over this decade. However, for the balance the alternatives will be to import from a world that will be long on heavy fuel and short of light products, or to refine and crack. We are anticipating a mix of this and estimate that African expenditures on refining over the decade will be $8.5 billion.

Capital expenditure on power generation and distribution capacity will certainly be necessary, with about 36 megawatts of additional capacity required. The investment would be on the order of $36 billion expressed in 1980 dollars.

Other energy-related capital expenditures will be associated with gas distribution and liquefaction for exports and while subject to many uncertainties this will probably be in the range of $15-20 billion in 1980 terms.

This enables us to summarize an approximate demand schedule for capital to finance energy projects in Africa over this decade.

CAPITAL NEEDS - ENERGY IN AFRICA 1980-1990

PURPOSE	BILLION 1980 $	BILLION CURRENT $
OIL & GAS E & P	72	115
HYDRO GENERATION	3	5
COAL PRODUCTION	6	9
OTHER ELECTRIC POWER	36	58
REFINING	9	14
GAS DISTRIBUTION	18	29
OTHER	10	16
TOTAL	154	246

To put this in perspective, we anticipate that the total capital investment of the world petroleum industry, excluding the Communist Bloc, will be about 2.6 trillion dollars over the decade, or more than 10 times the total energy investment in Africa. The "other" is included to cover the expenditure on such items as nuclear power, biomass, geothermal and solar power.

As a final part of this brief look at what the capital needs could be, I have put the various forms of energy available on an approximate cost comparison basis. There are so many caveats that need to be covered that I was tempted not to show the table at all. However, it is useful in looking at some project comparisons, and in case you might feel it helpful, I have included it.

APPROXIMATE COST OF DELIVERING FUEL TO "CITY GATE" OR EQUIVALENT
(COSTS IN 1980 $ PER MM BTU)

	CAPITAL COST	OPERATING	DIST.	TOTAL	APPROX. MARKET PR.
OIL	1.13	0.55	1.50	3.18	6-7
GAS	1.13	0.20	2.25	3.58	5-6
COAL	0.20	0.40	0.40	1.00	2-3
NUCLEAR	8.00	0.50	1.00	9.50	12-14
HYDRO	7.00	0.05	1.00	8.05	12-14

Now we come to possible sources of the capital. This varies from entity to entity and fuel to fuel. The oil industry, for example, funds over 70% of its capital investments by internal cash flow. By contrast, many public utilities are very highly leveraged, using debt as a major source of capital. As one point from which to operate our forecast of the source of funds for the world petroleum industry outside the Communist Bloc is shown here.

WOCA PETROLEUM INDUSTRY CAPITAL SOURCES
(BILLIONS OF CURRENT DOLLARS)

	1980		1990		CUM. 1980-1990	
	AMT.	%	AMT.	%	AMT.	%
INTERNAL CASH FLOW	94	73	415	71	2,429	73
CREDIT MARKET	28	22	132	23	710	21
OTHER	6	5	33	6	210	6
TOTAL	128	100	580	100	3,349	100

*TOTALS include sale of assets, issuance of common stock and drilling partnerships.

It must be remembered that the capital required includes dividends, debt retirement and increase in working capital.

From now on I will stick with cumulative current dollars over the decade. I am also, of course, ignoring any relative change in currency values, and am using the U.S. dollar as a convenient reference point. However, I am going to consider an approximate division between local and foreign currency for these projects. This will vary greatly from project to project and location to location. Despite this, there is some directional consistency even if the absolute numbers vary greatly.

APPROXIMATE DIVISION OF CAPITAL COSTS BETWEEN LOCAL AND FOREIGN CURRENCY

	LOCAL CURRENCY	FOREIGN CURRENCY
OIL & GAS EXPLORATION 1/	30%	70%
OIL & GAS DISTRIBUTION	40%	60%
OIL & GAS PROCESSING	25%	75%
COAL PRODUCTION	50%	50%
NUCLEAR PLANTS	40%	60%
HYDRO GENERATION	60%	40%
THERMAL ELECTRIC POWER GENERATION	50%	50%

1/ Excluding any lease cost

To further add to the confusion, who will provide the funds? In the case of oil and gas exploration it is usual under the relevant agreements for the exploring company to fund at least the major part if not 100%. Once the project has yielded proven reserves, the situation varies. In some cases, the state participates directly at this point (or the state oil company) including the provision of capital. In others, the state participation is via a sharing agreement under which the capital investment is provided entirely by the exploring oil company.

Processing, particularly refining, is more and more becoming a direct function of the state oil company, and the direct capital contribution by overseas oil concern is slim. This is reversing the level of the 60s and early 70s.

The provision of capital for coal production varies also, but the major investment occurring is in South Africa where the state is heavily involved in the capitalization of new export facilities, but the coal production itself is in private hands.

Electric power generation is generally a function of the state. This table gives an estimated breakdown of the capital needs into local and foreign currency and the responsibility for raising capital.

ESTIMATED CAPITAL NEEDS - AFRICA 1980-1990 BY TYPE OF CURRENCY AND RESPONSIBILITY
(BILLION $)

RESPONSIBILITY	STATE & LOCAL		OVERSEAS INVESTORS	
TYPE OF FUNDS	LOCAL	FOREIGN	LOCAL	FOREIGN
OIL & GAS E&P	3.6	8.4	30.9	72.1
HYDRO POWER	3	2	--	--
COAL	5	4	--	--
POWER GENERATION	29	29	--	--
REFINING	3.5	10.5		
GAS DISTRIBUTION	2.9	4.3	8.7	13.1
OTHER	4	4	4	4
TOTALS	51.0	62.2	43.6	89.2

Around 45% of the capital expenditure on energy in Africa will be the responsibility of state or local concerns, primarily state. The balance will be funded by overseas companies. Of the funds raised by overseas companies, 73% will be funded by internal cash flow. Of the state proportion, such a division becomes in many ways meaningless, but at least 30% will be provided by way of grants or soft loans leaving some $20 to 25 billion of foreign currency to be found by the state companies. When it is remembered that the current oil exports of the African oil producers generated $55 to 60 billion of foreign currency a year at present, and assuming consistent inflation, this figure will be over $190 billion in 1990, this funding should not be infeasible. As a precursor to the oil production or, at least much of it, this expenditure is indeed essential.

To summarize, we would anticipate that state concerns will raise at least $20 billion on the private markets over the next 10 years. The balance of their needs, about $51 billion in local currency and over $40 billion in foreign currency, will come from internal sources, grants from international institutions and soft loans. The private concerns will also raise some of their capital needs on the private market, probably close to $40 billion in total, though only about half at most will be directly against the credit of African projects via the various forms of project finance.

I would like to spend the last part of this review covering the factors that a Bank considers in making loans in this field. Before we go into this, I would like to remind everyone of what a commercial Bank is, and what its function is. Quoting from the Encyclopedia Britannica, "A commercial Banker is a dealer in money and in substitutes for money,

such as checks or bills of exchange.... The basis of his business is borrowing from individuals, governments, etc. With these resources and his own capital, he makes loans or extends credit.... The banker makes his profit by borrowing at one rate of interest and lending at a higher rate." The critical points to remember are that its responsibility to its stockholders is to make profit, and that a Bank does not take equity risk. The margin between the banker's loan rate and his cost of funds limits the risk a bank can take to a very minimal one. A very large part of a line officer's time in a commercial bank is spent convincing the bank's credit officers that the project he wishes to lend to is as near to being risk free as possible. The law varies from country to country, but U.S. banks are limited in the extent of their exposure to individual entities by law, and limit their exposure to countries and/or regions by way of their own internal controls.

POINTS CONSIDERED BY BANK IN MAKING LOAN

- PROJECT RISK
- "ONE OBLIGOR" LIMIT
- COUNTRY LIMIT
- RATE OF RETURN

The order in which a review proceeds is not fixed, but the project or concern to which the funds are being loaned is considered first. If the loan is against the credit of a company or state corporation, then the financial strength of that concern is thoroughly investigated. The reputation and financial strength of an Exxon is fairly well known and established, and a loan against Exxon's credit would rapidly move to the next step -- one obligor limit. A loan against the credit of, for example, a U.S. pipeline company to cover the construction -- or their share -- of the Alaskan gas pipeline could represent such a proportion of the company's net worth -- like 150%! -- that much investigation would be needed. A loan to a state or state entity will be developed on fairly analogous terms.

There is a great deal of interest these days in Project Finance. This is a form of lending in which the bank making the loan has recourse to the project being financed only. It is as if the project was a separate concern (and it often is) and the sponsors (owners) of the project provide the equity capital only. The provider of the debt does not have recourse to the assets of the sponsors beyond this equity provision. The advantages of project finance are many, but they are primarily concerned with keeping the debt off the balance sheets of the sponsors, such that the sponsor's credit rating does not get affected.

Coordination of a project finance deal is going to require specific investigation of a project, its likely costs, its product and the market for the product as well as the general management ability of those responsible for the project. This puts a need for a broad level of understanding of all aspects of the project on the lender. The bank must be able to assess all the risks -- engineering, geological, political, market and financial. A good project finance group is an interesting mix of many disciplines, all with baking expertise

superimposed. I should add that even in today's uncertain job market, they are very much in demand.

From this you can see that a bank requires a great deal of information in order to make a loan. A company making an investment in a project can do it if the management and the board is satisfied that the risk is worth the potential return. To restate the point, a bank cannot take an equity risk, since its return is fixed and is not a function of the degree of success of the project being financed. This, in very many cases, if not all, leads to a mortgage concept. No loans can be made by a commercial bank against an oil or gas exploration venture. Such loans have to be against the credit of the sponsors or against proven reserves of oil, gas or other minerals already in the ground. If a project such as a refinery, a pipeline or a synfuel project is being financed, and the loan at any point in time exceeds the "scrap value" of the project at that time, then a completion guarantee from the sponsors is needed such that if the project is not completed, then the sponsors will become responsible for the outstanding debt. Guarantees from other agencies are also possible (government, etc.), but in each case, as well as a thorough investigation of the project, the credit of the guaranteeing agency has to be assessed.

If the project is completed within budget (or roughly so) and on time, the marketing of the product has to generate the funds needed to repay the debt. Concerns evaluated by the bank include the risk that the project may suffer from government actions (political risk) including war, nationalization, change in tax structure, etc. These risks are taken by banks in many circumstances, and it is generally left to the "country limit" concept to limit the bank's exposure to this risk. Some of the Iranian projects have been painful to some banks. MITI, for example, has to meet its guarantee of some of the loans to Japanese petrochemical concerns.

The element I have not yet covered is competition. This, I must admit, is fairly ferocious. The days of the gentleman's agreement to divide markets, if they were ever there, have now gone. The number of banks and financial institutions competing both for funds and for loans is very large. However, the differences between the final cost of the loan will not be too great since we all go back to the same market for our source of funds. This competitive banking system has proven to be much tougher and much more resilient than was expected. However, to expect the private banking system to provide too much more of the share of funding than I have indicated would be foolish. The banking margin precludes the bank from taking a major risk.

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NATIONAL ENERGY PLANNING ASSISTANCE IN THE DEVELOPING WORLD

Mike Bess*

Many of us recall a television series that was very popular during the 60's that centered around a weekly assignment, with instructions, to several brave characters. I propose to set up the same scenario for those who would wish to embark upon a national energy planning assistance project in the developing world. Picture yourself in a room receiving a little cassette tape with the following set of instructions:

"Your assignment, should you choose to take it:

One. Go to a country with an annual per capita income less than $500 (U.S.), with a population growth in excess of 2.5 percent per annum, that depends on oil imports for 100 percent of its petroleum needs, and that has been experiencing acute balance of payments problems for at least a decade.

Two. Conduct a "national energy assessment" in this country that will become the basis for future national energy planning.

Three. In so doing, develop sectoral data on energy supply, distribution and consumption from an information base that is poor at best, non-existent at worst.

Four. Work with the national administration that is less than one year old, that lacks a defined organizational structure, whose senior staff are "seconded" from at least four other ministries and whose junior staff are recent university graduates with little or no practical experience including ministries which may be in direct competition with your own, and several additional departments and agencies. While working with this agency, try to assist it in its efforts to become the national energy planning agency. Train its people during the process. In other words, go out and accomplish some "institution building."

Five. Respond to the nation's immediate and short-term needs for energy policy decisions. Serve as advisor and counselor to the appropriate Minister, your local USAID Mission, your head office (in Washington or elsewhere), and to USAID/Washington.

But, before setting out on this assignment, you must first design a program that will enable you to accomplish the above tasks. If you are unable to have any voice in the design of your project, pray that the project designers have examined all the following constraints:

1. Your budget will be too small.

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2. You will be working for a funding agency that, while sympathetic to your needs (and never at a loss to express such sympathy), will rarely be able quickly to respond to or deliver on your requests for immediate assistance; crises will be as many as the days are long.

3. You will be a long way from Washington, or any other home office location. Therefore, communications with and responses from your home office will often be slow. Moreover, your requests will rarely be properly understood. You will be a very fortunate person indeed to have access to a reliable communications system (but, don't get your hopes up).

4. You will have a dearth of long-term experts and a wealth of short-term experts at your disposal. You will, therefore, quickly realize the value of the famous "learning curve." More important, you will be wise to learn the value of training, and to utilize the skills of those people (your hosts) with whom you will work day to day.

While carrying out the above tasks, under the above constraints, you will experience a persistent and ever present temptation to do things yourself or with your own foreign experts. You will quickly want to package and deliver your assessment. After all, it is just too damned difficult to take "institution building" seriously. You will not be the first to experience or yield to this temptation. Should you have any doubts about this, just walk into any Ministry or national corporation and look at all the stacks of nicely, colorfully packaged reports and assessments, replete with beautiful charts and diagrams, piled unread, unused, and dusty on book shelves and inside bureaucrats' desk drawers.

Remember, regardless of your personal philosophical inclinations, you will be working for and with a central government agency in the heart of some nation's capital. Any talk of "appropriate" or "adaptation" technology and local self-help will not set well with your Minister, until you have fostered his confidence in your ability to respond to his/her more immediate needs. Remember, s/he faces constant petroleum supply problems, inadequate power/electricity to drive the national industry and to light the capital's homes, not to mention the constant attacks from others who feel they (or someone else) could do a better job. While you may be a technician by training, more often than not, you will be asked for political, social and economic rather than quick-fix, technical solutions to national energy problems. Therefore you must work within such a framework.

If you have any input into project design, you should proceed with the following:

1. Make a thorough examination of the country and its socio-political and economic setting.

2. Make as thorough as possible an examination of the institution you will work with. Look for the following strengths and weaknesses:

a. Age of the institution

b. History of the agency

c. Make-up or constitution of its senior staff. Do not just examine the technical qualifications of that staff. While these are important, more important still are those people's institutional backgrounds. Ask yourself: "How long have they worked with this institution?" Do they appear committed to working with this institution under its mandate?" Remember, "institutional awareness, responsibility and memory" is not merely a public policy catch phrase, but is a very real determinant of an agency's ability to mobilize its own as well as the nation's resources.

d. Look at that agency's position within the government. That is, do other people or other agencies take it seriously? Will they take it seriously given the proper circumstances which you may be able to influence? How powerful is it or can it be? How much of a national mandate does it have?

e. After you have attempted to answer the above questions, ask yourself how capable is this institution in conducting a national energy assessment and of lobbying for changes in the country's national energy policies once that assessment has begun to fit together.

3 You must view "national energy assessment" as an ongoing process, not as a final product. You must adopt a working strategy with your host agency to ensure that ongoing process.

If you do the above well, you will find that, in the process, you will identify many other potential, valuable projects, most of which will be much more micro and local in nature than what you began with. If this is the case, you have done part of your job well and you will find that your agency will begin to mobilize the central resources of the government (and a number of donors) in these directions. In addition, if you have accomplished the above well, you will begin to perceive a national awareness of the problems you and your host agency have been working with from the onset. You should strive to see energy issues and policies debated, and hope that some national consensus will be achieved that will bring needed resources to bear on the nation's energy problems, including many of those small, local problems you have been wanting to see addressed from the first day of your job.

That is, while doing all the above, keep in mind that solving the firewood problem will not solve all urban and industrial energy problems. Improving cookstove efficiency will not improve energy inputs into the modern agricultural sector. You will never be truly able to

affect most developing nations' abilities to control a good part of their energy destinies, to stop reacting to and start acting on their energy problems without a national awareness of the total national energy picture. And, to accomplish this will require, at least, the mobilization of a central, powerful, strong and well-informed agency in the government.

"Sound like a tall order? It is. Should you decide to take this assignment, good luck!"

CASE STUDY: KENYA

Philip O'Keefe*

I. Analysis

The following preliminary report analyzes the energy policy issues confronting Kenya over the next 20 years. Focus has been placed on generating an adequate data base to identify the current patterns of energy use, on projecting the demand and supply picture using detailed computer simulations, on identifying trouble spots in resource sufficiency, and on suggesting the type and scope of policy interventions required for remediation.

The analysis explicitly recognizes that the allocation of land for purposes of growing wood implies that less land is available for agriculture. The evaluation of the wood balance is therefore related to the national food balance, and we have chosen for this reason to incorporate an analysis of the food balance in the schema.

The data employed in this analysis were procured from a variety of primary and secondary sources. Three surveys of energy use were undertaken in the course of this study. The first survey queried urban households regarding their use of energy at the household level. Particular emphasis was placed on the uses of fuelwood and charcoal. This was done within each household sector on the basis of income groupings, and enduse services within each grouping. The second survey performed a comparable enumeration for rural households. Both household surveys noted information on income. The final survey represented a pioneering effort at the enumeration of energy use by informal industry.

Additional surveys were undertaken to establish the patterns of land use by province and ecological zone. These surveys included measurements of study and yields of wood resources on a province/zone/landtype basis.

In addition, the project included a comprehensive survey of energy use in the industrial sector, breaking out on-site fossil fuel consumption and electricity.

The field team also engaged in a regional demographic analysis and forecast. Finally, estimates were made of future levels of sectoral activity and stocks of energy using equipment. On the

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* Don Shakow and Cara Seiderman contributed to this report. All authors are from Beijer Institute's Fuelwood Project (Nairobi). This paper is based in part on "One Step Forward, Two Steps Back: The Experience of Energy Planning in Kenya", October 1981.

basis of these data a series of forecasting analyses were undertaken. The initial analysis was made under "business-as-usual" (or Base Case) assumption. This assumes that present trends and existing policies hold relatively unaltered over the forecast horizon.

The Base Case analyses of supply and demand indicate a disquieting prospect of shortages in three basic commodities: food, petroleum, and fuelwood. In particular, the trends indicate the presence of unsatisfied demand for wood beginning about 1990. By the year 2000, this shortfall will amount to approximately 15 million tons per annum, or about 50 percent of total demand. Moreover, the analysis indicates massive cumulative depletion of standing stocks of wood biomass.

These results demonstrate that in the absence of significant policy intervention by government, Kenya faces the prospect of continuing and accelerated shortages in commodities necessary to its continued development and growth. Satisfying the growing demand for petroleum will lead to an endemic shortage of foreign exchange. Deficits in the trade balance imply three consequences:

- Kenya will be forced to curtail its imports of source materials and capital goods necessary to the development of an efficient modern sector in manufacturing, industry, and agriculture.

- Due to the shortage in foreign exchange, Kenya will be limited in its ability to import food as a means of compensating for deficits in domestic production.

- Alternatively, the allocation of scarce foreign exchange resources to satisfy domestic food, materials and capital goods requirements, may lead to curtailment of petroleum imports, in turn hampering those very activities which generate foreign exchange.

Equally important, the analysis suggests that accessible standing stocks of wood resources would suffer a very dramatic decline implying possible major shifts in settlement patterns or the allocation of labor and economic resources to wood harvesting. Moreover, depletion of stocks could increase erosion and undermine soil quality, leading to further deterioration of agricultural production and the local ecology in general. Decline in agricultural productivity will in turn adversely affect the critical food situation. Foreign exchange earnings from export crops could decline and foreign exchange needs for food imports could increase.

Under these circumstances it is essential that the possibilities for intervention in the network of energy transactions be reviewed. While the Base Case projections do appear ominous, the aim of this analysis is not to generate alarm but rather to emphasize the urgency of timely intervention by means of policy.

A strategy for assessing policy alternatives involves a two-stage procedure. The first stage is aimed at establishing the potential scope of specific classes of intervention. Interventions through such means as enhanced appliance efficiency, fuel conversion, income redistribution, electrical capacity expansion, and specific wood enhancement programs are analyzed assuming technical optimal conditions. A series of sensitivity runs were undertaken for each potential intervention.

Finally, a plausible policy scenario was defined, incorporating target achievement levels for each class of intervention. The application of this scenario on both the supply and demand side was sufficient to eliminate the potential shortfall. Application of the demand related options associated with the plausible policy scenario, but not including supply options, reduces the projected shortfall in the year 2000 from about 15 to 12 million tons per annum.

In short, in the absence of policy interventions, Kenya faces substantial depletion of standing wood stocks and growing shortfalls of regional and national fuelwood supplies. An aggregate national wood resource shortfall of about 50 percent of total wood demand in the year 2000 can be expected. A cumulative of standing stocks amounting to about 26 percent would result by the end of the century.

Approximately 29 percent of the projected shortfall could be avoided assuming implementation of a plausible demand policy package. This package would embody measures affecting end-use appliance efficiency, primary to secondary fuel conservation efficiency (i.e. charcoal kilns), industrial process efficiency, and electricity generation enhancements. Moreover, the remaining deficit in regional wood resources can be eleiminated by implementation of a program of conversion of some 500,000 hectares of forest and largely uncropped agricultural land to woodlots in those provinces where shortfalls occur. The wood resource projects embodied in the policy scenario are of sufficient magnitude to maintain the aggregate volume of standing stocks. Depletion of existing stocks would be reduced by about one-third while additional stocks on the new woodlots would compensate for the remaining depletion. While the conversion of some productive agricultural land would be necessary, this would entail only about a 4 percent increase in year 2000 food imports.

The analysis shows, in general, that the current trajectory regarding Kenya's food, energy, and biomass situation is extremely worrisome. Serious programmatic initiatives could make substantial inroads towards solving these problems. Assuming that the overall growth of the Kenyan economy can handle growing oil and food requirements, it appears that, so far as wood resources are concerned, a breathing spell of about 20 years can be achieved by an ambitious programmatic effort.

Because of the energy focus of the Workshop, energy planning problems for fuelwood will be considered in the following discussion.

II. Planning

Wood will remain the basic energy source for household consumption needs beyond the year 2000. If consumption continues at present levels, there will be a shortfall of 15.4 million metric tons in 2000. This shortfall occurs as charcoal demand expands with the acceleration of urbanization. Although several conservation and supply enhancement strategies could be advocated, consideration of these strategies within the Kenyan social context indicates several serious problems.

A. Conservation Strategies

Two conservation strategies are usually touted as solutions to reducing fuelwood consumption: improved stove design and improved pyrolytic conversion processes for charcoal manufacture. Both conservation strategies have limited impact because both disregard the social setting, the peasant modes of production and consumption, into which they are diffused.

1. Stove design

The literature of improved cooking stoves abounds with naive rules of thumb. T. Harris has summarized the results of experimental work on the combustion-related technical parameters of stove design. He notes,

> "... it is important to remember that, while fuel efficiency may be the principal interest of the designer, it can only be achieved if the more diverse values of the user are first satisfied." 1/

But what are the more diverse values of the user? Essentially, this is a reference to the impossibility of using simple end-use analysis to derive broad convervation policies. In peasant production and consumption systems, the traditional open fire, which, when carefully managed, can be as efficient as some stoves, has several fuel sources and multiple end uses. Many stove designs are fuel specific, thus limiting source material. This is especially true when considering the size requirements of fuel loads due to the redesign of the combustion chamber. Many peasant and periurban families do not even possess the elementary tools, specifically pangas (heavy cutting knives), required to cut the fuel to appropriate sizes. Such stove design does not satisfy the values of the end user. More importantly, current stove design efforts are

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focused on only one end use -- cooking-- when traditional open fires serve several end uses, including:

- Rapid Boiling
- Light
- Space Heating
- Maintenance of thatch by reducing insect population
- Preservation and flavoring of food stored in rafters
- Reduction of human disease
- Social focus

Current stove design efforts that essentially seek to improve the efficiency of simmering do so at the expense of other end uses. Of necessity, the peasants then require a multiplicity of other end use devices and fuels which raise the real cost, in both monetary and labor terms, of energy procurement. Is improved stove design really more socially efficient? Should the emphasis in the household consumption sector be on accelerating movement "up the energy ladder", with use of other fuels such as kerosene and gas, rather than reinforcing the poverty-ridden status-quo? We see little consideration of these structural questions, although we see considerable amounts of capital and effort devoted to a growing sideshow of technical appliances.[2]

The place where improved stoves may indeed be useful is in urban areas where "jikos" are already in use on a large scale. The main constraint here is cost; above US$4, a stove is unaffordable for average Kenyans. Low-cost, higher-efficiency stoves could potentially be a positive conservation strategy at the present.

2. Improved Pyrolytic Conversion

The techniques of improved pyrolytic conversion are widely known. Peasant charcoal conversion techniques are relatively inefficient (8 to 10 percent) and modern production methods could increase yield threefold. But such techniques are centralized, frequently capital intensive systems, that would be controlled by the urban, industrial middle class, and not by the peasants themselves.

In order to survive, peasant production systems require access to off-farm income. These sources of income are essentially off-farm wage labor and income from the production and exchange of commodities from communal land. The single most important income source in the latter category is income from charcoal manufacture. Should that income be threatened, then the peasant order itself is threatened. Rural to urban migration would

significantly increase as a result of the loss of off-farm income, exacerbating problems of underdevelopment and further distorting the energy system.

There are few examples of peasant production cooperatives that would be a model for community control of a pyrolitic conversion technology. Moreover, even the pyrolitic production processes that are scheduled for the large state forests are focused on the provision of charcoal for process heat generation in heavy industry and not for urban household consumption. It is not surprising that such initiatives are led by the energy transnational corporations.[3]

Current strategies for wood conservation are inadequate because they do not consider the social context of energy utilization. Measures to improve stove and charcoal conversion efficiencies will have to be reconsidered if the results of their implementation will not be a substantial increase in the existing burden of poor peasants.

B. Supply Enhancement Strategies

If demand management strategies required careful reconsideration, supply enhancement strategies require total revision. The survey of natural wood supplies in Kenya[4] produced the following conclusions:

1. Woodstocks and production under prevailing patterns of land use provide the bulk of Kenya's present energy needs. The rangelands, which cover 87 percent of Kenya's land surface, support some 600 million tons of wood. However, sustainable production amounts to only 14 million tons. Less than 50 percent of this is available for charcoal.

2. Most wood presently used is extracted from the high potential agricultural lands and fringe areas. In contrast, the bulk of remaining stocks exist in the rangelands where both transport costs and low yields preclude large-scale extraction. The unaccessibility of these stocks will increase pressure on the agricultural areas -- the main source for food and export crops.

3. Large-scale extraction on the high potential areas will have a more detrimental environmental impact than on the rangelands. Temporarily, there is sufficient wood to meet demand because:

   a. There has been an expansion of the arable land frontier which has, through clearing, produced

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an artificial surplus.

b. There has been selective cutting of forest stock which disguises the actual rate of forest depletion. 5/

Supply, however, will dwindle sharply over the next decade.

C. Constraints

The limited potential of Kenya's natural woodstocks emphasizes the urgent need for planned afforestation efforts but there are several constraints which must be overcome if such efforts are to succeed.

1. Administrative Constraints

The present governmental structure of the forestry administration focuses almost exclusively on watershed management and the maintenance of the gazetted forest areas. If the forestry administration responds to any pressure, it is the pressure of industrial consumers who require chemical feedstocks and building materials. Yet, these demands total less than 20 percent of the demand for wood. Eighty percent is the demand for wood as an energy source, a demand that the forestry administration does little to meet. 6/ Until administrative reorganization produces a structure that reflects the demand for wood and wood products, we can expect little progress in energy afforestation efforts.

2. Social Constraints

Repeated emphasis is given to planned community woodlots on, or near, arable land, These recommendations, however, do not appear feasible because they omit consideration of the operating social constraints. Some of these are:

a. Kenya is in a rapid process of transformation which has seen the consolidation of capitalist relations of production in the rural areas. In this transformation, land has been privatized and communal relations, "community spirit", have been severely eroded. It is impractical to suggest that energy supply policies should seek to function through relations of production that have already been destroyed.

b. Community-based projects most frequently are badly-disguised attempts by development agencies to extract free labor from the

peasantry. This free labor is generally womens' labor. Even during the best of times, there is a labor constraint in peasant production systems. 7/ Women traditionally carry the heaviest burden of agricultural and domestic work. Now, as children are often away all day in school, and men are going to urban centers seeking wage labor, the work load has increased even further. To design community-based forestry projects which assume free labor donations, especially from women, is to misunderstand totally the nature of the peasant economic structure.

c. Even a cursory glance at the East African landscape reveals the lack of a village settlement pattern. In the densely populated areas, individual tenure, with the household settled on the land, is the established order. Such an ownership pattern makes it difficult to envisage a community (i.e. village) woodlot as exists in Asia. Moreover, the distance to be traveled in order to collect wood from such "community" projects is frequently too great.

d. Most importantly, given the current political economy of Kenya, many schemes designed as decentralized systems based on fuelwood production, will fail because not all the population has access to land. Increasing privitization of land, coupled with a rapidly growing population, will mean that fewer people will have access to land in the future as well. In turn, this will mean longer periods of time devoted to the collection of a decreasing resource. But the scarcity in this case is a direct result of the changing social order and not a decline in biomass productivity.

3. Production Constraints

There are several production constraints on enhancing the supply of energy from forestry. The most fundamental is that forests are unimportant for wood production. The key issue is how to establish "trees outside the forest", for that is where most of fuelwood is gathered. There are two major areas of intervention:

a. Improved pollarding techniques with the design of simple tools that will enable non-destructive removal of secondary vegetation on "within-farm" trees.

b. Improved agroforestry practice within

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individual farms where, at the present moment, much of the land, especially along pathways and hedges, is under utilized.

Improving offtake is essentially intensifying agricultural offtake. We are still experimenting with ways to intensify agricultural offtake without increasing the energy inputs.

4. Development Constraints

We have already indicated that the forestry administration requires substantial reorganization. The current forestry, and particularly nursery, practices have no adequate extension staff. It will be necessary to decrease the number of large-scale nurseries as distribution from these nurseries is difficult, particularly in the rainy season when the seedlings are required for outplanting. 9/

But small-scale nurseries, at a greater frequency, should double as seed orchards in order to make for a successful plant diffusion policy. Additionally the seeds and seedlings available must be carefully selected for energy purposes: the current practice of stocking nurseries with ornamental and fruit trees might fulfill the desires of the still-resident settler community but it does nothing for the peasant trying to maintain supplies.

III. Conclusion

If the administrative, social, production, and developmental constraints can be overcome, then a viable energy supply enhancement policy might be operational. If not, we will merely retain the current position in which most young seedlings are gathered spontaneously by children but, unfortunately, not at a rate which is sufficient to counteract the demand for wood. The poor planting rate, and the limited conservation opportunities, may force a move "up the energy ladder", irrespective of what the Kenyans themselves desire.

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ENDNOTES

1. Harris, T. "Designing Fuel Efficient Wood Buring Stoves", Ambio, Vol, X, No. 5. (1981). For more detailed information see the Technical Appendices of the Beijer Fuelwood Project Report.

2. Harris, T. "The Need for Better Stoves," Ambio, X, 5 (1981).

3. In recent years, there have been several attempts, including a Presidential Directive, to prohibit charcoal production. The outcry, essentially from the rural and not the urban areas, has blocked such attempts.

4. "Kenya Takes to the Woods and Weeds", New Scientist, 3 September 1981, p. 600.

5. A Survey of Natural Wood Supplies in Kenya and an Assessment of the Ecological Impact of its Usage. Beijer Fuelwood Project, 1981.

6. Ongoing mensuration surveys in the high potential areas indicate that the population structure of the remaining tropical high forest is senile. In other words, the population has relatively few young trees. Such a situation means that future stock wood capital is nonexistent and that the forests are already "dead on their feet". The most probable explanation for this phenomenon is that, given available technology, people can only cut trees which are less than 12 cm in diameter. Thus, pressure on the forest resorce is pressure on the young trees. Our calculations on the gazetted forests show that the aerial extent has remained constant over the last 15 years. Landsat and air photographic imagery confirm these calculations, but the images are only of the closed crown cover of mature forest. The mensuration surveys suggest the problem of deforestation is more serious as forest capacity for sustainable yield is already eroded.

7. O'Keefe, P., D. Weiner, and B. Wizner. "The Tail that Wagged the Dog: A Precautionary Tale of Forestry Planning in Kenya" in L. Buck, ed. Proceedings of the Kenya National Seminar of Agroforestry, 12-22 November, 1980. ICRAF/University of Nairobi, 1981.

8. Given available levels of technology, peasant production systems are hardpressed for labor, especially during planting seasons. In Kenya, most agricultural labor is done by women who, in addition, have to complete a series of daily reproduction tasks including energy harvesting. As the period of positive water balance is short (i.e. the length of time when the soil has sufficient water to enable the germination and early growth of plants is limited), to suggest that labor be transferred from food and cash crop production to forestry is extremely poor planning.

9. We are receiving considerable numbers of "seedling failure" reports. At the present moment we think the cause of this failure is due to 1) sun scorch during the transportation of seedlings from

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nurseries to individual farms which results in the plant exhibiting drought symptoms, and 2) late delivery of seedlings which, with the labor constraint (see 8, above), means that outplanting occurs as soil moisture content is decreasing and seedlings again exhibit drought symptoms. In both cases drought essentially reflects the drying up of resources, not a lack of rainfall!

PEACE CORPS RURAL VILLAGE SURVEY

Paul Jankura*

I. Introduction

In 1979, the Peace Corps Rural Energy Survey was developed as one component of a renewable energy program undertaken with the support of a three-year grant from USAID. The purpose of the Peace Corps Energy Program is to assist developing countries in identifying energy needs in rural areas and in implementing alternative, renewable energy projects at the community level.

Individual Peace Corps volunteers living and working in Third World villages had frequently initiated or supported renewable energy projects such as biogas digesters, windmills and tree nurseries, in response to the immediate needs of their communities. The purpose of the AID support has been to enable the Peace Corps to organize a systematic program for energy assistance worldwide by devising programming strategies for joint PC/host country renewable energy and appropriate technology projects and by developing relevant energy training programs and technical materials in support of these projects.

An essential part of such programming and training efforts is a means of assessing existing village energy use patterns, the needs for additional energy sources, as perceived by rural dwellers, and the potential resources available for renewable energy technologies in the area. In addition, it is necessary to have information about the social and cultural practices associated with energy use, and the possible effects on these practices of the introduction of alternative energy technologies. Only with proper consideration of all of the factors involved in rural energy use patterns can program planners amd implementers promote energy technology interventions which will be truly "appropriate" for those intended to benefit.

At the time that the study started there was little data available on energy use in rural areas. Because large numbers of educated, motivated Peace Corps Volunteers living and working in villages throughout the developing world are uniquely placed to provide this kind of information, it was felt that the Peace Corps could be instrumental in developing a survey instrument and methodology for gathering energy data in rural villages. By field testing the survey in selected countries, the project would produce actual data on selected village level energy use, needs and resources.

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The goals of the energy survey, therefore, reflect the overall purpose of the Peace Corps' energy program. Indeed, the programming and training components of the program are designed to complement and build upon the information generated through survey activities and other community level efforts in the development of an integrated approach to the problems of rural energy needs.

II. Rural Energy Survey Project Goals and Objectives

A. To design, test and revise a survey instrument which will furnish data at the village level regarding current energy uses, needs, and resources, and about the economic, social and cultural context of energy use in the community.

- The questionnaire should be comprehensive in scope, specific and detailed, and adaptable to use in any rural community.

B. To design, test and revise a methodology, and a training program in that methodology, whereby the survey can be conducted by Peace Corps Volunteers, host country development workers, rural villagers or other interested parties who may be unfamiliar with surveys.

- The methodology should include active participation by members of the communities being surveyed, and the training design should provide bi- or multi-lingual models.

C. To collect and analyze detailed, valid information from selected villages in various countries:

- as a field test of the survey instrument, methodology and training program;
- to provide host country and Peace Corps energy planners and programmers with a better idea of energy needs at a village level; and
- to provide baseline information on the "before" energy conditions of a village, to help determine the effectiveness of introducing a new technology to meet perceived energy needs.

D. To create an awareness of energy uses and needs, and an interest and participation in energy planning and conservation, on the part of Peace Corps Volunteers, host country development workers, and the people of the villages taking part in the survey. This goal should be accomplished by:

- encouraging active participation in and discussion of the survey project by members of households in the survey sample, village leaders, local development

workers such as teachers, extension agents, and health and sanitation workers, and by local government officials;

- providing training and technical information about renewable energy technology options, where possible; and

- encouraging the understanding of the village as a system wherein the sum of individual actions and practices relating to energy can and do have significant impact on the prosperity of the village and each member within it.

III. Conclusions

The development and implementation of the rural energy survey proved to be a productive and worthwhile, if somewhat frustrating experience. Most goals of the project were met, and a great deal was learned both positive and negative from the endeavor. The most obvious conclusion to be drawn concerns the scope of the project.

The scope of the study, as envisioned in 1979, was definitely overambitious. The distance and time limitations were underestimated. It became necessary to significantly reduce the number of countries in which the survey was to be piloted. Likewise, it became obvious that a longitudinal survey conducted over an entire year was a much too demanding task to be undertaken by voluntary workers and that the number of villages reporting would be smaller than anticipated.

However, if the quantity of data produced by the survey field test was less than expected, the quality of the information was quite encouraging and confirmed the value of the instrument and methodology.

Another positive conclusion which can be drawn from the implementation of the energy survey project is that governments, development workers and villagers in developing countries share with the Peace Corps a concern about energy issues and an interest in studying needs and working to develop alternative, renewable energy programs. There has been strong interest in the survey project expressed to Peace Corps staffs in many countries, and a shorter, slightly revised version of the survey could prove to be a useful assessment tool for energy program planners.

Some of the positive conslusions drawn from the survey project are:

- demonstration of a survey methodology combining observation, interviews, actual fuel measurements and renewable resource assessment;

- the development of a thorough training program for local enumerators;

- demonstration of the utility of using local villagers as

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successful members of an enumeration team;

- the ability to collect useful data on energy use, needs and resources in villages;

- demonstration that the activity of administering a village energy survey in a participatory manner is a useful mechanism for increasing the awareness of energy issues and interest in conserving fuel/developing new energy resources in the villages where the survey was conducted.

Some of the negative lessons learned from the survey project are:

- one year is too long a period of time for survey enumerators to remain available and motivated to collect data;

- the survey project, as presently designed, is too extensive; the instrument needs to be more sharply focused on particular end-use investigation and particular measurement procedures for each end-use;

- regular supervision and support from a survey coordinator is essential to maintain motivation of enumerators; and for the maintenance of quality information;

- timely collection and forwarding of survey reports is extremely difficult in rural areas of developing countries; and

- in conducting a survey on a voluntary basis it is extremely difficult to maintain the interest and motivation to complete the study.

It is difficult to judge whether the shortening of the survey period will suffice to make the survey more feasible as a voluntary activity. Certainly, the feedback from PCVs who conducted the survey field tests indicated in their feedback comments that the length of time was the biggest problem for both enumerators and village participants.

Regarding the instrument itself, three basic recommendations are made to strengthen its weaknesses:

- sharpen the focus of investigation to those areas which are of primary concern in examining energy demand and supply in order to better identify areas of policy intervention;

- sharpen the procedures for fuel measurements to remove some of the open-ended nature of the fuel measurement section and to remove ambiguity from the responses;

- restructure some of the response formats to facilitate data processing.

The information to be collected is intended primarily to provide the basis for a broad assessment of current energy needs in the village locations surveyed in each country. Such an assessment is a prerequisite to the formulation of detailed village level projects to assist each community in meeting its current and possible future needs. Energy demands energy as a particular focus for investigation because little is known about their current pattern. Information on the supply of fuels presently used is also essential to determine the particular difficulties of meeting energy needs in each location. A mode of analysis is required by which current demands and supply can be examined in an integrated manner to arrive at an understanding of the interrelationships between end-use activities, methods of converting fueld to useful energy and the current resource base. Ideally, the chosen method of analysis should be one which allows simple explorations of future policy options given present trends. An example of such simulation exercises might be to examine the effects of improved cookstoves on the pattern of fuel use under conditions of population and income growth.

The end result of calculations made is an estimate of total resource requirements by fuel type to meet a particular pattern of energy use. Once a "base case" has been established showing the details of energy flows in the energy system as a whole, policy options can be explored by constructing alternative future scenarios based upon particular assumptions about changes in demand, end-use and supply technologies.

The data requirements of this approach and hence the design of a rural survey depend strongly upon the options to be analyzed, and the financial resources available for primary data collection. A decision to focus on the household component of rural energy use will require a relatively limited set of data on the current pattern of fuel demands for household activities (primarily for cooking and lighting). This will limit fieldwork to the task of making accurate fuel consumption measurements in a representative group of households. The level of detail at which data on household consumption is collected must also be guided by considerations of policy and financial resources.

Thus, there are three essential components of data required for each demand sector:

- Demand Activity Level: a unit of measurement must be specified to quantify the level of demand. This may consist simply of physical unit representing the energy consuming entity in the particular sector ('households in each income group', or 'number of diesel pumpsets').

- Direct Fuel Consumption: the amount of fuel (in energy units) of various types delivered to a particular

end-use.

- Relative Efficiency since some energy is always lost when converted to another form, or to work, the relative efficiency of conversion processes or end-use devices must be known in order to estimate the useful energy consumption of each sector.

The data from field surveys of rural areas is most important in establishing the level of direct fuel consumption and in estimating the levels of activity in each end-use.

The narrative data provides a useful contextual backdrop for the computable data, and the renewable energy resource analysis contains helpful information for identifying areas for developing potential applications of renewable energy technologies to existing village needs.

RURAL ENERGY SURVEYS: MALAWI

Richard Scobey*

We have reached the point in the field of renewable energy where we have developed alternative energy systems that are technologically sound and viable. But in order for a new system to be of any use, it must fit with the social and economic realities of the community for which it is intended.

Despite our occasional trips into the field, we essentially know very little about the world of the rural smallholder farmer and the urban poor. One way to learn about their needs and priorities is the energy survey. By collecting information on people's needs and people's perceptions of their problems, we know where to begin planning energy projects.

The following discussion of the rural survey work done in Malawi illustrates the utility of survey results and may assist Missions interested in developing renewable energy projects.

In Malawi, Government has become increasingly concerned about deforestation. It has been estimated that 94% of all energy used in Malawi is fuelwood and therefore, the growing fuelwood crisis has severe implications for all sectors of the economy. In line with this concern, Government has established a World Bank funded Wood Energy Project, which establishes urban fuelwood and polewood plantations and encourages farmers to grow woodlots. The Project has a research component, the Energy Unit, which monitors the success of the Project and investigates alternative energy technologies.

The first major project of the Unit was a natural rural energy survey. Since little information on rural energy use existed, we asked questions that illustrated the basic patterns of energy use (what jobs do people do that use energy, what fuels are used to do these jobs, how difficult is it to procure these fuels) and that showed the consequences of fuelwood scarcity.

We were able to conduct our survey quickly and cheaply because we joined an existing survey process. The National Statistical Office maintains 340 enumerators throughout the country that regularly administer surveys on a variety of topics, such as crop production, household composition, and household income and expenditure. We negotiated with NSO to join the 1980/81 work program, and we wrote our energy survey, trained the enumerators, checked schedules for errors, and processed the results.

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The survey results have been interesting and have made us rethink some basic assumptions about rural energy use in Malawi.

The survey confirmed that fuelwood is the dominant energy source, with 90% or more of the households using wood for cooking, heating, curing tobacco, and almost all other rural tasks.

One non-wood fuel used in rural areas is paraffin, on which three-quarters of the families rely for lighting. However, paraffin is not used for the preparation of quick meals or tea. Another commercial fuel used in the villages is diesel for the maize mills, on which four-fifths of the households rely for preparing flour.

When we asked about the problem of collecting firewood, we found that two-thirds of all households said firewood collection was difficult. Similarly, two-thirds of the respondents felt that firewood collection had become more difficult over the past five years.

However, when we studied the pattern of energy use of people who said firewood collection was difficult or who walked lengthy distances for fuelwood, we found that fuelwood scarcity had little impact on their use of energy. People in wood scarcity areas have not yet begun to perform less often fuel-consuming tasks like cooking or beer brewing. Similarly, we found few people who were purchasing a portion of their fuelwood, burning wood from commercially valuable trees such as mango, or relying heavily on secondary cooking fuels such as crop residues.

Although a substantial number of households planted trees during the past year, this was done for building poles and fruit rather than firewood. Significantly, people were no more likely to plant trees where wood was scarce than where it was abundant.

These survey findings raised several points about reforestation programs and the Energy Unit made the following recommendations to the Wood Energy Project.

1. Emphasis should be on trees for building poles, since this is the most immediate concern of farmers. The branches of these trees would be available for fuelwood, as would the indigenous trees which would no longer have to be cut for poles.

2. Trees specifically for fuelwood should be encouraged only where people have already begun to but wood or to rely on inferior fuels for cooking. Eight target districts were suggested.

3. In fuelwood scarcity areas, it is worth exploring whether women as well as men can be involved in planting trees since it is women for whom firewood is becoming an immediate problem.

4. Reforestation efforts may be expected to have only modest success until the firewood "crisis" grows appreciably worse than it is today.

In addition to assisting in the planning of the Wood Energy Project, the survey results also assisted in formulating the work program of the Energy Unit.

1. Maize milling was identified as a possible area for technological intervention. As the price of diesel increases, people will need alternative sources of energy for preparing flour.

2. Since the fuelwood "crisis" is having little impact on rural energy use, the Unit must bear in mind that the rural population will most likely be unreceptive to renewable energy technologies.

3. The motivations, preferences, and problems associated with rural tree planting was identified as a critical area for further study.

The Malawi rural energy survey work suggests several caveats for Missions interested in conducting survey work.

1. Surveys must be simple, well crafted, and extensively pre-tested.

2. Survey is more likely to be successful if it is part of the host country's existing survey structure. Many countries conduct national census or national surveys of agriculture, and these mechanisms provide a cheap, competent, efficient method of data collection.

3. Energy surveys must focus on people's perceptions of their needs and problems. All too often an energy survey measures wind speed or counts sunny days, and is used to justify a specific technological intervention. We should do surveys because we little understand the world of the poor and we need guidance to see if we can assist them in solving their energy problems.

SECTION III

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THE FORESTRY/FUELWOOD PROBLEM IN AFRICA AND ITS ENVIRONMENTAL CONSEQUENCES

Marc Rene de Montalembert*

I. The Deteriorating Fuelwood Situation

A. Fuelwood plays a unique role in the energy supplies of Africa

- Approximately three fifths of the total energy consumption is from fuelwood.
- In countries such as Mali, Upper Volta, Ethiopia, it accounts for over 90% fo total energy consumption.
- In rural areas its share of energy consumption is currently close to 98% (excluding human energy and animal power).
- Nine tenths of wood removed from the forests areas is used for fuel.

B. Dependence on fuelwood is very marked

- According to a recent FAO study, it was estimated that approximately 290 million people (out of a total population of 320) depended on fuelwood in 1980. This is made up of almost all the rural population and a large number of urban dwellers, particularly the poor.
- The use of agricultural residues for fuel is limited to areas of fuelwood scarcity.
- Fuelwood is the preferred fuel for domestic uses and for a number of rural industries: for most populations, fuelwood has been, until recently, a locally available free fuel. Fuelwood does not require complex nor expensive equipment to use or to procure it and it is part of the traditional way of life.
- Higher prices of possible substitutes and irregular availabilities not only maintain the dependence but in some cases lead to a reversion to fuelwood of some uses which had shifted to conventional energy; in this respect, the limited success of butanization in Senegal provides useful thoughts.

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As a result of tight supplies, fuelwood has become an increasingly marketed good, the price of which has risen substantially making the purchase of fuelwood a major expense in household budgets. In urban areas, charcoal is usually preferred and concentrated demand adds to the transportability of charcoal in drawing on supplies over large surrounding areas.

C. Growing fuelwood deficits

- From recent energy, environmental and forestry studies, there is evidence that the fuelwood consumption is greater than the sustainable level of supplies.

- Forest resources are being depleted at an intensive rate. Over 1.3 million ha are being depleted annually over the recent period as a result of growing human and animal population pressures and the need for more land for agriculture.

- Indiscriminate land clearing, the mismanagement of natural resources and the increased fuelwood needs of growing populations have the worst ecological implications. An estimated 50,000 km² of land suitable for production are lost year in areas where people have no alternative than the locally available natural resources.

- The implications of fuelwood deficits are dramatic and well known: nutrition, time, money.

D. Magnitude of fuelwood deficits and populations affected

This is illustrated by the FAO Map of the Fuelwood Situation in Developing Countries. Fuelwood situations are classified as follows:

- Fuelwood scarcities: minimum energy needs cannot be met even through overexploitations of available supplies.

  - 13 million people in arid/sub-arid areas; deficit 4/5 of needs.

  - 36 million people in mountainous areas; deficit 2/3 of needs.

- Fuelwood deficits: minimum energy needs can be met only by overexploitating available supplies.

  - 130 million people in savannah areas: deficit 1/3 of needs.

- Critical situations: additional areas which will be in deficit by year 2000 if current trends remain unchecked.

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- savannah areas: 112 million people in 2000

- High forest areas: 63 million people in 2000

In 1980, 180 million people were affected by a deficit of 112 Mm^3 between needs and sustainable level supplies.

In 2000, 460 million people could be affected by a deficit of 270 Mm^3.

This means that under current trends fuelwood will be a marginal source of energy over an extensive part of the Region, essentially in the poorest countries where substitution will be more difficult.

E. The problem of large scale substitution of fuelwood

Energy is indispensable for subsistance and development and for political and social reasons, governments will have to secure energy supplies particularly for cooking.

Replacing fuelwood by conventional energy and distributing it would be very costly. There is a large consensus about the lack of alternative for large scale substitution under conditions which meet the possibilities and needs of the users, in the foreseeable future. Fuelwood will therefore remain a major source of energy in the region, especially for the daily household life.

II. The Environmental Impact of the Fuelwood Crisis

Fuelwood usage in rural areas is mostly of a subsistence nature and it is collected at short distance around the home. As most rural populations live away from the forest, most of the fuelwood supply comes from tree vegetation outside the forest. Forests are cleared for creating more land for food production and it is later that the fuelwood pressure of growing population needs becomes the major factor for the destruction of the remaining tree cover.

A deteriorating cycle is then generated:

- removal of remaining trees even those of economic and subsistance value (acacia senegal, karite, mango, etc.) and use of agricultural residues for fuel instead of for manure.

- Declining yields of lands exposed to erosion and left without organic recycling.

- Loss of productivity of natural resources, erosion, desertification.

- Clearing of new land of poorer quality originally left under protection of tree cover, decreased agricultural production and more poverty and hunger.

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Worsening factors:

- Trends of modern agriculture: monoculture, failure to maintain sufficient wood supplies in new land settlement schemes.

- Impact of concentrated urban demand in surrounding rural areas and of increased commercialization of wood fuels.

- Impact of charcoal transportability.

The environmental impact of the fuelwood crisis adds to its socio-economic and nutritional implications. This points to the very important conclusion that in the fuelwood crisis the energy, food, and poverty dimensions are inextricably related and that the fuelwood crisis over increasingly large areas threatens the more subsistance base of the people. The more fragile the ecological conditions, the poorer the people affected and the more serious the problem.

III. Solving the Fuelwood Problem: Strategies and Issues

A first point here is the urgent need for massive action; until now, efforts have been totally inadequate. The task is formidable but fortunately the technical solutions are there. The main dimensions are social, institutional and financial.

- A global strategy needs to be applied:

  - energy should now be systematically integrated in all rural development efforts.

  - The continuing dependence on fuelwood in the foreseeable future should be fully recognized as well as the potential to maintain or increase the supply.

  - The complex contribution of trees as a combined solution to the energy and environment problems should be a basic element in land use planning.

  - Research and development should be intensively pursued for improving the production and use of energy from biomass.

  - People's active participation in efforts and benefits are indispensable elements for success.

Specific strategies have to be designed according to specific situations, and should be a combination of actions. Short term action would include substitution as a temporary measure to restore fuelwood supplies, improvement of conversion technologies (charcoal and stoves), organizing marketing and distribution. Longer term action should include bringing into

effective management natural fuelwood resources, state and communal forests and woodlands, planting more trees and managing the plantations.

Major issues involve changing the attitudes of people and institutions. The institutional framework should be strengthened in order to support the efforts of all those which can contribute to solving the problem. Training at all levels to prepare the right type of technicians with social capability is probably the most critical issue.

IV. What FAO is Doing

The FAO is taking the lead among the UN system in addressing the problems of rural energy and fuelwood. Currently the main orientations of work are: monitoring the fuelwood situation, evolving suitable community approaches, developing and adapting suitable technical packages, strengthening the institutional framework, assisting developing countries in preparing and implementing fuelwood programs.

In 1981, FAO began a special action programme on Forestry and Rural Energy to meet the much larger scale of assistance required for the preparation and implementation of projects in fuelwood deficit areas. This program is supported by special contributions from donor countries.

V. Conclusions

Fuelwood is and will remain a major source of energy in Africa for 20 to 30 years. There are vital links between the fuelwood situation and the environmental stability required to sustain and increase food production. Massive action is only possible through mass mobilization and participation. Year 2000 is tomorrow.

For the international community the question is relatively simple. Given the fact that the social and environmental implications of fuelwood scarcities will cost much more than acting to reverse the deteriorating fuelwood situation, the international community should stand ready to support the efforts of local people and governments with technical and financial assistance. Time and scale of action are crucial factors.

AFFORESTATION FOR ENERGY IN AFRICA: PROBLEMS AND POSSIBILITIES

E.M. Mnzava*

I. Introduction/Background

Africa is heavily dependent on fuelwood (including charcoal) for its domestic and village or cottage industries requirements. This renewable source contributes about 60% of the total energy consumption. In fact, in some African countries the percentage is much higher than this. For example, in Tanzania it is 96%, while Uganda, Kenya, and Malawi figures are, respectively, 75%, 90% and 89%. The bulk of the fuelwood (more than 98% in Tanzania) is obtained from natural forests. And unfortunately these forests are being depleted at an alarming rate - more than 1.5 million hectares in Tropical Africa. Consequently, about 55 million people live in acute fuelwood scarcity, while another 146 million live under fuelwood deficit conditions. 1/ These figures will total about 535 million by the year 2000.

Almost all the forest clearing activities are linked directly with human activities (agriculture, animal husbandry, timber and fuelwood exploitation, fires, construction of infrastructure). So as the population is rapidly increasing, deforestation will inevitably increase as well. That being the case, the efforts to intensify the management and conservation of the remaining natural forests must go hand in hand with massive afforestation. There are problems to be encountered, ranging from technical/technological to social/human.

This paper reviews some of these problems and gives some possible solutions. It focuses mainly on energy plantations and woodlots for domestic and cottage industries needs. And Eastern Africa is used as the principal example.

II. Afforestation Problems

Afforestation problems in Africa are varied, not only because of the strikingly heterogenous nature of the environment but primarily because of great diversities in the people, population dynamics and social structure. For convenience, the problems are grouped as follows: ecological (environmental), technical, technological,

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1 FAO (1981): Map of Fuelwood situation in the Developing Countries.

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wood energy shortage, institutional, peoples's attitudes and participation.

A. Ecological Considerations

Four main areas are involved. These are climate, deforestation, soil degradation and erosion, and choice of species.

1. Climate

Climate: Much of Africa is characterized by dry tropical climate, dominated by savanna woodlands. The total mean annual rainfall ranges from less than 50 mm to 1500 m. But a big portion receives between 300 to 1000 m. The mean rainfall does not depict clearly the magnitude of the problem. What matters more are the reliability and predictability of the rainfall. As a whole the rainfall is unreliable; and the length of dry season is very long in some countries - ranging from 6 to 8 months or even to 11 months in zones like Sahelian Africa. Thus the number of rainy days is naturally low in some areas are hence characterized by very low water balance in the soil.

This situation is worsened by temperatures which are consistently high, unless modified by local factors. Normally the evapotranspiration greatly exceeds precipitation. This has been the case in Niger, Nigeria, Sudan, Kenya, parts of Zambia and Botswana. The resultant moisture deficit for most part of the year makes it difficult to grow trees in terms of high plant mortality, slow growth, low yields, and increased tree establishment costs.

Possibilities for improvement include keeping good weather records in order to predict rainfall patterns. Preparing seedlings and planting on time is axiomatic. Optimum planting dates should also be worked out using rainfall probability maps and tables. Irrigation should be encouraged as it is in Sudan.[2]

2. Deforestation

Deforestation: Deforestation is very serious in many parts of Africa. As stated earlier for the last five years tropical Africa has lost more than 1.5 million hectares (estimate) of forest. Only about 53% of the original forest remains. In some countries the percentage is much less; for example Algeria, Tunisia and

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[2] Mnzava (1980): Solar Energy Forum "Fuelwood Needs in Africa."

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Morocco have 11% remaining while Gambia has only 4% remaining.

In these deforested areas land degradation is accelerating. Therefore, any regeneration, whether natural or artificial, is difficult, especially under semi-arid conditions of the Sahel, Northern Kenya, Central Tanzania and parts of Zambia. Here, soils can no longer retain nutrients and organic matter. So fertilization of the trees becomes imperative. In fact, the invasion of other competing vegetation in these areas slow tree growth. Deforestation also interferes with water regimes, usually reduces them, and indirectly reduces available water points for starting nurseries and for irrigating woodlots.

Flooding is also closely linked with deforestation, which may obliterate nurseries, small woodlots and infrastructure helpful in afforestation.

3. Degradation

Degradation: Like climate, soil is also varied. As a whole, soil depths are reasonable except in the mountain and planteau slopes where soils are frequently shallow, hence limiting root penetration. Another feature which normally hinders tree growth is the so-called "black cotton soil" found in many parts of Eastern Africa. These soils are plastic when wet and crack deeply when dry, sometimes more than two meters deep.

Soil erosion also impedes afforestation; in some parts of African countries it has prohibits tree planting completely. In Konodoa district (Central Tanzania), about 12% (more than 150,000 ha) of total area is so severely eroded and gullied that tree planting is difficult and expensive.

In order to lessen these problems farmers should be encouraged to ensure good land preparation before planting. The use of farm tractors may not be very expensive. And since soil erosion often results from human activities, the best solution seems to lie not only in encouraging proper land management but also in demonstrations. Special campaigns, such as Tanzania's "Forests are a Wealth", are a good approach.

4. Choice of Species

As stated above the choice of species is crucial. The problem is that most foresters think so much of timber and fuelwood production that they often forget that if farmers do not have food for themselves or fodder for

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their livestock they will not listen to tree planting pleas. This is the case with the Maasai, for example, of Kenya and Tanzania who are essentially pastoralists. In these circumstances the choice of species must revolve around fodder production (Acacia, Leucaena, Prosopis, etc.) These tree species will eventually produce some quantities of fuelwood. The main point to be made is that species should be chosen which are relevant to the local communities needs.

III. Technical and Technological Aspects

The technical and technological constraints are primarily associated with the establishment, management and utilization of the energy plantations. Many nurseries are located far away from the villagers. Seedlings may have to be transported long distances (even more than 50 to 60 km). This causes high mortality and is expensive. As much as possible, nurseries should be situated near the villages. Villagers should be encouraged to own and manage their own nurseries. This approach is gaining momentum in East Africa. The Forest Departments should supply seeds and should train the villagers in nursery management. In some countries, villagers have not reached this stage; and seedlings are supplied to them free. What are the merits and demerits of this approach?

Problems associated with establishing nurseries include land preparation, late planting, weeds, fires, pests (especially termites), livestock and harvesting. Tree planting can be seriously hampered by non-land preparation, especially in areas where there are hard-pans and black cotton soils. However, trees do not always have to be planted in specified areas; they should also be planted in non-conventional places like farm boundaries and next to roads. Once land or planting areas are prepared, it is important to plant on time.

During tree establishment, early weeding is necessary. Unfortunately, some villagers think that once trees are planted their work is over. Trees can take care of themselves, but some species are very sensitive to weeds, for instance, the Eucalyptus. Investigations have revealed that up to 80-90% tree mortality during the first two years of establishment in Northern Tanzania is attributed to weed competition. The weeds do not only compete for nutrients but also house pests; and they increase fire hazards. Fires are a chronic problem in Africa. They destroy the newly established plantations and often change the tree growing environment.

Livestock is another setback in afforestation. Because of livestock being inseparably tied, with traditions and ritual activities, farmers keep large numbers. In parts of Kenya and Tanzania, a household can pay 100 units of livestock as dowry. Keeping livestock in excess of carrying capacity is commonplace in Africa (e.g. as low as one half hectare per unit as compared to the desired hectares per unit in Central Tanzania).

The results of all this are compaction of soil in the plantations, with accompanying run-off and mineral leaching. The animals also eat and break the young trees. Possibilities include live fencing, using species such as Acacia spp., Agave spp., Euphorbia, Hakea, Pithecelohium dulce and Cupressus spp. There are some countries which have advocated livestock destocking. But this has not seen much success, partly because of the people's attitudes and poor marketing facilities. Education of the public, though it takes time, always pays dividends.

Once the tree crop is ready, harvesting problems sometimes arise even though no complicated technologies are needed. Trees may be harvested when they are still too young. And this implies that more trees have to be planted within short periods, hence more financial inputs are needed. Further, some trees do coppice (e.g. Eucalyptus); but wrong tree cutting may greatly reduce the coppicing capability. The public needs our guidance in this issue.

Although the utilization of fuelwood and charcoal does not involve any complicated technologies, the methods employed in converting wood to charcoal are very wasteful; more than 70% of the energy may be lost. Similarly, much fuelwood (in open fires) and charcoal is wasted because of inefficient stoves. This means more wood is used than necessary and more forest is cut. Improved cookstoves are important but the designs should come from the villagers themselves.

IV. Wood Energy Shortage

It is estimated that more than 465 million m^3 of wood are harvested annually in Africa, and out of these 360-370 million m^3 are used as source of wood energy. Yet, as pointed out earlier more than 201 million people in Africa live in acute scarcity and deficit fuelwood conditions. And this figure is expected to rise to about 535 million by the year 2000.

The fundamental problem is the rapidly increasing population with simultaneous diminishing of the forest resource. These shortages are more pronounced in East Africa, some parts of South Africa, and the Sahel zone. In countries of West and Central Africa where wood seems abundant overall, much of it is locked in as forest reserves, national parks and is not readily available to the villagers. Also, some is so far away from the local communities that its collection is cumbersome and expensive.

Besides this shortage of fuelwood for households, cottage industries are increasingly consuming a large share. These include tobacco curing, tea drying, local brewing and brick and pottery works. For example, Tanzania needs 1.7 million m^3 annually for tobacco curing; this figure will rise to approximately 2.1 in 1985.

The results of all this is further depletion of the remaining forest resource, hence more dependence on plantations and more resources needed to increase them. In addition, labor and

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household funds otherwise used for afforestation are diverted for wood collection and its purchase. Cow dung and agricultural residues are also diverted. In Tanzania, one hectare of cotton needs 16 tons of dung per year. If this is diverted, it can have serious repercussions on agriculture.

Some of the remedial measures include more efficient use of wood, using more forest and industrial wastes, encouraging agroforestry, and the use of other energy sources. Substitutes to charcoal should be investigated. For example, in Kenya, coffee husk briquettes in 5 kg. bags are finding their way to super markets.

V. Institutional Constraints

Tree planting may still be difficult without sound institutional arrangements such as, rational policy and plans, legislation, land tenure, incentives, sympathetic local and national organizations and supporting services.

A. Policy and Planning

There are still some countries in East Africa which do not have clear policies on wood energy, nor do they have clear plans and programs for afforestation. Plans are normally focused on the urban centers and little attention is given to rural areas where the majority of the people live. Consequently, wood energy plans are sporadic and implemented when other sectors have been allocated with "enough" inputs.

B. Organization

Since development and plans are centralized, organization and administrative machinery follows suit. In other words there is too much "Telephone Administration". The poor farmer in remote areas has difficulty in getting seedlings and technical advice. Tanzania has substantially decentralized afforestation activities and have given much of the responsibility to village governments.

C. Legislation and Land Tenure

Rigid legislation can adversely affect afforestation by making villagers passive and disinterested. Thomson[3] has observed in Niger that afforestation is greatly affected by legal barriers. The legal institutions have caused the villagers to think that trees, as a whole, are either a common property or belong to the forester. As such they are not obliged to protect them, and can harvest forests at will. There are

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[3] Thomson (1981): Sylvia Africana No. 10.

still a few local communities which hesitate to plant trees because of uncertainty in land tenure regulations. Villagers fear that once they establish woodlots the same can be taken over by land owners. This has also been observed in Niger. In addition to the land tenure constraints, land shortages also hinder afforestation. In mountain ecosystems of Eastern and Southern Africa, land may be so fragmented through land inheriting tradition that setting aside areas for woodlots is unrealistic.

The Kenya highlands, Arusha Region (in Tanzania), parts of Malawi and Zambia are example of this situation. In these areas, trees should be planted in non-conventional places. Agroforestry can play a key role; so is the provision of various incentives such as giving farmers facilities to practice more intensive farming and tree planting. In some parts of Africa, the governments may establish plantations and turn them over to the farmers after a year or so. Afterwards the government gets a small portion of the revenue accruing from sales in order to remove the idea of "free good". The best incentive is to work together with the villagers.

VI. People's Attitudes and Participation

It is generally accepted that the establishment and management of short-rotation energy plantations do not constitute serious technical and technological constraints. But foresters, social scientists and economists seem to be divided on how to go about it. A brief consideration of people's attitudes steming mainly from social structure and stability, traditions, habits, taboos, and apathy are necessary to take into consideration.

A. Attitudes

In the African social structure, cooking is the responsibility of women. The fuelwood with which to cook the food is collected and/or purchased by women. But these same women are expected to farm, fetch water, look after children, go to the market, and participate in social and communal activities of the village. Villages located in remote areas are frequently neglected by centralized government organizations. As a result, the communities develop apathetic social behaviour to many things, including tree planting. Further still, there are some tribes which, by tradition and unfounded beliefs and taboos, do not like trees near their dwelling places. Some tribes in East Africa still resent trees because they shelter omen-bearing birds like the owl - its sound near the village means someone will die.

These attitudes coupled with family and village instabilities. The loose social organizations and the institutional factors discussed above greatly hinder progress in afforestation.

B. People's Participation

In planning afforestation projects, initial ideas hatched by foresters can be introduced to village governments by foresters. An exhaustive debate should be encouraged. Once the villagers are convinced, then the ideas should be translated into a project. Once the project is formulated, it can be discussed by the village leaders with no need to discuss with the whole assembly. Where village governments do not exist, other gatherings like local political rallies and meetings should be used.

During the implementation of afforestation projects a bulk of the work should be done by the villagers themselves who should then become the owners. The government may help by raising seedlings for villagers, and sell them at a nominal price. Land preparation, planting and maintenance of the plantations is the villagers responsibility. Ideally, villagers should own and run everything, including the nurseries. When the wood is harvested the villagers should decide what to do with the proceeds. The government should only get benefits from its own plantations.

VII. Conclusions and Strategies

The main problems hindering afforestation for energy stem from sociological attitudes and activities. Any efforts to solve these problems must hinge on the people themselves. The question of people's participation in afforestation programs ought to be very clearly spelled out. The level of participation will definitely depend on the local situation and the existing circumstances at a given time. The effectiveness of people's involvement depends significantly on the training and extension services we offer them. A more "revolutionary" approach is needed: that of involving more socio-oriented scientists (sociologists, anthropologists, social workers, women). The forestry curricula should be re-oriented to cater more for producing "social foresters". In this respect there is a complaint among local communities that there are too many foresters but not enough trees.

Once it is accepted that afforestation for energy centers around people and not around trees, it is, then, easier to formulate realistic policies and plans, the implementation of which aims at satisfying people's needs and ensuring proper environmental management. In the same token it is likely to ease the problem of persuading the people to manage and protect energy plantations efficiently and economically.

SOCIAL FORESTRY IN INDIA (GUJARAT)

R.L. Java*

I. Background

A. India

Forests in India cover 23% of total land area. Conifers constitute 4%; the remaining 96% are broad-leaved species. In 1980, requirement for industrial wood was 30 million cubic meters against the production of 20 million cubic meters. The fuelwood gap is larger yet. Projections have shown that the production of fuelwood by the year 2000 would be 75 to 80 million cubic meters, against the requirement of 184 million cubic meters for year 1980, alone.

In our country, the contribution of wood to domestic fuel is 62% and up to 78% in rural areas. The rural communities traditionally depend on forests as a source of food, energy, and shelter. Forests in India have been so used, abused and misused that the delicate balance with soil and vegetation has been upset resulting in accelerated erosion. The precious top soil, which takes from 100 to 400 years to develop a 10 mm layer has been swept away with disturbing results on vegetable growth.

This loss of fertile top soil is estimated at 6 billion tons a year representing a financial loss in terms of crop production of 3 billion rupees and a fertilizer equivalent loss of 12 billion rupees, together representing an annual loss of 15 billion rupees.

If this loss is to be avoided, the resources of fuelwood and round wood have to be augmented so that the urban poor are supplied their urgent needs of domestic energy with no more cost than that of collection.

Systematic forestry in India is over a hundred years old, with the Forest Act being enacted in the year 1865. In 1894, the forest policy was enunciated with a definite emphasis that forestry should serve as an adjunct for agriculture. The privileges and rights of the forest dwellers who are the customary users of forests was clearly defined, restricted and regulated. This resulted in fairly well organized forest departments existing all over the country at the time of

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Independence (1947). In those days, the slogan was "progress through industrialization". The year 1967 saw wood-based industries using 2.6% of the total value of production and 2.9% of employment of all manufacturing activities. Coupled with the population growth, which is doubling every 30 years, the supply demand position with respect to wood and firewood will indeed reach an alarming situation in the near future.

A twofold strategy has therefore been developed in India to fight this frightening situation. Programs have been strengthened during the successive five year plans to augment production forestry, mainly for supplying the spiralling demand of domestic wood production industries such as paper pulp and allied industries, and secondly through community forestry programs to supply in adequate quantities fuelwood, fodder, small timber and other minor forest produce to the rural population.

In India, the forest departments in Gujarat and Uttarpradesh, taking their cue from the National Commission on Agriculture (1976), became the first two States to create separate Community Forestry wings.

B. Gujarat State

Gujarat, which is a small State in the western region of India, lies between 21° and 24° north latitude and 69° to 75° east longitude. With an area of nearly 200,000 square kilometers and a population of over 3 million of which 72% live in rural areas, the State has only 19,500 sq. kilometers under forestation making it a forest-poor State. The rainfall, which is erratic, varies from 200 mm in the North to 2,550 mm in the South. Nearly half of the State is chronically drought prone. The climate and edaphic factors are also varied, from the saline wastes of Runn of Kutchh in the north to the Arabian sea in the west resulting in very dry and harsh climate in the former to the humid and wet climate in the latter. In the Northeast, East and Southeast there are the mountain ranges of Vindhyas, Satpuras and Sahyadris.

Electricity and gas as sources of cooking energy are virtually nonexistent in rural areas. During 1978, 78% of total domestic fuel utilized was comprised of firewood (48.2 lakh tons), dungcakes (10.6 lakh tons) and charcoal (1.6 lakh tons). Against this annual requirement of wood, the recorded production of timber from State-owned forests was calculated at 1.3 lakh cubic meters and 11.6 lakh tons of fuelwood, which included the recorded production of firewood of 1.3 lakh tons and the rest 10.3 lakh tons of unrecorded nature removed by the villagers for the daily bonafide domestic use, by way of rights, privileges, unauthorized removal, etc. Because of this over exploitation, average annual recorded production which was 2.66 lakh tons of firewood and 2.23 lakh cmt. of timber during the period 1960/65 has fallen to 1.37 lakh tons

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of firewood and 1.56 lakh cmt. of timber during period 1975/80.

C. Forests

Depending on the rainfall, Gujarat can be divided into three distinct forest regions. On the western side (Kutchh and Saurashtra), the rainfall is very low and dry scrub forests predominate and include species like Acacia nilotica, Anogeissus latifolia, Azadirachta indica, Erythrina suberosa, Zizyphus spp. and thorny shrubs with bamboos in hilly pockets. The central area of Gujarat has moderate rainfall. Dry mixed deciduous forests are found in this area with species like Tectona grandis, Adina cordifolia, Telminalia crenulata, Dalbergia sissoo and bamboos, Dendrocalmus strictus and Bambusa bamboos. Moist deciduous forests are found in the southern parts of the State where rainfall is quite heavy and soil factors are more favorable. The above mentioned species are found in bigger size and better growth. In addition, mangrove forests are found along the sea coast. These consist mainly of Avicenia officinalis which supplies firewood to the adjoining population.

D. Production Techniques

Industrial species such as teak (Tectona grandis), khair (Acacia catechu), and bamboo (Dendracalmus strictus) are being grown at the rate of 5,500 ha. annually. Degraded areas, subject to adverse biotic factors are being reboised through fast growing fuelwood species like Eucalyptus, Acacia tortallis, Leucina leucocephela etc. at a rate of 2,000 ha. every year. In badly deteriorated areas, soil and moisture conservation measures such as gully plugging, nala bunding, and terracing, are carried out before carrying out afforestation. An area of about 12,000 hectares is being developed under this scheme each year.

In saline and desert wastes, like the Great and Little Runn of Kutchh measuring almost 13,000 sq. kilometers, efforts are being made to raise plantations of hard species like Prosopis juliflora and Accacia tortallis to contain and stop the desert from spreading inward towards fertile fields. An area of 1,600 hectares is developed under this scheme every year.

Along the coast line stretching over 1,600 kilometers, plantations of Prosophis juliflora and Casurina equesitifolia are raised to stabilize the sand and save the fields from salty spray.

Beginning from 1951 to 1978, the following achievements have been made under different plantation programs.

Economic plantation	59,763 hectares
Plantation of fast growing species	34,383 hectares
Soil and moisture conservation and reforestation of degraded forests	65,347 hectares
Desert border plantation	33,872 hectares
Plantation along coastal border.	8,322 hectares

II. Social Forestry

A. Why necessary?

Even though we know that more and more areas should be forested to make them more productive, the reverse continues to be true. It is estimated that during the period 1961 to 1979, valuable fertile land and good tree bearing areas (545.15 sq.km.) have not been forested due to the following reasons:

For major and minor irrigation projects	223.9946 sq. km.
Rehabilitation of persons displaced from project areas	162.4060 sq. km.
Regularization of forest cultivation	43.4360 sq. km.
Miscellaneous.	115.3212 sq. km.
Total	545.15 sq. km.

Thus, the gap between demand and supply of fuel and timber was so wide that even the most intensive management of existing forests could not bridge it.

Recognizing the dwindling forest resources of the State and realizing the immediate need for increasing the tree cover especially outside the traditional forest areas, the State forest department set up an independent unit for undertaking the Social Forestry program from the year 1969-1970. This organization planted trees along a 50 km. strip and the State was divided into two Divisions under the overall control of Conservator of Forests for taking up this new project.

The Social Forestry program received good response from the people. In 1974-1975, plantations in village community lands were developed.

In the field of social forestry, public participation and cooperation in raising trees is the most important component. In order to encourage the public, seedlings were distributed free. Other activities such as raising student's forests, planting in municipal vacant plots, industrial estates, compounds of Government buildings, and raising seedlings at primary schools were initiated. Later on, innovative schemes like raising plantations in malki lands and social security through plantations were added.

Seeing the success achieved by the Forest Department of Gujarat in the social forestry programme, the World Bank is funding a 5 year project totalling $76 million (653.59 million rupees).

B. Village Woodlots

Village woodlots are raised in community lands popularly known as "Gaucher lands", have been covered starting from 1974-1975, an area of about 17,000 hectares spreading over an area of 2,000 villages (out of 18,275) in the State. Under the World Bank Project, village woodlots will be self managed by the panchayats. The department will assist with free seedlings and technical advice. The purpose behind initiating self-managed woodlots is to involve village panchayats so that they get all the profit. During the 1980 rains, 4,560 hectares of village woodlots were raised.

C. Rehabilitation of Degraded Forests

Some of the State forest areas have been badly degraded due to severe biotic factors. Efforts to rehabilitate these areas by the department have not yielded fruitful results. Therefore, an innovative scheme of settling some families to afforest part of these areas has been put into operation. This scheme aims at giving social security to the local tribe. Groups of 10 to 15 tribal families having no cultivatable land will be employed. These families will also be given 20% share from the net profit of the harvest. During 1980/1981, 200 hectares will be planted through full time labor and 4000 hectares on casual labor. If this labor scheme succeeds, most of the degraded area will be afforested through full time labor.

D. Afforestation of Private Agricultural Land

This is another important scheme of afforestation of hilly areas unsuitable for raising agricultural crops. Under this scheme, a tribal farmer who sets aside 2 hectares of his cultivated area for raising trees will be paid Rs.250/- per year for 15 years. The plantations of fast growing species such as teak and bamboo will be raised. The government will bear the cost which will be recovered from sales. The net profit will go to the farmer. The target for the year 1980 was to afforest 200 hectares under this scheme.

E. Farm Forestry

Due to the concentrated efforts of the Forest Department, the cultivators and other people in the State have become tree conscious and every year a large number of seedlings are being planted and looked after. The Department has introduced a scheme to raise seedlings through primary school children. The poly pots and seeds are supplied free by the Department and technical guidance is given to the children who perform

the labor. About 100 schools have adopted this scheme in the State and many more are coming forward.

F. Conservation of Fuelwood Supplies

Gujarat is facing severe shortage of fuelwood and hence many trees are being hacked in the rural areas in their prime. The future fuelwood resource is thus declining as newly planted trees will take some time to mature to fuelwood size. The Department, quite conscious of this situation, has decided to save as much tree growth as possible from the countryside by reducing the consumption of fuelwood with more efficient wood burning stoves. By providing a simple adjustment to the firebox and adding a smoke pipe, more efficient smokeless Chula can be made which reduces fuelwood consumption to the extent of 25%. Under the World Bank Project, 10,000 smokeless Chulas will be provided in rural areas especially in the villages having population of more than 2,000 and which have self-managed woodlots.

G. Difficulties Encountered

The main difficulty in the execution of the Social Forestry program was to gain the confidence of the people. At first the people were very sceptical regarding the success of the program. They felt that it was money down the drain because who would expect a plantation on the open road where hundreds of thousands of cattle roamed freely.

When the people refused to come to the department, the department went to them. Seedlings were taken to the villages and through lectures, demonstrations and audio/visual aids, the people were convinced of the beneficial results.

III. Conclusions

Gujarat has become more green, more beautiful, more clean and more famous thanks to the massive tree planting program. This has also had effect on rainfall and microclimate. The capital of Gujarat, which used to be called "andhinagar" or the city of dust storms prior to the social forestry project, has become a picnic spot for Sunday visitors from adjoining industrialized cities.

With more grass available for cattle, the dairying industry has been increasing its production. It is not uncommon during the months of August to November to see hundreds of people cutting grass along the roadsides, in the plantations, earning Rs.5-Rs.6 for 3 to 4 hours of labor. This has given self employment and income to thousands of urban poor all through the State.

SAHEL: FORESTS AND FORESTRY

G.F. Taylor, II*

I. Introduction

The U.S. Agency for International Development is currently undertaking a wide variety of forestry projects across the Sahel as part of its Sahel Development Program. In addition to two large-scale plantation projects (in Senegal and The Gambia) and a number of pilot rural forestry efforts (in The Gambia, Mali, Mauritania, Niger, Senegal and Upper Volta), important pioneering work is being carried out in natural resource inventory and land use planning (in Mali, Mauritania, Niger and Senegal as well as through the OMVS and OMVG river basin development projects), forestry education (in Upper Volta), and natural forest management (in Niger and Upper Volta) (1). Papers describing a number of these projects have been prepared for presentation at this Workshop. Readers interested in pursuing further both AID and others' experience with forestry development in the Sahel are referred to the bibliographic postscript of this paper.

Although most USAID-funded projects are only a year or two into implementation, initial results coupled with experience gained from a wide range of other efforts have raised a number of important issues related to forestry development in the region. A few of those issues have been selected for treatment in this paper. If the presentation is found to be provocative, it is intentionally so - with the aim of airing the issues, stimulating reflection and discussion, and thereby providing a more solid basis for both ongoing and future forestry development activities in the Sahel.

II. Natural Forest Management - the case for increased attention

The case for substantially increased attention to natural forest management has been building across the Sahel in recent years. Critiques of the large-scale planting of 'fast-growing' exotics have been based on a variety of concerns ranging from escalating costs due to the dependence of these techniques on imported petroleum and heavy machinery on the one hand to concerns over a range of environmental issues on the other (2). More recently, initial production figures for Eucalyptus camaldulensis from plantations in Upper Volta coupled with research results from Senegal have made it clear that the estimates upon which these projects have been based were highly optimistic and will not be achieved (3).

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It must be noted at the same time that the experience with large-scale plantations of fast-growing exotics in the Sahel has not been uniformly dismal: Gmelina arborea continues to perform well when planted in higher rainfall zones with production volumes of 12 to 15 m^3/hectare/year achieved since 1966 in plantations in Mali. Encouraging work is also underway in Senegal (under a USAID-funded project) designed to reduce the costs of plantation establishment in an attempt to ensure the economic viability of Eucalyptus plantations in the face of lower yields. Nonetheless, results across the region as a whole provide a clear signal that the fast-growing exotics have not performed as well as was expected and that substantially increased attention must now be devoted to the management of existing woodlands to meet both current and anticipated future energy and forest product needs.

A. Natural forest management - a new priority?

Although the call for large-scale plantings of 'fast-growing' exotics has captured much of the limelight in recent years, some foresters have questioned the viability of these schemes for some years now and have stressed the central role of natural forest management in forestry development in the Sahel. Aubreville, for one, noted as far back as 1938 that the idea of 'artificial forests' in the Sahel was utopian. In the 1950's French foresters working in the region considered rainfed plantations inappropriate in areas under 1100 mm of annual rainfall (4). In the period following the most recent drought a continuing skepticism surfaced in a variety of documents. For example, a paper prepared by CTFT in 1975 for the MAB Technical Note The Sahel: Ecological Approaches to Land Use noted:

> 'Generally speaking, fry plantations are not to be recommended. Infact, though such plantations can be successful, they require large investments (150,000 FCFA/hectare) and are based solely on local, slow-growing species, the production of which is scarcely higher than that which can be obtained with a much lower initial investment - from natural regeneration (5).'

In this passage, ironic in view of the current situation, the paper went on to note:

> 'Technical workers are often criticized for not using exotic species reported for their resistance to drought. Indeed, few exotic species are to be seen in the Sahel, but this is not due to lack of imagination on the part of local technicians. The reason is rather that very few introduced species can withstand the local environmental conditions, which are among the most severe in the world (6).'

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After reviewing the whole range of forestry interventions underway across the region in 1976, J.C. Delwaulle, in a paper prepared for the CILSS/UNSO/FAO Consultation in Dakar, noted:

> 'Apres avoir passe en revue, d'une maniere assez critique, l'ensemble des actions susceptibles d'etre menees dans la zone, en matiere de technique forestiere, nous voudrions attirer l'attention des responsables forestiers sur la trop grande importance qu'ils accordent, a notre sens, aux plantations, perdant ainsi de vue trop souvent le recours aux techniques de regeneration naturelle, d'amenagement des peuplements, de defense et restauration des sols et d'animation rurale (7).'

Nevertheless, relatively little has been done in the way of natural forest management in the Sahel to date. The observation made by Delwaulle in 1976 continues to hold true, namely:

> 'Mis a part ces cas (a few examples in Senegal) il semble bien cependant qu'il n'existe actuellement aucun amenagement serieux de forets dans les pays membres du CILSS alors que les superficies susceptibles d'etre amenagees, soit du point de vue sylvopastoral, soit du point de vue production de bois, sont enormes (8).'

B. Natural forest management - a new panacea?

Although it is now clear that urgent attention must be devoted to improving the management of existing natural formations across the Sahel, it is equally clear that:

- substantial long-term research into the dynamics of the natural vegetation will be needed as a prerequisite to the development of appropriate silvicultural techniques.

- even with the technical knowledge in hand the constraints (institutional, financial,social, etc.) to carrying out more intensive management on any wide scale will be substantial - and,

- the increased productivity that is expected under the more intensive management of natural formations is not likely to meet current let alone projected fuelwood and forest products needs.

As a result, forestry development in the Sahel must continue to include a wide range of interventions designed to increase production (including large-scale plantations, rural forestry and pilot irrigated plantations with concomitant research, training and infrastructure development). Concurrently, efforts to reduce fuelwood consumption and develop alternative

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energy sources thereby reducing pressure on the natural vegetation must be pursued with all deliberate speed. It is abundantly clear from the experience of the last five years that there are no panaceas to the complex issues that surround forestry development in the Sahel - including natural forest management.

III. Reboisement: Process vs. Project

Among the issues that emerge from development efforts in forestry in the Sahel is the observation that the successful implementation of a particular project, or set of projects, should not be confused with 'successfully solving the problem' or even necessarily with setting in motion a process that will eventually 'solve the problem'. While the concern expressed by various observers (myself included) - that talk about forestry needed to be translated into more concrete action sur le terrain - continues to be a valid one, an excessive preoccupation with project outputs (number of trees or hectares planted, number of students trained etc.) can serve to confuse short-term objectives with long-term goals. In other words, what must be examined is not simply how much is achieved in quantitative terms but how it is achieved and whether or not a process has been started that can and, hopefully, will be contimued in the absence of external funding. These issues of replicability and absorptive capacity (including the ability to cover recurrent costs) are, of course, central to the development process - issues that may all too often be lost sight of in an impatience to 'solve problems' and demonstrate concrete project results (9).

Recommended long-term goals for various types of forestry interventions include:

- for large-scale plantations: a move towards increased private sector involvement in fuelwood production, particularly around urban centers.
- for rural forestry: the development of locally controlled, village-level forest and land resource management.
- for natural forest management: the development of controlled multiple-use management of the national forest estate (10).

A. The harnessing of natural processes

The importance of harnessing natural processes (particularly natural regeneration) in any schema for forestry development in the Sahel cannot be overemphasized. While project-specific tree planting activities will assist in addressing the 'other energy crisis' on a limited scale in selected locations, the understanding and harnessing of the dynamics of the natural systems is the only viable long-term strategy for the region as a whole.

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B. The harnessing of social processes and 'felt needs'.

A careful examination of the 'felt needs' of local populations coupled with the production and distribution of a few tree species that meet those needs may contribute more effectively to the long-term goal of reboisement than dozens of 'planting projects'. Mention has been made elsewhere of the remarkable spread of one tree species, Azadirachta indica (neem), across the Sahel over the past few decades - a process that combined the harnessing of both social and natural processes: starting with planting and being continued through natural regeneration aided by the birds and the bats (11). While the importance of the social context of forestry development is now widely recognized in forestry circles (12), the effective integration of 'felt needs' into project design as well as the harnessing of social processes to promote forestry development remain the exception rather than the rule (13).

C. Possibleness - a guiding principle?

The issue of absorptive capacity deserves urgent attention in forestry sector activities across the Sahel. While projections continue to be generated showing that current planting programs are only a fraction of what must be done immediately if catastrophe is to be averted, Forestry Departments across the region are being stretched to their limit just handling current project portfolios.

A recent article in Unasylva summed up this issue well. Stressing the importance of practically achievable objectives, it noted:

> 'It is possible to project present trends in fuelwood depletion and find they lead rapidly to total disaster. Such exercises tend, however, to be counterproductive. They do not take into account the flexibility and the versatility of human response. More important, they call for large-scale remedial measures which are far beyond the boundaries of political and economic feasibility. In proposing impossible responses to what may appear to be exaggerated projections of future needs such analyses may succeed in paralyzing rather than galvanizing policy makers. Effective policy making depends upon matching practically achievable actions to needs and priorities as they are actually experienced. This does not mean that the seriousness of the outlook for fuelwood supplies should be ignored but that action should be concentrated where it is most likely to be productive and effective (14).'

Absorptive capacity, practically achievable objectives, possibleness - concepts to be reckoned with in relation to the current status and future direction of forestry development in the Sahel.

IV. Forestry and Agricultural Development - the importance of the forestry/agriculture interface (15).

Increased attention to forestry in the Sahel in the years following the most recent drought can be traced to a number of sets of interlocking issues including: a) energy (the 'other energy crisis') and b) environmental degradation/rehabilitation (both the 'advancing desert' and tropical deforestation have been prominent themes). While each of these continue to provide an important rationalefor ongoing sector activities, it has become increasingly clear that forestry programs need to be based on a clearer understanding of the multifaceted role of woody vegetation in the Sahel. As a result, forestry development needs to be tied more closely (both conceptually and in terms of project interventions) to agricultural development activities.

Trees and tree crops play a central role in traditional agricultural production systems (both crop and livestock as well as mixed farming systems) across the Sahel. The important contribution of trees and tree crops has been documented for some time now (see, for example, the work on Acacia albida done at Bambey in Senegal, Paul Pellisier's Les Paysans du Senegal and R.A. Pullan's seminal article 'Farmed Parkland in West Africa' in Savanna 3(2), 1974, p. 119-152 to mention just a few examples). More recently this theme has been picked up as an area of active research by international agricultural research centers such as ILCA, ICRISAT and IITA (see, for example, ILCA's International Symposium on Browse in Africa (Addis Ababa - April 1980. Proceedings currently in press); ICRISAT's Sahel program director Clause Charreau's article, 'Le rôle des arbres dans les systemes agraires des regions semi-arides tropicales d'Afrique de l'Ouest' in the IDRC volume Le Role des Arbres au Sahel; and IITA'a work on leucaena/maize intercropping and indigemous tree-crop species trials reported in the Proceedings - United Nations University/IDRC/ICRAF Workshop on Agroforestry in the African Humid Tropics held at IITA in April of this year.) (16). Word has, however, been slow to filter through to the development community.

As indicated above, forestry development in the Sahel needs to be based on a definition of forestry that is considerably broader than that provided by the 'energy perspective' alone. This is illustrated in a recent National Academy of Sciences report as follows:

> 'Although family plantations should be encouraged and compound plantings will undoubtedly continue to contribute marginally to fuel needs, interviews with men and women in rural areas of Mauritania and Senegal have revealed less concern regarding fuelwood supplies than anticipated but considerable anxiety concerning the growing scarcity of wild fruits, browse shrubs, medicinal herbs, building materials, and other forest products that were available locally in the past.... Hence, the establishment of village woodlots represents only a partial solution to the perceived problems of these populations....

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The continuing emphasis placed upon fuelwood by donors tends to obscure the complexity of local problems and could prolong their resolution (17).'

Agroforestry is one area that deserves increased emphasis in the context of closer attention to the linkages between forestry and agriculture. Although agroforestry has been the subject of renewed interest and considerable discussion in recent years, effective mechanisms have yet to be developed to initiate much of the basic research prerequisite to effective project interventions. It must be cautioned that agroforestry (and, for that matter, tree planting in general has, in some circles, suffered from an excess of wishful thinking: it is not a panacea that will cure all the evils of inappropriate land management. As the recently appointed director of the Nairobi-based International Council for Research in Agroforestry (ICRAF) has noted:

> 'In the promotion of the agroforestry concept, there has been no limit to the alleged positive influence of trees. Sometimes this has achieved almost mystical dimensions - the frequent talk about 'miracle trees' is one aspect of this. Although it may sound like lack of imaginative thinking, it must be flatly stated that there exist no miraculous influences of trees on soils (18).'

Nonetheless, the simultaneous cultivation of food and tree crops does make sound production sense in a wide variety of situations - traditional production systems across the Sahel confirm this point. It is hoped that ICRAF, working with national and other regional and international agricultural and forestry research organizations, will be able to serve as a catalyst in initiating the research necessary to develop appropriate improvements in agroforestry production systems.

In addition to the importance of trees, tree crops and agroforestry systems in meeting the food and nutrition requirements of Sahelian populations, another facet of the forestry/agriculture interface is the protective role of forests and tree cover in relation to agriculture. These concerns have, to date, been addressed primarily under the rubric of environmental protection. While broad environmental concerns continue to be important in the Sahel Development Program, a more direct linkage at the program and project level between soil and water conservation and agricultural production is called for if these concerns are to receive the attention they deserve. A closer linkage between forestry and agricultural development is a first step in that direction.

The relationship between forestry and agriculture and the contribution of forestry to agricultural and rural development stands as a fundamental parameter of forestry development in the Sahel. One programatic implication: the need to insist on a definition of forestry substantially broader than that provided by the 'energy perspective'. A second implication: the need for careful attention to incorporating appropriate forestry activities

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(both production and protection oriented) into ongoing and proposed agricultural and rural development projects in USAID project portfolios.

V. Forestry Research - essential prerequisite to more effective project interventions.

One of the clearest lessons to emerge from forestry development in the Sahel in the post-drought period is that forestry research must be both reoriented and receive substantially increased emphasis.

A. The need for reorientation

That a reorientation is called for is evident not only in the disappointing results currently being registered across the region with the species that has received the bulk of research attention in recent years - Eucalyptus - but in the growing awareness that a) technical packages are unavailable for use in rural forestry and b) much of the basic research prerequisite to natural forest management remains to be done. The development of technical packages for rural forestry is particularly urgent. As noted in an FAO report in 1979 on the prospects for FLCD (Forestry for local community development) projects in Senegal:

> 'La necessite d'amplifier et d'intensifier, dans de tres fortes proportions, la recherche forestiere dans ce domaine est une des constations majeures de la mission car le developpement communautaire est deja lance et les insuffisances techniques qui resultent des lacunes de la recherche ne peuvent avoir que le plus mauvais effet pour l'integration indispensable de l'arbre et de la foret dans les preoccupations paysannes.' (entire passage underlined in original) (19).

B. The need for increased emphasis

The case for increased emphasis has, in part, been made above as well as in earlier sections of this paper. The recently completed CILSS/Club du Sahel Forestry Sector Analysis Report for Niger summed up the need succinctly when it noted that forestry research was 'un domaine ou presque tout est a trouver (20).'

C. Setting research priorities - the process

The recent World Bank/FAO paper entitled Forestry Research Needs in Developing Countries - Time for a Reappraisal? prepared for the 17th IUFRO Congress in September set forth with clarity both the need for increased attention to research and some of the issues that deserve priority attention. Using the IBRD/FAO paper as a starting point including a) the primary conclusion that first priority should be given to strengthening national research institutions in developing

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countries, b) the CGIR-derived mechanism for establishing priorities for forestry research (Annex 3) and, c) the indicative list of forestry research needs in developing countries (Annex 4) it is recommended that an Africa-specific follow-up study be launched including an in-depth assessment of current research capabilities, a review of work completed to date, and the identification of research priorities coupled with specific suggestions on the most efficient means of getting that research started. An Africa-wide rather than Sahel-specific focus is suggested so that one of the most important issues facing forestry research - namely, the need for vastly improved coordination and information dissemination mechanisms between francophone and anglophone Africa - is squarely faced.

It should not be assumed from what has been said above that little or no thought has already been given to the question of research priorities. As is often the case, the Sahelians are well ahead of the donor community in this regard. In Senegal alone, for example, ISRA's Plan Indicatif National de la Recherche Agricole 1979-1984 (which, in case anyone is interested, runs to 370 pages) includes 37 pages of detailed proposals for forestry research. Many of the proposed topics (natural regeneration, the silviculture of indigenous species, the development and commercialization of 'minor forest products' etc., etc.) fit directly with some of the 'new priorities' proposed earlier in this paper. What has been lacking has been not an understanding of what needs to be done - but the means to do it.

D. Forestry research in the Sahel - a few reflections

While the case for increased attention to forestry research has been outlined above, a few reflections are in order:

1. Review of work done to date is an essential prerequisite to the launching of new efforts.

   Although reports are scattered and often very difficult to get hold of and although the methods used in many cases were less than fully scientific, a substantial amount of research work has been carried out over the years across the Sahel. The insight gained from this work must, wherever possible, be used as the starting point for any new efforts. This procedure would, perhaps, appear to be self-evident. Unfortunately, a review of a number of research proposals currently making the rounds in the Sahel indicate that this is not the case. Fortunately, some compiling of research results has already been done. Among the sources that deserve to be highlighted is D. Toni's, Recherches Effectuees en Haute-Volta en Matiere

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Forestiere. ENITEF - Nogent/Vernisson- Domaines des Barres. October 1975, 75pp.

2. The strengthening of the research infrastructure in the Sahel will be a costly, long-tern proposition.

   Although the IBRD/FAO paper recognized in a global sense the costs associated with its proposals, it did not address in any concrete way a number of important issues tied to the strengthening of research institutions including a) recurrent cost ramifications, b) the ability of financially strapped governments to both make effective use of and hold on to trained research personnel, and c) the additional financial and human resource commitments that are implied in the development of research infrastructures i.e. demonstration programs, an extension network etc. These are only a few of the many issues that will need to be addressed prior to the establishment and/or strengthening of forestry research institutions. It must also be clearly recognized that although 20 years have elapsed since independence, most of the forestry research in the Sahel continues to be carried out by expatriate researchers. As a result, the training of a Sahelian research cadre will, in most instances, need to be the initial priority.

3. Utilization of results to promote development is the ultimate test of research effectiveness.

   Given the pressing need for development across the Sahel and the limited resources available to work towards that end, to insist on the need for relevant; applied research is perhaps a moot point. That careful attention must be given to developing mechanisms for the dissemination and utilization of research results is, however, something that cannot be overemphasized. Later in the paper a couple of examples are given illustrating how difficult a task information dissemination demonstrably is. Those examples could be multiplied many times over - cases of research results, reports etc. that lie forgotten not because they have nothing to offer but because effective mechanisms for information dissemination are not in place.

4. Coordination efforts currently underway will form the basis for future action.

   On a more upbeat note, there have over the past year been a number of developments that point with optimism to the future of forestry research in the Sahel. These include a) the reorientation of

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research priorities in a number of countries with substantially increased priority given to research on indigenous species (including their wide range of 'non-wood' products) and natural forest management and b) the establishment of coordination mechanisms for forestry research. To cite an example of the latter, Upper Volta recently set up a Commission on Sylviculture et Techniques Forestieres designed to bring together all research workers involved in forestry research (from as many as three separate government Ministries) on a regular basis to exchange information on work underway, coordinate and provide peer review of that research, and prioritize proposed research. While it is too early to judge the effectiveness of this Commission, that it was established in the first place and that it is headed not by an expatriate but by a Voltaic (with a Ph.D. in forest ecology) appears to bode well for the future of forestry research in Upper Volta.

VI. The Regional Dimemsions of Forestry Development in the Sahel: cooperation coordination and information dissemination.

The final issue to be touched briefly in this paper is the regional dimension of forestry development in the Sahel. While both time and space preclude devoting the attention to this issue that it deserves, a few observations follow.

Given the limited resources (human and financial as well as physical) at the disposal of Sahelian governments, the enormity of the development task, and the underlying similarity of many of the problems across the region - cooperation and coordination take on a heightened importance in the Sahel. The rationale for USAID's Sahel Development Program and the broader CILSS/Club coordinating mechanism of which it is a part is firmly based on this fact. In forestry, as in virtually every other sector, there is much to be gained from a coordination of effort and a sharing of experience. Mechanisms - both formal and informal - to promote this sharing are in place. Much can, however, be done to expand the role and increase the effectiveness of the formal mechanisms (including, inter alia, CILSS and the Institut du Sahel). The potential role of such mechanisms is becoming increasingly important as results become available from the many forestry activities currently underway across the region.

Information dissemination is a particularly important component of regional cooperation. Two recent examples of the lack of adequate dissemination serve to illustrate this point: a) Forestry technicians starting work on a large-scale plantation project in the 1100 mm zone of Upper Volta using Eucalyptus camaldulensis were unaware of the excellent results that had been obtained since 1966 with Gmelina arborea under similar climatic conditions in two Sahelian countries: neighboring Mali and The Gambia. b) A dendrology textbook was recently 'rediscovered' in Mali (21).

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Prepared as part of a UNESCO project in 1973, eight years later not only were copies unavailable for students at the national forestry school, but a piecy of work that could with relatively minor additions and revisions become a standard dendrology text across the Sahel had been virtually unhearch of out side of Mali. Examples of this type abound. Pointing out the problem and decrying the unnecessary duplication of effort and 'reinvention of the wheel' that result from it are easy. What is both more difficult and arguably among the most pressing priorities for forestry development in the Sahel is the establishment of information dissemination networks that are both found by those working in forestry across the region to be useful and are, as a result, used.

VII. Conclusion

In closing - a bit of historical perspective on the development of forestry in the Sahel. The French agronomist Etesse, writing in 1918 as Directeur d'Agriculture des Colonies on the question of reforestation in Senegal, noted:

> 'Pour etre un bon agriculteur, il faut etre entreprenant, observateur, patient et obstine. Ce sont les qualities qui ont domine une experience de dix annees sur le boisement au Senegal, et dont les resultats commencent seulement a apparaitre (22).'

Reporting on successful trials with Casuarina that had begun as early as 1908, it was Etesse's hope 10 years later in 1918 that one day the entire coast from Dakar to St. Louis would be protected with plantings of filao. Some 60 years later that dream is about to be fulfilled: the Senegalese, working with assistance from the FAO, CIDA and USAID, expect to complete the first line of windbreaks next year. Various morals could be drawn from this example. The one that I choose to draw: forestry development in the Sahel is likely to be a longer and a more complex undertaking than many had imagined. That is, however, hardly reason enough to give up hope - the line of filao will be completed between Dakar and St. Louis.

For many of the forestry activities currently underway in the Sahel we are, in 1981, close to where Etesse was in 1918: results are just beginning to appear. His counsel continues to hold true: il faut etre entreprenant, observateur, patient et obstine.

Endnotes

1. This list is indicative rather than exhaustive. For a full listing of USAID-funded forestry projects see J. Comings (Comp.), Forestry and Natural Resource Activities Supported by the Africa Bureau. Washington D.C.: U.S. Agency for International Development - AFR/DR/SDP. (Updated by K. Mullally, November 1981) and P. Larson (Comp.), Energy Activities Supported by the Africa Bureau. Washington D.C.: U.S. Agency for International Development - AFR/DR/SDP. March 1981. 62pp.

2. Important recent critiques include J.D. Keita's 'La Crise de la Foresterie au Sahel' (presented at the ECA/FAO Seminarire sur le Developpement des Combustibles et de l'Energie pour les Femmes Africaines en Milieu Rurale. Bamako December, 1980) and Politique d'Amenagement 'des Forets Classees. Ouagadougou: Ministere de l'Environmetn et du Tourisme. June 1981 28pp. The latter, coupled with the recent formation in Upper Volta of a 'Unite Amenagement des Forets' within the Ministry of Environment and Tourism, are indications that natural forest management is beginning to receive the increased attention it deserves.

3. See, for example, O. Hamel and C.R. Bailly, Premieres observations sur les potentialites de l'Eucalyptus au Senegal. Dakar: ISRA/CNRF July 1981 10pp. (Paper presented at the 17th IUFRO Congress Kyoto, Japan September, 1981)

4. P.L. Giffard, 'Arbre Dans Le Paysage Senegalais: Sylviculture en Zone Tropicale Seche. Dakar: Centre Technique Forestier Tropical 1974, p. 329.

5. UNESCO, The Sahel: Ecological Approaches to Land Use MAB Technical Note No. 1 Paris: UNESCO. 1975, p. 49.

6. Ibid., p. 50.

7. J.C. Delwaulle, Plantations Forestieres en Afrique Tropicale Seche - Techniques et Especes a Utiliser. Nogent-sur-Marne: Centre Technique Forestier Tropical 1979, p.2.

8. J.C. Delwaulle, 'Le role de la foresterie dans la lutte contre la desertification et sa contribution au developpement. 'Bois et Forets des Tropiques 174, 1977, p.8.

9. An example may serve to further illustrate this point: just as the Trans-Sahel Greenbelt proposed by various 'experts' made neither technical nor economic sense, however compelling the visual image of a line of trees 'stopping that desert', so too the vision of the reforestation of the Sahel based on donor-funded forestry projects is naive. Reforestation on any substantial scale will take place only if and when the Sahelian populations decide to undertake it themselves. This does not negate the importance of externally-funded efforts - far from it - but it does serve to illustrate the importance of the process that is started by these efforts.

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10. For an elaboration of appropriate interventions designed to meet these goals see the SDP Draft Forestry/Ecology Sector Strategy and G.F. Taylor, SDP Forestry/Ecology - A Discussion Paper. Bamako: SDPT June 1981 6pp.

11. see SDP Draft Forestry/Ecology Sector Strategy.

12. For a recent example relevant to the Sahel see J. Burley, 'Obstacles to tree planting for wood fuel in arid and semi-arid lands with particular reference to India and Kenya.' International Tree Crops Journal 1 (2/3), 1980, p. 147-162.

13. It could also be noted that while social scientists have provided telling (and at times most useful) critiques of both proposed and ongoing gorestry projects, their ability to provide concrete direction to project interventions also remains the exception rather than the rule.

14. G. Foley and A. van Buren, 'Substitutes for Wood: turning to coal and other approaches to easing the pressure on fuelwood resources.' Unasylva 32(130), 1980, p.23.

15. For a definition of the forestry/agriculture interface and an examination of its importance elsewhere in the developing world see G.F. Taylor II, 'The Forestry/Agriculture Interface: Some Lessons from Indian Forest Policy.' Commonwealth Forestry Review 60 (1), 1981, p. 45-52.

16. Note: The Proceedings of the Ibadan Workshop are still in press. A particularly important recent work is IDRC's Le Role des Arbres au Sahel: Compte Rendu du Colloque tenu a Dakar (Senegal) du 5 au 10 Novembre, 1979. Ottawa: International Development Research Centre 1980, 92p. Other recent works of note include: G.A. Watson, A Study of Tree Crop Farming Systems in the Lowland Humid Tropics. Washington, D.C.: The World Bank. AGR Technical Note No.2. 1980. 2 vols.; J.C. Okafor, 'Trees for Food and Fodder in the Savanna Areas of Nigeria' International Tree Crops Journal 1, 1980, p. 131-141; and P. Pelissier, 'L'arbre dans les paysages agraires de l'Afrique Noire.' Cahiers ORSTOM (Serie Sciences Humaines) 17 (3/4), 1980, p. 131-136.

17. J. Gritzner, Environmental Degradation in Mauritania. Washington D.C.: National Academy of Sciences. Staff Report 1981, p. 59 (in Draft version).

18. B. Lundgren quoted in G. Budowsko. 'Applicability of Agroforestry Systems, (Paper presented at United Nations University/IDRC/ICRAF Workshop on Agroforestry in the African Humid Tropics. IITA, Ibadan April 1981. Proceedings in press.) Budowski's paper provides a welcome antidote to the 'oversale and wishful thinking' that has characterized some tre atments of agroforestry. Both the pros and cons of agroforestry systmes are discussed and compared with production systems are discussed and compared with production systems based on the monoculture of economic crops.

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19. M. Hoskins and G. Guigonis, Actions Forestieres pour le Developpement Rural Communautaire au Senegal. Rome: FAO November, 1979 p.18. The unavailability of appropriate and tested technical packages is, of course, not limited to forestry. Production oriented agricultural projects across the Sahel have suffered from the same problem. A recent de-emphasis of production projects and substantially increased funding for agricultural (including livestock) research (on the order of $129 million has been committed by various donors over the next five years in Senegal alone) is the result.

20. CILSS/Club du Sahel, Analyse du Secteur Forestier et Propositions: Le Niger. Ouagadougou/Paris: CILSS/Club du Sahel. August, 1981 Vol. I, p.111.

21. J. Parkan, Dendrologie Forestiere. Bamako: Institut Polytechnique Rural de Katibougou/UNESCO. 1973. 2 vols. 256 pp.

22. M. Etesse, 'Sur le reboisement au Senegal.' Bull. d'Etudes Historiques et Scientifiques de l'AOF (Paris) 1918, p. 245-248.

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Bibliographic Postscript

A large and rapidly expanding literature exists on various facets of forests and forestry in the Sahel, much of it generated as part of forestry programs and projects launched in response to the most recent Sahelian drought. Readers unfamiliar with forestry development in the Sahel seeking background information on the work carried out by the U.S. Agency for International Development should, in the first instance, consult Forestry Resources Development Assistance: A Selective Bibliography of Reports prepared by AID's Office of Development Information and Utilization in November, 1980. In addition to the reports listed in this bibliography, a number of discussion and issues papers have been prepared over the past few years on Agency and other donor forestry efforts in the Sahel. These include, among others,

F. Weber, Economic and Ecologic Criteria: Proposed Club des Amis du Sahel Forestry/Anti-Desertification Program. USAID, Washington, D.C., May 1977. 35pp.

R. Winterbottom, T. Greathouse et al., Review and Analysis of the Forestry/Ecology Sector in the Sahel. Prepared by AFR/SFWA/SDP. September/October 1979.

J. Thomson(ed.), Proceedings of the AID/Peace Corps Sahelian Forestry Design Workshop - Ouagadougou, Upper Volta February, 1980.

R. Winterbottom, Talking Paper on Environmental Protection and Natural Resource Management Issues. USAID/Ouagadougou. April 1980. 9pp.

G.F. Taylor, Environmental Degradation in the Sahel - Reflection on the AID Response. SDPI/Bamako. August 1980. 23pp.

Turning more specifically to the literature on forests and forestry in the Sahel, a variety of bibliographies provide a useful starting point. In addition to bibliographies prepared by CILSS, the Club du Sahel and the Institut du Sahel these include:

H.N. Le Houerou, 'Contribution a une bibliographie ecologique des regions arides de l'Afrique et de l'Asie du Sud-Ouest.' p.170-212. IN: La Desertification au Sud du Sahara - Colloque de Nouakchott 17-19 Decembre, 1973. Dakar: Nouvelles Editions Africaines. 1976.

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G.F. & B.A. Taylor, 'Forestry in the Sahel: A Selected Bibliography of Source Materials Relating to Arid Zone Forestry and the Southern Fringe of the Sahara' A Current Bibliography on African Affairs (African Bibliographic Center, Washington, D.C.) Vol. 12 (1), 1979-80, p 33-49.

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G.F. & B.A. Taylor, 'Forestry in the Sahel: Selected Bibliography II.' A Current Bibliography on African Affairs Vol. 13 (1), 1980-81, p.26-42.

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CILSS/Club du Sahel, Forests and Forestry in the Sahel: The Gambia- A Case Study. Ouagadougou/Paris: CILSS/Club du Sahel. February 1981. Volume I Report (74p.), Volume II Supporting Documentation(184pp.)

CILSS/Club du Sahel, Analyse du Secteur Forestier et Propositions: Le Niger. Ouagadougou/Paris: CILSS du Sahel. August 1981. Volume I Report(138p.), Volume II Supporting Documentation (in preparation).
Note: Similar country studies have recently been completed for Upper Volta and Mali. These reports should be available early in 1982.

ECA/FAO, Proceedings - Seminaire sur le Developpement des Combustibles et de l'Energie pour les Femmes Africaines en Milieu Rurale. Bamako, December 2-13, 1980. (forthcoming)

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Ferlin, G.R., Techniques de Reboisement dans les Zones Subdesertiques d'Afrique. Ottawa: IDRC. 1981 48pp.

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Thomson, J.T. Peasant Perceptions of Problems and Possibilities for Local-level Management of Trees in Niger and Upper Volta. Paper presented at the African Studies Association Annual Meeting, Philadelphia October 15-18, 1980. 22pp.

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Winterbottom, R.T., Reforestation in the Sahel: Problems and Strategies - an analysis of the problem of deforestation and a review of the results of forestry projects in Upper Volta. Paper presented at the African Studies Association Annual Meeting, Philadelphia, October 15-18, 1980. 32pp.

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SENEGAL: FUELWOOD PRODUCTION PROJECT

David Gibson*

I. Background

Without dramatic changes in lifestyle or adoption of new large-scale energy alternatives, fuelwood is, and will likely to continue to be (until supplies are exhausted) the primary domestic energy source for an overwhelming majority of Senegalese. At present, an estimated 85% of household energy needs are met through the use of wood fibers in the primary and the altered forms of firewood and charcoal (Eaux et Forets, 1979).

Due to drought, overcutting, poor range management, wildfire and increased agriculture, national forest resources are being reduced by 60,000 hectares annually (Clement et al., 1981). While managed and natural fuelwood production varies drastically at the regional level, national trends in the following table are quite evident.

TABLE I

ANNUAL PRODUCTION OF COMBUSTIBLE WOOD FIBER AVAILABLE FOR DOMESTIC CONSUMPTION IN 1980 1/

Region	Total Available Production (000 m^3/yr)	Per Capita Availability (m^3/person/year) Rural Pop.	Tot. pop.	Per Capita Surplus (+) or Deficit (-)[2] (m^3/person/year)
Fleuve	271.9	0.62	.4/	- .1
Louga	159.4	0.40	0.34	- .25
Western Regions (Cap Vert, Thies, Diourbel)	49.1	0.05	0.02	- .55
Sine Saloum	303.1	0.31	0.27	- .3
Senegal Or.	4,947.6	17.6	15.5	+ 14.0
Casamance	2,565.4	3.8	3.1	+ 2.5

1 Source: Clement et al., 1981.
2 Assumes 0.6 m^3 of solid fuel fiber per person.

At present only Senegal Oriental and the Casamance regions are energy self-sufficient or surplus producing in relation to their own populations. Even this situation is somewhat misleading in that Senegal Oriental is the largest, least inhabited and second wettest (after Casamance) region in Senegal.

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While the long-term ability of the forest sector to supply Senegal's energy is in question, the demand side of the equation has shown equally ominous signs. However, anticipated increases in fuelwood requirements are below population growth estimates (2.7% and 3.3% annual increases respectively into year 2000). Table II well illustrates expected demand from forest resources.

TABLE II

EXPECTED POPULATION TRENDS AND SUBSEQUENT FUELWOOD DEMAND IN SENEGAL 1/

Year	1980		2000			
Region	Population (000)	Fuelwood needs (000 m³)	Population (000)	(%+)	Fuelwood (000 m³)	(%)
Fleuve	570	340	870	(52)	500	(47)
Louga	450	270	630	(40)	350	(30)
Cap Vert, Thies and Diourbel	2,450	1,480	4,660	(90)	2,500	(68)
Sine Saloum	1,140	680	1,690	(48)	1,000	(47)
Senegal Oriental	320	190	510	(59)	300	(58)
Casamance	800	480	1,220	(52)	700	(46)
TOTAL	5,730	3,440	9,580	(67)	5,350	(55)

1 Source: Clement et al., 1981

Barring any major and unforeseeable changes in consumption patterns or development of readily assimilated alternative energy sources, Senegal will theoretically exhaust all wood fiber reserves before 2010.

II. Project Description (No. 685-0219)

Basic data of the Senegal Fuelwood Production project is as follows:

Project Authorization Date	April 27, 1979
Project Agreement Date	May 21, 1979
Dates CPs Met	December 21, 1979
Project Assistance Completion Date	Decemter 31, 1979
Cooperating Agencies	GOS,Eaux et Forets, USAID, ISRA, CNRF, ORSTOM
Life of Project Funding	$3,134,000 (U.S.) + 779,000 FCFA (GOS)
Disbursements to Date	$1,525,000
Project Directors	Mr. Sidibe and Mr. Gibson

The Senegal Fuelwood Production Project addresses the most obvious and severe problems illustrated in the background information:

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disproportionate supply/demand tendancies fostered by urban conglomerates.

Through the mechanized development of 3,000 hectares of rapid growing forest plantations in the Bandia National Forest, 60 km from Dakar and 25 km from Thies, the project promotes fulfillment of two major goals:

- Stabilize/increase the Dakar and Thies fuelwood supplies (charcoal and firewood) while stabilizing/decreasing their market prices. Upon completion, the project expects to furnish between five and 10 percent of this region's total needs.

- Halt/reverse environmental deterioration through the easing of cutting pressure on marginally productive and already deteriorating upland forest reserves (expected yields of between seven and 10 m^3/hectare/year would produce equivalent of 15 to 40 hectares of upland, unmanaged, forest).

Replacement of the existing degenerated Acacia Seyal forest type of the Bandia Forest (annual production between .1 and .92 m^3/hectare/year) with naturalized and exotic fast-growing species involves several key ideas. A major emphasis of this pilot project is the development of a readily replicable model which can be rapidly and successfully extended into other similar peri-urban areas. To assist in this goal of rapidly maximizing the project's spread effects, $238,000 have been allocated to the local forestry research center (CNRF). In close collaboration with project personnel and the Service of Water and Forest (SWF), CNRF will assist in 1) reducing input costs at every implementation level, 2) identifying urban centers with similar problems and determine their potential to successfully support a replication (site characteristics, monitor rainfall, ascertain land availability), 3) performing basic research into ecological and hydrological effects of intensely managed forest plantations.

Theoretically, the project will become self-funding after implementation. Timber receipts from sales to authorized forestry cooperatives will assure plantation maintenance and protection as well as pay for office space, equipment repairs, gasoline, etc.

Successful implementation of the project thus far has been due to several factors. The flexibility designed into the PP and ProAg as well as the relatively autonomous structure afforded to the project by SWF officials has allowed an administrative framework which lends itself well to the project's experimental nature. Senegalese expertise in industrial plantation management is being assured through an extensive training program emphasizing nursery operations, diesel mechanics, equipment operations, soil management and technical forestry.

Although nearly 70% of local cost financing is spent on salary vouchers ($280,000 in FY 81), the project is heavily dependent on

mechanized equipment. A Peace Corps diesel mechanic and three apprentices are responsible for the maintenance of three bulldozers used for final land clearing and subsoiling (initial clearing is done by forestry cooperatives) as well as 10 tractors and other agricultural equipment used for plantation establishment and maintenance.

III. Project Status

Due to delays in equipment procurement and location of an expatriate forester to serve as U.S. Team Leader, only 150 hectare of exclusively eucalyptus plantations were planted in 1980. Results have been mixed for several reasons; paramount of these reasons being insufficient rainfall (total in 1980 - 310 mm) and inadequate site analysis in regard to soils. Limited quantities of selected eucalyptus seed (E. camaldulensia, var. No. 8411) and wasteful nursery techniques also forced planting of less than optimum nursery stock.

In 1981, 700 hectares of the 750 hectares objective were totally prepared (i.e. cleared, levelled, subsoiled, harrowed and picketed) prior to the rainy season. Completion of the largest and most modern nursery in Senegal (capacity more than 1.0 million seedlings) was completed in June although renovation of an office/living complex and completion of the physical plant are not yet terminated. 500,000 containerized E. camaldulensis seedlings were produced as well as 50,000 Cassia siamea, Azadirachta indica (neem), Prosopis juliflora (mesquite) and Casuarina equistifolia (Australian pine). Cost for seedlings was reduced 30% from 1980 to 6¢/unit. Excess nursery production (nearly 100,000 seedlings) was distributed to projects, government agencies and the private sector in six of Senegal's eight regions.

Due to nominal and sporadic rainfall (total ppt. - 357 mm) only 650 hectare were finally planted. Although this hampered work efficiency, raised costs and will certainly lower expected production rates (annual production initially expected between 6 and 10 m^3/year/hectare) total per hectare costs were reduced nearly 60 percent 1980 figures to $1,000/hectare. (Note: Figure includes both training and research components as well as technical assistance at Dakar level. The subtraction of these indirect costs brings the per hectare price down to approximately $680.)

In spite of deficit rainfall for the second consecutive year (667 mm composite for 1980-1981 vs. expected 550 to 600 mm/annually), productivity and survivorship among the 1980 plantations has been over 90% in 100 of the 150 hectares (70 to 80% in the remaining 50 hectares) through enhancement of water retention through timely harrowing. Results for 1981 promise to be considerably better due to: 1) the identification and location of plantations on the most suitable soils (assistance received from the Soil Conservation Service - USDA - Soil Management Service Support Service PASA), 2) exclusive use of locally adapted E camaldulensis No. 8411 seed stock, 3) efficient weeding/harrowing which eliminated water loss

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to herbaceous vegetation and 4) enhanced organizational structure which insured timely planning.

IV. Major Problems/Future Considerations

Problems which seem endemic to and limit the success of most forestry projects in Senegal such as failure or inability tomobilize funds and resources or lack of technical expertise have been nearly eliminated in this project. However, during the course of two years implementation experience, some even more basic problems have occurred.

Less than complete analysis of all aspects of the project site by the implementing agency (SWF) and the PP technical team have led to several misconceptions concerning expected productivity and the potential for local expansion of the project into a second 3,000 hectare phase.

Lack of meteorological data for the area may have hidden possible climatic variations which seem limited to the project zone. Available information indicates that the area in question has for the past five years consistently received less total rainfall than meteorological stations 20 km north or south (three of the five years showed more than 30% differences).

Although the exact number of hectares of soil suitable for fuelwood plantations within the Bandia Forest is presently unknown, soils scientists familiar with the area doubt that the forest can support more than the initial 3,000 hectares. Unfortunately, due to the fact that accurate soils maps were unavailable, all pedological investigations were conducted after the site selection had been made. For these reasons, phase two of the project will likely be implemented elsewhere. This likelihood will require a reorganization of equipment to allow for the second 3,000 hectares to be established elsewhere.

Equipment procurement was also negatively affected by inadequate study of site characteristics. Irrespective of the fact that nearly all the agricultural equipment was purchased from a U.S. concern not franchised in Senegal (i.e. no warranty service, spare parts, etc.), the equipment has proven to be poorly adapted and unsatisfactory. Light weight tractors and harrows designed for use in Colorado for dryland wheat are unsuitable for forest plantation establishment and maintenance in Senegal. The same problem occurred with the procurement of bulldozers slated for forest clearing. Optional equipment such as brush rakes, full cage protection and power shift transmissions are all mandatory for efficient, cost-effective clearing operations, and should have been ordered.

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MALI: REFORESTATION EXPERIENCE

Jon Anderson

I. Introduction

The bulk of USAID's efforts to address the deforestation issue in Mali on a long-term (5 year) basis is relatively recent and centers around the design and implementation of the Village Reforestation Project (VRP) (625-0937). The Project Agreement was signed in September of 1980 and full-scale implementation began in May 1981. Given this short history, it may be dangerous to make generalizations for the design and implementation of other reforestation projects. Nevertheless, USAID feels that the VRP has some unique aspects that might be useful to others working in this area.

II. Project Background

The problem that this project addresses is unfortunately typical to many African nations and has been dealt with extensively elsewhere. Suffice it to say here that at least regionally, deforestation and desertification mean further distances to travel to wood supplies, higher fuelwood costs, increased erosion rates, and less availability of the immense variety of products that the forests produce either directly or indirectly.

The GRM infrastructure which exists to address these problems is fairly old but is well-staffed. The forestry service was created in 1935 mainly as a rural police force to "protect" the natural resource base by fining people for "illegal" hunting, cutting and fishing and by selling permits for these activities. The nature of this system makes tension between villager and "forestor" inevitable and its abuse has led to a general situation of distrust and misunderstanding.

Recently, the GRM has realized that this system of "protection" has not been effective in combating deforestation and more positive steps were urgently needed. The GRM created several organizations supported by donors to do essentially large-scale plantations of exotic species. This, however, still left gaps in an approach to widespread reforestation. The VRP is an attempt on an experimental basis to address some of these gaps.

III. Project Purpose

The overall goal of this project is to contribute to the rehabilitation of Mali's renewable resource base and thereby improve and protect the well-being of the rural population. The project will assist the Forestry Service in a trial effort at a) the creation of a tree nursery infrastructure, b) strenghtening of

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* Project Manager, USAID/Bamako

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the Forestry Service's extension capability, c) the creation of experimental and demonstration plots, all leading towards support of and encouragement for villagers' attempts to implement rural forestry interventions. Although small scale and experimental, this is a fundamental reorientation of past approaches and practices.

IV. Highlights

The following represents elements of the project that USAID considers significant.

A. Design

Given that village participation is essential for successful rural reforestation and that good forester-village relations were a necessary prerequisite for this participation, USAID, during the collaborative design process, negotiated a condition which stipulated that project personnel would not be involved in repressive forestry activities in the project zone for the life of the project. The fact that this CP was accepted and met by the GRM represented a major concession and a substantial reorientation of forestry policy. The low level of funding involved also demonstrated that small projects can have considerable leverage in influencing policy changes at the national level. It appears that the CP is being put into practice in the field but it is too early to measure improved forester-village relations.

B. Financial Management

Given past experience in implementing projects in Mali, considerable effort was made before project implementation to work with the GRM in defining the project's financial requirements. The active participation of the USAID Controller's Office has meant that a system acceptable to AID has been developed while also considering the realities of the Malian situation.

C. Some Technical Aspects

1. Exotic vs. Indigenous Species

It is often argued that certain African countries need fast-growing tree species to address their deforestation/fuelwood problems. It usually follows that these fast-growing species are exotic and should be imported. The VRP, however, decided to put substantial emphasis on indigenous species because a) generally, the fast-growing exotic species that have been tried in West Africa to date have not produced anywhere near expectations, b) villagers in the project area expressed interest in indigenous species as something they know and of which their benefit and usefulness is assured

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(risk-minimization), and c) it appears that little work has been done on indigenous species and thus their growth potential is unknown.

The VRP has stipulated that at the beginning, 60% of the project's nursery area be set aside for the production of indigenous species and that this percentage be changed only after an analysis of villager demand. Although technical problems exist, the Forestry Service has already begun to use a variety of local species such as Karite, Nere, Acacia Albida, Detarium and Balanites in the project nurseries. The SDPI Forestry Adviser has noted that this is one of the few examples of work on indigenous species that he has seen in the Sahel. Villager interest appears to be very high and it will be interesting to see how the demand for indigenous and exotic species differs.

2. Protection

The protection of trees is a crucial element in any reforestation effort. The VRP has approached this issue by considering that in most cases adequate protection is a function of clear individual ownership rights over the trees Hence, VRP will avoid situations where ownership of trees is in doubt or dispersed, i.e., where villagers may think that trees belong to the forestry service, village elders, or to some other group who will later decide who shares the benefits. Woodlot strategies unfortunately run into ownership problems.

The controversy surrounding protection schemes usually centers aroung the theory that 100% protection means importing costly sheep fencing. While this may be necessary for nurseries, traditional protection techniques are abundant and cheap for plantings. There are techniques using local materials (thorns, mats, stalks, adobe, etc.) that are labor intensive and have the potential to be quite effective. At one VRP site, a trench has been dug along one side of the nursery perimeter with the soil piled on the outside of the trench. This seems to be effective barrier against cattle. Combinations of trenching and thorn or banco walls might also be effective. If money can be saved on protection, a big step is made towards making the project economically viable.

3. Seeds

Since little work has been done on the indigenous species, it follows that it is next to impossible to get improved or selected seeds for these species. The VRP has been constrained to collecting its own seed, the quality of which is unknown. Sudan (through USAID) has

been a major supplier of seed for this project but the quality of those seeds is also unknown at the moment.

4. Woodstoves

The VRP has a fairly large component for the introduction on a pilot scale of improved woodburning stoves. Because of the importance of non-wood products to the economic viability of reforestation projects, it appears that efficient woodstoves might be the major complementary activity to reforestation. The VRP stoves will probably be versions of the Lorena stove based upon adaptions made in Mali and elsewhere. This activity also has the potential, if implemented correctly, to demonstrate to the villagers the Forestry Service's good faith and to counteract to some degree the relatively longer time forestry projects need before return on investment is realized.

5. Water

Nurseries. The VRP will assure all year water supplies in project nurseries through the construction of good quality wells and the installation of locally-made hand pumps.

Interventions. Although a small number of wells are planned for the small number of woodlots that VRP will execute, by and large it appears to be clear that rural forestry interventions should get no more water than the local agricultural activities since agriculture is the first priority. Also since an integrated approach seems the most valid, water needs of agriculture and forestry are not easily separated.

D. Economics

A main reason why economic analysis of reforestation projects is difficult is because of its large social cost/benefit component. This has led to some neglect of the economic aspects of reforestation, especially the need to cover recurrent costs and the need to minimize these costs where possible. Under the auspices of the VRP, economist Asif Shaikh was made available to the Forestry Service. This visit resulted in the report entitled "The Economics of Village-Level Forestry: A Methodological Framework." The report and the visit emphasized a) the necessity of economic analysis, b) the types of information that must be gathered to do economic analysis, c) that based upon available information, individual farmer agro-forestry is probably more economically attractive than village woodlots, d) the importance of non-wood products to economic viability (and hence the importance of the use of multi-purpose tree species), and e) that forestry should be a part of an

"integrated approach to rural production and exchange systems."

In an attempt to cover recurrent costs, the VRP will sell trees that provide commercial byproducts and is exploring the possibilities of the sale of all seedlings from project nurseries. The sale of seedlings for a nominal price, while perhaps inhibiting some villagers from participating in the project, will probably encourage better care and higher survival rates for the trees of those who do participate. The sale of seedlings in a market at one of the project sites demonstrates that villagers are prepared to buy some types of seedlings. Different price and time schedules are being developed and proposed.

E. Extension

The need to develop an effective extension effort continues to be a GRM/USAID priority. Malian forestors, by and large, do not receive much training in extension techniques. The VRP stipulated that community development agents be assigned to the project to assist in this effort. The project plans to develop a forestry extension package and sensitize forestry personnel to extension techniques. However, it is clear that the GRM cannot afford to create a "forestry extension service" nor is having several different agents for different sectors (agricultural, livestock, forestry, health, etc.) always effective. Eventually, the Forestry Service would have to get out of the extension business after having developed packages and techniques which can then be integrated into rural production extension efforts.

F. Training

Peace Corps Volunteers have been assigned to work on the project. The VRP took advantage of their technical training period to simultaneously train their counterparts. This training was organized by Peace Corps/Ouaga using ex-PCV forestors with Sahelian experience. The training was useful and concurrent training of PCVs and HCNs may be an idea for other projects to explore.

G. Data Collection

The experimental nature of this project dictates an extensive reporting and data collection component. Technical, economic and social data will be collected, tabulated, analyzed and reported. To assist the GRM in setting up this system, the VRP has called upon the resources of the U.S. Bureau of Census. A visit by a BuCen expert is expected during December to develop and formalize a data collection system.

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H. Collaboration

Excellent collaboration exists between the Forestry Service, USAID and Peace Corps. To a large extent, this is a consequence of the personalities involved and their willingness to work together. However, given the turnover of personnel in these three organizations, it appears to be important that the collaborative process be documented, i.e., agreements reached verbally are followed up by letters, etc.

I. Documentation

Particularly in the absence of technical assistance, USAID considers the supply of technical documents to project personnel an essential component of the project. A very small library has been ordered under the project and is constantly being supplemented by documents supplied free of charge by various organizations. Not only does the documentation serve as a technical reference and source of experience, but it has stimulated discussion of the differing techniques and has opened up new channels of communication. The desire to read and the quasi-total lack of reading materials in the field can be capitalized upon in increasing staff's technical knowledge and capability.

J. Incentives

In most cases, USAID is opposed to systems of bonuses or salary supplements for public servants who work on USAID-funded projects. However, a system of bonuses is being implemented under the VRP in order to compensate forestry agents for the income that they lose because of the prohibition on fining. It is known that forestry agents, legally or illegally, often supplement their rather meager salaries considerably through taking a percentage of a fine. Hence, this incentive for fining had to be counterbalanced. It is hoped that over the long-term, the revenues generated under the project will compensate for the use of USAID funds.

V. Summary

This project may demonstrate that the response to the rural forestry issue is not necessarily implementing what is presently being done aroung urban centers (industrial plantations) on a smaller scale aroung villages (woodlots). The rural problems are different and a different approach is needed. This approach would appear to include stressing a) individual ownership, b) indigenous species that are multipurpose, and c) integration into rural production systems.

NIGER: FORESTRY AND LAND USE PLANNING PROJECT (683-0230)

John Heermans*

I. Introduction

The Forestry and Land Use Planning Project started on December 1, 1980 and is scheduled to finish in December 1984. Project cost is approximatley $4 million. There are four main components involved in this project: 1) development of model sites, 2) resource inventory, 3) human inventory, and 4) documentation center.

II. Model Sites

This component of the project is concerned with applied forestry techniques and research on choses sites throughout the country. These sites will serve as models for other places in Niger with similar rainfall and soil conditions. So far, four model sites have been choses: 1) Niamey greenbelt; 2) management of the National Forest at Guesselbodi (500 MM); 3) management of the National Forest at Tanda (900 MM); and 4) study of the windbreaks in the Majgia Valley.

A. Niamey Greenbelt

After many meetings and discussions with the various interested parties (Mayor's office and Urban Planning), we have come to the conclusion that the greebelt in its present form (1 km. wide) is not achieving any of its original goals which were: 1) to stop the spread of the city in several directions; 2) to protect the city from the Harmattan wind and dust; and 3) to provide the city of Niamey with firewood. The only possible use for this greenbelt which extends almost half way around the city is recreation. Dust and wind are best prevented by planting trees inside the city (in compounds, along roads, and in "green spaces"). Firewood cannot, from a resource economist's point of view, be planted on land within the city limits because of the high rent of land. The city has already "jumped" the greenbelt in several places and, according to the city bureau of planning, the greenbelt, in its present form, will be approximately in the middle of the city in 10 years. Therefore, we proposed that the GON discontinue the greenbelt (which is being financed by UNSO) after this year and begin planting along roads and creating city "green spaces". This proposal seems to be acceptable to all parties.

B. Guesselbodi and Tanda: National Forest Management

Also included in the model sites component of the project are management plans for several classified National Forests in

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different rainfall zones which could be used as models for other forests. The two sites chosen are Guesselbodi (22km. southeast of Niamey in 500 MM zone), and Tanda (380 km. South of Niamey in 900 MM zone).

The idea of managing natural vegetation and national forests has been around for some time, but there seems to have been very little work done on this subject up to present. We decided that, apart from the more obvious tasks (redefining the forest limit, drawing maps and defining the vegetation in general terms), that we would list all of the parameters that we felt should be studied and plan out work to answer as many unknowns as possible. Our list of parameters that we are looking at in both Forests is as follows:

1. Soils

   Collection of past information on soils analyses in areas of study; take soil samples from profile pits of 1.5 meters in different parts of the forest.

2. Vegetative Analysis

   Draw vegetation map 1/20,000 for entire forest; determine dominants and sub-dominants in each vegetative type; establish vegetative sampling according to what information is required and according to overall objectives. For example, in Guesselbodi, we are looking at firewood potential in Combretum type vegetation. Little work has been done in regards to sampling within the Combretum type and as a result much of our time has been spent establishing a sampling technique applicable to this type of vegetation.

3. Socio-Economic

   This study is done through a series of interviews with villagers found around the forest. We have been doing these interviews since we began work in each forest, and we would like to assure the thoroughness of this work before drawing up our management plan. Probably, the number one cause for the failure of forestry projects in Niger is that the local population have not been consulted or included in the design stages of the projects.

4. Wildlife

   The more research done on causes for deforestation, the more evident the need becomes for a total ecological and historical picture in order to ascertain a better understanding of present and past habitats. We are trying to estimate wildlife populations in those areas where it exists in these forests. In those areas where

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wildlife has disappeared, we are attempting to ascertain from the local population what types of wildlife existed and how long ago.

5. Pastoral Studies

We are currently using the same sampling techniques employed by the USAID Niger Range and Livestock Project. These techniques are based on frequency, composition and production. Also, animals and herds are counted at different times of the year in order to get an idea of grazing pressures.

6. Independent Research Projects According to Forest

At Gaya, we have begun two studies: one on burning practices; the other on honey production. Each forest has its own characteristics which must be taken into consideration. Sometimes the need for certain studies is not apparent until later, but all parameters should be addressed before sitting down to draw up the management plan.

As soon as research has been terminated, the management plan shall be drawn up and implementation will begin. Studies should be terminated sometime next year.

The use of aerial photography has been useful in studying the forests themselves, and has provided information about surrounding areas. Given the fact that many of these forests were officially created in the 1930's and 1940's, their actual boundaries are meaningless. Part of the management plan might be to alter these boundaries in order to either increase or decrease the total surface areas of the forests.

C. Magjia Valley: Windbreak Studies

These windbreaks were previously proven effective in an earlier study (Els-Bogmetteau 1980). They are now aged to the point that they can be exploited for poles and firewood. How much can be cultivated without losing the effect of the windbreak, and what method of cut should be used are the two main questions that we will be addressing in this study.

III. Resource Inventory Component

This component will be responsible for creating resource planning maps of Niger using aerial photography, Landsat imagery, and ground truthing. These maps will examine soils, water and vegetation. We are currently in touch with the resource inventory project in Mali (TAMS) and may, or may not draw our maps using their techniques. The resource inventory workshops to be held in February 1982 should aid us in organinzing and defining objectives for this component.

VI. Human Resource Component

This component includes education and extension programs. There are four 2-year scholarships available for this purpose (two in the States, and two in Africa). We will be working in conjunction with the second phase of the World Bank Project in organizing "recyclage" type training sessions in Niamey. The extension programs will take the form of publicity campaigns, and during the course of our interviews at the model sites, audio visual type extension activities will be carried on in both urban and rural settings.

V. Documentation Center

This component will integrate our own documentation center at Project Headquarters with that which now exists at the Ministry. We are in contact with other documentation centers and universities and have ordered a wealth of material which will be incorporated into our center. The center will publish a newsletter every 3 months which will be circulated to all forestry agents. This newsletter will be a means to gather and disseminate newly acquired information.

VI. Problems encountered in the First Year of the Project

The original director selected for the project was the most immediate problem at the outset of the project and created problems in the handling of day-to-day administrative business. On the other hand, problems in AID administration have also cropped up in that people assigned to backstop the project as project managers have been generally burdened with other project duties, therefore leaving much of the burden of administrative work to be assumed by the contractor consultant. As a result, the project has been depending upon the aid of short-term technical consultants. We are presently attempting to recruit an additional long-term consultant who would devote his time solely to mapping for the resource inventory component. Candidates for this position are being screened now, and the final decision will depend principally upon which techniques will be used to draw the maps.

Another major problem during this first year of the project was the amount of time spent on administrative processes (PIL's, local accounting, etc.). The lack of coordination and procedural skills on the part of AID and the GON was the major reason for this difficulty. AID is now providing a two-week course condunted in French covering project accounting and procurement procedures for Project Directors, Project Accountants, and Project Managers. Something like this should be a condition precedent for each new project. Before the commencement of each project, AID should meet with key project personnel to explain exact procedures and responsibilities for each person during the course of the project.

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UPPER VOLTA: FORESTRY AND NATURAL RESOURCES

Bob Winterbottom*

I. Introduction

These remarks are intended to review the experience of reforestation projects in Upper Volta. For a more complete project by project discussion, one can consult the paper "Reforestation in the Sahel: Problems and Strategies", Prepared for the African Studies Association meeting, Oct. 15-18, 1980, Philadelphia.

II. Fuelwood

Forestry interventions in Upper Volta are in large measure responses to the "firewood crisis" -- the Forest Service is preoccupied with doing something about the very real and evident shortages of firewood.

In addition to dwindling or inadequate supplies of food, water and forage, the average villager in Upper Volta is also concerned about firewood. Small branches cut and collected from the bush surrounding the village are still the primary source of energy consumed by people in Upper Volta, and accounts for roughly 90% of the typical household's total energy requirements.

There are numerous signs of the increasing scarcity of firewood. Wood is beginning to be sold for the first time in the more remote areas. Wood prices have doubled or tripled over the past five years in more densely settled areas. Small families spend 50 CFA or more a day on firewood; larger families use more than a donkey cart load every month (about 400 kgs.) at costs up to 4500 CFA per load. Numerous studies have concluded that 20 to 30 percent of an urban family's average annual income is spent on firewood, leaving less for other basic household expenditures, food, education and health care.

With each passing year, women in rural areas walk greater distances and spend more time gathering and transporting firewood. It is not unusual for a woman to devote 4-6 hours, three times a week to the task of collecting firewood. If one assumes a woman works ten hours a day, seven days a week, she may spend a quarter of her time hunting firewood, at distances up to ten kilometers from her home.

Rising prices and shortages of firewood are, however, only one of the more obvious symptons of a widespread and growing imbalance between people and their environment.

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In the northern and central areas of the densely populated Mossi plateau, farmers are abandoning eroded, exhausted farmlands and leaving homelends and relatives in order to resettle in the more fertile, less densely populated river valleys of western and southern Upper Volta. In the northernmost areas, severe degradation of the vegetation triggered by the 1969-1973 drought is still apparent, as large areas have yet to recover from the dieback of that period. Elsewhere in Upper Volta, trees have given way to shrubs, and the vegetative cover is constantly thinned or cut out in patches as a result of clearing new farmfields, firewood harvesting, heavy grazing and bushfires.

It is now recognized that trees play a major role in maintaining the productivity of Sahelian ecosystems. The loss of the woody plant cover will bring with it a steady lowering of the productive potential of the resource base. Once the vegetation has been degraded, the soil is more exposed to erosion. The organic matter content of the soil is not adequately renewed and maintained, and its moisture holding capacity declines. Rainfall infiltration rates decrease. More rainfall is lost through runoff, which carries with it the most fertile part of the topsoil. Soil nutrients are not as efficiently recovered and recycled by the deep roots of trees, and the nutrients are gradually leached out of the soil.

III. Natural Resources

The natural resource base of Upper Volta is both fragile and resilient. Natural regeneration of protected areas has sometimes been remarkable. But, overall, the resource base is now steadily deteriorating and becoming less productive as a consequence of too many people and animals pressing too hard, for too long, in ways no longer appropriate. The accelerating growth in demand, fueled by population growth and development, insures that the land will not have the rest it requires if productivity is to be sustained.

This "ecological crisis", of which declining supplies of firewood is only one aspect, admittedly involves more than mere imbalance between farmers, herders and the land. Other factors, often originating in the colonial period and diversified and intensified in the post-independence development decades have exacerbated the impact of population growth. These include the introduction of animal traction (which allowed more land to be cultivated, often without precautions against soil erosion), the pressure to increase cash crop production (which increased the total area being farmed), well digging, vaccination programs, and the development of irrigated agriculture (which upset former balances in agro-pastoral zones).

IV. Forest Service

From the perspective of Upper Volta's Ministry of Environment and Tourism (which includes the Forest Service), deforestation is less a result of land use and population pressures and more an unhappy

consequence of institutional constraints. For them, the problem can be summed up as: too few forestry agents and not enough means at their desposal to effectively control over-cutting and to plant enough trees to keep ahead of the cutting.

At present, there are about 250 to 275 field and technical people in the Ministry of Environment/Forest Service. In a country with an area of 275,000 km^2, this translates to roughly one forester per 100.000 hectares. The deficiencies in terms of simple numbers is compounded by the insufficient training given to the Forest Service personnel, and by the inadequate support provided to them once they are posted in the field. Housing and office space are in poor condition or lacking; vehicles, tools and fencing materials are in short supply or in poor shape, and there is very little money available to cover the cost of fuel, nursery workers and other operating expenses. For example, the forest district of Banfora (Department de la Comoe), one of ten in Upper Volta, has an annual operating budget of less than $1000 to provide support to 11 foresters. These eleven foresters are expected to effectively monitor and manage 16 forest reserves totalling over 260,000 hectares, as well as the remaining natural forests within the district. The Ministry can only provide 50 litres of gas per month to this District Forester, who has a single vehicle available to his staff to cover the entire district.

Given the severe budgetary and logistical constraints which exist, the Forest Service staff tends to be preoccupied with relieving them, and discounts or ignores population growth, land use pressures, land tenure and patterns of resource use, migration, development activities and other socio-economic factors contributing to deforestation and environmental degradation. How can they deal with those factors when they cannot keep people from cutting down a forest reserve, and cannot supply more than 20,000 seedlings a year to a population of half a million? Since other Ministries and technicians are similarly preoccupied with the shortages of means at their disposal, the upshot is that few people appreciate the crucial linkages between forestry, agricultural production and economic development.

V. Fuelwood Projects

In response to the problems in the forestry/ecology sector, a number of different types of development projects have been funded in the past ten years. Most fall into one of three categories: fuelwood plantations, village reforestations, and small scale, experimental or pilot projects.

The fuelwood projects aimed to increase production of firewood and poles by the planting of large blocks of fast growing exotic (introduced) trees such as *Eucalyptus*, *Gmelina*, *Cassia*, and neem (*Azadirachta indica*).

It was forecast that these high yielding plantations would produce at least ten times as much wood as the natural forests they

generally replaced: in the 600 to 800 mm rainfall region, from 0.5 m^3/hectare/year from the natural vegetation to 5 m^3/hectare/year yields in the plantations; and in the wetter regions with 800 to 1200 mm rainfall, from 1 m^3/hectare/year in the natural forest to 10 m^3/hectare/year yields in the plantations. The estimated productivity of these plantations was felt sufficient to justify heavy investments in site preparation, including subsoiling with bulldozers, complete protection from fire, and frequent weeding. These plantations were established both inside and outside of existing forest reserves.

As more attention was given to "integrated rural development", foresters were encouraged to promote village reforestation projects, as complimentary activities to those initiated in agricultural development. At the outset, most village reforestation projects were add-on activities or subcomponents of large-scale fuelwood planting projects. Seedlings were distributed to villagers in the expectation that they too would plant them on good soils (cropland) and care for them dilligently throughout the growing season and afterwards. The same exotic, fuelwood species and essentially the same plantation techniques and management were promoted. Site preparation was generally much less intensive, and fencing was sometimes provided to protect the widely scattered, small plots (usually 0.5 to 2 hectares) from livestock grazing damage.

The plantations were planned and established in some instances by the Forest Service working directly with the villagers, but more often by the rural development extension agents who were sometimes assisted by Forest Service field agents and Peace Corps forestry volunteers. Yields were expected to be lower, because of the lack of heavy machinery for site preparation; but total establishment costs were also lower, as no paid labor was needed. (Villagers contributed their labor.) The village authorities made the final selection of sites to be planted, and only rarely designated relatively deep, fertile soils.

A number of pilot or experimental projects in improved fuelwood utilization, renewable energy development, soil and water conservation and range management were also supported, but the total investments in these types of resource management projects was only a small fraction of that committed to reforestation projects. Prior to 1980 there were no significant investments in forestry training, aside from occasional scholarships and support to seminars. Assistance in now being provided to both the university and field agent levels of forestry training, by projects funded by USAID.

VI. Observations

Looking back over the past ten years, what were the results of these investments in forestry? What lessons have we learned?

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We have learned that reforestation, especially in rural, impoverished areas with less than 800 mm of rainfall, is more likely to fail than to succeed when one relies on the classic technical package of block plantings of exotic species for wood production, and if one does little more than provide operating costs for nursery production and seedling distribution. There has been only limited lasting impact from a succession of projects that picked up nursery and transportation costs for reforestation activities, but which did little to retrain the field agents involved, or adapt the technical package to local socio-economic and environmental conditions. Furthermore, even in areas with obvious deforestation and shortages of firewood, one cannot simply assume that villagers can plant and care for seedlings with little or no continuing extension efforts by well trained, full time forestry extension agents. Much careful planning and design is needed, as well, to creatively overcome of compensate for problems of land availability, tree and land tenure, labor arrangements, harvesting and distribution of benefits, and susceptibility to damage from drought, animals, fire and termites.

A key problem in past projects has been a failure to generate a village-level reforestation capability; projects neither envisaged nor fostered autonomous, self-sustaining village tree-planting and resource conservation activities. A large percentage of project funds were often devoted to building up the government "infrastructure" and in the final analysis simply generated a dependency on the part of the Forest Service on outside funds for operational expenses. As a result, the Forest Service often planted, trees (not the people) and after several years the Forest Service was left with plantations it could not care for and manage.

As a rule, one cannot completely bypass the government in development assistance projects, but projects can be designed to redefine government agencies' roles. The Forest Service could, for example, focus on providing technical information and practical guidance in the field, to directly assist village-level conservation efforts. In principle, the local people should be the ones deciding in each specific instance, the scale of operations, the species to be planted, work organization and allocation of benefits. Up to the present, standard techniques, species and approaches were defined by the project directors, and decisions were made on a top-down basis.

Given the very obvious limitations on the capability of the Forest Service, and the magnitude of the deforestation and desertification problems, lasting progress will only come when the people take responsibility for more rational management of their environment and conservation of their natural resource base. Foresters need to be trained not to execute projects, but to sensitively and competently respond to the expressed needs and desires of rural populations so that they can accomplish the conservation activities they decide to undertake in ways they feel are most appropriate and promising. The Oxfam-supported Agro-forestry project in the

Yatenga region of Upper Volta is now setting an example in this regard.

From an economic (as well as a socio-cultural) standpoint, it has become obvious that much more attention needs to be given to reforestation with local species, forest management, and regeneration and more rational use of the existing vegetation. The fuelwood plantations have proven more costly than anticipated (up to $1000 per hectare total investments after 3 years, instead of the projected $500 per hectare), often as a result of inefficient use of labor, heavy machinery, and the difficulties of managing inputs well. Even if the projects could be implemented more efficiently, the investments can only be justified on very productive soils, in areas with more than 1000 mm rainfall, that are located close to firewood markets and sources of labor. Given existing land pressures, especially close to urban areas where firewood demand is concentrated, fuelwood plantations cannot feasibly supply the firewood needed in many areas of Upper Volta.

The higher than expected costs of fuelwood plantations is especially troubling when one notes that yields have generally been lower than expected: an average of 2 to 3 m^3/hectare/year instead of 5 to 10 m^3/hectare/year after 4 to 6 years. The causes of their poor performance range from the heterogeneity of soils, to difficulties in protecting the plantations from fire, to late plantings, and poor management of the required maintenance, thinning and harvesting operations. In addition to problems fo financial soundness, many fuelwood projects have socio-economic drawbacks.

An approach which relies on the intensive production of fuelwood from fast-growing species like Eucalyptus has also required the forester to utilize relatively fertile soils that could otherwise be used for growing crops. The high-yield plantation technology thus puts wood production in competition with food production. In instances where the plantations were established outside of a forest reserve on village communal lands (UNDP/FAO plantations south of Ouagadougou), a lack of local support and cooperation (to the point of setting fires in the plantations) has been a recurrent problem.

While fuelwood plantations may take pressure off the surrounding bush by providing an alternate source of firewood, they do not directly serve to reclaim degraded, eroded, marginal land, nor do they contribute to the production of highly valued non-woody forest products such as edible fruits and leaves, forage, tannins, dyes, honey, local medicines and such. Different management schemes, making use of local species and naturally occurring vegetation associations could conceivably produce firewood more economically (with much lower level of investments) and yield a wide range of secondary and tertiary products as well. Such types of management schemes are now being explored by USAID-funded forestry projects in Upper Volta (Dinderesso) and Niger.

Although the inadequate numbers and level of training of host country personnel was discussed and evaluated years ago, the small number of investments in training has not proved sufficient to resolve the problem. As a result, the shortage of well-trained counterpart personnel at all levels has made it difficult to implement projects on schedule, to achieve targets, and to expand or even continue planting programs. In general, manpower deficiencies have contributed to administrative, management and logistical problems that have driven up costs, reduced survival, limited the area of land being reforested, and decreased the prospects for follow-on activities (once the technical assistance is pulled out). As examples, one can point to the FAC-assisted projects in Dedougou and in Bobo-Dioulasso, PVO-assisted woodlot projects in Yatenga, and the UNDP/FAO and German-assisted fuelwood projects. In a typical Forest District (with more than 500,000 inhabitants settled over 25,000 km^2) it has proved difficult to sustain a village reforestation program of more than 100 hectares per year (producing enough wood on a sustained basis to meet the needs of 200 persons). The typical fuelwood planting project has had difficulty planting as much as 500 hectares a year. This scale of planting can be contrasted with the World Bank estimates stating that Upper Volta needs to plant more than 10,000 hectares annually for the next 20 years in order to reverse the pattern of overcutting and meet the expanding fuelwood requirements of the country.

Another related problem has been the institutional character and attitudes of the Forest Service itself. Despite good project design, with provisions for local involvement and integrating of forestry activities into a rural development context, the attitudes of the Forest Service personnel charged with project execution are not changed overnight, and have proved a constraint to moving along the pathways of "social forestry", and forestry for local community development (FLCD). Most forestry agents in Upper Volta still pride themselves most on their knowledge of forest protection laws, and feel most comfortable in a uniform checking wood cutting permits.

It is apparent that the FLCD activities will require a relatively long start up time, before they can be implemented on a large scale, in order to retrain foresters and gradually institutionalize new approaches and techniques which are appropriate and effective responses to the problems of environmental degradation in rural areas. We need to redirect foresters to reclaiming and rehabilitating eroded, marginal lands, and restoring their multiple use productivity, instead of supporting them in planting cropland with trees producing firewood and bulldozing forests to make room for financially unjustified Eucalyptus stands. Once a momentum is generated in new directions, there could be a significant payoff in the long term in terms of desertification control and sustained agricultural production. At present, however, the Forest Service of Upper Volta is not dealing in a significant way with the underlying problems of soil erosion, declining soil fertility

(overfarming), overgrazing, and overexploitation and destruction of natural woodlands.

VII. Conclusion

Caught as it is in a struggle to absorb and manage development assistance focused on classic reforestation projects (e.g. World Bank, FAC/CCCE, German projects), the Ministry of the Environment has only begun to appreciate the true dimensions of the deforestation and desertification problems in the country. With each passing year, however, it is increasingly obvious that provision of funds to Forest Service personnel, rehabilitation and expansion of nurseries, distribution of seedlings, and planting of fast-growing exotics will not correct or compensate for the basic imbalances between people and their resource base.

Much greater efforts are also needed in fuelwood conservation and improved utilization (to reduce consumption) and more intensive management of the natural forests and bushlands. Projects need to be designed to directly address the larger issues of declining soil fertility, uncontrolled land clearing and the destruction of once productive range/fallow/farm lands. In particular, more innovative, experimental projects are needed that will systematically explore and refine new technical packages that integrate and adapt the recommendations of research in agriculture, forestry, range management and soil conservation, to rural development activities. Constant involvement and feedback from the affected, target populations must be insured. Better land use planning and a consistent integration of "conservation" elements into production-oriented development projects is also needed. And finally, to make it all keep on happening, much more emphasis on training is essential.

NIGER: RANGE AND LIVESTOCK MANAGEMENT

Vernita Fort *

I. Introduction

Some of the conference participants may wonder why a case study on methodology for range and livestock management, drawn from the Niger Range and Livestock Project (683-0202), is presented at a Workshop on Energy ,Forestry and Environment. The reasons are straight forward. Range and livestock comprise a significant portion of Africa's biophysical environment. This is particularly true in the Sahel, where it follows that pastoralism is the principal form of livelihood. At the same time, range degradation is one of the greatest environmental problems in the Sahel. Livestock in many areas compete with people for forests and woodland resources. For example, livestock consume tree foliage, under-story grasses, and seedling and young sprouting trees before either can become directly useful to humans. If not properly managed, livestock can also damage tree seedlings and sprouts in forests by trampling. Trees are often lopped so that animals can eat the foliage. From the same forests and woodlands, people consume wood for energy and for construction and fiber material. They also extract important secondary products provided by the forest and woodland habitats such as wild meat, fruits and plants for dyes. People clear forest for farming and habitation, removing the sylvo-pastoral systems that may ahve been in place, or the opportunity to introduce such systems. To address energy and forestry, particularly in the Sahel without taking into full consideration the implications for range and livestock, could mean failure for well-intentioned projects and an inefficient use of funds. More fundamentally, it could mean an inaccurate or incomplete definition of a problem, and necessarily an inappropriate solution for the actual problem.

This paper seeks to inform persons who can directly or indirectly influence or catalyze actions in the range and livestock sector about a tested methodology and model that, if employed and absorbed, could significantly improve livestock production and ecological stability. The methodology is applicable in the vast array of ecosystems in Africa and other parts of the world. In essence, the methodology determines the balance between animal numbers and available vegetation for optimum and sustained productivity. The acronym AVB will stand for animal - vegetation balance. The significant uniqueness and strength of this methodology compared to conventional western approaches (some which have been applied in Africa), is that it relates animal performance to a quantity of feed available, rather than to the traditional flat ration of the

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number of hectares required per animal for a given period of time. In other words it recognizes that animals do not eat hectares. They eat vegetation found on the hectares of land. This distinction is quite important with profound implications for management, particularly in an environment like the Sahel where rainfall and vegetation are highly variable.

The contributions that the AVB methodology can make towards improving food and protein production, reversing range and environmental degradation and augmenting the productivity of associated renewable resources including energy and forest resources, are significant. Its further application is highly recommended. The Niger Range and Livestock Project has employed the methodology. It has provided a context and a set of support activities for doing so and for facilitating extended application of the animal-vegetation relationship as determined by the methodology. A brief project profile thus preceeds the description of the methodology.

II. The Project Profile

The Niger Range and Livestock Project (683-0202) is a 4-year $5.4 million project which began in 1977. The project purpose is to: 1) develop and test methods of optimizing livestock production while preserving range and water resources and reducing devasting effects of future droughts, in Niger's pastoral zone, and 2) develop a national institutional capacity to successfully manage Niger's rangelands. The project acknowledged that data had not been developed on which sound range management programs could be designed and implemented. The necessary response was to focus primarily on developing the appropriate data and information, and on preparing a cadre through training that could implement actual range management programs that would constitute a second phase. Thus, this project is the first of two phases which has as its main activities:

- Range Management and Animal Production Research - This activity employs a methodology that has significant potential for improving livestock productivity while restoring degraded environments. The methodology is the main focus of this paper and is described below for the purpose of publicizing it and encouraging its application.

- Socio-Economic Research - The socio-economic research team has been systematically collecting data on current land use and resource allocation practices including water availability and use, the nature of decision making in societies in the area, the economic and other variables influencing decisions and actions, household economies and labor and other requirements for herd management.

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- Training - The training component includes on-the-job and informal training covering the areas of range management, animal husbandry, agricultural economies, sociology and livestock extension.

- Communications and Information - This activity provides for two-way information flow between responsible government authorities, the project implementors and the inhabitants of the zone, through periodic information bulletins, radio broadcasts, cassette tapes, and meetings between the official and project representatives and the pastoral populations to discuss project work, goals and results.

III. Methodology for Determining the Balance between Anumal Numbers and Feed Resources for Optimum and Sustained Productivity

A. Description of the Methodology and Model

The project's research component on rangeland management and animal productivity employs a methodology for determining the balance between animal numbers and available vegetation. The central characteristic of the methodology or procedure is that it relates animal performance to a quantity of feed available rather than to the traditional flat ratio of the number of hectares required per animal for a given period of time. It recognizes that animals do not eat hectares; they eat vegetation. This distinction is quite significant, particularly in an environment like the Sahel where rainfall and vegetation are highly variable. The stocking pattern from one year to the next, from one season to the next and from one region to the next will be correspondingly variable. The procedure provides a tool for managing rangelands accordingly and relinquishes a static notion of carrying capacity. It defines the animal-vegetation relationship for a given vegetation type or community, corresponding to a given season. It provides a guide for adjusting animal numbers to balance with vegetation production, to achieve resource stability with a high level of livestock production and economic return. It also illustrates the consequences when adjustments are not made.

Animal production is dependent on quantity and quality of its food supply. As this food supply becomes limited, animal production decreases. When the food supply is the forage crop on grazing lands and the forage plants are excessively utilized, the vigor of these plants also decreases. Livestock production can be expressed as the rate of increase in weight per individual animal or weight change per unit area grazed, each influenced by the forage supply available to the grazing animals. For any given time period, livestock select for quality of forage if the quantity is adequate to allow selectivity. Adequate quantity best insures the highest available quality. When properly documented and graphed, the

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animal production and forage availability relationships permit the development of a model for optimum and sustained livestock productivity.

The fundamental animal-vegetation relationship may be illustrated by plotting two animal responses (production per animal and production per hectare) over forage remaining ungrazed at the end of a grazing period.

Table I and Figure 1 present generalized data for animal weight changes in response to available forage. The available forage is plotted on the X axis in Figure 1. Again, since forage production is variable, the livestock forage relationship is best shown with the available forage or some index of this available forage. For example, the availability of one or more key forage species may be used as an appropriate index for the X axis.

The relationship shown in Figure 1 as the individual animal gain in units of kg/animal, is the normal average response of an individual animal to its food supply in the grazing trial presented here in full as an example. The curve is plotted by identifying maximum gain per animal (240 kg in Table I) and arraying this as 10 equal parts above zero to the left of the Y axis as done in Figure 1. This curve is plotted as kg/animal for each corresponding amount of forage remaining at the end of the grazing season represented by the livestock weight data. At point C on the Figure 1, food supply is not limiting. If production is limited at this point, genetic or other factors, not food supply, would be attributable.

TABLE I: Generalized example of mean animal weight changes and available forage remaining at the end of the dry season for seven stocking rates.

Forage remaining at end of dry season (kg/hectare)	Mean weight change per steer, kg	Mean weight change per hectare* kg	Stocking rate hectares/steer
50	-20	-6.25	3.2
100	0	0.00	3.5
225	42	10.5	4.0
400	80	16	5.0
500	93	15.5	6.0
650	100	12.5	8.0
800	100	8.33	12.0

* Calculated by dividing Mean Weight change per steer by the Stocking Rate in hectares per steer.

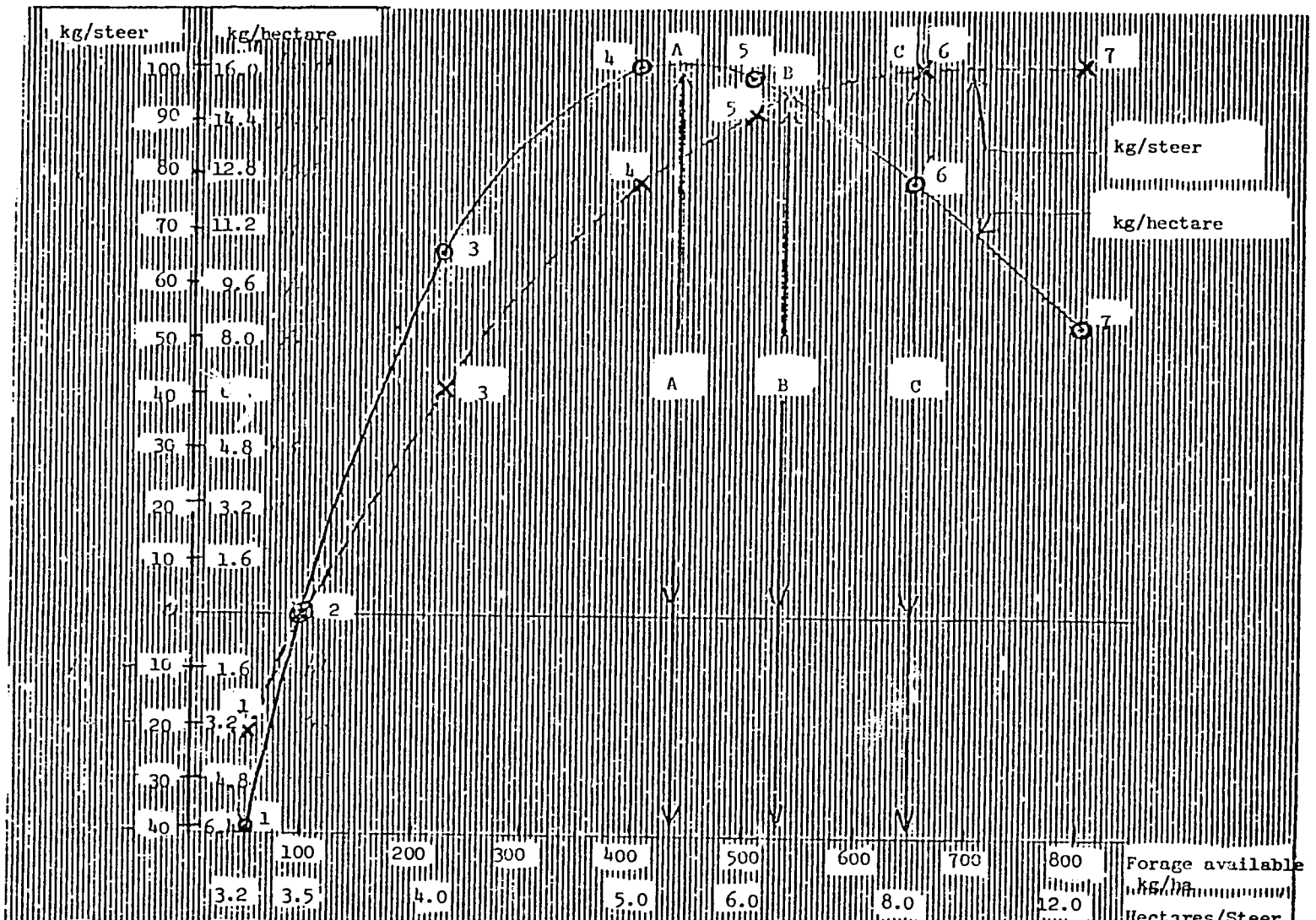

Fig.1 Steer weight changes per individual and per hectare as influenced by availability of forage with different stocking rates.

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In Figure 1 the weight change per hectare (kg/hectare) curve is drawn by identifying the maximum weight change per hectare shown in the table above (kg/hectare) and placing this value to the right of the Y axis opposite the maximum kg/animal weight. This amount is arrayed in 10 equal parts as shown in Figure 1. The curve is plotted as kg/hectare as it corresponds to remaining forage.

Point A, as illustrated in Figure 1, shows when maximum animal production per hectare is reached. This point is always reached when ungrazed forage per hectare is less than where maximum individual gain, point C, is reached. When maximum animal production per hectare is attained, individual animal performance is not maximum and the range vegetation may be utilized beyond its ability to maintain vigor and favorable plant composition. Therefore, the optimum point of forage availability for livestock production lies somewhere between points A and C.

Point B in the graph is the intersection of the two animal response curves and identifies the amount of ungrazed forage left on the ground when a balance point between maximum weight gain per hectare and maximum weight gain per animal is attained. The guide to stocking is therefore the amount of forage left on the ground at the end of a grazing period when this balance is attained. The guide shown in the example graph is to stock to leave 530 kg of forage at the end of the grazing season. Livestock numbers required to attain this amount of ungrazed forage becomes the proper stocking rate for the season covered by the grazing trial. As vegetation changes are monitored, this initial stocking guide may be modified if the ungrazed forage does not provide for stability or improvement of the vegetation and soil resource.

After the guide is established for a specific season, range site and vegetation condition, the stocking guide graph provides targets based on ungrazed forage to which stocking rates can be adjusted for reaching desired animal and vegetation response goals. The amount of ungrazed forage which corresponds to the intersection of the two curves representing individual animal weight change and weight change per hectare, provides a guide for an initial estimate of the use level which is likely to provide the highest net economic return.

The data listed in the table and displayed in the graph are based on measurements from seven grazing intensities. If a good initial estimate of grazing capacity is made at the beginning of a grazing trial it is possible that three intensities of grazing (numbers 4,5, and 6) could result in the approximate intersection at point B. If, however, plotting of data points such as points 3,4, and 5 resulted from the trial, the stocking is too heavy and should be made lighter in future years.

If all points show a relationship as points 6 and 7, then stocking is too light. Adjustments in livestock numbers are made until the point of maximum production per hectare, and the leveling off point for individual animal production on the intersection are located.

Early data may show an intersection prior to the location of these two peak points. This intersection may shift either to the left or to the right after more data are developed. When the maximum points on the two curves are located, the relationships of livestock responses to ungrazed forage can be properly plotted. A viable tool has been developed.

In the procedure, data are developed which also permit estimation of vegetation growth rate, conversion rate of feed to meet and potential animal production for an area. Data on climate and soils is also collected. Aberrations of the known animal vegetation relationship can signify the functioning of unique characteristics for the range and livestock ecosystem and valuable information for management. For example, at the Imbecetine Ranch in Niger, individual animal production in the heavy-use pasture was found higher than in the moderate-use pasture. This was not expected, given the normal animal-vegetation relationship.

A closer look at the heifers and the heavy use pasture was taken. It was found that the animals were selectively grazing certain Cenchrus plants that had developed new green leaf growth. In some cases, new seeds had developed at the nodes of old apparently dormant plants. Using a post hole digger to dig into the soil, the team found that the soil moisture in heavily grazed pastures was significantly greater than that in the moderately and lightly-grazed pastures. The restricted vegetation growth in the heavily-grazed pasture allowed some moisture to remain deeply stored in the soil. It is with this moisture that the annual plants, probably because of temperature changes, were making one more attempt to produce seed. The new seed and small new leaves were green and provided some protein as well as vitamin A for a short time in the heavy-use pasture. Thus, the animals gained more weight than anticipated.

In a similar way, unexpected animal weight gains revealed that a high source of protein was being consumed by the animal which allowed them to more effectively assimilate the total forage they were consuming. A bush by the name of Chrozophora was discovered to be the source. This information will certainly contribute to increasing animal productivity.

B. Economic Implications

Highest economic returns are found at the intersection point C since there are variable costs of production associated with each animal and also variable costs associated with additional hectares required to produce forage. The intersection point provides an estimate of the point where optimum economic return might occur. This correlation has been demonstrated for livestock production in Colarado, U.S.A. where the above described model and procedure was developed and in the other countries where the methodology has been employed.

C. Absorption of the Methodology into the African Pastoral Context and its Application

Herders like most people in the world, make rational decisions for livelihood and life support, based on the information, resources and tools they have available to them. Herders have altered their grazing and other land use practices over the centuries to adapt to changing conditions. Many natural resource use practices and management systems, that during one period are viable, can become inoperative and even destructive with changing conditions. Biophysical and socioeconomic circumstances, including human numbers, evolve and change to the point that alternative and responsive natural resource use and management practices are essential to adequately support the population of a given area. When viable alternatives are available that clearly resolve or address what herders themselves consider to be a problem, and that produce changes which they regard as clearly beneficial to them, the alternative is likely to be absorbed. It is from this vantage point that socioeconomic organization and support would need to be shaped for favoring and encouraging range management practices that could increase and sustaing productivity, arrest range degradation and result in ecological stability.

The involvement of the few herding groups in initial grazing trials, and the response of these same groups and of some observers, has been positive and thus encouraging for further work. Local herders have actively participated in carrying out the trials. They have recognized the value of certain grazing practices over others, based on visible results. The tools and initial support would be needed to assist these few herders families adapt and change their practices in a manner that they themselves have recognized as beneficial and that in fact is based on the results of the grazing trials. Their examples and resulting benefits would then demonstrate the viability of the new practices to an even wider group of people in the area. A significant transition, that would undoubtedly take time, would require joint decision making among herders about land use and grazing practices, additional technical assistance and support through extension, and supportive national policy on land and range use and marketing.

In terms of day-to-day management by the herders, a visual value can be ascribed to the animal-vegetation balance point determined by the grazing trials. With this, herders in time would be able to identify the amount of vegetation that should be left ungrazed at the end of a given season, and manage accordingly for optimum and sustained productivity. This visual value would be an appropriate management tool if the actual vegetation were periodically measured to confirm continued viability of the visual value.

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With increasing demand on the range resource base and decreasing vegetation productivity on some of the same rangelands, severe perhaps brutal changes would be naturally imposed on pastoralists in the Sahel, if change is not conscientiously undertaken by people in the region. Though the task is not easy, the opportunity to work with herders in Niger to map out and direct positive change, and to avoid subjection to inevitable, possibly undesirable change, will be available to USAID in February 1982 when so designed, Phase II of the Niger Range and Livestock Project. The biophysical and socioeconomic data, including the "animal-vegetation balance" points that were developed in phase I, will provide the basis for the phase II design.

D. Originial Development of the Methodology

The methodology described above, was developed by Dr. Robert Bement, former director of the USDA Colorado Experimental Range Station. It results from 32 years of data from animal weight gain per individual and per hectare, as related to ungrazed herbage available to cattle grazed on the Central Plains of Colorado. Dr. Bement is currently the Rangeland Management Consultant for the Niger and Livestock Project. He is based in Colorado where he runs his own ranch. He consults extensively in many countries on range and livestock management, employing the methodology presented in this paper.

E. A Detailed Manual of Procedure to be Issued

A manual is currently being developed which describes how to set up and run the grazing trials, develop the biological response curves and use the results for managing rangelands for optimum and sustained productivity. The manual, with Dr. Robert Bement as primary author, should be available through the USAID Office of Development Information and Utilization (DS/DIU) in AID/W, from REDSO/WA or from USAID/Niger in the summer of 1982. With this manual and the extremely useful results from multiple grazing trials based on the methodology, a significant contribution to livestock production, range management, agro-sylvo-pastoral schemes and environmental protection and restoration is certainly available.

IV. Recommendation

I strongly recommend that AID missions and host country colleagues consider employing the methodology which is presented in this paper (and which will be elaborated in the anticipated manual) in ongoing or upcoming rangeland initiatives. Representatives from Sahelian countries and Sahelian AID posts might particularly benefit from visiting the ongoing grazing trials in Niger, if Niger's appropriate government institutions and the AID mission, were to concur. Concrete Sahelian results from the globally applicable methodology could provide applicable range mangement tools and guidelines for the region.

AGROFORESTRY AND ICRAF

Bjorn Lundgren*

I. Introduction

Agroforestry is a new word for the old practice of growing crops and trees together on the same land. Development of the concept does not simply mean trees, but those with very specific purposes. An agroforestry land use system can yield both food products, from plants, animals and/or the trees, as well as various "tree" products, thus meeting, as comprehensively as possible, the needs of the user. Agroforestry systems can, and should, have a stabilizing or even improving effect on the environment; and also a stabilizing effect, on total productivity from the land. These requirements may be met by selecting a range of tree species, or by the use of multipurpose trees, and "matching" them in one appropriate system with crop plants and/or grasses.

Among the many roles which trees can play in the agricultural landscape is that of the provision of energy for the household. Some 80 percent of the wood used in the tropical world is for home fuels. This inevitably leads to destruction of forests and woodlands, and the potential destabilization of the environment. Coincident with this consumption of forest resources is the inexorable pressure from expanding human populations to increase food supply which, in turn, can lead to an increasing level of agricultural activities on previously non-agricultural lands - in the majority of cases forests and woodlands. Thus the urgent needs are: to meet both the food and the energy requirements of the peoples in developing countries; to deal objectively with the problems of land use in order to best reconcile and optimize utilisation with potentials and restraints; and to lend stability to the environment. It is not surprising, therefore, that many now see modern multiple output agroforestry systems as a promising choice for the resolution of certain land use problems.

II. ICRAF

A. Organization

The International Council for Research in Agroforestry (ICRAF) is currently supported by five donor agencies, namely: The Canadian International Development Agency; The International Development Research Centre; The Ministry of Cooperation of the Netherlands; the Ministry of Economic Cooperation of Switzerland; and - the German Agency for Technical Cooperation (GTZ).

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The German Foundation for International Development (DSE) has supported a seminar while the Rockefeller Foundation and the World Bank have contracted for specific services. It is expected that the Ministry for Overseas Development of the United Kingdom will soon join in support of ICRAF.

ICRAF by its Charter has been charged with the responsibility of "promoting agroforestry systems to achieve better land use... to encourage and support research and training relevant to agroforestry; to facilitate the collection and dissemination of information relevant to such systems and to assist in the international coordination of agroforestry development". The objective is "to increase the social, economic and nutritional well being of people of developing countries".

B. Research Strategy

Agroforestry schemes are systems of land use, and often rather complex ones; the outputs are both food and tree products. ICRAF's strategy is to develop this analytical approach - the diagnostic methodology - which will enable anyone to analyze the state of their land use systems so as to identify the critical subsystems, and to determine the problems or operative constraints as well as the potentials for improvements of system performance.

C. Research Logic

The basic logic of ICRAF's research approach is dictated by the cycle of development depicted in Fig. 1. Each phase in the cycle embraces a series of research activities. Each situation to which the cycle is applied will require a different mix of the particular activities in order to complete the cycle.

The cycle takes its starting point from the premise that the process of developing a solution to a problem should begin with the capacity to analyze the problem situation, in this case the land use system in which agroforestry technology is deemed to have a role. The diagnosis of existing land use systems is aimed at discovering the constraints and potentials, especially those which relate to agroforestry schemes. This is the deductive, analytical, or diagnostic part of the technology development cycle. One important outcome of Phase I of the diagnosis is the capacity to identify land use systems in the right way. ICRAF is developing a "basic needs" approach to the identification of production subsystems in terms of output categories which answer the universal human need for food, energy, shelter, cash and community integration. What is analyzed is therefore highly relevant to human needs.

Phase II of the development cycle involves identification of constraints in the existing land use system and an analysis of potentials, with implementation of further diagnostic procedures if required. Phase III identifies either existing agroforestry technology which could be used to synthesis a new, or modified, agroforestry system (Phase IV), or it establishes a research program to develop appropriate technology. The outcome of Phase IV, that is the synthesis of a new agroforestry system (or the redesigning of an existing one), can be compared with the diagnosis of the original situation in Phase I, so as to ascertain whether or not it is measurably better. The reiterative cycle can continue until existing technology has been fully utilized and the development of technology becomes the main stumbling block. The latter process is, however, always directly guided by the requirements of an objective diagnosis which will help identify priority problems.

The implications of the adoption of such a strategy is that there will be two distinct but complementary research activities. These are:

1. The development of the diagnostic capability for the identification of agroforestry needs and potentials. This will be done through "on-farm" studies of the system used by the small holder. This will also deal with, 'communities', particularly when land use and/or environmental impact is of major concern. This research will initially be carried out in Kenya, but later extended to other countries.

2. The development of methodologies to develop new agroforestry technology. These may range from devising quick methods to evaluate multipurpose trees, designing low cost field experiments to test particular variables in tree-based systems, to trials of complete agroforestry systems. This kind of research will be initiated on ICRAF's Machakos Field Station in Kenya.

There will undoubtedly be some technology generated as a consequence of this research activity. Generation of this technology, however, is not the objective of the research but is a spin off from the development of the methodology.

C. Long Term Effects

Agroforestry systems should be sustainable. Environmental sustainability on individual land holdings implies two things: the basic environmental impact of the system being used, and its capacity to fulfill the needs of the landholder. If the latter is not satisfied, either in total or in kind, then some form of exploitation may be resorted to and the system may fail to realize any potential it has for environmental

sustainability or benefit. The problems resulting from a severe reduction in the tree fallow period in shifting cultivation systems is a case in point. Woody perennial vegetation can have beneficial effects on the environment through a range of processes (climatic amelioration, nutrient cycling, soil stabilization) so that the inclusion of trees and shrubs in a land use system may, if the species chosen and their management are appropriate to the situation, help raise the potential for basic environmental stability or enhancement. It is this factor which should enable agroforestry systems to be environmentally sustainable at generally lower levels of nutient inputs than agricultural ones.

In terms of outputs it is almost inevitable that the food and energy subsystems in agroforestry will have priority byt with emphasis on the latter only where an energy crisis is actually perceived at the present moment by the land user. The potential capacity for individual land holdings at least to offset the family's fuelwood needs by adopting one or more or several agroforestry solutions to this problem is a possibility which has to be clearly borne in mind at the Technology Identification part of the cycle.

THE CDA FORESTRY/FUELWOOD INITIATIVE

John D. Blumgart*

Cooperation for Development in Africa; (CDA formerly CADA) is the acronym for an informal grouping of donors (Belgium, Canada, France, Germany, United Kingdom and United States) that have agreed to cooperate for the purpose of expanding and enhancing their programs in support of economic and social development in Africa. Each donor has agreed to assume a leadership role within the group for a certain program or series of activities (e.g. Germany has opted in favor of supporting Southern Africa transport development). In consultation with the other donors during 1980, the U.S. elected to become the lead donor in three fields: (a) health delivery systems, (b) agricultural research, and (c) forestry/fuelwood programs. CDA technical committees ahve been formed on each of these topics to elaborate a strategy, define operational roles, and to develop collaborative relationships with African governments.

During the course of 1981, on the basis of consultations with the African governments and the other donors, the Forestry/Fuelwood Technical Committee presented a conceptual approach and course of action that was endorsed at the September meeting of CDA policy level representatives held in Ottawa. Conceptually, CDA agreed on the following program ideas:

(a) Forestry and fuelwood programs should be given increased priority in donor and African economic and social development programs, as major elements in sub-Saharan agricultural production, natural resource management and energy supply systems.

(b) The primary goal of a CDA initiative in this sector should be to assist in the creation of a broad African institutional capability to undertake national reforestation and fuelwood production programs on a scale commensurate with the needs within each country selected.

(c) Initially the effort should concentrate on a few countries. On the basis of criteria identified by the Technical Committee, the following five countries were selected for special attention: Senegal, Upper Volta, Malawi, Burundi and Somalia.

As a means of coordinating in-country implementation, the six donors agreed to identify a senior resident official to serve as point of contact and alternate point of contact as follows:

Senegal: France, U.S. alternate
Upper Volta: Germany, Canada alternate
Burundi: Belgium, France alternate
Malawi: United Kingdon, U.S. alternate
Somalia: United States, U.K. alternate

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* Chief, Special Development Problems, AFR/DR.

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It was agreed that the in-country efforts should, to the extent possible, proceed along the following process:

(a) Review and confirm the quantitative dimensions of the forestry and fuelwood problems, including the implied land requirements;

(b) Inventory host country, CDA and other donor assistance in terms of their effectiveness in providing the main components required for successful national programs;*

(c) Identify and support projects required to provide priority assistance, through donor bi-lateral programs, to strengthen those program components which are missing or are the weakest link.

Subsequent to the Ottawa meeting, the following in-country progress has occured:

(a) All CDA donors have appointed local points of contact and alternate points of contact in the five African countries in accordance with the matrix noted above.

(b) Somalia: Somalia has circulated a five-year forestry sector paper and proposed programs. Several meetings of local donor representatives have been held to explain and coordinate fuelwood/forestry activities. USAID/Somalia has submitted a $9./ million PID for a national program of reforestation, research and institutional development. The U.S. program would be complemented by projects being planned or implemented by France, U.K., Germany, Italy (which is joining CDA), UNSO/FAO. Meanwhile, AID/W has advanced $250,000 to the Somalia Mission for pre-project initiatives and PP design.

(c) Burundi: designation of Burundi as a CDA priority country has led to the securing of funds for the Bururi Forest project ($1.1 million) and its initiation in FY '82.

(d) Senegal: the Senegalese government plans to convene a multi-donor meeting under the auspices of the CILSS and Club du Sahel in May to review its recently formulated national forestry plan.

(e) Malawi: The Malawi Forestry Department is preparing a forestry strategy paper along the lines of the suggested CDA approach which will be submitted to the local CDA group.

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* See 1980 State 262414 for a summary of the technical components agreed upon by the Technical Committee.

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It is planned to hold the next meeting of the Forestry/Fuelwood Technical Committee to review in-country progress just prior to the next CDA policy-level meeting which is to be held in Washington during June 1982.

SECTION IV

NATURAL RESOURCE MANAGEMENT

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SECTOR APPROACH TO ENERGY AND NATURAL RESOURCES IN AFRICA

REDSO/EA Panel*

I General Problem

Resource management problems in the LDC's are symptoms of much deeper political and economic maladies, which are significant barriers to future economic development. While private organizations, overseas corporations and development agencies are struggling valiantly with a host of problems, they confront enormous difficulties in their attempts to overcome the large, complex failings of individuals and political and economic systems now in place. A coincidence of events including price hikes in fuel, drought conditions, population pressure, political turmoil, refugees and declining buying power of export commodities, has places particular pressure on the natural resources of Africa. The resulting crisis has received much publicity (UN conferences, TV coverage, advocacy groups, etc.). As a result, Governments and donors are attempting to respond but what seems to be lost in the shuffle is the fact that several sectors: energy, natural resources, environment, forestry, agriculture and population are interrelated. Instead of dealing with this fact, focus tends to be on specific projects or single elements of the overall problem. Yet, there is a growing realization that the total resources required to deal effectively with natural resource related problems are enormous, perhaps beyond the current capability of coordinated government/multidonor responses. It is clear that the full range of natural resource problems must be addressed in an integrated and systematic way if priorities are to be established. An attempt must be made to identify: (1) natural resource interactions, (2) critical points of intervention where greatest progress can be achieved, and (3) the trade-offs associated with alternative courses of action. To do this requires detailed knowledge of natural resource conditions and trends. Typically, key information of this type is lacking. For example, most USAID Missions are aware that soil erosion is a major problem; however, few of the African LDCs have reliable data on biomass production, carrying capacity, soil erosion trends or soil types. The degree and extent of land degradation is often unknown, erosion monitoring is seldom done, etc. The LDCs and Donor agencies have difficulty in identifying these interaction effects occurring between resource sectors because they are even more complex than single sector effects. For example, intensified agriculture and the associated increased use of pesticides has contributed to a resurgence of malaria in the LDC's (Nature, vol. 293, 1981). Many missions and host country governments have simply not been in a position to

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* This paper was prepared by the REDSO/EA's Natural Resource Committee consisting of: B. Robinson (Chief, Analysis Division); J. Gaudet (Science, Technology and Environment Advisor); W. Fisher (Energy Advisor); J. Seyler (Forestry Advisor); C. Barnes (Social Analyst); and R. Ford (Environmental Training and Management Specialist).

identify interaction effects. The only course of action open to them has been to undertake single sector interventions, with the hope that project resources will provide maximum benefit and that other natural resource interactions will not overwhelm the project and cause it's failure over the long-term. Missions must weigh the costs of integrated natural resource analysis against the potential benefits to project design and implementation and then choose a balanced level of study effort. However, even a limited effort using natural resource specialists to gather more complete information on natural resource trends and to attempt to identify resource interactions could significantly reduce the risk of misallocating resources.

II. The Sector Approach

A. Methodology

Assuming some type of integrated approach to the analysis of natural resource problems is called for, is there a way of approaching such a task which does not result in unending studies, makes use of limited AID resources and obtains maximum benefits and multiplier effects for the host-country? The sector approach proposed here provides a step-by-step methodology for a systematic analysis and the consequent development of a natural resource strategy for the host-country which can produce maximum benefits and multiplier effects. It should accomplish three primary goals:

1. Provide better and necessary information for host-country and mission planning and decision making;

2. Strengthen host-country institutional capability in: monitoring, data collection, data processing, analysis, policy formulation, and mangement of natural resources;

3. Identify priority corrective measures and help the host-country implement and evaluate the identified interventions.

B. Analysis

On the analytical side, the approach consists of three distinct phases: preassessment, sector assessment, and sector analysis. At each phase the above three I's would be considered (Information, Institutions, and Interventions). It is proposed that the process of obtaining information be carried out at each stage, but with increasing depth and precision by: (1) measuring and locating the major problems; (2) explaining the major causes of the problems; and (3) providing feasible, corrective measures which lie within the administrative and financial capacity of the host- ountry. The final outcome and purpose of the appraoch is to lead to a more coherent LDC natural resource policy and more effective management of natural resource problems over the long run.

1. Preassessment

This phase is a preliminary, quick assessment which provides a mission with guidelines for mission strategy. A REDSO team of 1 to 4 people conducts this study over 3-4 weeks. During the preassessment, existing data and information is gathered and reviewed. Through discussions and interviews with people in the host-country, AID and other donor representatives, major problems and corresponding objectives are identified along with an initial investigation into grassroots perception of the problems and general areas of intervention. The purpose of the preassessment is to identify initial practical activities which can and should be carried out by the mission. The completed preassessment will: (a) identify the major resource problems and areas of intervention; (b) assess the existing institutional capacity to address these problems; (c) identify significant gaps in the available information; (d) assess activities of other bilateral and multilateral donors; (e) list special problems or sector interactions foreseen in ongoing or future projects; (f) determine if a sector assessment is feasible and, if so, define the scope of work; and (g) on the basis of existing information, identigy those interventions that are clearly of high priority.

2. Sector Assessment

This is still a comparatively short-term activity (3-5 months) following from the preassessment and using similar techniques. It is a unilateral exercise to be funded by AID and will use available data and information to:

a. Further define the priority problems and interactions by in-depth assessment of the three I's (Information, Institutions, Interventions);

b. Determine the extent of host-country government concern and commitments. In other words, are the problems perceived by the people in the host-country the same as those identified by the government and other donors? If interventions are undertaken, will they participate?

c. Identify grass roots support. This is especially important in natural resource conservation, renewable energy and propagation projects (e.g., terracing, treeplanting, etc.) where costs necessitate active village participation.

d. Determine if other donors will collaborate with AID in this sector approach to information gathering, institution building, identification and undertaking of potential interventions.

One of four general conclusions may emerge from the sector assessment:

- No further analysis is needed because the country resource sectors are well-managed and are under control;

- The resource sector problems, interactions and interventions can not be further analyzed due to lack of trained host-country personnel and institutions. An immediate training program is essential and/or PVO's should be identified who can undertake interventions pending the development of trained personnel;

- A long-term sector analysis would be of use, but greater host-country commitment is needed. An in-country, resource sector seminar might be held at this stage.

- Long-term sector analysis is desirable and feasible. The Mission could decide to promote the support of a sector analysis project with other donors. The scope and methodology of this analysis would be specified in the sector assessment.

3. Sector Analysis Project

Sector analysis necessitates the assembly and support of a long-term in-country team. Outputs would result at several stages so that the project could provide findings and conclusions of immediate utility for resource policy and management. It is important here to realize that the analysis would be a collaborative project wherein host-country personnel would be trained on-the-job and through formal training programs. The purpose of the analysis would be to strengthen host-country capabilities in data collection, data processing, analysis and policy formulation. For example, U.S. technicians working in information analysis can provide host-country counterparts with on-the-job training. Formal training can also be provided in the project for individuals who will work in resource data collection, processing and analysis. On-the-job and formal technical training would take place in areas such as: sample surveys, remote sensing, ecology, renewable energy, forestry, etc.

One of the outcomes of a collaborative sector analysis project is the establishment of a new sub-unit and permanent staff capable of directing a continuous ongoing analytical and monitoring process in the appropriate host-country institution, e.g. Ministry of Natural Resources.

As in analysis of other sectors, surveys of public institutions, private firms, farms and households are carried out. Resource sector analysis uses remote sensing, resource inventory, mapping, etc., to provide raw inventory and trend information not previously available to the host-country. Further, it helps the host-country develop the trained personnel and the institutional capacity to analyze and interpret the data produced by such techniques.

C. Interventions

At all three levels (preassessment, sector assessment and sector analysis) information and institution-building are considered essential inputs. One of the goals is to make use of ecological and development indicators and trend analysis coupled with on-going monitoring techniques to judge resource degradation. The host-country should then be able to develop a fairly sophisticated approach to resource management. In LDC's this approach will only work if these analytical and monitoring techniques are applied and/or managed directly by host-country individuals and institutions.

As well as acquiring more information on physical trends, data are collected on relevant economic and sociological factors. This will make it possible to carry out a better analysis of selected resource sector problems, i.e. a fuller explanation of major causes should result. This identification of principle causes will, in turn, make it possible to identify appropriate corrective measures that can be applied as interventions in light of the limited physical, financial and human resources available.

It is important here to note that at every stage natural resource interventions or action projects must be started concurrently with efforts to obtain better information and to strengthen institutions. Perhaps the preassessment and sector assessment stages will lend themselves more readily to immediate action projects because of their faster turnover time. But even at the sector analysis level concurrent interventions will be possible. In fact, most host-countries doubtlessly have already started interventions in practice, because of their long-term nature, sector analyses will probably provide LDC's with better long-term planning and monitoring capabilities, as well as indicating the more immediate corrective measures.

III. Conclusion

Once this sector approach is implemented, can it be sustained by the LDCs? Although sector analysis has been used in the past, it is liable to become an even more important tool for AID if we look at current trends. For example, in a recent action memorandum to the administrator (15 September 1981), it was recommended that technical expertise be mobilized to "oversee the preparation and appraise the soundness of sectoral analytic studies...." Following this in a recent AID general notice (17 November 1981) the Bureau of Science and Technology has created sector councils (including one entitled "Energy and Natural Resources") which will be responsible for erview of AID's sector policy papers. In the draft of the "U.S. Bilateral Economic Assistance Strategy for Africa in the 1980's" now under review, an emphasis is placed on both the need for better host-country resource policies and on analysis as a basis for such policies.

Sector analysis can be used to focus AID expertise on natural resource problems, but more importantly it is a dynamic approach which carefully builds a host-country capability to cope with these problems.

REGIONAL REMOTE SENSING FACILITY

Merrill Conitz*

I. Introduction

The past four years have seen the development of the Regional Remote Sensing Facility as an effective instrument for resource technology transfer. This is an AID project which, under REDSO/EA brings remote sensing training, user assistance and services to the East and Southern Africa region. The facility is now operational and its services are available to missions as well as government agencies. The facility's considerable data holdings provide information on natural resources on a regional basis. This can be an effective source of data for projects in the region which are concerned with forestry or other vegetation cover, with energy (water for hydropower, fossil fuel exploration), or with other natural resources (rangeland, wildlife habitat) that would benefit from the inclusions of appropriate remote sensing data in the planning, implementation and monitoring stages.

II. Project Summary

A. Background

The Regional Remote Sensing Facility was conceived and designed by AID to support the transfer of those aerospace technologies applicable to resource analysis, monitoring and mapping. The U.S. Government has led the world in the development of space related technologies which make such monitoring and analysis possible on a continental regional scale. This project is one that is specifically designed to make the benefits of these technological innovations available to East African countries. The facility can also support and partially execute development projects for AID and other donors.

B. Host Organization Structure and Support

The Regional Centre for Services in Surveying and Mapping is an African Regional organization sponsored by UNECA but financially supported by Kenya, Tanzania, Uganda, Somalia, Malawi, Comoro, Zambia, Lesotho and Swaziland. It provides building accomodation and administrative staff support, shares technical equipment and has recently begun paying the salaries of locally hired staff of the facility. Through an arrangement with the Survey of Kenya it also gives the Facility access to the surveying and map printing capabilities of that organization. Active divisions of the Centre are administration, library, calibration and maintenance, printing and cartography, and geodesy. The Remote Sensing Facility functions as a semi-autonomous division of the Centre.

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* Director, Regional Remote Sensing Facility, Nairobi

C. Training and Services Provided:

As of November 1981 the Remote Sensing Facility has sponsored 13 three-week specialized short courses with a total of nearly 300 participants from 14 countries in East and Southern Africa. In addition four information seminars have been held in the participating countries with a total of over 200 attendees. Individualized training is regulary carried on at the Facility.

Over 100 projects in the region have been assisted with satellite imagery, aerial photography and/or technical assistance in the form of image interpretation, specification writing, etc. Approximately 10,000 photographic images have been produced in the facility's photo laboratory. The majority of these are reproduction for the facility's reference files but many specialized products have been distributed to users in the region. Numerous experimental maps, brochures, training illustrations and information bulletins have also been produced.

D. Physical Facilities:

- Modern classroom, briefing room and seminar room equipped with all necessary audio visual aids.

- Satellite image and air photo analysis capability supported by extensive reference files, multispectral viewers, scale change equipment and various items of photo interpretation and drafting equipment.

- Modern photo laboratory capable of producing black and white or color enlargements, color composites, mosaics and other specialized reproductions.

- Project support capabilities include aerial cameras for pilot and sample surveys, geodetic satellite positioning equipment, and equipment for various ground surveys sampling and testing.

- Capability to provide staff consultants for resource surveys in forestry, agriculture, land use, rangeland monitoring, geology, hydrology and others with the required thematic and image mapping capability. Staff also available for project design and monitoring.

E. Staff

- Remote Sensing Facility staff includes nine professional/technical positions representing various disciplines and four administrative and support staff.

- The host organizations provides technical support in cartography, geodesy, printing and electronic/optical

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equipment maintenance.

F. Future Plans and Prospects

As the ministries in East and Southern Africa that are concerned with renewable resources become aware of the technologies available for monitoring these resources, there is an increasing demand for training and technical assistance in remote sensing. The facility plans to continue its training and technical assistance program at an expanded level. Specialized training in agriculture, land use monitoring, range management, water resources and others will continue. Anticipated changes in the training program include a gradual shifting of financial responsibility from the facility to the participants or their sponsoring agencies and the introduction of extended training courses. Beginning in CY 1982, the participants or their sponsors will assume responsibility for travel to and from Nairobi. Later there may be a gradual assumption of per diem and training costs. The first extended training course is planned for March through August 1982 and will feature the monitoring of renewable resources. It will be a project-oriented course designed to train participants in association with ongoing projects in their home countries after a period of orientation in Nairobi.

Another change in facility activities in the near future will be an increase in project activities. The Regional Remote Sensing Facility presently holds the largest collection of Landsat imagery in Africa. This is supported by an extensive collection of maps, air photos and other reference material. The facility's multidisciplinary staff has expertise in many resource application areas and has access to consultants in other areas as needed. It is hoped that this expertise along with the reference material and analysis equipment of the facility will be utilized in the implementation of resource development projects of AID and other donors.

III. 1982 Training Program

Missions are requested to bring these opportunities for training in remote sensing to the attention of relevant government departments.

A. Courses

1. Remote Sensing for Geology February 1 - 19, 1982 Nairobi

This course will be of three weeks duration and will include two field excursions. The emphasis will be on geological mapping and exploration. Participants are encouraged to bring to Nairobi maps and reports relating to a particular area of their home country. They can then make their project work of direct relevance to their field area.

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Participants must arrange their own travel to and from Nairobi, including all visas and taxes. The Remote Sensing Facility will provide travel from the airport, to and from the hotel to the classrooms, tuition, field travel and accomodation (bed and breakfast). A small daily allowance (150 Kenya Shillings) is also paid to cover meals and incidentals. The facility accepts no responsibility for medical insurance and is not liable for costs or damages arising from accidental death or injury. Applications for places on this course should be forwarded immediately to the Training Programme Manager, Remote Sensing Facility, P.O. Box 18332, Nairobi, Kenya. Applicants should normally hold a degree or diploma in geology and have five years or more post graduate experience.

2. Natural Resources Extended Training - Nairobi March 15 - 27, August 8 - 12, 1982.

This course will begin in Nairobi on 15th March and there will be two weeks of classroom sessions. Participants will then return to their own countries to undertake project work. The project work should emphasize resource monitoring, particularly vegetation monitoring. Participants will be selected by arrangement between the facility and participating agencies rather than directly with individual participants. Project work undertaken in the participants own countries will be chosen in consultation with the sponsoring agency which must agree to support the work with all in-country requirements and not transfer the participant until the course is completed. Topics will be in the area of natural resources.

At the conclusion of the project work there will be a final session in Nairobi. All arrangements in Nairobi will be as stated for the geology course above. The participating agency is expected to furnish in-country support for the participants and for the supervision and consultation provided by the Remote Sensing Facility.

3. Teaching with Remote Sensing Data - August 23 - September 3, 1982, Nairobi

This course is intended as a follow on from the course given in 1980. Participants will be given the opportunity to create materials for use in teaching in the context of their accumulated experience with remote sensing courses. Preference will be given to participants from the previous couse but places will be available for other teachers using remote sensing data at the college or university level.

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Arrangements for this two week course will be as stated for the geology course above.

4. Remote Sensing in Hydrology Extended Training, Nairobi October 25 - November 5, 1982 and January/February 1983

This course will begin with two weeks of classroom instruction in Nairobi followed by project work in the participants' home country. It will feature groundwater exploration and the monitoring of surface water by remote sensing methods. During the field work some supervision and consultation will be provided by the Remote Sensing Facility. There will be a concluding session in Nairobi. Applicants from appropriate agencies will be selected in the same manner as for the natural resources course above.

B. General Notes

1. Background

All training courses intended to provide insight into the application of remote sensing in specialized professional areas. Participants are expected to have a college degree in the appropriate application area and several years of practical experience. Short Course participants may be at the operational or managerial level. Extended course participants are expected to be assigned to specific projects with data collection or supervisory duties.

2. Financial Arrangements

Training costs, training materials, hotel accomodation and subsistence for the participants are provided by AID through the Remote Sensing Facility. Beginning in CY 1982 all travel to and from Nairobi by the participants will be paid for by the participants or their sponsoring agencies. Travel and per diem for facility staff in connection with the extended training courses will be paid by the facility but any local transport and other logistic support for staff or participants is the responsibility of the participating agencies.

3. Applications

Persons interested in applying for the geology or teaching materials course should submit their applications to the Training Program Manager of the facility including present occupation and responsibilities, other biodata and certification by the employer that such training is sanctioned and travel to Nairobi is approved. Details of application for extended courses contained in the Facility Newsleter.

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IV. Applications of Remote Sensing

A. Mapping with Landsat Data

Because the Landsat satellite is in orbit at 930 km above the earth it provides a view of the earth which is approximately equivalent to that of an oblique mercator map projection. In general the Landsat data can be thought of as useful picture maps. Computer processing of the data can make a picture map fit any given map projection, and at scales of 1:100,000 or smaller the fit is very good.

Overall the photomap product based on Landsat data gives a good visual impression of the landforms and the major natural regions of an area. Irrigation projects are particularly visible and so too are major differences in land use. Forestry plantations are also well defined. Such experimental photo-map products appear to offer a useful view of an area and can be used in conjunction with conventional maps to address many questions about the distribution of natural resources.

B. Monitoring Fires in Open Grasslands

Landsat can play a vital role in long term monitoring of the extensiveness and impact of fires on woodland/grassland dynamics of large natural part areas such as the Serengetti National Park. These images clearly show the seasonal pattern of fires and their extensiveness. Furthermore, historical series of Landsat images show the frequency which the different vegetation components are burned.

Using such information, it is possible to produce maps of the extent of fires each year and to note their location. Such information, apart from providing basic knowledge, also assists in the planning of fieldwork and ground or light aircraft surveys. Because Landsat data provides information on a large area at a specific time, they are ideally suited to the management of extensive parks such as the Serengetti.

C. Evaluation of Forestry Resources

Repetitive Landsat images over a given area on a periodic basis have been used to evaluate changes in African forestry resources. Changes in vegetation conditions due to moisture variations and due to activities of removing vegetation are very obvious on these images. The repetitive and large area views from Landsat can be very useful to planners and administrators in identifying areas for development projects and by providing a permanent record of progress which is also useful for monitoring the impact of the projects.

Recent studies indicate that the world's forests are being

depleted at the rate of 20 million hectares each year. Much of this loss is in the tropical region and in Africa projections of current rates of forest cutting indicate that 40 percent of the present forest cover will diappear by the year 2000. The demand for additional land for food production accounts for a substantial loss of forest each year. This demand is usually regulated and documented in agricultural development projects. However, a growing demand for fuelwood for burning as firewood or for conversion to charcoal is less easy to regulate and monitor.

For most countries in the Eastern Africa region the need to assess present forest cover can be easily met using Landsat data in a photo-print form. Comparisons between Landsat scenes of different dates reveal information about changes in forest area and about progress of regrowth in plantations. An overall view of the forest resource can be rapidly and cheaply obtained in this way.

Many items of importance to foresters are also visible on satellite images. Such things as geological structures, some soil types and the major terrain units can be rapidly mapped from Landsat images. Thus afforestation projects or rapid mapping of areas for forestry development can be assisted with such information. Using the satellite images as a base for planning soil surveys, terrain mapping and field deployment, including the planning of survey flights, can be a most effective low-cost strategy in development.

In summary, Landsat data provides a picture map of forest resources. This is a low cost, large-area picture which can form the basis of country-wide forest mapping. Such mapping can be achieved rapidly and with acceptable accuracy but is limited by cloud cover, especially in coastal regions. Because the satellite remains in orbit, pictures are taken in a time sequence. Therefore comparison between pictures can show change. In addition the satellite data indicate the vigor of vegetation growth and can be valuable indicators of disease or stress in forest growth. Fire damage can also be easily mapped over large areas.

D. Remote Sensing and Hydrology

Over large areas of the earth the identification, evaluation and monitoring of water resources are of vital importance. Agricultural development, rangeland management and urban or regional planning are dependent upon the availability of adequate water supplies. In many cases these water supplies are a function of the hydrology of a large area. The data from Landsat, providing views of large areas on a repetitive basis, can be very important in the examination of certain hydrologic features. Major hydrologic applications are groundwater exploration, flood monitoring, surfacewater inventory, water quality analysis, irrigation monitoring, the

detection and mapping of wetland areas, and the mapping of some coastal features and reefs.

Important in many hydrologic applications is Landsat's ability to detect open water. The principles of air photo interpretation can be applied to the Landsat images to delineate open water easily, providing low-cost and rapid mapping of floods, rivers and surface-water bodies. In addition, data from Landsat reveals turbidity patterns in larger water bodies as well as floating vegetation and shallow water areas. Where water is in association with vegetation, as in wetlands or swamps, the Landsat data provide some detail of the variation in the vegetation and a ready means of mapping the vegetated area. In other cases, areas of groundwater seepage are revealed by the presence of vegetation, and groundwater movement may be inferred from the patterns of geological structure and rock type evident in the Landsat image.

E. Landsat Data for Hydrology in Eastern Africa

In the Eastern Africa region Landsat data provide an important source of information about water resources. The repetitive coverage of Landsat is ideally suited to provide seasonal images of surface waters including changes in the areal extent, presence of vegetation, and degree of turbidity that may be correlated with contemporary or previous field studies of actual conditions. Data derived from the analyses of such images can provide a rational basis for planning the economic utilization (salt or water extraction and agriculture) and engineering development (roads and airfields) of these hydrologic features.

Simple location of surface water can be done very effectively with Landsat. Surface areas greater than five hectares can be identified with 99 percent accuracy. Mapping of floods and water courses or water body changes for map updates can also be done very effectively.

Repetitive coverage of Landsat may determine if a stream is in continuous or intermittent flow. It has provided reconnaissaince-level data needed for the development and operation of large irrigation projects as in Swaziland. Such data may also be used for the design of major impoundment structures and their impact can be Landsat monitored. Landsat data have in some situations provided input to water-demand and ground-water-flow models for irrigation projects.

Landsat data are used to assess major watershed characteristics that affect runoff. It is possible in the semi-arid and arid watersheds of East Africa to develop information on runoff prediction based on data from Landsat and available meterological satellites.

Meterological satellites also provide information on cloud cover, cloud type, and cloud persistence, and information on moisture which may be useful for agricultural crop yield prediction.

Interpretation of a photographic print of Landsat data also reveals features associated with ground-water occurrence such as landforms and landform patterns, drainage characteristics, vegetation types and associations, outcrop patterns, soil tones, lake patterns, and land use or land-cover characteristics. Some detected features directly imply the presence of shallow sands and gravels; other features indicate rock types or the presence of folds and fractures. There is often a good correlation between lineaments detected on aerial photographs or satellite images and the occurrence of ground water in dense, fractured limestones. There is good reason to believe that many lineaments are related to ground water occurrence in other types of dense, fractured rocks. Another application of Landsat can be the delineation of zones of potential recharge for groundwater supplies. Delineation of such recharge zones could aid in more efficient management of water quantity and quality.

SECTION V

ENERGY TECHNOLOGY PROJECT POSSIBILITIES

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OVERVIEW OF ENERGY TECHNOLOGY PROJECT POSSIBILITIES

C.F. Kooi*

There is such a wide range of possible and potentially productive energy projects that one is hard pressed to decide which to pursue. One could, for example, do a project designed to get African petroleum refineries operating at full capacity, one could do a project to utilize wood-burning internal combustion engines for mobile or stationary power, or one could develop solar dryers, etc. To which project should money, time, and effort be allocated?

We suggest that this be done by a three-step process. The steps are:

(1) Determine and prioritize energy needs. These are things like the need for fuelwood (more is needed and at a lower price in Sahelian cities), the need for large new energy inputs to agriculture in order to increase food production and the need for energy to reduce excessive mechanical work of rural women (water drawing, grain grinding, etc.).

(2) Determine the available energy resources. These vary according to the region. For example, petroleum is available in the Ivory Coast, Nigeria, Gabon; gas in Nigeria; coal in Niger; hydropower in Zaire; biomass resources in Liberia; geothermal energy in Kenya; wind in the Cape Verde Islands; and solar energy is predominant in Sahelian countries.

(3) List the technologies which convert the energy resources into satisfaction of the energy needs. Some resources can be used almost directly by standard devices (gasoline engines, mini-hydro turbines), others require additional development and/or cost reduction, training, infrastructure development, etc. (photovoltaics, biogas production, ethanol production).

In Tables I and II we give a partial list of these needs, resources and technologies. There are obviously hundreds of project possibilities corresponding to different combinations of resources, technologies, and needs. If one decided to concentrate on grain grinding, for example, one could use the direct solar resource via a variety of heat collectors (flat plate collectors, concentrators, solar ponds) in combination with a variety of thermodynamic engines (Rankine cycle, Stirling Cycle), or photovoltaics with or without concentrators. One could use a variety of wind machines, biogas-fueled engines, wood-fueled engines, engines burning palm oil, small hydropower, etc. Too often people commit themselves to a certain combination without adequate consideration of the large number of alternatives, some of which will probably better satisfy all the physical, social, economic, management, and political requirements of the situation.

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We are concerned with the determination of the energy sources available in the regions under consideration which could be used to satisfy a need and selection of a technology that can couple the energy source to that need. (If water pumping is needed and wind speeds are high, wind pumps may be a good idea.)

In this process we would ask questions such as: What are the promising energy sources at the location in question? For example, is solar insolation adequate and at the time of year or day when the demand is highest? What is the diffuse component (which concentrators wouldn't collect)?

When the promising sources have been identified we then select a technology or technologies. We would ask questions such as:

1. Will a system do the job? (Will it grind the required amount of grain to the proper fineness in an acceptable time?)

2. What is the state of system development? Does it have an acceptable track record; or none at all?

3. What skill levels are required for routine operation and maintenance?

4. What is the expected life of the system and the expected repair and major overhaul schedule?

5. What is the installed cost? What are the major repair costs? Operation and maintenance costs?

6. What is the cost per unit of product?

7. What spare parts must be on hand or purchased during life of system? Can parts be fabricated in the country or must they be imported?

Example:

Let us make an attempt to identify a good energy technology project. We start with the need. We know that most African countries have placed a very high priority on increasing food production. Likewise the AID CDSS's give it a high priority. We will therefore assume this to be a valid, established need.

Increased food productivity requires increased energy inputs. These are (1) mobile mechanical energy for land preparation, planting, weeding, harvesting and product transport, (2) stationary mechanical energy for irrigation and grinding, threshing, etc., (3) chemical energy for pest and insect control and for fertilizers and (4) heat energy for drying and cooking. Maize productivity can be increased by increasing these inputs.

Although increased productivity depends on furnishing a balance of these inputs, we will concern ourselves for the moment with a specific case,

namely, supplying irrigation water. Let us say we are concerned with a location in central Upper Volta where the water must be pumped from a depth of 30 meters.

What are the energy resources available to do this job? We simply run down the list given in the left hand column of Table I. Solar energy is plentiful, fossil fuels must all be imported and are expensive especially in view of the lack of roads. Agricultural, human, and animal wastes exist but quantities and collectability must be determined, forestry wastes and wood are scarce, biomass for conversion to ethanol and methanol is scarce, biomass for animal power (forage) is adequate, wind speeds are too low to be attractive (average = 2m/s), and small hydropower resources are absent. Thus we are left with solar radiation and wastes of agricultural, animal and human origin. Let us assume that after a suitable study it is found that these wastes are not present or collectable in sufficient quantities to do the water pumping job envisaged. Then we are left with the solar resource and biomass for animal power.

We now consider the technologies that will connect the solar resource to the need. From the right hand column of Table I, we find that there are five direct solar possibilities: thermodynamic engines 1/ driven by one of three types of heat collectors (flat plate, solar pond, or concentrator) and photovoltaics (with or without concentrators). For animal power, donkeys and cattle exist in the region but there is no record of their use in water pumping. The criteria listed above must be applied to these systems in order to select the most suitable. This will be done, with the exception of animal power, in the discussion group which immediately follows this talk.

Once the best technology is selected and the system is installed the project has just begun. Unfortunately that's just when most AID energy projects end. All renewable energy pumping technologies are more or less unproven and need years of changing, improving, adapting, and working-out of bugs. Local management, operation, and maintenance must be worked out. Duplicate and improved systems of similar types should be installed in the same neighborhood and an infrastructure (preferably private) for installation, service, and sale of parts should be developed. Financing must be made available since the initial cost is so large (and running costs low). Diffusion of a new technology, no matter how good, is not likely to occur if long term attention is not paid to all of these relevant factors.

1/ There are many types of heat-driven engines but we will limit ourselves to the organic fluid Rankine cycle engine, the most commonly used and most proven.

TABLE I

ENERGY RESOURCES AND TECHNOLOGIES

	Energy Resources	Technologies
1.	Solar Energy (direct use)	flat plate collectors concentrators salt gradient solar ponds dryers desalination cookers thermodynamic cycles, mechanical, electrical power refrigerators, air-ditioning thermoelectric electricity photovoltaic electricity
2.	Solar Energy (biomass)	
	Agricultural & Forestry -wastes -straw -shells, etc. Wood Animal & human manures Starches (corn for ethanol) Sugars (sugar cane for ethanol) Vegetable oils (palm oil)	improved pyrolysis (charcoal) stoves (wood & charcoal) gasification & internal combustion engines ethanol production methanol production direct combustion for heat, steam, etc. briquetting biogas (methane + CO_2) internal combustion engines using vegetable oils external combustion engines using wide range of fuels
3.	Solar Energy (physical conversion)	
	Wind	windmills - water pumps - grain grinding - electrical power
	Hydropower	mini-hydropower installations
	Ocean Thermal	hydraulic ram
4.	Geothermal	direct use thermal electrical generation
5.	Fossil Fuels	
	Coal Peat Lignite	synfuels, coal-oil slurries charcoal substitution, electrical power

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TABLE II

ENERGY NEEDS IN AFRICAN COUNTRIES

1. Agricultural Production

   land clearing and preparation
   planting
   tilling, weeding
   pest, insect, and animal control
   fertilizing
   irrigation
   harvesting
   transport (agriculture)
   storage
   drying
   refrigeration
   processing (grinding, threshing, etc.)
   cooking

2. Water Production

   well drilling
   pumping (human, animal, plant uses)
   desalination
   purification

3. Domestic and Residential

   lighting
   washing & drying clothes
   cooking
   hot water
   electric power (diverse uses)
   grain grinding, etc.

4. Transport

   liquid fuels needed

5. Industry

   electrical, mechanical, heat energies

6. Commerce, government

   lighting, space cooling

GEOTHERMAL: KENYA CASE STUDY

OLKARIA GEOTHERMAL FIELD: DEVELOPMENT HISTORY AND FUTURE PLANS

Sebastian Bwire-Ojiambo*

I. Exploration

Olkaria geothermal field is situated in the central part of the Kenya Rift Valley about 120km. northwest of Nairobi and about 10km. south of Lake Naivasha. Earliest geothermal development at Olkaria was carried out between 1956 and 1959 when two exploration wells were drilled but failed to produce steam and were consequently abandoned. Interest in geothermal development then subsided until after the mid-1960's when a reconnaisance geophysical survey was carried out in the Rift Valley between Lake Bogoria and Olkaria in 1967.

The survey indicated several low resistivity areas suitable for geothermal development, Olkaria being one of them, Others are Eburu, Lake Bogoria and Lake Magadi. In 1969, the Government of Kenya requested United Nations assistance in starting an exploration project. The project commenced in October 1970, with UNDP and E.A.P.&L. Co. Ltd. as the Executing and Counterpart Executing agents respectively. Extensive geological, geophysical, hydrogeological and geochemical surveys were carried out while tests were performed on well X-2 which resulted in discharges of steam. From these surveys and other economic considerations, Olkaria was chosen for exploration and production drilling.

II. Drilling

Drilling commenced in 1973 with the assistance of UNDP and by April 1976 when UNDP personnel left, six wells had been drilled. Since then, 13 more wells have been drilled. Of the 21 wells so far drilled, one is a non-producer, four are poor producers and the rest are good producers with outputs varying between 1.5MWe and 7MWe at 5 bars absolute wellhead pressure. The deepest well so far drilled is 2484 metres (well No. 19) and the shallowest is 900 metres. There are generally two major production zones, one between 750m. and 900m. which is richer in steam and one between 1100m. and 1300m. which is richer in water. The quantity of proven usable steam up to well No. 20 but excluding 19 and 21 is equivalent to 40MWe. The total Olkaria field is estimated to have minimum power production potential of 316MWe over 25 years.

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* Geothermal Superintendent, The Kenya Power Company Limited

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III. Power Plant

The Olkaria Power Station turbine is a single flow, four stage condensing type with gas ejectors and inlet pressure of 5 ata on a condenser vacuum of 0.127 ata. The turbine speed is 3000 rpm and consumes about 143 tons per hour of steam at the rated output of 15MW. Exhausted steam enters a direct contact type barometric condenser at the bottom while cooling water cascades in four stages from the top. Condensed steam and the cooling water are collected in the hot water tank and pumped to the mechanical counterflow draft cooling towers from where it flows back to the condenser.

Directly coupled to the turbine is an 18.75 MVA totally enclosed air cooled generator with a rated voltage of 11 Kv. Power from the generator is conveyed via insulated cables to the single double primary transformer rated at 36 MVA and connected to the National Grid at Naivasha SubStation via a 22 km. single circuit 90MW 132kV transmission line.

The first 15MW turbo-generator unit was synchronized on 20th June 1981 and commenced generation on 10th July 1981 and as at 30th November 1981 it has produced 27.62 GWhrs. during a total running time of 1889 hrs averaging 97.5% Load Factor. The power station auxiliaries consume 4.7% of the power generated. A second 15MW unit is under construction and plans to install a third one are being contempleted.

IV. Waste Water Disposal

The liquid effluent to be disposed consists of excess water from the cooling towers and the well discharges separated at the wellhead. These amount to 6000 to 8000 gallons per hour. Water from the wellhead separators is conveyed in open ditches to a retention pond located at each well where silica precipitates on cooling. From there, the effluent is again conveyed in open ditches to the infiltration pond. The overflow from the cooling towers will be disposed of directly into the infiltration pond. Owing to the high content of hydrothermal minerals in the effluent, it is not fit for human or animal consumption without treatment and the infiltration pond will be fenced. The effluent water will be pumped into the ground at a rate of 500 m^3/year will have negligible effect on the chemical composition of groundwater estimated to be over 150 million m^3 per year.

There have been inquiries from local farmers on the possibility of using low quality geothermal steam for dehydrating vegetables and also the use of excess condensate to neutralize the alkaline soils in the nearby farms. This matter is being given active consideration in view of integrating all the possible alternatives of waste disposal in the geothermal project.

V. Future Development Program

The future development program is based on developing the present

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drilled area or Olkaria I area to 45MWe and at the same time drilling deep exploration wells at the four sites selected by the Scientific Review meeting in December 1980. It is intented to use the old rig for production drilling at the present area up to 45MWe plus surplus for reserve while the new one is used for drilling the deep exploration wells. One such well is now drilled to 250m. At some of the sites, directional drilling will be done with the aim of intersecting the near vertical faults in the area at deeper depths. These are thought to be more permeable. If some of these exploration wells prove to be good producers (more than 4MWe per well) then appraisal production wells will be drilled in that area.

If enough steam is found at any of the western exploration areas, feasibility studies will be carried out with a view toward construction of other power stations with greater capacity than the present 15 MWe units.

Development of the present area and the proposed exploration areas will go along with environmental studies. Waste water disposal is always problematic in geothermal power development, and apart from looking for more infiltration/evaporation ponds as at the present area, studies into drilling re-injection wells for waste water disposal will also be undertaken. Geological, geophysical, geochemical and reservoir response studies under production will also continue.

Training of our manpower so as to eventually phase out expatriates is to be actively pursued. As a first step to this a drilling technology training officer has been hired to train our drilling crew on site and others may be taken abroad for further training. The scientific and power station crew will also be trained on site and others taken abroad for specialized courses on short-term basis.

In order that the above development program may be effectively undertaken, we may require the assistance of consultants on a short-term basis.

ENERGY CONSERVATION

H. Mike Jones*

I. What is Energy Conservation?

I believe in the broadest possible definition. That is, energy conservation is the husbanding of scarce energy resources, the creation of sustainable energy systems, the assignment of opportunity cost pricing to energy sources, and last, curtailment of lower valued energy uses. The basic dilemma remains how to make conservation happen -- not how to technically accomplish particular measures.

Conservation of energy is best achieved by following five basic principles;

- Make it known, that is, how to do it and what benefits will accrue.
- Make it affordable
- Make it available
- Make it acceptable
- Make it self-perpetuating

These principles are particularly appropriate for developing countries, as they rely heavily on stimulating self-help attitudes, aim at minimizing foreign exchange needs, and emphasize development and reliance on local talents.

Energy conservation is not only often misunderstood, but frequently has been given totally inadequate consideration as an energy option. In fact, energy conservation is the natural result of the application of sound economics to a scarce resource - energy. The frequent understanding is related to ignorance of:

- How badly inefficiency hurts,
- The relative cost of supplying energy vs. reducing use (some 10 to 15% less for fossil fuels and many times more for electrical capacity),
- Failure to recognize that immediate mitigation of energy import costs or deforestation can essentially only come from conservation, and
- Failure to consider the costs and benefits of different energy options.

However, neither energy conservation nor energy planning in

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* Energy/Development International, Team Leader, Kenya Renewable Energy Project.

general can proceed without basic information in five areas:

- Sources and amounts of energy used by fuel type
- Uses of energy by sector
- Sustainability and opportunity costs of domestic energy, and careful assessment of imported fuel cost and security of supply.
- Prospective growth and relationship to economic progress and meeting basic needs.
- Priorities on how and where to apply energy policies.

Another critical element in country development aid programming with respect to energy conservation is to recognize that arguments concerning the relative merit of "conservation" in domestic woodfuels versus commercial imported energy, can be misleading and counterproductive. Development progress requires both. It would be nonsense to argue that merely maintaining the current standard of living involving use of wood, charcoal dung and other domestic fuels is our primary goal for energy development. To focus only on these energy sources is to miss the essential role of current imported fuels in sustaining development and fueling economic growth. Failure to control the foreign exchange costs of imported fuels, perpetuating dependence on foreign aid for such energy supplies, and failing to modify or replace inefficient capital equipment, all weigh heavily on whether the majority of the population will ever achieve improvement in material well-being.

II. Energy Aid Cost-Benefit Analysis

Resource allocation to the energy sector by governments, the private sector, and from donors, also needs to be targeted with extreme care. There is simply no surplus in skilled manpower or funds to squander on low-payoff investments. Thus, a rigorous cost-benefit assessment is a vital element in future energy aid programming. Such an analysis, without question, will assign a higher priority to conservation than in the past. It hopefully will also reduce the attention given to marginal technologies and refocus expenditure on those areas really likely to make a difference.

If one accepts the importance of energy conservation in both the imported and domestic fuels, i.e. wood and charcoal, then how can we best proceed to realize these ends. Following the implementation theory presented above, we must examine how and why energy is used and what factors may impede more efficient energy use.

Several brief illustrations help to understand what may need to be done. From past experience in examining industrial energy use, the set of impediments most often encountered are:

- Lack of awareness of how much energy is used and for what purpose,
- Ignorance of the potential magnitude of energy that could

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be saved,

- Lack of management interest in efficiency versus increased costs related to production expansion,
- Lack of expertise in how to retrofit equipment,
- Lack of engineering staff time for energy use evaluation,
- Lack of domestic sources of equipment,
- Lack of capital and/or the cost of capital, and
- Lack of belief that large benefits will really occur,
- Major problem is getting equipment to operate given lack of spare parts and unreliable electricity.

Another observation is that industrial firms are extremely sensible in economic terms, and that real constraints in skills, manpower, capital and equipment, mean they are doing the best they can under the circumstances.

In the traditional rural sector, the charcoal producer operates in a rational manner as well. He produces a saleable commodity with very low capital inputs, uses free or low cost wood and moves to the site of the wood to minimize the burden of wood transport. Unfortunately, as we know, given the severe deforestation occuring throughout Africa, the social opportunity cost of such wasteful use of wood (not sustained by replanting) far exceeds the minimal cost borne by the charcoal producer.

Similarly the rural household uses an "energy inefficient" three-stone fire with locally available fuelwood for heating and lighting, cooking food, killing or driving off insects and preserving and water-proofing thatch roofs. To the household this is a remarkably efficient technology. The urban charcoal user as well purchases the only practical and available high-cost charcoal. Nor is this unreasonable in light of his income, the available alternatives, his skills and information, and the costs of energy equipment and other cooking options available.

The key to successful conservation efforts is often in resolving certain significant constraints and providing alternatives -- and then permitting the firm or individual to pursue his own best interests.

III. Program Development

A. Priority Setting and Implementation

Unfortunately, there is no single measure of global solution for Government to pursue in energy conservation nor energy supply development. It is essential that Government develop a program (as opposed to an incoherent set of projects) providing the private sector with information, national prices, and access to equipment.

Given the scarcity of skilled manpower and financial and physical capital, it is also necessary to rank which energy conservation areas deserve greatest attention. The following

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crude priority listing for Kenya typifies the relative ranking of areas from high to low energy reduction potential.

- Domestic cooking technology and practice
- Wood to charcoal conversion
- Transportation system changes
- Industrial energy conservation and cogeneration
- Commercial energy conservation
- Electrical system improvements
- Solar water heating substitution.

B. The Time Dimension in Conservation Planning

Another prerequisite in conservation program development is recognition of the critical factor of timing. One of the most appealing qualities of conservation as an energy policy is that it permits almost immediate returns to our investments. However, each of the elements of a conservation program will actually produce an effect only after differing periods of time. Therefore, phasing of activities and relative priorities must recognize just when benefits can be expected. The table below illustrates this point, and highlights the fact that some large pay-off options such as introducing new industrial processes, agroforestry, and changing transport patterns will not produce major benefits for some 5 to 10 years in the future.

Therefore, while these may be essential, they are by no means sufficient to meet today's needs. In fact only by developing a balanced program of short, medium, and long-term activities will the best opportunities appropriate now, next year and thereafter be realized.

C. Recognizing the Importance of Growth

It must be recognized as well that the forces driving energy demand can overwhelm a weak or ill-conceived energy program. The power of exponential growth in the factors below is easy to underestimate:

- Population growth
- Urbanization and movement to commercial fuels
- Income growth
- Modern sector development requirements
- Transport, particularly government
- Public transit and government fleet use
- International air transport

Conservation plays a major role in coping with this growth by providing a means of lowering not only current levels of demand but more importantly the rate of growth in energy required for each increment of income, population, etc.

IV Conservation Options Deserving Priority Attention

Conservation actions and measures deserve much greater emphasis in aid programming, and Government energy policy considerations. It should be stressed that none alone is sufficient, rather these and other opportunities need to be developed into a coherent multi-year program.

A. Domestic Fuel Production and Use

1. Urban and rural stove redesign, field testing, manufacture and marketing.

2. Fuelwood supply - increase supplies through agroforestry programs on individual farms and afforestation for other areas and urban/commercial use.

3. Charcoal production - improve conversion technology and reorganize production and replanting, and introduce charges for wood supply where possible.

4. Produce usable fuels from waste materials e.g. as charcoal from agricultural waste, coffee husks, sawdust, etc.

B. Industrial Energy Use

1. Inform industry of economic benefits and type and extent of energy saving improvements possible.

2. Assist in energy audit of all energy inputs, efficiency of conversion and use, waste heat utilization potential ans opportunities for maintenance, redesign, and fuel switching.

3. Train engineers and technicians in conservation analysis and maintenance, retrofit, and redesign.

4. Provide incentives to invest in conservation opportunities and ensure equipment is available whether imported or produced locally.

5. Evaluate new industry and economic development plans in terms of future energy requirements.

C. Commercial Energy Use

1. Provide information and education on benefits and opportunities for conservation.

2. Assist in energy audits and training to:
   - Measure energy inputs and uses
   - Recognize and evaluate conservation opportunities in:

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- water heating for domestic and other uses
- ventilation and space heating
- lighting
- and fuel substitution, e.g. solar water heating.

3. Regulate and/or provide information and incentives to achieve energy efficient building materials, design and operation.

D. Transport System 1/

Support assessment and program implementation in areas such as:

- Vehicle Operation Improvements

  - Speed reduction
  - Reduction of number of trips
  - Improve traffic flow-reduce standing time

- Vehicle Maintenance and Equipment

  - Regular tune-ups
  - Make spare parts available
  - Use speed limitators on trucks and air deflectors

- Practice

  - Restrict/tax downtown parking
  - Encourage car pooling
  - Stagger working hours/reduce congestion
  - Discourage trips home for lunch

- Public Transport

  - Provide bus and/or private minibuses service on heavily used routes
  - Provide routes and parking for bicycles
  - Introduce fleet conservation programs, including careful fuel use monitoring and conservation goals for public fleet operators.

- Fuel switching - dieselization and domestic biomas fuels development

- Discourage or prohibit energy inefficient vehicles import

1/ A prerequisite is to price fuels at opportunity cost to the Country.

- Introduce transport considerations into land-use planning.

V. Implementation Mechanisms

A. Public Education

1. Aimed toward the commercial and urban fuel sector.

2. Aimed at the rural domestic fuel sector.

3. The public school system in general.

B. Incentives

1. Prices should be set on fuels to reflect economic cost, including the added cost of use of foreign exchange vs. domestic currency.

2. Financial incentives in terms of low-interest loans and special (or even normal) terms for unconventional energy sources such as conservation, tax credits and special tax deductions for producers or purchasers..

3. Duties and sales taxes can be lowered or removed on selected large capital items to facilitate their import and use. Also, selected raw materials used by manufacturers of energy using equipment such as solar collectors and wind machines, should be given import preferences and be eligible for import duty and sales tax exemption.

C. Industry-Business-Government Cooperation

1. Building design and operation should be evaluated with an emphasis on both low energy consumption operation and construction with low energy content materials.

2. An advisory group approach can be used and facilitated by Government supplied consultants to provide seminars, energy audit classes and design advice, and information on existing design manuals and experience elsewhere.

D. Electric Utility Advice and (Sometimes) Financing

1. Use the technical resources of the electric utility to provide consumer services in energy conservation. Such services could include seminars on conservation, lists of energy requirements for different appliances and equipment stressing conserving equipment, advice on ways to cut household and business energy use, and energy audits of major users.

2. Use the utility billing system to offer low-interest

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loans to retrofit energy conservation equipment. Such simple improvements as power factor correction, equipment matching to loads, can produce major benefits.

TABLE 1

Conservation Options - Time Required to Produce Major Benefits

Energy Sector	Short-term	Medium-term	Long-term
Woodfuel/Biomass OR Other Renewables	Better Jikos	Rural Stove Improvements	Energy Crops
		Charcoal Production Improvements	
	Wind/Hydram Pumping		
		Agroforestry-Afforestation	
Imported Fuels	Industrial/ Commercial Conservation: Operation and Maintenance	Industrial/ Commercial Conservation: Retrofit	Industrial/ Commercial: New Capital Equipment
	Solar Water Heating		
	Transport System Maintenance and Operational Improvement	Transport System: -Fuel Switching -Public Transport	Transport System: Land Use Patterns

SMALL DECENTRALIZED HYDROPOWER

Allen R. Inversin*

Though already a popular source of power around the world, hydropower has become increasingly attractive in the light of the rising trend in the cost of oil. Large hydroelectric schemes can make a significant contribution to a nation's available energy and reduce a dependence on imported fuel and the outflow of foreign exchange. On the negative side, however, large hydroelectric undertakings engender a dependence on foreign equipment and on foreign expertise to construct and maintain. They require a large capital outlay, both in absolute terms and in cost per kilowatt and have a long gestation period between the time of conception of the idea and operation of the scheme. And since these usually require dams, they can lead to long-term environmental problems, social dislocations, and innundation of agricultural lands.

In Africa, large hydropower plants will generally continue to provide power to the more concentrated, urban industrialized areas. They will have negligible direct impact on the majority who live in rural areas, on deforestation, and on related problems because electric power through the national grid will not be available to these areas for years. The cost of grid extension would be exorbitant, the scale of the undertaking immense, and even if implemented, the electricity could not be afforded by most.

Small decentralized hydropower plants can be closer to the rural user and promise the potential for avoiding virtually all these negative attributes. It has the added advantage that if and when the grid is extended to the rural areas, the population will then more likely have advanced economically and be able to use and pay for the power.

But because the capacity of small hydropower plants is small, installing a couple plants in a country would probably be an ineffective use of foreign aid. Rather, to have any marked impact, a well thought-out framework, within the public or private sector, for the implementation of small hydropower schemes in an area, or country-wide scale, must first be developed and instituted. Installing several "demonstration" schemes in a real setting within that framework would then follow. At the same time, maximizing local manufacture would be essential both to maintain reasonable costs and ensure continuing viability of such a project. And finally it must be kept in mind that, as is generally the cast with development programs, it would be an illusion to expect that an effective and viable program can evolve and an impact made without at least a several year commitment to the program on the part of a technically qualified individual or team.

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Of course, prior to the formulation of any framework for implementation, it would be necessary to undertake a country-wide assessment of small hydropower potential to determine its extent, both in terms of where it is found geographically as well as in terms of the size of units which could best be accomodated. It would also be necessary to assess end-use potential for both direct use of mechanical power as well as use of electrical power. Only by actively incorporating economic end-use of can viable schemes be implemented. Experiences worldwide have well illustrated the fact that provision of electricity to rural areas contributes to lighting but does not of itself give rise to much economic activity, if any. Such activity is essential if fully subsidized projects are to avoided, subsidies which no funding agency or government department can afford.

Small decentralized hydropower schemes might be undertaken by the public sector at the national level but experience indicates that such projects are expensive and generally poorly planned in the broad sense. Other approaches are fortunately possible.

In the early 1970's in Pakistan where the Ministry of Water and Power installed about 10 small hydroplants at a cost of $5,000 to $6,000/kW, the Appropriate Technology Development Organization, a small unit under the Ministry of Science and Technology, initiated a program whereby villagers initiate, implement, manage, operate, and maintain their own schemes in the mountainous areas where no grid extension is envisioned in the foreseeable future. Since the mid-1970's, nearly two dozen sites have become operational, at a cost of $350-$500/kW, and several dozen more are being implemented.

In Nepal, where the government's Small Hydro Development Board has been involved for some time in approximately 20 hydropower schemes, virtually none are yet in operation. On the other hand, two local companies have installed more than 100 locally fabricated turbines and associated equipment, mostly in mills in remote areas, with no subsidy. Implementation is continuing at an increasing pace and several other small workshops are also beginning to fabricate similar equipment.

Both of these successful ventures in Pakistan and Nepal rely on community involvement, locally fabricated turbines and related hardware, and use of appropriate materials and design in the civil works. While the Pakistani projects required no technical expertise or financial assistance from outside the country, the two Nepali companies were initiated and technically and financially supported by overseas organizations. However, in Pakistan, the financial contribution of the national government is being phased out and in Nepal, Nepalis are taking over all aspects of the work from field assessment, turbine manufacture, and plant installation. A Case Study: Microhydro Schemes in Pakistan is available from NRECA and A Case Study: Microhydro Schemes in Nepal should shortly be available.

In both cases, because of the framework under which the hydropower schemes were implemented, the schemes are replicable on a wide scale and growing demand is proving that the idea is contagious. These are two

attributes which are essential if any foreign assistance is to be effectively utilized.

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SOLAR

C.F. Kooi*

I. Introduction

"Solar" is usually taken to mean direct conversion of solar energy to perform useful functions without the intervention of natural, physical or biological processes. That will be the meaning used here. Wind, hydropower, oceanthermal, biogas, etc., all of solar origin, will be excluded from the "solar" designation.

There are two principal ways to use solar energy: (1) by conversion to heat, for example, water heating, space heating, drying of agricultural products, etc., and (2) by conversion to electrical or mechanical energy. In order to determine the feasibility of either of these conversion paths one must know the characteristics of the source of the energy - the solar power inpinging on a unit area (insolation) at the location in question. Thus, this presentation falls naturally into three parts: (1) Insolation, (2) Conversion to Heat, (3) Conversion to Electrical or Mechanical Energy.

II. Insolation

The regions of Africa of primary interest are the drier, sunnier regions such as the Sahel. The more humid regions have less sunshine, and therefore lower potential for direct use of solar energy, and more potential for utilization of other forms of solar energy such as biomass, hydropower and, as a matter of fact, fossil solar enrgy. What are the characteristics of insolation in the Sahel?

Firstly, there are very good measurements extant. Weather stations usually measure only sunshine duration and the method (Campbell-Stokes Device) is far from precise. The AGRYMET (Agricultural Meteorological Network), based in Niamey, has started making insolation measurements on an extensive Sahelian network but its results are still too new, few, and somtimes unreliable to be of much use. Of the measurements made at two national solar energy laboratories in the Sahel, Senegal and Mali, only the data from Senegal (and only at Dakar) is extensive and reliable 1/. Thus the insolation picture in the Sahel must be pieced together from very little good data plus assorted scattered data whose type and reliability leave much to be desired.

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1/ This author has heard that good data exist at ONERSOL in Niamey but has not yet seen the data.

The picture that emerges is the following:

> Insolation increases as one goes north. At 15° north latitude it is about 7 kWh/m² in March, April, and May and about 4.5 kWh/m² in December. It falls between these limits during the intervening months. There is a large diffuse component, presumably caused by water droplets in the wet season, smoke in the burning season (Nov., Dec., Jan.), and dust in the harmattan season. The diffuse component varies from about 20% in January to nearly 50% in August. The north-south variation in insolation is rather strong. Insolation decreases by about 25% between northern and south-central Senegal, a distance of 300 kilometers.

This pattern implies that solar energy production is practical in the Sahel. Attention should be paid to the rapid decrease as one moves toward the southern and southwestern coastal regions. Furthermore, concentrating systems, which do not collect the diffuse radiation, are not as attractive as they would be in a climate with a higher ratio of direct to diffuse insolation.

III. Conversion to Heat

Conversion of solar radiation to heat may be used for the following useful functions: water heating; space heating; solar cooking; desalination of water; drying of agricultural and food products; and cooling by the absorption cycle.

A. Water Heating

This is well-developed and extremely cost-effective when pitted against the electric hot water heater used in West Africa. Because of the combination of high electrical energy costs and good insolation, a solar hot water heater in Ouagadougou could pay for itself in saved electricity in a year or two.

B. Space Heating

This is likely to be impractical in most of Africa due to low utilizability, i.e., heating is rarely needed in most regions.

C. Solar Cooking

This can be done and at lower cost than by purchased wood or charcoal in many locations - particularly Sahelian cities. However, use has been almost negligible. This is thought to be due to various inconveniences and restrictions associated with their operation.

D. Desalination

Simple solar desalinators produce water that is too expensive for other than special usage such as for car batteries.

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Larger, more complex, solar desalinators are expected to produce cheaper water. An example is the multistage, flash evaporation system driven by heat from a solar pond.

E. Drying of Agricultural and Food Products

Solar drying is universally used but almost always done in the open where losses and product deterioration from various causes occur. It is thought that closed solar drying devices would prevent such losses and deterioration by protection from insects, rain, and dirt. However, they are rarely used probably because the advantages are too small compared to the disadvantages such as cost, low output, and extra labor requirements.

F. Cooling by Solar Heat-driven Absorption Cycle

This is presently too expensive where electrical energy or inexpensive fuels are available. In some locations in Africa it may be cost-competitive because of full usage and high cost of electricity and fuel.

IV. Conversion to Electrical or Mechanical Energy

There are two major routes availabe. One can convert solar radiation directly by means of the photovoltaic effect 2/ or by solar
production of heat which drives a thermal engine. The photovoltaic converter is highly developed but still costly. Various thermal engines are also highly developed but combinations of thermal engines and solar heat collectors are not yet at an acceptable stage of development.

The common types of solar heat-driven systems can be classified according to the nature of their heat collection device. These are the flat plate collector, the solar pond, and concentrators of various types. The first two are low efficiency devices resulting in systems efficiencies of about 1%. The third can operate at higher temperatures and reach system efficiencies above 10%, perhaps 25% ultimately.

Photovoltaics may be placed directly in the path of the solar radiation (called flat plate type) or may employ a concentrator. The advantage of the concentrator is that expensive solar cells can be replaced by less expensive concentrator surface. If solar cell costs decrease to the neighborhood of concentrator costs (per unit area) the concentrators will be out of business.

2/ There are also photochemical effects but not yet developed to a practical state.

When considering a solar mechanical or electrical energy producer for uses such as village electrification, grain grinding, or water pumping, a large number of factors must be considered. Such factors are: the cost of the energy produced, maintainability, ease of operation, life of system, reliability, supply of spare parts, etc.

V. Prospects

In Sahelian cities, or other sunny urban centers of Africa where electric rates and fuel costs are high, colar hot water heaters are more than competitive.

In rural Sahelian regions solar mechanical or electrical energy for village electrification, water pumping, grain grinding, etc., promises to become less expensive in the near future than diesel and human energy production (presently used).

Photovoltaics appears to be the best prospect for smaller systems, while solar pond and concentrator systems may be attractive for larger systems.

High capital requirements, lack of an infrastructure for spare parts and maintenance, and lack of semi-skilled and skilled operators are major problems.

IMPROVED WOODSTOVES IN THE SAHEL: A CRITICAL ASSESSMENT

Timothy S. Wood*

I. Introduction

The age of the improved woodstove has arrived in West Africa. In the Sahel, where four years ago the expression, "foyer ameliore" was virtually unknown, over 6,000 such stoves have now been built, most within the past 18 months. These have attracted the interest of governments, private organizations, and financial institutions. In Ouagadougou, the Permanent Interstate Committee for Drought Control (CILSS) has established a regional Sahel team to assist far-flung stove-building programs. Governments in five Sahelian countries have received funds for establishing special woodstove coordinating committees. Throughout the area, nearly every woodstove program is planning to expand.

The reasons for this sudden interest in woodstoves are not hard to find. A series of shocks in the world oil market during the 1970's made energy a public issue, especially in the industrialized countries. A timely paper by Eckholm (1975) on fuelwood scarcity in the Third World also had a profound impact. And with the appearance of simple clay stoves in Asia and Central America, it was apparent to development agencies that here was a project that was inexpensive, simple, answering a critical need, and giving rapid results. Most of the initial impetus for woodstove projects in the Sahel came from European and American volunteers and technicians with financial backing from their governments. African elements are now becoming increasingly involved.

II. Project Shortcomings

Given the nature of the fuelwood scarcity, woodstoves can certainly not be considered a passing fad. But despite their apparent success, woodstove projects in the Sahel face a number of problems which must be seriously addressed if the current momentum is to be sustained.

Problem 1. The selection of stove models is limited. One might expect that in this pioneering phase of woodstove development it would be prudent to experiment with as many different stove models as possible. De Lepeleire et. al., (1981) has described and illustrated over 90 varieties of wood-burning stoves suitable for the Third World. But in the Sahel, only half a dozen different stove models are currently being promoted. These models were not selected from among many promising candidates. Rather, their

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adoption has come about mostly by historical accident or on the advice of a single short-term consultant.

Problem 2. Materials and construction techniques are seldom questioned. Not only have many stove designs been accepted uncritically, but in most cases they are seldom re-evaluated. An example: In 1979 in Kaya, Upper Volta, a Peace Corps volunteer worked on the problem of mass-producing efficient woodstoves. Originally, his cement stove top was pre-cast as a separate unit and thus required an internal reinforcing of steel rebar. Today, Kaya stoves are being actively promoted in Mali, Niger, and Upper Volta. The stove top is now cast in place, so rebar is not needed. However, the expensive reinforcing is still used. Few people have apparently thought to question the use of rebar - "It's just the way we were shown to do it".

Most stoves are made of cement or banco (sand-clay) or a combination of the two. However, both of these materials lose their strength when exposed to combustion temperatures. Cement will crack and cannot be easily repaired. Sand-clay stoves do not survive exposure to heavy Sahelian rains. In some projects, the sand-clay mix is altered by the addition of fresh manure, wood ashes, brick dust or small quantities of cement. But comparative tests are seldom made, and the relative properties of these mixtures remain essentially unknown.

Problem 3. We still do not know how much wood is saved by using "improved woodstoves." In most cases it is assumed that the stoves use about 50% less wood than the traditional open fire. However, Prasad (1981) shows that wood savings depends largely on the nature of the wood, the condition of the stove, and the way in which the stove is used. One often hears about the total number of stoves built by this or that project. It would be more useful to know how much wood is actually being saved as a result of these stoves. Surprisingly, most project managers do not know, and many do not seem very interested.

Both in Senegal and Upper Volta, wood consumption has been measured in families before and after they have received their new stoves. The results showed a fuel savings of up to 60% with the stoves (Madon, 1981; Wood, 1981). These studies are only preliminary. What is needed now is for similar surveys to be made six months or a year after the stoves have been installed. Are the stoves still being properly used? Are they in good condition? Have any repairs been made? Is the wood savings still as good as originally?*

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* There is a certain bias in surveys conducted when the stoves are new and still in excellent condition. Using the stove is still a novelty, the user gets daily attention and is motivated to conserve wood. In Upper Volta, two weeks of daily measurements of wood consumption in households without stoves was alone sufficient to reduce consumption by 25% (Wood, 1981).

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III. A Needed Shift in Emphasis

One of the most serious problems facing the people of the Sahel is the rapid rate of deforestation, with all of its devastating ecological consequences. The widespread use of efficient woodburning stoves to replace the traditional open fire can significantly alter this trend by reducing the per capita consumption of firewood. However, if this is the objective of most woodstove projects in the Sahel, it will not be easily achieved within the current scope of activity.

The criterion by which most stove projects measure their success is the number of stoves built. Often these are criteria imposed by financial backers. It is unfortunate, because at this stage, the building of imperfect stoves alone will have little effect on the rate of deforestation. There are three additional aspects of stove development which, I believe, should have a higher immediate priority:

A. Research and Development

Inexpensive, efficient stovebuilding is an infant technology. It would be a mistake to delay dissemination until the appearance of truly "perfected" stoves. But it seems equally unwise for any stove program to ignore models. Research and development should focus on:

- lowering the cost of materials and labor;
- improving materials to increase durability or facilitate repair;
- increasing stove efficiency;
- making the stove easier to use and maintain.

B. Field Testing

Until a stove has been properly evaluated under actual cooking conditions it is not suitable for wide dissemination. This seemingly obvious axiom is often ignored. Among the 92 stoves described and illustrated by De Lepeleire, et al. (1981), only six are known to have been field tested. When women critically evaluate their own stoves, their ideas become the basis for changes in subsequent models. It is not unusual for stoves to perform flawlessly in controlled testing only to be rejected outright by women who try to cook on them. Perhaps the pots are not held securely, or the food tends to burn, or the fire requires too much attention. Long-term follow-up may reveal weak points in construction or special problems in use and maintenance. This information is essential for the improvement of stove models.

C. Proper Training of Stove Builders

It is relatively easy to build a stove that looks like a stove, but to build one that is both effective and serviceable

is a bit more difficult. In the widely built two-pot, high-mass stove, common building mistakes include:

- Fireboxes that are too large - they should be no wider than the pot;
- Pots that are too close or too far from the fire - the correct distance is one-half the diameter of the fuel bed;
- Insufficient pot surface exposed to the firebox due to potholes being too small or stovetops too thick;
- Potholes that are too far apart and flues that are too long;
- Fuel and air entries that are too large or too small, or incorrectly placed or shaped;
- An interior conformation that inhibits effective heat exchange with the pots;
- Chimneys that create too much or too little draft;
- Poorly prepared mixtures of sand and clay, or improper curing of cement;
- Lack of appropriate reinforcing.

These are all simple errors that can reduce substantially the effectiveness of a stove. With proper training of stove builders, such mistakes can be avoided.

IV. Conclusion

The effort to reduce the rate of deforestation in the Sahel may be compared to making a large bonfire. Building a lot of stoves is like using kindling for the fire: it is a necessary first step which quickly attracts attention and makes a small, local impact using little effort and few resources. But kindling alone does not build a long-lasting fire; neither can pioneering stove projects have a long-term impact if building stoves is all they achieve.

In the Sahel, most stove projects are still at the "kindling" stage. It is now time to "apply logs to the bonfire" with an intensive program of research, evaluation, and training. When these areas are emphasized, the widespread dissemination of stoves will follow naturally, and an effective long-term woodstove effort will be more easily sustained.

If this shameless analogy is crude, at least may it be apt.

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CHARCOAL STOVES, CHARCOAL CONVERSION AND BIOMASS

Keith Openshaw*

I. Charcoal Stoves

In most developing countries domestic use of fuelwood accounts for about 85% of total wood energy use and cooking is the most important activity taking between 2/3 and 3/4 of this consumption. Therefore saving of energy in this activity can have a considerable impact on total energy requirements. Charcoal is principally an urban fuel and although the urban population using this fuel is generally not more than 10 to 15% of total population, because of the inefficient manufacturing process, charcoal could account for up to 30% of the wood energy. Therefore the design and manufacture of more efficient charcoal stoves should have a significant impact on wood consumption.

In most African countries charcoal stoves are made of metal which is a suitable material for space heating but a very poor material for cooking stoves as it radiates too much heat. Burnt clay in mixture with other materials such as rice husk ash, - which gives the mixture both lightness and strength, is ideal for it is a refractory material. Tests have been carried out both in the laboratory and in the field which show that a three-layered clay stove - that is a burnt clay inner layer a cushioning middle ash layer and a protective outer tin shiely - can save up to 50% of charcoal when compared to a traditional metal stove. Further improvements in efficiency can be made by sinking the pot or pan inside the stove thus heating the sides as well as the base. Traditional stoves cost about $4, whereas improved clay stoves should sell for approximately $6. In Kenya charcoal costs US$4 per 40kg bag and a family of 6-7 uses about one bag per week, therefore the additional cost of improved stove can be paid for out of charcoal savings within two weeks. Other related ways of saving energy include using a lid on the pot/pan, soaking food such as maize and beans overnight using an insulated hay box to 'cook' the meal once the pan has been brought to the boil, and most importantly using wood in place of charcoal, but in order to make wood an economic fuel it must be grown in proximity to the user such as in urban forests.

II. Charcoal Conversion

This discussion is limited to conversion into charcoal and densified wood; methanol production is mentioned briefly in the next section and 'oil' production has been omitted as it is still in the pre-production phase. Charcoal can be made by a number of processess in kilns made of earth, portable steel, brick, and steel

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* Beijer Institute, Nairobi

retorts. The earth kiln is the least inefficient and the steel retort the most efficient method. See Table I.

TABLE I

Kiln Type	Tons of Airdry Wood (15% moist.) to Produce 1 ton Charcoal	Relative Cost
Earth	10	1
Portable Steel	7	20
Brick	5-6	140
Retort	4½-5	1000

Even though the earth kiln is the most inefficient conversion method in many parts of Africa it is the most appropriate method for many 'charcoal' trees are scattered and remote from consumption centers and transport networks. Therefore the producer has to move to the fuelstock and not the reverse. Only if wood in sufficient quantities is in close proximity to the production and if the feedstock is remote from the kiln the total production costs are usually more than in an earth kiln. Therefore total manufacturing costs have to be considered when selecting kiln type, not just efficiency and actual kiln production costs. In developing countries production of charcoal in a retort is not economic unless there are markets for the by-products - acetone, acetic acid, gases, tars, etc.

Production methods can be improved by better earth kiln management controlling air intake and the earth seal, and for all kilns making sure the wood is air dry.

Densified wood is made by compressing wood after it has been dried down to about 15% moisture content. The wood is dried using a woodfired boiler, compressed and then sliced into small sizes. By reducing bulk, transport containers are able to carry their full weight and by slicing the wood into easily handled units the industrial and household amrket becomes readily accessible. However, like industrial charcoal production the wood resource must be available in sufficient quantities within a small radius of the manufacturing plant. Also, because the calorific value of densified wood is the same as that of wood (at the same moisture content), the economical transport distance to the market is less than that of charcoal. It should be noted that any vegetable material, e.g. pineapple residue, may be densified. Where possible, densified wood (and fuelwood) should be encouraged in preference to charcoal.

III. Biomass

Biomass includes a whole range of products but this discussion is confined to biogas, methanol, ethanol, producer gas and acetylene. For all of these products, the cost aspect must be considered, not only the actual production cost, but the production cost of the alternative fuels. However, technical aspects are central to many

production processes. For biogas production there must be an adequate, easily accessible and all year round supply of animal (and crop) residues and water. Biogas production has been most successful in areas where a main task was destroying pathogens in human and animal excrement. If Indian costs are used as a standard for biogas production, alternative energy costs, particularly fuelwood production, are cheaper in many areas. That is not to say that biogas production does not have a place in Africa but at best it will only marginally affect supply for at least two decades. Ethanol production from sugar is a reality in at least two African countries. This is a substitute fuel mainly for the light fuels, namely gasoline (petrol). Before deciding whether land should be set aside for sugar-ethanol production the demand/supply situation for petroleum products should be examined. If there is a shortage of heavy fuels such as diesel and/or an excess of gasoline, then ethanol production should not be encouraged since the production costs is likely to be at least as expensive as gasoline production.

If the production of alcohols are not only feasible but there is a demand for the product, then studies should be undertaken to see if methanol or ethanol is the most economical fuel. It is assumed that the new material for each fuel would be equally available. Producer gas (and water gas) techniques are well known and units are already in production. Such units may open up remote areas such as remote forest areas where vehicles may go and collect fuelwood/densified wood/charcoal and fill up with the wood energy to drive the unit. Again the cost of such units, especially the saving of foreign exchange, should be appraised.

Finally, acetylene paraffin (kerosene) substitute is considered although it is not, strictly speaking, a biomass fuel. Acetylene gas is produced by the action of water on calcium carbide. It was a major source of light in prewar Europe and America. Calcium carbide can be made by passing electricity through a mixture of carbon (charcoal) and lime. If countries have an excess of cheap 'night' electricity, then calcium carbide production may be economical. Kerosene is the principal lighting fuel but is in short supply in many developing countries and in some countries it is diverted to the aviation gas market where it earns foreign exchange. Acetylene may be an economic fuel substitute for kerosene and studies should be undertaken into the practicality of manufacture, the production of the burners and the economic feasibility of such production.

SECTION VI

RENEWABLE ENERGY CENTER PROJECT MANAGEMENT

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LESOTHO: RENEWABLE ENERGY TECHNOLOGY PROJECT (632-0206)

Jay Stryker *

I. Background

The Lesotho Renewable Energy Technology (RET) Project Paper was written in July/August, 1979. The Project went to bid in 1980, and after several delays was awarded in February, 1981 to Associates in Rural Development, Inc. The 3-year project commenced in March with the arrival of the team leader. The project team is comprised of a team leader, field supervisor, laboratory supervisor and four volunteers. The purpose of the project is to develop and disseminate feasible technologies in the renewable energy areas on a pilot basis in Lesotho. The project will also develop the institutional basis for the development and dissemination of these RETs nationwide, if proven in the pilot areas. The project will try to minimize the growing demand for combustible fuels by the introduction of village conservation measures such as fuel efficient wood and dung-burning stoves, thatch insulation and weatherization, pedal powered grain grinding and passive solar greenhouses and growholes. In addition, two technologies have been selected for research and development and possible implementation: feedlots or large scale anerobic digestors for the production of methane gas and fertilizers from the sludge; and small scale hydroelectric installations. Solar cooking and solar water heating are also to be considered.

The social component of the project is as large as the technical. The project is to establish a process of identification and implementation of technologies at the village level by the creation of village energy technicians (VETs). These VETs will be selected by their fellow villagers to receive training under the auspices of the project, and to return to their villages to provide installation and maintenance services of REIs. This requires the RET Project to create a teaching capability within the Ministry of Cooperatives and Rural Development (MINRUDEV) and its Appropriate Technology Unit (ATU). It is anticipated that the MINRUDEV counterpart staff will, within the life of the project, be able to assume and continue all project-related activities.

Along with the development of the village organizations (such as village energy committees and village demonstration programs), there is the training of both VETs and the MINRUDEV staff. Training is to be conducted at four levels:

- the project staff and volunteers are trained in process documentation and the actual construction of RET equipment and its evaluation under field conditions,

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* Associates in Rural Development, Inc.; Team Leader, Lesotho Renewable Energy Technology Project.

- training of the Ministry staff in RET equipment and its evaluation under both laboratory and field conditions,

- both technical and social process training of VETs along with a possible option of small business or entrepreneurial skills, and

- RET and ATU staff development for the logistic support of VETs in their villages.

Training packages will be developed for each level and possibly shared with similar projects worldwide.

The certification of VETs will include a proviso that she/he build and operate (or maintain) a certain number of RET devices within one year. This certification will lend credence and respect to the VETs. The services of the VETs to villagers will be at a set fee. The VETs are to maintain information links with the national ATU laboratory to report local innovations (or problems) which require attention at the laboratory.

A research and development laboratory (RDL) in the capital city of Maseru is a major project output. This laboratory will have at least three full-time professional or para-professional members. The mandate of this laboratory is to 1) build and test prototype RET units and to modify designs (when feasible) to optimize performance; 2) to act as a technical liaison with all other energy-related matters within the government and private sectors; 3) to act as a technology transfer agent within the areas of energy and RET systems; 4) to evaluate the overall performance of RET systems with an emphasis on village installations; 5) to participate in the technical design and the construction of biogas systems and micro-hydroelectric installations; and 6) to actively participate in the design and modification of training materials for the ATU staff and the VETs.

Since many persons will not have the opportunity to become VETs, the project will produce a set of "how-to-do-it" fliers, pamphlets and booklets in cooperation with various non-formal educational organizations. A curriculum and training program will be developed jointly in Sesotho and English, and will be modified or updated as indicated by both field and laboratory findings.

Various media will be used in promotion and training. Brochures, posters, photo-story books, slide shows and motion pictures will be used along with simpler or more traditional methods such as story telling, pantomime, puppets, or diorama displays.

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II. Project Funding

USAID Project Inputs:	Technical Assistance	$554,000
	Commodities	583,000
	Training Costs	101,000
	Construction	64,000
	Support Costs	65,000
	Other Costs	233,000
	Sub-Total	$ 1,600,000
Government of Lesotho Contribution (including eight permanent staff within ATU and office, laboratory, and warehouse space)	Support Costs	77,000
U.S. Peace Corps:	Technical Assistance	$168,000
	TOTAL	$ 1,845,000

III. Implementation

Implementation of the project is through the combined efforts of USAID/Lesotho, the prime contractor (Associates in Rural Development, Inc.), the Government of Lesotho, and the U.S. Peace Corps (and other participating agencies such as the Danish Volunteer Service). The project is to be jointly administered by the contractor's team leader and the ATU Chief (under recruitment) in the Ministry of Cooperatives and Rural Development. A Project Advisory Committee, drawn from the host ministry and other ministries, plus a USAID representative, lends a balance which provides a national viewpoint on RET issues. Also, there is a process evaluation group which is comprised of a cross-section of persons impacted by the Project, including MINRUDEV personnel who deal with villages, the VETs, and villagers. The process evaluation group is the means by which the village needs are identified and quantified, and technologies to met those needs are selected. This group also liaises with individuals and institutions in the villages who receive RETs and provides feedback information ot the research and development laboratory. The project team's field supervisor, who is a social scientist, works closely with this group in survey development and analysis of data. Both qualitative and quantitative information is compiled and merged with Lesotho national and regional data banks.

The training is jointly conducted by the RET-ATU staff and the Ministry of Education's specialized services, such as the Lesotho Distance Teaching Center. The Ministry of Agriculture is also participating via its Farmer Training Centers and the Food and Nutrition Unit. The Basotho Enterprises Development Corporation (BEDCO) will participate in the development of commercially viable kits or RET system subassemblies for construction in the village. RET Project is also to work with the Ministry of Works to replace diesel-electric or photovoltaic, and to assist in the design of energy-efficient buildings.

Each VET will be provided with a set of tools upon acceptance into the training program. The types of tools will vary according to the technologies VETs are trained for ranging from earth works and masonry (for mud stoves, mud wall solar dryers and hydroelectric impoundment dams) to plumbing and electrical tools (for solar water heaters and hydroelectric installations). The VETs may receive more than one training session if their abilities and the sales of RET systems warrant it.

The research and development laboratory will examine the existing energy using devices such as stoves, water heaters, space heaters, electrical generating systems and water pumping systems to determine if any of the REIs can make a favorable impact. Such an impact must be determined in light of social acceptability as well as economic analysis and availability of materials and skilled personnel. The laboratory will build up a skills reservoir in the ATU staff, such that when the project is terminated these persons will carry on the work and perhaps develop better RET systems for Lesotho.

Evaluation, both internal and external, is central to the administration of the project by providing rapid and timely feedback to help guide decisions. Frequent internal reviews and evaluations underscore emerging problems.

The project formally started in February 1981. By April the contractor's professional staff were in Lesotho and initial office and laboratory space was obtained. Much time was spent on obtaining support services and equipment, including vehicles, additional office space, and work sites. One problem which emerged early was that two of the Peace Corps Volunteers assigned to the project had to await project start-up and spent time in other energy-related areas. While they actively participated in the initial stages of setting up the project, this was far from their expectations of rather routine and structured jobs working with RET systems and teaching VETs.

The eight host country counterpart staff positions have been found difficult to fill because of a scarcity of qualified personnel and a current freeze on filling vacant positions. There is presently one counterpart staff member who is assigned to the project and works closely with the REI Project staff and has constructed several devices and pieces of shop equipment.

The initial laboratory space provided is inadequate. The problem with the space for the laboratory and for a regional center remains unresolved, in part due to government administrative problems and interministerial disagreements on implementation methods. The project has moved along by utilizing an alternate regional worksite and by finding other laboratory space on a short-term basis.

Cooperation with the established Ministry of Agriculture Home Economics Unit resulted in numerous opportunities for demonstration and evaluation of RET equipment. That program, for example,

already was teaching village women about mud stoves and solar dryers. A most mutually beneficial collaboration has developed in these areas. RET staff members have been invited to professional meetings to present the ideas of renewable energy technolgies. These have resulted in many requests for information and participation in other ministries' ongoing programs as consultants. For example, new designs of solar houses, manufacturing of energy-conserving equipment, and fuelwood conservation are potential consequences of these interactions.

Close study of prevailing opinions and cooking practices provided several surprises. For example, numerous solar water heaters have been installed in Lesotho but there were few enthusiastic owners or potential buyers. It was found that most of the heaters had been improperly installed or fell into disrepair by poor or no maintenance. This resulted in opinions that "Solar heaters don't work, I know somone who has one". The RET Project may develop a short course in solar water heater maintenance and repair to correct this situation. Part of a survey of water heaters showed that units which were properly installed and maintained had highly satisfied owners. Some of these units have been in service for over a decade.

The RET Project has spent a great deal of time examining the social acceptability of many of the RET systems. For example, it is well known that solar cooking is not easily introduced in a country where much cooking is done in the early morning or at dusk. Moreover, in Lesotho it was found that some of the more efficient portable stoves (which can bring water to a boil with less fuel than the traditional cooking which involves hours of simmering. Also, these particular improved designs often do not allow the glowing coals to radiate out from the stove. The traditional design is used both for space heating and to provide limited light for conversations around the fire. This is not to say that the new designs have no potential. The project has found some acceptance for them, but changes in lifestyle and even recipes may follow in their wake. Therefore, promotion of a new technology requires comprehensive social analysis which is being undertaken by the project. The renewable energy technologies, or conservation strategies, are often totally new ideas to most people. As firewood is depleted near a village, the people accept without reservation that someone (typically the women) will have to walk farther to obtain wood. The concept that a stove could use less wood, or a different technology could be substituted, is often lacking. There is no consumer advertising, as such, for the alternative technologies. The RET Project is investigating this issue.

The project is also reviewing the energy needs in the urban and commercial sectors. Hotels, manufacturing concerns, and institutions such as schools and hospitals require large energy inputs. Part of that energy especially for hot water and food cooking, can be supplied by renewable energy technologies. The implementation of RETs in the institutional sector can serve to

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help develop a local skills base while proving the larger-scale feasibility on a daily basis. Students who wash with solar heated water, or eat food cooked by solar or biogas, or who occupy solar heated rooms, are given a most practical object lesson.

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KENYA: RENEWABLE ENERGY DEVELOPMENT PROJECT (615-0205)

Joe Pastic

I. Need for an Energy Development Program:

Kenya faces three particularly serious energy-related problems.

A. Oil imports

The projected growth in Kenya's annual oil import will lead to ever-increasing balance of payments deficits unless corrective action is taken. Although consumption has been about level the past few years, costs continue to rise. The strain on the balance of payments due to oil costs are likely to be accompanied by weak development, country demand for Kenya's primary exports, increased costs of imports of manufactured and intermediate goods, and high costs of international borrowing -- themselves attributable in part to higher oil prices.

B. Wood Supply-Demand Imbalance

Current wood consumption for firewood or conversion to charcoal appears to exceed the rate of replenishment of Kenya's forest resources by about fifteen to one. The situation is likely to worsen very quickly as wood fuel consumption increases and pressure to convert forests to agricultural land intensities.

C. Impacts on the Poor

The rural and urban poor face particularly serious problems. Increases in cost of wood and charcoal, and time required for collection, will be borne primarily by the poor. Reduced economic growth, and reduced availabilty of government services, will affect all poor people. Problems of soil erosion and river siltation will affect the poor by hastening deterioration of their lands, by making potable water more difficult to obtain and by making it more difficult to produce basic foods.

The Government of Kenya has recognized the seriousness of the energy situation. The National Council of Science and Technology began formulating a workable approach to the problems ca. 1974. In 1978 the Council sponsored a conference on Kenya policy alternatives to the energy crisis, and in May 1979 the Council, with the assistance of the Swedish Academy of Science Beijer Institute sponsored in Kenya the Conference "Energy and Environment in East Africa." Although the conference covered a wide range of renewable energy

technologies, considerable interest focussed on the problem of fuelwood and forestry depletion.

After this conference, the Government of Kenya and the Beijer Institute began negotiations to undertake a fuelwood energy cycle study for Kenya. This study was to develop an energy accounting system and a supply model, and was to be a basic planning tool for GOK. Several donors - Germany, Netherlands, Sweden, USAID - expressed interest in participating in this effort.

Concurrent with the growing interest in the energy accounting system/supply model, USAID, encouraged by AID/Washington energy policy guidance, held discussions with the National Council of Science and Technology and the newly established Ministry of Energy (established November 1979) to identify Government's immediate requirements and to explore possible USAID assistance.

Also, during this same period, several other donors were actively exploring modes of assistance in Kenya's energy sector. In order to minimize confusion and conflicts among donors, at least two joint donor meetings and several meetings between USAID and individual donors were held throughout 1980. These meetings were very useful in the planning of each donor's contribution (although not all cases of redundant efforts were re-directed.)

USAID negotiations with MOE began in late 1979, and the PID was approved in early 1980. A consultant was selected to prepare the Project Paper in June 1980. The project agreement was signed in August 1980.

II. Proposed Project Goal, Purpose, Strategy and Constraints

A. Project Goal

The project's goal is to reduce the adverse impact of fossil fuel imports on Kenya's balance of payments and to make progress in achieving a balance in wood fuel supply and demand. The project is intended to respond both to Kenyan national energy-related problems and to the specific energy needs of AID's target groups, the rural and urban poor. This will be accomplished through energy conservation, expanded afforestation and the increased use of renewable energy technologies.

The specific purpose of the project is to establish a capability in the Ministry of Energy to formulate policy and to plan, oversee implementation of, provide technical assistance on, and monitor and evaluate renewable energy programs and energy conservation measures in all sectors of the economy.

B. Program Strategy

The general strategy may be described as:

- Helping the Ministry of Energy establish the necessary energy, information and analytical base and then devise appropriate national energy policies and programs, with emphasis on measures to improve efficiency of use of petroleum fuels and measures to achieve wood supply-demand balance.

- Developing -- together with other donors -- sufficient renewable energy and energy conservation technical, analytical and extension expertise in the Ministry of Energy to enable it to support other GOK ministries and non-governmental organizations where they have related programs.

- Establishing, wherever possible as an addition to existing GOK nurseries, a network of centers in various ecological zones to serve as regional sources of seeds and seedlings, species research centers, and bases for demonstrating and disseminating afforestation, forest management, and agroforestry techniques appropriate to each ecological zone.

- Establishing an Energy Development Fund within the Ministry of Energy to support either promising demonstration/extension programs of non-governmental groups or specific demonstration projects which promote afforestation, more efficient wood/charcoal cookstoves, more efficient charcoal kilns, use of wind or water power for community water supply systems, or other appropriate renewable energy technologies focused primarily on the rural and urban poor.

- Evaluation of technologies and extension approaches supported, in order to provide a basis for expanded afforestation, agroforestry, cookstove dissemination, charcoal production and other programs in future years.

C. Constraints and Determinants

This project attempts to both economize and assist in the development of scarce Ministry of Energy personnel resources. It relies on existing resources of other Ministries where possible. It is intended to complement and relate closely to the programs of other organizations, notably the Beijer Institute Fuelwood Planning Project. Finally, it is designed to stimulate experimentation with many different demonstration

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and extension approaches, using both governmental and non-governmental organizations.

The Ministry of Energy is new, and will likely remain understaffed. It has no extension staff of its own and must rely on the other ministries with which it is in the process of establishing relationships. Considerable assistance will be needed in formulating energy policy, one of the Ministry's mandates. The Energy Planning Branch of the (then) Ministry of Power and Communications initially had seven people on its staff, five of whom were electrical distribution system engineers on transfer from the national utility company (EAPL). After reorganization in 19/9 the new Ministry of Energy (MOE) assembled a staff of 100, very few of whom were capable, either by formal training or practical experience, to undertake national policy planning.

The GOK and Beijer Institute have already begun work on the Fuelwood Cycle Study and USAID intends to complement this effort in order to quickly provide MOE with a permanent in-depth planning and analytical capability.

GOK interest in renewable energy on the part of some GOK personnel was (and still is) overshadowed by general concern with Kenya's rapidly increasing costs of oil imports and by growing urban commercial energy needs. Mission strategy in providing technical assistance is to have the team knowledgeable of, and sensitive to, overall national energy planning and energy conservation issues, besides having expertise in renewable non-conventional energy technologies. Renewable energy issues will therefore be addressed by the team within the realistic context of Kenya's overall energy situation.

Of the several renewable energy technologies, the one most likely to have the greatest impact is fuelwood/agroforestry, as has been frequently documented in technical articles and AID policy. Kenya has recognized this as a priority concern as shown by support of the Beijer Institute Fuelwood Cycle Study Project and by strong public statements by President Moi.

Within Kenya, various parties are interested in biogas, wind, solar water heating (and to a lesser extent photovoltaics), ethanol and minihydro applications. Also, there is interest in improved cookstoves and in more efficient charcoal production. Some of these technologies are being explored in the commercial sector. Most efforts are spotty and unorganized. A central problem is to select from the technologies those most likely to be adopted and disseminated. Therefore, USAID decided to avoid direct endorsement of a particular technology and to establish an Energy Development Fund (EDF). This EDF will support a broad range of government and nongovernment organizations, both for

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fuelwood/agroforestry demonstrations and also for other promising technologies.

Other Ministries have ongoing operations which relate directly to the proposed programs. These Ministries include: Environment and Natural Resources (Forest Department nurseries, gazetted forests, and Rural Afforestation Extension Officers); Agriculture (Nurseries, Agricultural Extension Officers, Home Economics Centers, Small-Scale Irrigation Program, and Farmers' Training Centers); Cultural and Social Services (Community Development Officers and Assistances, Women's Bureau, Village Polytechnics); Livestock Development (field Water Engineers). The Renewable Energy Project must complement these efforts.

D. Summary of Project Inputs

Total project inputs amount to $6,500,000 broken down as follows: (See Appendix for Project Description.)

	AID Input	GOK Input	TOTAL
Initial Planning and Surveys	780	169	949
Institutional Development	1,976	481	2,457
Applied Research and Demo.	1,944	1,025	2,969
Monitoring and Evaluation	100	25	125
TOTAL:	4,800	1,700	6,500

E. Implementation

The implementation schedule has been somewhat slower than planned primarily because of the time required to negotiate and sign the Host Country contract. Being a new ministry, MOE required considerable time to evaluate proposals. Frequent shifting of the MOE internal structure resulted in a change of host-country spokesman midway through contract negotiations. Many items had to be renegotiated. Furthermore, the GOK Treasury and Attorney General offices require considerable time for contract review, probably because the new MOE has yet to command status with these reviewing agencies.

Soon after signing the Project Agreement, USAID received notification of the AID-Peace Corps collaborative policy on forestry. Peace Corps participation in the project in the form of extension services was offered to MOE, was accepted, and will be incorporated in project implementation. MOE is presently looking for GOK funding of PCV living allowances and provision of housing.

During project negotiations the issue of inter-ministerial cooperation of the fuelwood/agroforestry centers was recognized as critical. Because of cost and personnel constraints, it was considered essential that the centers be established at existing well-run nurseries. It was found that

some nurseries are operated by the Ministry of Agriculture (MOA) while others are operated by the Ministry of Environment and Natural Resources, Forestry Department (MENR). Since there was insufficient time for MOE, MOA, and MENR to work out cooperative arrangement, a condition precedent was set which required that memorandums of understanding be prepared prior to the disbursement of funds for the centers.

The risk of inadequate cooperation was considerable at the outset, because the MOE was only newly established and the MOE and MENR were reluctant to yield up control to each other or to MOE. Part of this risk has been reduced by placing an assistant conservator of forests as MOE project coordinator. This person brought the good will and cooperation of the MENR, Forestry Department.

The initial computer analysis and training was originally to be provided by the Institute for Energy Research at SUNY/Stony Brook. However, rapid progress in the Beijer study modeling efforts together with procedural delays in acquiring SUNY AL-EDIS services rendered the AL-EDIS services redundant. The funds to provide these services are now being reprogrammed to provide enhancements to the LEAP system.

Project implementation is chronically hindered by extended and frequent periods of absence of GOK counterpart personnel who frequently leave implementation actions unaccomplished and with no one to take over in their absence. Many of the absences are caused by training/orientation opportunities made available by other donors to the few Kenyans available to take advantage of the training.

F. Lessons Learned

Donor coordination of training programs should have been closely coordinated to avoid drawing down host-country counterparts below a minimum level to insure continuity of project implementation opportunities. Coordination of donor areas of interest was successful, but failed to provide for this continuity.

We should have anticipated more realistically the time MOE would require for host-country contracting procedures, since they are a new ministry and are very understaffed. The prospects of continued delays in host-country contracting remain bleak.

Establishing an Energy Development Fund appears to provide considerable flexibility in supporting a variety of technologies. Support can be channeled to those groups showing the most outreach capability.

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APPENDIX

I. Project Description

The project includes the following components, which had been identified early in the design process through USAID discussions with the National Council of Science and Technology and the Ministry of Energy:

A. Initial Planning and Surveys

The project will continue support of the Ministry of Energy/Beijer Institute Fuelwood Planning Project by funding program enhancements to the basic system. Specifically, the current modeling effort will be enhanced by including (1) a section on foreign exchange costs of imported oil and other fuels, (2) a linking of energy usage directly to the economic sectors of Kenya, and (3) placing particular emphasis on renewable sources of energy. Also, appropriate hardware and in-country training will be provided.

The project will provide short-term assistance to establish an Energy Data Bank and Library within the Ministry of Energy.

The Government of Kenya currently lacks the information systems, or staff expertise necessary to permit detailed assessment of energy use patterns or identification and analysis of energy conservation opportunities and costs. Without such information, the computer system will be of limited benefit. Therefore, the following assistance will be provided, in addition to that described above.

- A long-term energy economist/planner with experience in energy assessment information systems and energy conservation analysis. He also will provide economic analysis support to all other aspects of this project, in particular the fuelwood/agroforestry centers and the Energy Development Fund, and will work with the Beijer project team.

- Short-term consultants as required. The specific short-term consultant needs will be defined during annual work plan preparation and review.

B. Institutional Development

1. Technical Assistance and Training Forestry/Agroforestry

Afforestation is a pressing need within Kenya. Afforestation options include expansion of production from GOK gazetted forests, expanded fuelwood/charcoal

plantations, community and individual woodlots, and integration of multipurpose trees into food production systems. Because of substantial existing World Bank support, the project will not address the problem of gazetted forests. For other types of afforestation, the project will provide the following Institutional Development support:

- A senior Forestry Extension Expert and a Senior Agroforestry Expert, with extensive African experience in nursery and woodlot development and integrated tree/crop farming. These experts will be assigned to the Ministry of Energy for the full three years of the project and will work closely with the Ministry of Natural Resources (Forest Department), Ministry of Agriculture (Soil Conservation, Agricultural Extension, and Farmers' Training Centers), the Beijer Institute Fuelwood Cycle Planning Project team, and nongovernmental organizations.

- Short-term assistance to support the above experts in curriculum development, design of and participation in workshops for government or nongovernmental organizations, and development of informational materials.

- Printing of materials for the above courses or for public education purposes.

2. Technical Assistance and Training Other Renewable Energy

The project will support two resident experts assigned to the Ministry of Energy -- one expert in wood/charcoal production, utilization of agricultural residues, and other biomass systems and one water supply and renewable energy engineer with African extension experience in wind and hydram technologies. These experts will provide technical assistance and training/curriculum development support to the Ministry of Energy and to selected other government and nongovernment organizations involved in extension or technology adaptation. Areas of assistance will include cookstoves, charcoal, and community water supply and irrigation.

In addition to the above activities, the long-term experts -- supported by short-term consultants as necessary -- will help promising national or local organizations prepare Energy Development Fund (EDF) (described in following section 4) loan or grant proposals, conduct technical and financial evaluations of EDF loan or grant proposals and submit recommendations to the MOE and to the appropriate District Development Committee; monitor projects supported by the EDF; provide

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technical assistance to EDF or other projects; and evaluate results learned from EDF projects.

Finally, before departing, the long-term experts will provide written evaluation of the efficiency of the extension and training approaches supported, including an evaluation of each organization so supported.

AID will provide short-term consultants to assist the two long-term renewable energy experts incurriculum development, training or other extension-related areas. Specific activities from the wide selection will be chosen by the needs of the annual work plan and periodic reviews.

3. U.S. or Kenyan Training of Ministry of Energy Personnel

The staff of the Ministry of Energy is scheduled to increase from less than 100 persons in 1980 to an approved level of 146, with further increases likely. At the same time, recruiting difficulties have made staffing grow more slowly. Because it will remain difficult for the Ministry to spare any of its professional employees for long periods of time, the staff training budget will be allocated to short-term training such as that provided at Stony Brook or Gainesville, or to courses at the University of Nairobi, or other Kenyan educational institutions. The budget provides such training for 15 MOE staff members.

C. Applied Research and Demonstration

The project includes two components:

1. Fuelwood/Agroforestry Centers

The project will support the establishment of up to six agroforestry research, demonstration, and extension centers situated in various ecological zones. Each such center will include seed acquisition and species research appropriate to that region; distribution of seeds to other nurseries or, where direct sowing is feasible, to farmers or tree-planting organizations and government extension agents; distribution of seedlings of selected species and varieties for both extension and experimentation purposes; both conventional and agroforestry demonstration plots; and an extension/outreach staff to provide assistance -- directly and through government and nongovernmental extension groups -- in direct sowing techniques, nursery establishment and operations, post-planting maintenance, and use of trees mixed with crop or livestock production.

The extension staff will work particularly with local Agricultural Extension Officers, Farmers' Training Centers, and nongovernmental organizations (local church, women's, farmers' and other groups) to encourage introduction of trees on farms. They will monitor both progress in gaining acceptance for such introduction and results on farms where trees are introduced.

Each center will be established at an existing GOK nursery or one just being started up. The GOK organization operating the nursery also will operate the center, under contract to MOE. In general, GOK nurseries in the highlands and other high productivity areas are operated by the Forestry Department of the Ministry of Environment and Natural Resources, while those in marginal areas are operated by the Soil Convention Division of the Ministry of Agriculture.

2. Energy Development Fund

The project will provide consultant assistance and initial funding necessary to establish within the Ministry of Energy, an Energy Development Fund. The fund will provide grants or soft loans to organizations, on a cost-sharing basis, to develop and demonstrate innovative renewable energy technologies and extension approaches. The main purpose of the fund (or, as other capital is added, of the AID share of the fund) will be to finance demonstration or dessemination of those priority technologies meeting basic needs of AID's target population groups.

The long-term experts provided under this project will assist in preparation of promising project applications, perform technical and economic reviews of grant proposals received by the ministry, and provide technical assistance and training to support in proposal reviews.

D. Monitoring and Evaluation

AID will undertake the following monitoring and evaluation of this project:

- Forestry/fuelwood: Evaluation of results of tree species research, nursery operations (including costs, survival rates, distribution problems), effectiveness of alternative extension approaches (both those through the AID-financed nursery complexes and others supported indirectly), responses to afforestation extension efforts, and response to and results of agroforestry demonstration and extension efforts.

- Evaluation of costs, technical performance, and

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suitability for large-scale adoption of wood/charcoal and other renewable energy systems supported under the Renewable Energy Project.

- Evaluation of alternative training, technical assistance, and extension approaches and of urban and rural responses to both those approaches and the technologies being disseminated.

AID will provide a small team early in the project to prepare a detailed monitoring and evaluation plan. Annual project monitoring reports will be submitted by the technical assistance contractor to MOE and AID. Finally, midterm and final project evaluations will be conducted by a team acceptable to MOE and AID.

MALI: RENEWABLE ENERGY PROJECT

Jon Anderson*

I. Introduction

USAID and the Government of the Republic of Mali (GRM) have been involved with the design and implementation of a 5-year, 4.1 million dollar Renewable Energy Project (REP) since early 1978. The Grant Agreement was signed in August of 1978 but significant implementation progress did not start until the arrival of full-time technical assistance in October of 1980. USAID feels that certain lessons have been learned in the course of this project's design and implementation and, while complete data is not available for judging some project components, the following discussion may be useful to others working in the energy field.

II. Project Background

The LDC "energy crisis" is analyzed and described in detail elsewhere. Briefly, this project as well as others are based upon the link between energy and development and the fact that energy sources traditionally available for development are becoming more expensive and scarcer. The oil price hikes and the diminishing availability of firewood and deforestation have led donors and LDCs to design and implement energy projects.

The infrastructure available in Mali to deal with energy issues is on the one hand well ahead of its time and on the other not very well developed. Mali has had a Solar Energy Laboratory since 1964. There is, however, no Energy Ministry or even national direction. The Solar Energy Laboratory is under the National Direction for Hydraulics and Energy which is under the Ministry of Industrial Development and Tourism. Hence, it is clear that the immensities of Mali's energy problems have not yet been reflected in government administrative structures.

III. Project Purpose

The purposes of the REP are (a) to improve the quality of life in Mali, particularly in the rural areas, by energizing tasks that are now largely accomplished by human muscle power, (b) to contribute to the alleviation of Malian dependence on increasingly costly fossil fuels and firewood with its negative economic and ecological consequences and (c) to gain a better understanding of the social and economic consequences of introducing renewable energy technologies in rural Mali.

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Four phases have been identified as necessary to achieve these goals. The first phase is basically institutional support with the major focus on material, technical and training inputs on the Solar Energy Lab but with some support to other organizations as well. This support is to enable the SEL to carry out research and development activities on a range of renewable energy devices. Another aspect of the first phase is the installation of four photovoltaic solar pumps. The second phase is a rural energy survey in four distinct grographical and ethnic zones. The survey outputs will include (a) socio-economic baseline data, (b) data on the availability of energy sources, (c) village preferences on tasks to be energized (rural needs) and (d) potential village capacity to operate and maintain energy devices. The third phase, a direct follow-on of the first two phases is the testing of the devices developed under the R&D program in the survey villages. The fourth phase is devoted to a detailed analysis and evaluation of the field experiments.

IV. Highlights

The following represents several project issues that USAID deems significant:

A. Design

The traditional donor analysis focuses on two aspects of the energy problem. The first aspect is the oil crisis in which the rising costs of petroleum products negatively affects LDCs' economies and development efforts. The second aspect is fuelwood crisis where increasing population pressures, droughts and other factors are leading toward deforestation and the related soil erosion and lack of firewood problems.

These are important aspects of the energy problem and reflect national and donor concerns. What often follows from this analysis is that alternate sources of energy to oil and firewood must be found and technologies using these new sources be put in place to replace the old technologies. Hence, on a national level the results are put in terms of improved balance of payments, the protection of natural resources, etc.

If, however, projects are to be implemented in the rural areas, this perception of the energy problem might be misleading. For example, villagers in Mali do not now have nor have they ever had significant access to or reliance on petroleum products. Hence, one could imagine a project successfully replacing oil by a renewable source of energy and also having little impact on the rural areas.

If the "substitution mentality" is shifted from oil to firewood, one can imagine suggestions of substituting biogas and solar energy for wood. This, however, is very unlikely to happen in rural areas of Mali in the next 20 years. Wood is a

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renewable source and the way to enlarge and protect this source is to use it more efficiently.

At the village level, unlike at the national and industrialized level, the overwhelming energy source is human. Projects which are to be implemented in the rural areas should look closely at both the present technological level and the possibility of introducing progressively more efficient conversion technologies for human energy and the substitution of renewable sources for human beings.

While the design of the Renewable Energy Project recognized human energy as an important village energy source, it implied the substitution of other energy sources for human muscle power. This coupled with the confusion between national goals and village level priorities has occasioned doubts as to the appropriateness of the project's centralized research and development activities.

B. Coordination

Energy's key role in development and the emphasis put on it at the national level because of fossil fuel price hikes means that many different organizations are dealing with energy problems in Mali. Thus one of the major problems facing a comprehensive energy project is the attempt to coordinate and collaborate energy activities to avoid duplication and to assist targets of opportunity.

In Mali there are perhaps 15 different organizations working on different aspects of the energy problem and doing work of direct concern for the USAID project. In the case of Mali, there has been no organization charged with overall planning and coordination of energy activities in general or renewable energy activities in particular.

In an effort to assure minimum coordination, the design of the REP stipulated that a committee be set up with participation of the different organizations. This committee has never functioned as planned and is now essentially defunct. As a result, very little structured coordination takes place.

There appear to be three reasons why the committee failed in its attempt to coordinate. One was the fact that it was an artificial creation in order to meet certain financial criteria and such did not reflect GRM commitment. Second, neither the level of funding nor the structure of the project were such that the differing organizations could be assured that their ideas would be realized nor could the functioning of the committee be assured. Third, the committee was made up of members or organizations of approximately the same hierarchical level. Thus decisions were hard to achieve or enforce. In addition, there was little show of support for the committee from the upper levels of the GRM.

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Since coordination of activities is essential to good project implementation, a detailed analysis of the existing coordination structures should probably be done before a project is financed.

C. Planning

The REP implementation has been affected by planning or lack thereof at two different levels. At the national level, inadequate overall planning or assessment of the total energy picture and the role of renewable energy has meant that the implementing organizations are left without clear mandates and sense of priorities or proportion. It is unclear, for example, whether the project implementing agency has responsibility for research on different technologies such as biogas. In this situation it becomes difficult to coordinate activities and be selective about what areas are priorities. The implications of this are such that perhaps renewable energy projects should not be financed in the absence of such planning or that such planning be financed before implementation.

Without national level planning, of course, it is difficult to expect realistic planning out of the implementing organization. In Mali, the lack of planning ability has had a negative effect on the project. There seem to be two possible ways of alleviating this problem. The first is to be certain that the project design is detailed enough to be used as a planning document. This may mean substantially lengthening the design process. But unfortunately it does little to strengthen host country capability. The second way, and one that the REP has attempted, is bringing on board technical assistance to aid in the project planning area. Unfortunately, it sometimes appears that the T.A.'s planning ability only marginally surpasses that of the host-country organization.

D. Personnel

If AID is going to support research and development organizations, as is the case with the REP, careful matching of the number and qualifications of the personnel at the organization with the scope of work required of them is needed. The REP has discovered that both the number and qualifications of SEL personnel are lacking.

The major skills that are lacking appear to be:

- managerial and organizational capability
- financial management
- practical, hands-on engineering and
- coordination skills.

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There appear to be three main approaches to obtaining these skills:

- training,
- technical assistance and
- hiring of people with these skills.

REP is looking for appropriate training programs in the management area. As a stopgap measure, technical assistance - although not originally indicated in this area - is being diverted away from the technical project aspects to assist in all levels of management. One additional person has been hired to assist in the administrative area.

Management continues to be a weakness and future project designs should focus on this area. Management weakness was considered during REP design and an attempt was made to circumvent the problem by putting more responsibility at a high bureaucratic level. This technique did not work because lack of management skills exists at all levels and managers are especially needed at the day-to-day operational level.

To overcome the lack of practical skills for the engineers, two have been sent to the U.S. for short-term training. The most effective way of dealing with this, however, seems to be through technical assistance. Through T.A. all the engineers of a center can be reached as they work on concrete problems. REP is also in the process of hiring an instrumentation technician in order to help with the calibration, repair and upkeep of scientific equipment. A qualified technician to do this is essential if significant quantities of scientific equipment are to be procured.

Although the lack of coordination is probably a result as much of structural problems as lack of skills, much can be done to encourage increased coordination. Often it appears that technical assistance personnel are best at initiating the first steps.

The shortage of personnel in this particular case includes administrative, technical, and support personnel (drivers, etc.). The major question is who will provide the additional personnel. The Project Grant Agreement, of course, states that the GRM is responsible for all resources needed above and beyond the Grant. However, the GRM's budget is already weighed down by civil servant salaries. To encourage them to add to the bloated government bureaucracy may mean that they will not be able to support the center when donor funding ends. A suggestion has been made to use project funding to hire needed personnel on contract. This, of course, can assure short-term goals, but is more an expression of donor commitment than host-country commitment. Without good planning and clear mandates, it is difficult for the research center to put into perspective this role in the overall energy

and development picture and hence the numbers and qualifications of personnel to which the government is committed.

It can be augued that hiring of personnel with project funds on a short-term basis is preferable to encouraging the government to take on people because (a) the project can control the quality of the people hired, and (b) if in the long run much of the research center's work is to be taken over by the private sector, then their staff can more easily be diminished by letting contracts expire, and (c) there is more control over performance of contractors. This implies that much of a center's work can be accomplished in the short-run. There are, however, long-term projects which require longer term government support.

E. Production

The REP aims for the day when a prototype has been perfected and can be extended on a wide-spread scale throughout a region. The question arises as to who shold do the production of devices and what is the economic relationship between the research organization and the producer (if they are different).

It is, of course, easy to say that production should be turned over to the private sector. In most cases this is probably desirable provided that some concrete arrangement for royalties or other remuneration to the research organization is planned for. However, a REP cannot just dump a prototype in the private sector's lap. Much collaboration must be done before this stage is reached. To encourage such collaboration, the following steps might be tried: (1) Open-house. The research organization in collaboration with the Commerce Department can organize "open-houses" at the research facility for private businessmen. These manufacturers can perhaps produce part (glazings) or all (water heaters) of a particular device. If interest is expressed, then the modalities of collaboration can be worked out. (2) The workshop capacity of the research facility can be limited to force the organization to subcontract the fabrication of experimental prototypes. (3) Funding for the research organization could include amounts that are obliged to be spent in subcontracts with private sector companies (provided, of course, that an analysis shows they exist).

Advantages in getting the private sector involved in a fairly early stage include that it will probably give a better indication from an economic point of view of a technology's viability and it may show areas in which costs can be cut and more research is needed.

Too much focus on well-established enterprises needs to be avoided. In Mali, a walk through the markets shows that metal

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workers at the artisanal level are capable of doing a lot and probably represent more closely the decentralized production capabilities in the rural areas. In the end, a certain amount of decentralized production capability is desirable.

The Mali REP has included the ordering of a fair amount of workshop and production equipment. It is not planned for the SEL to do mass production but the fabrication of prototypes will be possible. A danger exists that this machinery will be underutilized. Forcing the lab to coordinate with existing production facilities may have been a more economical approach to production.

F. Extension

When dealing with national research centers one must ask the question "Who will serve as the link between the national center and the village?" Obviously, in most LDCs, governments cannot afford the creation of an energy extension service. In any case, it would probably not be effective even if they could afford it. This means that to a large extent the national centers will have to rely on existing extension services. Hence the national research centers will have to eventually focus on the development of technical packages and learn to coordinate with differing organizations.

In Mali it has been suggested that brigades of woodstove builders be set up in each of the regions equipped with their own vehicles, tools, etc. It is clear that although this approach might work given donor financing, it is not a long-term solution to setting up the link described above. Energy, not being an end in itself, must be linked to the ongoing integrated rural development extension work.

The research organizations must be able to respond to the priorities of the integrated rural development organizations and supply them with a technical package that they can test and comment upon.

V. Survey

The REP survey has not been completed and thus definite statements about its usefulness are not possible. However, the follwoing comments may be warranted:

A. Design

The REP survey suffered from the lack of good quality technical input during its conception. It was not until after the start of the survey that important technical questions were raised and it was difficult to integrate them into the survey questionnaires.

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B. Analysis

The analytic techniques affect the way the survey is designed and funded. The REP survey is to be analyzed by computer. Initially, however, the forms were not amenable to computer analysis and no funding was planned for computer time.

C. Comprehensiveness

It is difficult to judge the level of information needed to guide R&D activities. The level of survey effort required is correspondingly difficult to ascertain. There is much information to be gathered from previous survey work and this should be utilized to the fullest. There seems to be a tendency to start from zero with each survey.

D. Survey takers

Surveys must be designed with the capabilities of the takers in mind. In Mali the educational level of the survey takers is often fairly low. If the survey is too complicated, good data will be compromised by the fact that survey takers do not understand their jobs. Good simple data is preferable to complex data of questionable validity.

E. Coordination

There should be feedback between the survey and the R&D activities. In Mali this has been difficult to achieve especially since the R&D and survey activities are in different ministries. The naming of liaison people has been helpful but insufficient.

F. Size

The survey as designed in the PP quickly proved to be too large for the supervisors to cover in the careful, conscientious manner that is necessary. Once again, the temptation to touch all the bases must be subordinate to the need for good data. Smaller zones also make the enormous logistical problems easier to deal with. The zones have been reduced and implementation appears to be better.

G. Remuneration of villagers

The REP survey is of a one-year duration. In many cases, villagers have gone out of their way to support the survey by providing free housing to the survey takers and other benefits in addition to providing information. They rightly expect that certain concrete actions will be taken after the survey is completed. This expectation is compounded by the fact that many surveys have been undertaken with no concrete results at all for the villagers. It is hoped that the R&D activities

will develop prototypes that will benefit villagers. If it appears that there will be no concrete action appropriate to the village within the framework of the project, then serious consideration should be given to other ways of remunerating the villagers. Setting aside project funds for these villages which could be used to subsidize prototypes or support other development-related activities may be a solution.

VI. Incentives

In most cases USAID is opposed to the payment of bonuses or salary supplements to civil servants who work on USAID-funded projects. One of the major reasons for this is because the present systems do not reflect merit or outstanding achievement but are paid across-the-board. True, merit pay systems such as the ones used by the USG, however, can be effective. The situation at the Solar Energy Laboratory presents an occasion to implement a true merit system because the R&D activities lend themselves to regular review where progress can be measured against planned objectives. Under the REP, a realistic R&D program has been set up for all the engineers. As the target deadlines are reached a disinterested evaluation panel will review the work performed and judge its merits and hence decide if an engineer will get bonus pay. This system is being set up on a trial six month basis.

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SENEGAL: BAN AK SUUF COOKSTOVE PROGRAM

Carol Ulinski*

I. Introduction

The Senegal cookstove program, popularly known as the "Ban Ak Suuf" (2) is being financed under an AID grant to the Government of Senegal (GOS)(3) and implemented by the Centre d'Etudes et de Recherches sur les Energies Renouvelables (CERER). Its purpose is to develop, test, and introduce wood and charcoal burning cookstoves which meet the following criteria:

- fuel efficient (vis-a-vis open fires)
- low cost
- made with local materials
- simple to operate and maintain

Total AID funding for the first 2 year phase is $120,000. Planning is now underway for Phase III.

As of July 1981, over 2000 stoves have been built throughout the country, mostly in rural areas. Of this total, about 250 have been constructed in urban and semi-urban areas.

II. Start-up

The program got off to a quick and enthusiastic beginning in February 1980 with the arrival of a 3-person team from the Aprovecho Institute (based in Eugene, Oregon). During their 5-week stay, they worked closely with CERER and villagers to design and build a range of prototypes. The future direction of the project was established at this early stage with an emphasis on extension, and with activities moving from the laboratory to the field as quickly as possible. After building 12 Lorena type stoves at the CERER headquarters in Dakar, the team moved to the field where they worked with villagers to develop models responding to local needs and cooking practices. Ever since, the primary locus of activity has been the rural and urban household, although design and testing continue to be carries out by CERER in Dakar.

III. Stove Design

Most of the stoves built to date are designed to burn firewood, although some charcoal models have recently been constructed, primarily for urban areas. One of the most popular is the "Louga" model, a single burner, chimneyless stove which is easy to construct and most closely resembles the traditional method of cooking over an open fire. It is well adapted to the specific conditions of the region after which it is named, where fuelwood is scarce and cooking is normally done outdoors using a single pot. Hundreds of these stoves have already been built, mostly by women.

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In other parts of the country, chimneyed varieties with one or two burners are preferred. These are generally more complicated to build, and the work is usually done by village masons.

IV. Outreach

Since its inception, stove demonstration and training in construction techniques have been major elements of the project. Currently CERER has three official training teams: two are mobile and travel throughout the country, while the third is permanently stationed in Dakar. With one exception, the teams are comprised of masons and headed up by a technician. The exception is the two women team from the village of Ndieye Serour near Kebemer. One of the women, Coumba Gueye, who is a potter by trade, participated in a Peace Corps training session during the summer of 1980. When she returned home, she made stoves for herself and everyone else in the village, and then proceeded to build stoves in neighboring villages. Since November 1980, she and a companion have trained women in over 20 villages on how to construct the Louga model.

While CERER has primary responsibility for training, governmental and non-governmental rural development agencies were invited and encouraged at an early stage in the program to integrate cookstoves into their respective programs. CERER has trained extension agents from the Secretariat d'Etat a la Promotion Humaine, Maisons Familiales Rurales, SODEVA, Eaux et Forets, ENDA, YMCA, CARITAS and Cathwell to name a few. These organizations in turn organize and orchestrate training sessions throughout the country.

From the beginning, Peace Corps has played a major role in the promotion and introduction of cookstoves in Senegal. Karen Nelson, a volunteer, coordinates outreach activities. Many of the first stoves were built in Peace Corps villages, and volunteers have organized and run numerous training sessions throughout the country. Two volunteers residing in the Louga region provided continuing support, encouragement and assistance to Coumba Gueye and the women's program. And as indicator of Peace Corps/Senegal's commitment to cookstoves, all Senegal volunteers are now being trained in construction techniques and are encouraged to undertake this as a secondary activity. When Phase II begins, five volunteers will be assigned full time to work on outreach activities.

V. Fuel Efficiency

Owners and users of cookstoves insist that the stoves save fuelwood. They claim that the wood they collect lasts longer than before; that they use fewer sticks per meal; and that they now make fewer trips to gather wood. One woman in Tivaouane exclaimed that fuel savings from the stoves is at least 66%. Using the traditional method she fed the fire from three sides; now she only feeds it from one side. Although not scientifically accurate, these observations do indicate that fuel is being saved.

Results from surveys taken during the spring and summer of 1981 support the women's claims. Two women extension workers, seconded to CERER by Promotion Humaine, measured fuel consumption in 100 households throughout the country. Arriving at a village or town just after stoves were built, they took measurements over a 2 week period for each household. During the first week, traditional cooking methods were used (open fire, fourneau malgache); the "BAS". having dried in the meantime, was used during the second week. Analysis of the results indicate that in 60% of the cases, fuel savings averaged 41%. Use of smaller cooking pots than the stove was designed to accomodate largely explains why in 20% of the households surveyed fuel savings were negligible (4).

Fuel Efficiency of Improved Stove Compared to Traditional Hearth

% of Households	Avg. % of Fuel Savings
60	41
20	10
20	negligible

The technical team based at CERER is also evaluating the impact of various design parameters on stove performance. These parameters include: height of the chimney; interior design of the tunnels; use of dampers; and the utility of the arch over the firebox mouth.

VI. Publicity

CERER has undertaken a series of actions to publicize the program:

- Distribution of 2500 wall posters on the "BAS";
- Participation in the Energy Conservation Campaign organized by the Ministry of Industrial and Artisanal Development;
- Radio spots;
- Publication and distribution of a "how-to" construction manual;
- Preparation of a half-hour videotape on how to construct a "BAS", which has been broadcast on national television;
- Stove display and cooking demonstration at the Dakar International Fair in December 1980;
- Meetings with high level government officials.

In addition, articles on the cookstove program are published regularly in the national newspaper, Le Soleil.

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VII. Problems

A. Improper clay/sand mixes. Ideally, a variety of mixtures should be tested at each site before any stoves are built. Due to time constraints, this step is often eliminated. The result is early cracking; or, in cases where the mixture is too sandy, crumbling begins almost immediately, considerably shortening the life of the stove. Senegal's soils are characteristically sandy and suitable sand-free clay may not be locally available.

B. Maintenance. Almost all the stoves observed showed some evidence of cracking. In the Louga model, cracks almost inevitably appear over the fire door, and in many instances the arch over the door falls in. In some cases the women continue to use them whatever the state of the stove; in others, the stoves are abandoned the moment a crack appears. Greater emphasis needs to be given to training women in stove maintenance and repair.

C. Follow-up. To date, the emphasis has been on spreading the word, training people in construction techniques, and building stoves. Follow-up, (i.e. checking on the condition of stoves, determining if they are being used, identification of problems encountered) is being done by Karen Nelson, who visits training sites following a stove workshop. This job is already too much for one person, given the number of stoves already built and the large geographical area covered by the program. The stoves should be regularly monitored over a period of a year or two (e.g. site visits 1-3 months, 6 months, and 12 months after the stoves are built).

D. Training. While the CERER masons are expert stove builders, their teaching skills are weak, and they often build stoves rather than train others to build them. CERER is now making arrangements to train its masons to be more effective teachers.

E. Testing. To date, little testing has been undertaken. CERER is now in the process of developing a testing program.

F. Urban Program. To date, the stove program has concentrated its efforts on rural areas. Consumption of charcoal, and to a lesser extent firewood in Dakar and other urban areas, is significant. Although several training programs have been held in Dakar, Rufisque and St. Louis, resulting in the construction of about 250 stoves, the program has not caught on as it has in rural areas. Possible explanations include the difficulty of obtaining the necessary raw materials, as well as the apparent disinterest of unemployed urban youth in unremunerated manual work. Construction of urban stoves would probably be best undertaken by the private sector.

VIII. The Future

The goal of the project is to build 500,000 stoves over the next 3 years. As the first phase of the program nears the end, CERER is evaluating its efforts to date. Over the next 6 months a strategy for large-scale diffusion will be developed, building upon the lessons of the past and the needs of the future.

NOTES

1. Additional information on the program can be obtained by directly contacting Gerard Madon or Lamine Diop, Co-directors of the program; CERER, University of Dakar, B.P. 476, Dakar.

2. "Ban Ak Suuf" translates "clay and sand" in the Wolof language.

3. The stove program is one of three components of a renewable energy accelerated impact project. Also included are: promotion of an improved method of charcoal production; and the design, testing and introduction of simple, inexpensive solar fish dryers and storage tents.

4. Test results to be published by CERER in early 1982.

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BURUNDI: PEAT PRODUCTION PROJECT

Abbe Fessenden*

I. The Availability and Suitability of Peat

As mentioned in the Energy Sector Summary, Burundi must import all her petroleum products. Although the country has considerable hydroelectric potential, its development and distribution are so expensive that the rural population will continue to rely on wood for cooking and heating for many years to come.

Tree cover in most parts of Burundi is steadily decreasing, with attendant negative effects on the environment. The seriousness of this issue is highlighted in the 1979 forestry project analysis.

> "Burundi's forestry resources are dwindling rapidly. Both natural and man-made forests are being cut down faster than they are being replaced and production is far below the population's minimal requirements for fuel wood and building timber. The urban population is directly affected by the wood shortage, as prices of charcoal increase rapidly and periodic shortages occur. The prognosis for the future is a speedy aggravation of these problems compounded by increases in population and reductions in total forested areas. This is likely to lead to a severe energy crisis, and, unless remedial action is taken rapidly, charcoal and wood would simply no longer be available".

Fortunately, Burundi does have substantial peat reserves, although not as large or as accessible as some reports might indicate. The Grand Marais in the Akagera Basin, along the Rwandan border, has at least 100 million MT, perhaps 200 million MT.

In the Buyongwe valley of the Grand Marais, a detailed survey contained calculations of reserves amounting to 20 million tons. However, there are considerable technical difficulties in mining peat submerged in an undrainable swamp. Intensive exploitation of Grand Marais sites raises serious environmental questions since the swamp contains a large volume of water which affects both the stability of the system downstream and the climate of the region.

Both the Peat I and Peat II projects have concentrated on the smaller bogs of the Zaire Nile crest. The report of W.E. Ruston (a UNDP advisor who worked in Burundi from 1974 to 1979) estimated from very fragmentary evidence that there was 28 million MT of peat in the highland bogs. An Irish Survey (August - December 1979) estimated over 700,000 MT proven from samples taken in five easily accessible sites. Extrapolating for highly similar area of same bogs, Peat II approval was

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* Project Manager, USAID/Bujumbura.

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based on total accessible reserves of one million tons. Under the DANIDA-financed grant, surveys were conducted on the sizable Nyamaswaga swamp east of Ngozi, which has an estimated 4 million tons of peat. Although prospecting has been going on at Gusanza and Gashayra bogs, it is probable that Peat II will concentrate on the three bogs already begun (Kashiro, near Ijenda; Kuriyange, near Kisozi and Kishubi, near Matana), and Myamaswaga.

Burundi peat is quite different from European peat and varies greatly from site to site and area to area of the same bog. It is characterized by high ash content, low density, friability and tendency to contain undecomposed vegetable matter.

Catholic Relief Services financed a small project (less than $5,000) in 19/5 to test peat as fuel in rural areas. CRS recruited an experienced Irish peat cutter and supervisor as a volunteer in February 1977.

In that same year, the GRB created a peat management body, Office National de la Tourbe (ONATOUR).

During 1978-1980, the European Development Fund (FED) developed the bog near Kisozi, with the objective of providing an energy source for the Tora and Ijenda tea factories financed under the FED's tea cultivation program. The EEC developed the bog and turned it over to ONATOUR in December 1980.

II. Peat I

A. The Project

In August 1978, AID and the GRB signed the Grant Agreement for $490,000 under the Accelerated Impact Program. Catholic Relief Services implemented the Alternative Energy Peat I project. The project purposes were:

- To assist ONATOUR to develop Burundi's peat reserves for non-industrial thermal energy requirements; and
- To develop and design alternative approaches to encourage rural household consumption of peat as a thermal energy source.

The project's outputs included:

- Establishment of efficient management, personnel recruitment and financial control systems at ONATOUR;
- Production and marketing of 30,000 MT of peat during the two year life of the project;

- Availability of peat to rural consumers at low selling prices; and

- Availability of appropriate research and technology data and analysis.

To meet these objectives, CRS installed a project manager/advisor in ONATOUR and recruited two Irish bog foremen to develop the two project bogs. Several studies have been completed on marketing, economic feasibility and organization, as well as a sociological survey analyzing cooking habits and preferences. Work began on developing a low cost stove/cooker.

B. Lessons Learned from Peat I

From the January 1980 evaluation and later analyses, it is apparent that some of the Peat I project objectives were probably overambitious, in particular the institution building aspects and production technology development. Harvesting 30,000 MT of peat fuel by the end of the project and building up to the management structure were much more formidable tasks than originally foreseen in a two-year AID project.

Considerable steps were taken to strengthen ONATOUR's management capabilities during Peat I, but further assistance was needed (particularly in financing and marketing) for longer periods of time. The technical problems encountered in peat handling (crumbling and non-uniform product)* were not fully resolved. Experiments without any maceration, with hand maceration, and with bicycle powered maceration have shown that some form of mechanization is necessary. This is due to the lower quality, more fibrous nature of Burundian peat.

Peat I project implementation was also adjusted because two major assumptions in the original PP were incorrect.

1. The target group of this activity is 98 percent of Burundi's population -- "the rural poor". The rural majority do not have the income to buy peat, and do not yet have so limited a supply of wood, dung, and agricultural residue as to force them into purchasing a new and strange source of energy. They are more likely to invest in growing their own trees. Outside of very limited and special circumstances, rural household consumption of peat as fuel is unlikely in the near to medium term.

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* the process of mixing and compacting raw peat

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Therefore, without long term subsidies the rural poor cannot be considered a large market for peat within the time span of Peat II. The rural poor did benefit from the employment of several hundred day-laborers on the worksites and the marginal increase in their supply of fuelwood.

2 The studies on which demand was based were theoretical and assumed 100 percent conversion from other fuels to peat. Ian Pattinson's marketing study was the first real market reseratch done in Burundi. The major consumers were institutional. Although some effort was made to interest commercial artisanal users (with some success), the urban domestic market had not been a focused target. (It should be noted that the "great electrical blackout" of October 1980 resulted in an upsurge of peat demand). The 1981 peat harvest of about 6,000 MT will be completely sold off by March-April 1982, before the major production season begins.

We did learn very valuable lessons from Peat I, and these were incorporated into the design of Peat II.

III. Peat II

A. Project Description

1. Goal, Purpose and End of Project Status

The goal of the Peat II project is to maximize the effective utilization of Burundi's limited energy resources. The project contributes toward realization of this objective by helping to develop peat.

The purposes of Peat II are:

- To conserve Burundi's forestry reserves by increasing the availability and acceptability of peat as an alternative energy source.
- To strengthen the institutional capacity of ONATOUR to carry out present and planned operations on an efficient basis and without need for significant future financial or technical support.

The end of project status indicators are:

- Net drawdown of Burundi forestry reserves will have been significantly slowed.
- ONATOUR will have greatly strengthened its internal operations, will possess a trained staff, and be in a financially sound position and able to cover its operating costs.

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- Annual peat production will increase to 47,500 MT by the project's completion, at which time about 50 percent of Bujumbura's urban domestic market will be using peat.

2. Beneficiaries and Rationale for Selection of Target Groups

During the process of project design, it became apparent that the substitution of peat for charcoal is clearly the preferred usage. In Burundi charcoal making is inefficient, about seven units of wood to one of charcoal, so that the loss of energy in conversion is very significant. Peat's kilocalorie output is at a slight disadvantage vis-a-vis both wood and charcoal, but it is an underutilized resource that can compete with both of these solid fuels.

Consequently, the urban domestic market, which is heavily concentrated in Bujumbura, is the logical primary target group. The primary beneficiaries of the project will be about 14,000 urban households, about 25 small commercial/artisanal operations, two tea factories, and perhaps a dozen institutions. Assuming that the real and perceived obstacles to large scale conversion to peat can be overcome, the project should reach its objective of 60 percent of the Bujumbura domestic market by the end of the project. Given the rapidly escalating costs of charcoal and decreasing forest cover, the options are very limited for the rural poor. The expense of shifting to gas or kerosene appears prohibitive; this leaves wood and peat as the logical choices. The 1981 market price for peat was set at 10 percent lower than the equivalent cost of charcoal, and we expect the price differential to widen.

During the early part of the project, other markets will account for the bulk of peat sales, including:

- artisanal/commercial (bakeries, brick manufacture, lime kilns);
- institutional (armed forces, hospitals, missions); and
- industrial.

Guaranteed markets are the Burundi Army and the two FED-financed tea factories. The projected 1985 markets may be as high as 52,100 MT, assuming institutional requirements of 7,000 MT, industrial needs of 5,300 MT, commercial artisanal use of 12,800 MT and urban domestic consumption of 27,000 MT.

3. Project Outputs

a. Trained ONATOUR Staff

During the early years of the project major efforts will be made to develop a minimum core of trained Barundi for ONATOUR's staff. Most training will be done on-the-job under the guidance of long-and short-term advisors. Some specialized technical, financial and marketing training will be taking place in the U.S., Ireland and elsewhere. PP states the following staff will receive training:

- bog managers (6)
- mechanics (at least 4)
- field surveyors (at least 4)
- laboratory technicians (2)
- accountants (2)
- general engineer (1)

ONATOUR will recruit division chiefs for production, marketing, finance and administration. Their skills will be upgraded by working closely with the project advisors.

b. Improved ONATOUR Management Capability

Although successful training of Barundi is the key to upgrading ONATOUR's management capability, during the first two or three years of project implementation, the experts will assume direct line responsibility for certain key positions. They will then revert to advisory roles and work with their counterparts. Major areas where ONATOUR needs significant strengthening are: financial management, marketing, bog site production, laboratory control, prospecting and equipment maintenance.

c. Resolution of Technical Questions

(1) Macerating Machinery

Peat I made it clear that some form of mechanization was needed to reach planned production levels, the question was which technology works in Burundi that is also economically and sociologically acceptable (employment generation must be considered).

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(2) Selecting

Selecting the appropriate type of stove will require two or three years for design, construction and experimentation in Burundian households of efficient and inexpensive stoves manufactured locally.

d. Development of Commercial Bogs

The PP planned development of six bogs by 1983 to produce peat for commercial markets. Starting in 1986, the annual production rate should reach 47,500 MT and 59,000 MT when all of Burundi's commercially exploitable bogs are in full production.

4. Project Inputs

The total financial requirements for the five year life of the project is about $10,549,000, including AID, GRB and other donor contributions.

AID inputs total $8.0 million. By far the largest portion represents long- and short-term technical assistance ($4,602,000). The PP envisioned a headquarters team of three professionals: a financial expert, a marketing expert and a general engineer. The PP also proposed a field production/maintenance staff. This includes four bog site supervisors and two mechanics. Up to 36 months of short-term assistance were planned in fields such as industrial engineering, mechanical engineering, comsumer marketing, social analysis, stove design and construction.

Equipment and vehicles account for another $1,662,000, including macerating machines, trucks, utility vehicles, initial tools and equipment for outfitting bog laborers (ONATOUR will replace these from their operating budget), modest amounts of office and laboratory equipment, plus office and residential furniture for AID-financed technicians.

Demonstration and publicity account for $100,000 to be spent in extension activities to stimulate the demand for peat smong urban domestic consumers. It will finance, inter alia, construction of up to 1,000 low cost, locally designed and manufactured peat burning stoves for demonstrations, and radio and poster advertising.

The project finances up to $110,000 for short-and long-term training. The PP included $260,000 for construction of new offices (in the Project Grant Agreement this was increased to $306,000 and may subsequently be increased to nearly $500,000). The

$453,000 of other costs includes rental of technicians' houses, office rental for ONATOUR, and POL costs of project financed pickups used primarily by project technicians, and testing the macerators.

The Government of Burundi's project contribution is the local currency equivalent of $1,089,000 (11 percent of total costs). It consists of an equity contribution to help recapitalize support for ONATOUR's anticipated operating shortfall for the 1980 to 1984 period and the purchase of land for ONATOUR's offices. The operating shortfall, estimated at $1,011,000 includes added costs of staff increases, running costs of macerating machines, provision of housing of field technicians, depreciation and equipment replacement costs, increased utility and maintenance costs, and higher office operating costs.

Other donor inputs are estimated at about $1,460,000 over the life of the project. The largest of these is the Government of the Republic of Ireland. During 1979-1982 the GRB includes training ONATOUR and Ministry of Energy and Mines staff in management, prospecting and peat analysis techniques, additional surveys of Burundi's highland peat bog reserves; and technical services to study the feasibility of developing a peat briquetting factory. Other elements under consideration were the provisions of additional technical assistance and training. The GRI may be interested in testing the production potential of the Grand Marais.

The IDA urban development program has a small component to develop and test a more efficient, low cost wood burning stove. It may include a peat component.

Finland began work early in 1980 with Energy and Mines personnel on an initial exploration and test sampling in the Grand Marais. The IDA loan to study nickel mining included a component to study the possibility of the Grand Marais providing fuel for the project's energy requirements.

B. Project Implementation

The Grant Agreement for Peat II was signed on August 29, 1980. The project itself has gotten under way rather slowly, for several reasons.

ONATOUR has recruited additional staff and is using temporary office space. The transfer of title for the land on which the permanent offices will be built has been a complex undertaking, and is now in its final stage. ONATOUR has also adjusted its selling prices to cover amount of transport costs subsidy. Kisozi bog management was transferred from the European Development Fund to ONATOUR. About 6,000 tons of

peat was produced in the 1981 production season, and the new bog near Matana is developing nicely. As noted in the Energy paper, we anticipate that only one more bog will be developed under this project, the very large Nyamaswaga bog with 4,000,000 MT of reserves.

The serious delays have occurred in two areas: recruitment of project personnel, and procurement and testing of appropriate machinery. A contributing factor was a delay of several months in obtaining approval of waivers (submitted with the PP) for contracting with a 935 source/origin institution for peat production personnel and procurement of peat macerating machinery.

The result was that the host country contract with Bord na Mona (Irish peat board) was not signed until 21 August 1981. Justin McCarthy, a senior bog manager arrived in Bujumbura on 30 September, just as peat production was closing down for the rainy season. There have also been major delays in recruiting senior financial advisor with fluent French and African experience who is a U.S. citizen.

Regarding testing of appropriate machinery, there have been serious delays despite the efforts of the manufacturer to make the machines as fast as possible. The machines arrives here by air freight on August 20, 1981, were immediately taken up country and tested for a month. The manufacturer's son and ONATOUR ran the production tests of the semi-automatics on all three bogs until the beginning of the rainy season forced a halt. It is clear that the semi-automatic machines will require modifications to cope with local conditions. The delays meant that the 1981 season did not perform sufficient tests to permit a final chooce on technology. It is proposed that three different types of machines be tried during the 1982 production season beginning in May. These are:

- The three automatics;
- Lilliput machine purchased by the European Development Fund (which macerates and bags the peat);
- A newly developed machine, the tractor-drawn Diffco turf cutter, which appears to have advantages from energy point of view: production, quality, drainage, ecology and rehabilitation.

With these machines, production should be between two and three times that of 1981, and a decision can be made on the technology.

In late October/early November REDSO personnel and Bord na Mona/GRI Ministry of External Foreign Affairs personnel conducted an interim evaluation in Burundi aimed primarily at

reviewing progress towards meeting the conditions on technology and ONATOUR institutional development. This report should be available in January.

SECTION VII

ANALYTICAL TOOLS FOR PROJECT DESIGN

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COST/BENEFIT ANALYSIS: TOOL OR WEAPON?

Asif M. Shaikh*

I. Good Development vs. Good Analysis

No amount of cost benefit analysis no matter how sophisticated - can assure that the development policies underlying project design are sound. The ultimate value of cost/benefit analysis is limited by the appropriateness of the criteria on which it is based.

II. Approach to Project Economic Analysis

The first issue in project design in whether or not the project should exist. The economic evaluation tool serves to determine if their is sufficient economic basis for a project to exist.

Cost/benefit analysis should tell us the following things about any energy solution we seek to introduce or spread in Africa:

- Is it in the economic interest of the intended beneficiaries?
- Is it in the interest of whoever is going to pay for it?
- Will it spread?

This last question in turn relates to three subquestions:

- Does anyone want what is being offered in the first place?
- How do we expect the spread to occur?
- Are we being reasonable in our expectations?

The output of any approach to economic feasibility evaluation should not be a simple positive or negative judgement. It should instead be feedback as to a technology's feasibility, including information on speicfic characteristics or constraints which influence that feasibility. A technology is not simply a fixed entity, but rather a bundle of characteristics, many of which can and must be adapted in response to feedback on local needs, particularly in the context of small-scale technologies for African needs.

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Most AID energy projects in Africa are pilot projects. They must be replicable or they are irrelevant, except as learning experiences (sometimes very costly ones). The economic analysis of pilot projects requires a different "mind-set" than that of self-standing projects. The tool of cost/benefit analysis is best suited to analyse the financial and economic returns on a specific investment. Yet we routinely use it as the only economic criterion in judging pilot projects which should be subject to a broader analysis of project design and conception.

In order to properly evaluate pilot technology projects, we need more analytical tools than have traditionally been available. An appropriate set of tools would:

- be simple and usable in field situations
- make serious economic use of qualitative information, because there is little quantitative data to work in many rural project settings
- be able to process and present conflicting feedback on project viability
- be versatile, and not lend itself to guide-fix trigger-mechanism analysis.

The last point requires some explanation. A rate of return analysis is an example of a potential trigger mechanism: "The internal rate of return is 25%, so the project is economically sound". It is almost always true for pilot projects that no single criterion is sufficient to judge economic soundness. An economic evaluation methodology which boils all information down to a single rate of return probably hides more useful information than it shows.

A proposed approach to the economic evaluation of pilot energy projects is contained in my paper "A Framework for the Economic Evaluation of Renewable Energy Technologies". The principal components of that approach are briefly summarized in Section III, which follows.

III. Methodology for Cost Benefit Analysis

The three levels of feasibility analysis, and their most important subcomponents, are as follows:

- private investor/consumer perspective (financial/demand analysis)
- society's economic perspective
- dissemination efficiency perspective

The level of analysis which is the most important in evaluating a particular technology will depend, to a large extent, on who the actual purchaser (investor) is, and on the nature of that purchaser's motivation. Some technologies may be acquired by individual households as a "consumer durable" (mud stoves). Others may be purchased by households or entrepreneurs for income generation (solar mud ovens). Still others may be purchased by central, district or local government in order to create a new social service (solar electrified rural clinics) or as a more economical means of providing existing services (windmills instead of diesel to pump village water supplies). Numerous examples could be cited. The central point is that purchaser motivation has a great deal to do with what levels of analysis will be stressed, discounted or ignored altogether in the actual decision-making process. The following ordering principles are suggested:

- If a technology is significantly unattractive from the purchaser's standpoint, it should be considered impractical, short of some overriding social concern coupled with an explicit readiness to impose the technology, directly or indirectly.

- A technology to be acquired privately should be analyzed at both the private and social levels.

- Within the private level perspective, either investment or demand analysis, or both, can be used. Some technologies are clearly acquired more for investment than for consumption purposes, and vice versa. However, it would be rare to have a village level, small-scale, private technology choice be either purely an investment or purely a consumption decision.

- A technology acquired by a government need not be analyzed from the private investor's standpoint. This does not mean that a government may not be interested by some of the same factors as private investors, such as, for example, cash-flow analysis. Such factors can, however, be addressed within the framework of the social level analysis.

- All technologies should be evaluated from the dissemination efficiency perspective.

A. Investor/Consumer Perspective

Undertaking a given investment or adoption of a given technology requires that those who would pay for it be willing to commit a portion of their resources for the purpose. The likelihood that they will do so is a basic criterion of "economic feasibility". Two major issues are involved:

- Is the expenditure economically advantageous to the purchaser?

- On what basis will the investor or buyer decide?

The latter evaluation is not only a means of judging if a project technology responds to peoples' needs in the first place; it also serves to break out the specific characteristics which are more or less desirable to purchasers. This, in turn, is an important guide to what cosmetic or design adaptations are needed in a given setting. There are four steps to the economic evaluation at this level:

1. Financial analysis, which relies on the traditional financial tools: projections of revenue, costs, project life, and discount rates. Where appropriate, labor saved can be quantified using an estimate of opportunity cost as perceived by the individual.

2. Sensitivity analyses, which determine how sensitive the results of the financial analysis are to key assumptions. For example, an expenditure which saves villagers two hours a day in wood gathering time may be judged very profitable if the time saved is valued highly, or quite unprofitable if it is not.

3. Scarce resource analysis, which examines the likelihood that specific resource limitations may prevent the adoption of a technology, regardless of its overall attractiveness. For example, are villagers likely to have enough discretionary cash for the purchase? If not, is credit available? At what terms? Does the investment yield net benefits in cash (which is scarce), rather than just in time or resources (which may be more abundant)?

4. Demand analysis, which does no more than identify and categorize the principal factors which appear to influence the non-financial elements of the desire to make a given expenditure. It draws heavily on the sociological understanding on which the project is based. Attempts to artificially quantify demand factors are counterproductive here, since they reduce rather than enhance the informational content of the output.

B. Society's Economic Perspective

The steps in the economic evaluation at the social level are as follows:

1. Economic analysis, using the same techniques as the financial analysis at the investor level, but with several input substitutions:

   a. Labor time is valued at shadow wages, which equal the social opportunity cost of time.

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b. Shadow discount rates are used to reflect social, rather than individual, preferences as to the future growth vs. immediate benefits.

c. The analysis incorporates social costs, which take account of cost or benefits which may accrue to society, but which are not realized by the individual investor. These include such things as environmental benefits, costs of extension and so forth.

2. Sensitivity analysis, which, as in the investor level analysis above, determines how stable the economic results are in response to changes in key assumptions.

3. Scarce resource analysis, which, at the social level, becomes a measure of how practical a technology is within the specific constraints of LDC rural areas. For example, windmills require trained mechanics for maintenance and repair. Are those human resources available? At what cost?

4. Evaluation of national policy objectives, which may affect a technology's economic value to society.

C. Dissemination Efficiency

From the standpoint of a project's effectiveness in achieving its objectives (such as, for example, reaching the rural poor), it is not sufficient that a given technology be cost effective from the investor and social perspectives. It should also be a more efficient vehicle for achieving project goals than alternatives which are equally feasible at social/investor levels. Even where no clear-cut alternative technology exists, project design requires some judgment of whether it makes economic sense to spend program funds to introduce and disseminate a technology.

The commercial analog to "dissemination" is "sales". It would be absurd for an entrepreneur to introduce a new good without some indication that it will sell. Similarly, it makes little sense to introduce a technology intended to improve living conditions for a population without some indication that it is capable of reaching a significant portion of that population.

There are several dissemination mechanisms through which this can occur. These include, among others:

- extension/training
- informal social process,
- commercialization, and
- direct government implementation.

Generally, two or more mechanisms operate at once. There is often a time pattern to how different mechanisms come into play, with training/extension ideally giving way over time to dissemination processes generated within the socioeconomic system.

For purposes of judging project effectiveness, two aspects of dissemination are of particular interest:

- What is the likelihood that a technology will spread and actually reach those it is intended to help?
- What are the costs of dissemination, both absolutely and in comparison to the alternatives?

Each dissemination mechanism brought into play introduces a new set of actors and incentives, and thereby influences both of the above questions. Neither question can be answered with precision, particularly when speaking over a medium- to long-run time frame. However, useful information can be derived from analyzing the characteristics of the technology in question and of the economic environment of rural areas. A threefold approach is proposed:

1. Dissemination Cost Ratio

   A measure of the cost of dissemination can be defined by the following ratio:

$$\frac{\text{incremental budgetary cost of transferring a technology to one new user}}{\text{incremental benefit to society of transferring a technology to one new user}}$$

   In practice, the denominator can be measured by the Net Present Value of the technology when evaluated from the social perspective. While this is a crude measure, it does address the key criterion for a pilot implementation project: is it economically practical to spread the technology to a much larger audience should the pilot succeed? Moreover, when this ratio is used to compare technologies, it becomes a more refined measure of the relative merits of two or more program alternatives.

2. Changes in Dissemination Costs Over Time

   Changes in the dissemination cost ratio should be examined over time. That is, some technologies may have dissemination costs per unit which are high at the outset, but which decrease after an introductory period. This may occur because of demonstration effects, greater public familiarity, field-proven effectiveness or,

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simply, because new dissemination mechanisms have come into play. An appropriate time frame within which to project these changes would be in order of 15 to 20 years.

3. Overall Dissemination Effort

The above indicators of dissemination costs should not be applied mechanically. Together, they only provide inputs into a judgment of how likely it is that a technology will actually take hold and have a meaningful impact on some target population. For example, if the dissemination cost ratio is fairly high and remains high over time, reaching fifty percent of rural households over fifteen years may require a major national commitment of resources. In this case, such costs should be estimated and explicitly accepted as being both worthwhile and likely before project resources are committed to the initial effort. It should be emphasized that the dissemination cost ratio alone merely indicates whether spreading a technology generates net benefits (i.e., that dissemination costs are less than benefits). Only by combining this information with that on changes in dissemination costs over time and evaluating overall dissemination effort to reach a target population can a judgment be made as to whether a given technology merits priority consideration. This latter judgment, in turn, depends on the social opportunity cost of the budgetary and other resources required.

IV. Technology, Economic History and Clint Eastwood

Economic analysis has played an increasingly important and diversified role in the analysis of AID energy projects in Africa. Several years ago the focus was on assessing how beneficial various energy technologies would be if introduced. That criterion was refined as we looked more closely at project (or technology) financial viability from the user's perspective. The next step was to examine the prospects for widespread project replication and for the dissemination of useful energy technologies. Finally, more recent work has emphasized the value of technologies which will catch on largely on their own.

It seems to me we have come full circle in this process: Initially, we introduced technologies more because they were "good" than because they were economic. Now we may be seeking to deal only in those technologies which are so good that we almost don't need to introduce them at all: They will simply catch on by themselves.

We are at a decision point: how far should we go in emphasizing self-spreading technologies? How much should we expect from the "marketplace" in project design and conception? Is there any simple solution?

We in the development community often find ourselves trying to non-disruptively introduce technologies in the Third World, as though there was no such thing as historical process or social upheaval. Yet technological change has historically been a major vehicle for socioeconomic transformation. We know next to nothing about how that process occurs. If we did, I suspect we would know that there is no simple model. The simple fact of our having been wrong so often in the past should temper our certainty about a simple new solution, whether it be government extension or markets or anything else.

When we look at how large-scale technologies change has occurred through history, we find an enormous diversity. Compare the Meiji Transformation in Japan, the decline of the textile industry in Bengal, the enclosure movement in England, reforestation efforts in China or the spread of cash crops, transistor radios or Nestle's baby formula in Africa, and you will find differences, good and bad. Did the entrepreneurs of Ethiopia bet on the financial returns of Eucalyptus or on the historical struggle to capture the technologies of the conquering foreigner? I, at least, am not sure.

Markets have spread a number of technologies in Africa, and they have not spread others. So have governments (pre- and post-colonial). When markets play a massive role in the diffusion of small-scale energy technologies in Africa, social transformation of historic proportions will have occurred. This is not non-disruptive Appropriate Technology. We may propose energy technologies to the marketplace (where it exists), but the market will spread only those which meet its needs. Nestle's has been more successful in Africa than mud stoves. So has Clint Eastwood.

With some exceptions, on any large scale, markets are as likely to supplant out technologies as to implement them even if our solution seem market-oriented to us. The need to address the energy needs of Africa is critical. We know there are no quick solutions. We should also recognize that there is no single solution; even if there were one today, it may not be valid tommorrow. There are several million Africans in the throes of starvation. Perhaps 200 hundred million whose lot is getting worse. There is a lot of upheaval to occur before we get from here to there.

V. Conclusion

The principal contribution of economic methodologies for pilot project analysis will be to shift our focus from precise answers (based on questionable data) towards an understanding of the process we are trying to initiate. The principal danger is that we will slip into a well-established tradition of the economics profession by defining ideal solutions rather then analysing real problems.

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TECHNICAL SOUNDNESS

C.F. Kooi*

The analytical tools used are essentially (1) the laws of nature (physical, chemical, biological) (2) the methods of engineering, including cost estimations.

We will show by an example how these tools are used. The example will be water pumping, the objective being to determine the quantity and cost of water pumped by various techniques. We will choose to consider pumping by: (1) a single person with a rope and bucket, (2) a single person with a hand pump, (3) a wind pump, (4) a photovoltaic pump, and (5) a diesel pump. Water will be pumped from a well, a total lift of 30 meters, in a climate such as that of Niamey.

The principal laws of nature that we will apply are the first and second laws of thermodynamics which state that the energy gained by the pumped water cannot be more than the energy put into the pumping operation. This is a simple principle but often ignored. One knows immediately that a person whose food intake is 2000 kcal per day cannot lift more than 28,000 liters of water per day from a 30 meter deep well. In fact, since most of the 2000 kcal of food energy is needed to sustain his vital functions he can, in fact, lift less than 1/10 of this. Similarly, when measurements indicate the amount of wind energy available at a particular site and the characteristics of a particular wind pump, we can determine the amount of water it can lift.

In the following calculation it will be assumed that the persons and diesel will pump water 8 hours per day, 300 days per year. In calculation of the present value of all operating costs, the discount rate is taken to be 10%, all cost escalation rates are taken to be 10% per year, except for the price of diesel fuel which is assumed to escalate at 13% per year. The duration of the pumping project is assumed to be 15 years. All other parameter values and performance data is taken from measured data, manufacturers technical literature, engineering handbooks, and other sources of information.

DATA: Five Pumping Techniques

I. Diesel Pump

Four horsepower diesel; pump and transmission efficiency: 50%
Installed cost: $3000.
Five year life. Replace every five years.
Maintenance and operation cost: $800 per year.
Fuel consumption: 3000 liters per year.
Cost of diesel fuel in 1981: $0.70 per liter (as in Abidjan

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* Energy Advisor, REDSO/WA, Abidjan

II. Wind Pump

Six meter diameter, multi-vane, designed for low wind speeds.
Installed cost: $15,000.
Fifteen year life.
Maintenance and operation cost: $400 per year.
Manufacturer's curves specify quantity of water pumped as function of average wind speed. Average wind speed: 2.8m/s.

III. Photovoltaic Pump

One kilowatt (peak), no battery storage, pump efficiency: 50%.
Installed cost: $40,000
Fifteen year life.
Maintenance and operation cost: $400 per year.
Insolation: 6 $kWh/m^2/day$.

IV. One Person with Rope and Bucket

One person; work output of 50 watts over 8 hours per day.
Cost of equipment: $20.
Life of equipment: 1 year.
Efficiency of operation over complete cycle: 40%.
Wages: $2 per day

V. One Person with Hand Pump

One person; work output of 50 watts over 8 hour day.
Pump: High quality, long life. Installed cost: $1000.
Life of pump: 15 years.
Pump efficiency over cycle: 50%.
Maintenance of pump: $50 per year.
Wages: $2 per day.

The amount of water raised by each technique is calculated using the first law of thermodynamics (energy input = energy output) and the second law of thermodynamics as embodied in the efficiency parameters. Then the present value of all costs, including purchase of new diesels every five years and ropes and buckets every year, is calculated using standard methods as outlined in engineering economy textbooks. Finally the levelized cost of pumping a cubic meter of water is calculated by dividing the present value of all costs by the number of cubic meters of water pumped during the 15 year period. The results are shown in Table I.

Hand pumped water is the most expensive because a person can produce very little mechanical power (the 50 watts over 8 hours per day that we have assumed is optimistic). In fact, an internal combustion engine consuming less than 15 gallons of fuel (one gas tank full) produces as much mechanical work as an adult person working for a full year. In order to compete with a diesel the worker's wage would have to be lowered to about 20¢ per day.

It was assumed that the efficiency of a hand pump operation was greater than that of a rope and bucket operation. However, the author is not aware of any measurements to justify this assumption.

The wind speeds in Niamey are low. In a region with higher wind speeds, such as the Cape Verde Islands, the wind pump would be the least expensive option. Photovoltaic cell costs are only 25% of the total system cost used here. The cost of the balance of the system (BOS costs) can be reduced drastically. If that is done and if diesel fuel prices were to again escalate as they did in the last decade (average of 25% per year) photovoltaic pumping would be less expensive than diesel.

TABLE I

Amount and costs of water pumped by five different techniques; for a thirty meter well in an environment similar to that of Niamey.

	Diesel	Wind	Photovoltaic	Hand pump	Rope & Bucket
Present value of all costs ($),	60,300	21,000	46,000	10,750	9,300
Quantity of water pumped (cubic meters per day)	150	30	35	2.4	1.9
Levelized cost of pumping the water (dollars per cubic meter).	0.09	0.16	0.29	1.00	1.09

ENVIRONMENTAL SOUNDNESS

Vernita Fort *

I. The Need for Environmental Soundness

Concern for ecological stability and environmental soundness is occasionally viewed as obstructionism generated by sentimental enthusiasts. However, ecological integrity translates into a fundamental issue of survival and development for a large percentage of Africa's population.

Ecological stability is not a luxury. It is essential for sustained productivity of the same resources depended upon for sustenance, livelihood and income and foreign exchange. It is essential to adequately support human populations on a sustained basis. It is essential for sustained development. In these conclusions the value and need for environmental soundness in project and economic development more than clearly assert themselves.

Without concretely considering the possible environmental consequences that could result from specific development interventions, projects intended to solve one set of problems could create another. The new set of problems could even be more severe than the first set that the project addressed. Also real economic costs accompany environmental degradation. Such costs result, for example, from decreased productivity of certain resources (lost opportunities for returns) or damaged health that requires capital resources to correct or removes human beings from productive labor. Finally and most fundamentally, human well-being potentially suffers. The new problems can show up in the same place and as an immediate response to the project action. Often, however, the new problems show up at a different location, in a different form or sector, at a different location, in a different form or sector, at a different time and affecting different groups of people than those for, or by whom, the unsound project was implemented to benefit. In the latter case, though the new problems may be less readily discernible, implications for resource productivity, overall and long term economic costs and human well-being are no less severe.

The following examples of two projects illustrates the problem which were encountered due to no attention being paid to environmental soundness and the operative ecological context. These accounts are generalized, but stem from actual cases.

Project No 1: A dam was built across a major river in Africa for the purpose of generating hydroelectric power. No attention was given to the associated environmental parameters and the problems

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which resulted were more significant than the problem solved. For example, schistosomiasis and malaria were augmented, and thus the status of human health declined. Forests and valuable arable land were flooded and thus were removed from producing necessary food, fiber and surplus products for consumption and income. Certain fish species that provided an important source of protein were diminished or completely depleted due to grossly changed habitats. Water availability at critical points along the river that served critical needs were restricted. A host of additional secondary and tertiary negative effects emerged. Thus a well intentioned project, focussing on solving an energy problem, was more destructuve than helpful.

With an additional small investment, the multiple problems and opportunities associated with dam construction for hydropower could be addressed with complementary solutions rather than conflicting ones. This is a situation where a certain level of investment is necessary before a net level of viable returns can emerge. The solution is not to necessarily refraim from building the dam, unless all social, technical, economic and environmental costs so dictate. Rather, it is to assess and "design-out" the potential environmental problems as discussed in detail later in the paper. This means that the project should attempt to prevent, minimize, mitigate, monitor or beneficially harness and convert potential environmental problems. This means that the scope of this particular project would need to be broader, with a focus on the "system" or total river basin or watershed in which the hydropower would function, rather than just hydropower in and of itself.

Project No. 2: A second example is actually the scenario of a proposal made to design a woodlot project focused on addressing a problem defined as "deforestation". Without understanding and addressing the larger ecological context and the reasons why deforestation was occuring, the proposal only addressed the symptoms. The problem was improperly or incompletely defined. Without understanding how and why the inhabitants exploited their environment as they did to support themselves, the proposed project, if implemented, could in fact have further facilitated the deterioration of their capabilities to produce food. This would have been the direct result of putting trees on the land that had been cleared for food production.

An investment may have been made in the name of fuelwood production and environmental enhancement, which may have in fact encouraged the contrary. Costs in human well-being and optimum resource productivity would have also accrued. The proposal was not pursued and the potential problems and uncompensated costs were avoided. With the same level of funding and the appropriate consideration of the ecological and land use context, a project with net benefits could be designed and implemented. As it turned out, an agro-sylvo-pastoral approach that served food, fuel, fodder and

fiber needs at once, was determined to be a more viable solution based on ecological and land use analysis. It promises to be more responsive to the existing system of problems and opportunities in the country of concern.

II. Before Project Design, There is Project Identification

Environmental problems are often fundamentally the result of ad-hoc, piecemeal and laissez faire project identification. Many environmental problems can be avoided, and overall benefits from the environment and natural resources can be increased through planning and through a systems approach to project identification. This is particularly true in the arena of energy and natural resources which in fact constitutes a large percentage share for energy and natural resources, has its own logic, and is easily explained. Food, energy, water, fiber, materials and surplus for income, which are essential requirements for sustenance, livelihood and development, are all generated from the natural resource base.

Most AID projects associated with energy and natural resources are identified vertically, one resource sub-area in isolation of the next, where often opportunities are lost and problems created. However, rather than focusing on energy, forestry, and water separately, it is much more efficient, productive and increasingly necessary to identify projects horizontally, or in the context of the ecosystem in which they would function. The goal would be to develop a given energy-natural resource system or ecosystem where the possible components of agriculture, energy, forestry, range and livestock, fisheries, mining and industry would function in a reinforcing rather than competitive manner, and that optimally meets the multiple needs and objectives of the human population depending on the system. Optimum and sustained productivity of the system would be an inherent goal.

Once the resource capabilities of a given area or region are assessed and measured, and the current and projected human demands are assessed and measured, a preferred land use and resource management system can be articulated with the inhabitants. It is in this context that specific projects are best.

The methodologies of land use planning and watershed management provide examples of how a larger or preferred system is designed based on resource capability and human demand, and then how specific actions or "projects" are identified for coherently realizing the preferred system. These methodologies, or principles from them, could be beneficially used in AID's project identification process.

The strategy that the specific projects constitute would need to have a much longer view or time frame than the average five year project period. This is necessary, as experience is beginning to show, so that the technologies, institutions, practices or trained expertise initiated by a project, could have a sustained context for becoming strong and well integrated into the larger development

process. Commitment from all participating organizations and institutions, including AID, would need to be firm for such longer term support. The result would be greater benefits to the beneficiary and a more effective investment.

Currently the Country Development Strategy Statement (CDSS) is employed by AID to provide guidance in program development. Its utility as a guide or tool for coherent project identification could be improved if it included an appraisal of the natural resource base, its productive capability, current land and resources use and current and projected human demand on the resource base.

Some missions are beginning to include this type of information and appropriate maps in their CDSSs. They are beginning to use the information in the program and strategy development and project identification. I would strongly encourage furthering this practice and recommend that AID seek to provide the missions with assistance to improve their effectiveness in these areas along the general guidelines discussed above.

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SOCIOLOGICAL PERSPECTIVE OF THE ENERGY PROBLEM

Dr. Carolyn Barnes*

The analytical tool presented here can be used for more than project design. Often we have focused in a piecemeal fashion upon a solution after a simplistic identification of an energy problem. The solution has frequently involved the introduction of energy-related technologies or new energy forms, but our knowledge about these greatly exceeds our knowledge about the contextual situation of the problem we are trying to solve. This is particularly the case when it somes to household energy use. Too often analyses of energy use or demand by households has focused on wood supply and an estimation of households' requirements as based on the assumption that distribution and quantity used takes place according to the needs of all the people. This approach neglects ecological, cultural and economic variations. Most energy consumed in the household and informal sectors in African countries does not pass through the market economy. In order to obtain energy-related data on these sectors, surveys and qualitative studies are usually required to supplement existing information. These studies need not be extremely time consuming and costly.

In setting forth an analytical framework, this effort tries to identify some key elements related to energy use among households and operators in the informal sector. The informal sector is included since by definition it is largely dependent upon the household resource base. The aim of the framework is to articulate interrelationships. Thus, when considering projects, one can better predict how actions in one sphere may influence or be influenced by activities in another. Energy problems are inextricably linked with the wider social, political and economic system. When energy problems are viewed as part of a wider system, it is easier to recognize the way the effective actions in other parts of the system can positively or negatively lead to changes in the energy sphere. For example, as was mentioned yesterday, increased agricultural production through expansion of agricultural land can contribute to deforestation and thus negatively effect the availability of firewood.

The analytical framework which I wish to present assumes that either households or operators in the informal sector are the unit of analysis. To obtain a national profile, sampling should be conducted to take into account differences such as population densities, ecological zones, rural and urban areas, and for household dietary differences since cooking is the activity in most African households which requires the largest amount of inanimate energy: to cook maize meal takes less fuel than to cook maize and beans.

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Before going through the analytical framework 1/, I wish to state that this is presented as a tool to stimulate thought about key interrelationships. There are many ways of presenting this or similar conceptual frameworks. Also, I use the term energy to refer to inanimate forms.

End Use of Energy: Energy use by households covers a wide range of possibilities such as cooking, lighting, space heating, agricultural production and drying of crops. Among the numerous possibilities of energy use in the informal sector are preparation of food and beverages for sale, welding-related activities and brickmaking.

Type: The type of energy used may vary according to its end use.

Amount: Information on the amount of a particular type of energy used helps to provide a picture of the demand for particular energy types.

Variations in Type and Amount of Energy Used: Variations may occur according to physical place (e.g. cattle posts vs. village) time (i.e. daily, seasonally and annually), number of end users or consumers of the output, and the technology. These are influenced by the demands on the resources of the user.

Demands on Resources to Meet Basic Needs: The extent to which a household or informal sector operator can satisfy basic needs (food, clothing, shelter, health and education) relates to the degree to which there is competition for use of its resources i.e. land, labor and capital. Policy, such as on services, pricing and credit, also influences the degree to which the needs can be met. It is in this sphere that one needs to assess constraints and incentives.

Socioeconomic Group: The socioeconomic status of a household or owner of an informal sector enterprise influence his or her ability to meet basic needs and access to energy supply since it relates to access to property, income generating activities and investment capital.

Access: The extent to which one has access to energy supply is influenced by his or her socioeconomic situation. But access is also influenced by social relations and regulations and policy. For example, private ownership of land signifies lack of access to outsiders for collection of wood, but the owner might permit neighbors to collect wood free of charge because of a societal ideal which emphasizes sharing with the less fortunate. The higher a household's socioeconomic status the greater access to different types of energy, especially commercial energy, and the provision of appliances to use these commercial fuels.

Supply: The absolute amount of an energy form available is affected by the biophysical environment and market, both of which are influenced by

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1/ This is a modified and simplified version of one developed by the Beijer Institute Project in Kenya. See attached diagram.

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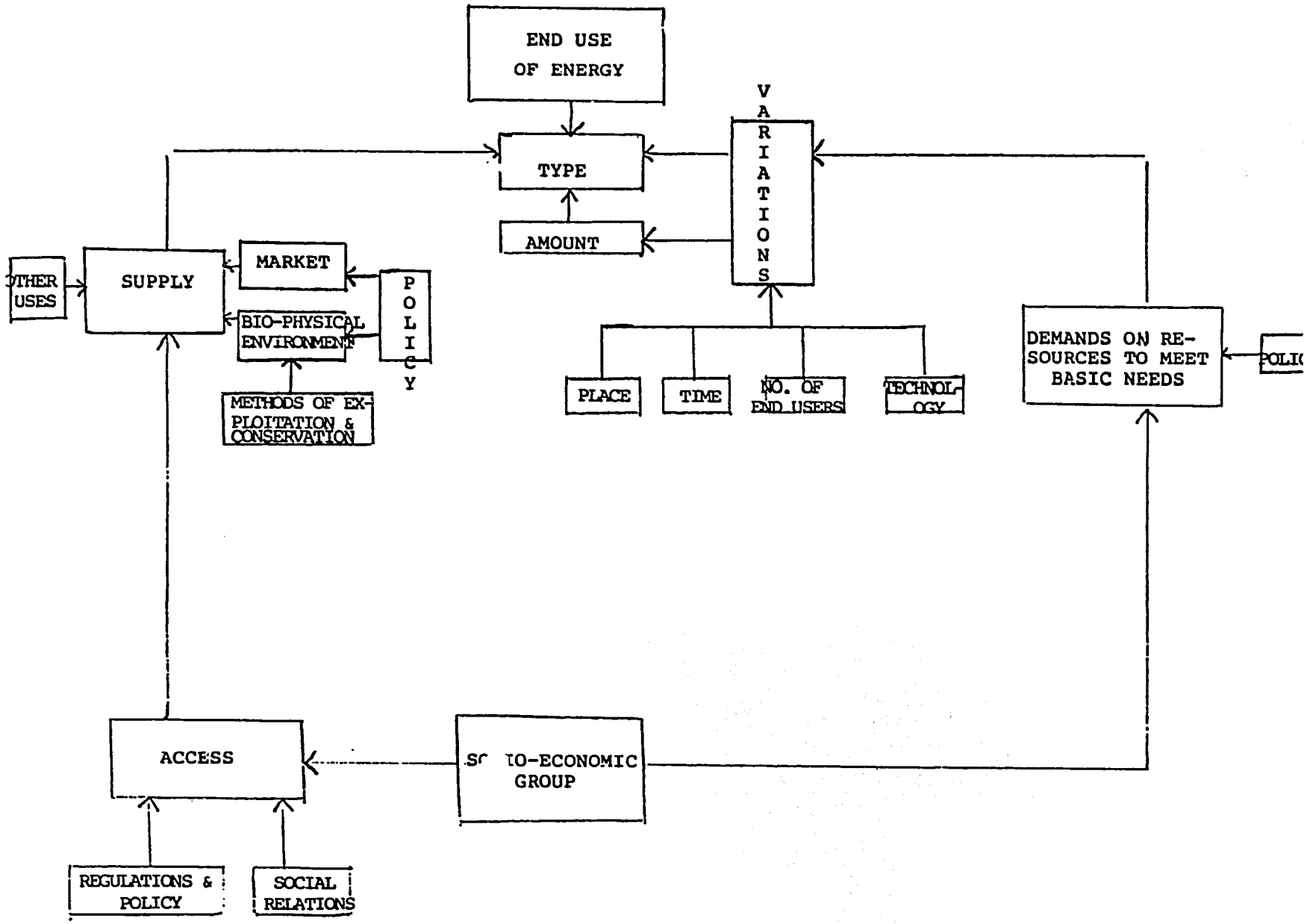
policy, such as on soil conservation, water management and pricing. The methods of exploiting and conserving the natural resource base also affect supply.

Competition with Non-Energy Uses: This category is relevant to some traditional energy types, particularly fuelwood and dung. For example, there is demand for wood for building and construction materials.


END USE OF ENERGY
TYPE
AMOUNT
VARIATIONS
PLACE
TIME
NO. OF END USERS
TECHNOLOGY
DEMANDS ON RESOURCES TO MEET BASIC NEEDS
POLIC
OTHER USES
SUPPLY
MARKET
BIO-PHYSICAL ENVIRONMENT
POLICY
METHODS OF EXPLOITATION & CONSERVATION
ACCESS
SOCIO-ECONOMIC GROUP
REGULATIONS & POLICY
SOCIAL RELATIONS

THE PURPOSE OF MONITORING AND EVALUATION FOR ENERGY PROJECTS

George Burrill*

I. Background

Information is needed at all stages of project design and implementation. Good information is essential to a good decision-making process, from conceptualization of a project through to a final evaluation. Ideally, a project should have a coherent information system that generates appropriate data, at the right times, to support all key decisions at the time they need to be made. Methods for collection and analysis of data during project design phases should be as compatible as possible with methods to be used during monitoring and evaluation. Ideally, the system should provide neither too much nor too little information.

Project monitoring and evaluation for energy projects should:

- track project activities, inputs and outputs, for level of achievement;
- identify present problems and possible future problems;
- provide mechanisms for analyzing problems and identifying possible solutions;
- measure project impacts;
- provide the correct information to the correct individuals, agencies, villages, etc., at the correct times to support good decision making related to the above items;
- answer all key questions about technology performance and transferability.

In designing or using a successful monitoring and evaluation system, experience has taught us that several key problems must be overcome:

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

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- Project managers do not understand or believe in information systems because (1) they believe it takes too much money and time away from the "real" part of the project; (2) they believe the cost is not worth the benefits of the system; or (3) they do not understand how they can use the information for their needs.

- Often, the only experience project managers have had is with systems designed for someone else's needs and goals rather than their own.

Therefore, in order to address these problems and have a good monitoring and evaluation system, it is highly important that:

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

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

II. The Project Design Process

I assume that a key goal is to develop energy strategies or technologies that are appealing from economic, social and technical viewpoints, and which will not require large amounts of government support, except perhaps initially. Therefore, in the initial stages of developing energy projects, we need to generate adequate data and information so that we can then put forth solid, quantifiable estimates, rooted in empirical data, of the potential cost-benefit impact of widespread use of energy concepts. What are the questions we need to address in order to generate this information?

There are five basic question areas. Projects must be designed to answer these questions, which means that the monitoring and evaluation design must allow for both generation of the correct data and methods of analyzing it.

- How well does a given device or strategy perform technically within the physical conditions of the area where it is being tested or used?

- What costs are associated with the installation and operation of the technology/strategy, and how do these costs compare to the benefits received and to traditional and other means of accomplishing the same work?

- How does the technology/strategy interact with the local culture, and with the social organization of the village and family?

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- How appropriate is the technology/strategy for the village institutions or individuals who could own, operate, and maintain it?

- What can be learned about the best ways of transferring or adapting the technology/strategy into the village?

The information necessary to assess the institutional strategies and the technological intervention of an energy project does not come easily. Therefore, the project paper design should actually describe the analytical framework for monitoring and evaluation. It should be a rigorous analytical guide which poses all the key questions and indicates what data must be gathered. These questions and data should be categorized and listed within the outline of the analytical framework. The project paper should also indicate who in the project will be responsible for gathering particular types of information. Finally, the design should provide guidance on data analysis methods.

Therefore, in a broad sense, any monitoring and evaluation plan must include the categories of:

- technological performance,

- economic performance,

- social/cultural adaptiveness, and

- organizational structure or organizational development requirements.

When completed, the monitoring and evaluation plan should be examined in light of the output and purpose levels of the project's logframe to make sure that the main thrust of the project is always being addressed. It should also be checked against the six points listed on the first page of this paper.

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

Moreover, as we all know, energy use is a means to an end, and energy projects are a means to other development aims. As such, there are implicit assumptions in any energy project that a successful project will result in achievement of some type of development aim. These assumptions also need to be constantly tested as they provide the larger framework and rationale for our development efforts.

SECTION VIII

IBRD AND OTHER DONOR ENERGY ASSISTANCE PROGRAMS IN AFRICA

IBRD AND OTHER DONOR ENERGY ASSESTANCE PROGRAMS IN AFRICA

Frances A. Gulick

I. Introduction

A brief review of the energy activities of donors (other than AID) in sub-Sahara Africa, reveals the following facts:

- a large number of donors are providing a substantial amount of assistance in the energy sector;
- a large proportion of such assistance is being directed toward hydroelectric and urban power distribution projects;
- led by the World Bank and other donors, increased emphasis is being placed on locating and developing indigenous sources of hydrocarbon energy sources (coal, lignite, oil and gas) as well as renewables, including fuelwood;
- led by the World Bank and other donors, including AID. increased emphasis is being placed on energy planning and assisting countries in identifying their priority energy problems and policy issues;
- adequate coordination among donors in providing energy assistance appears to be weak.

A special feature of the expanding donor interest in energy is the development of a more inclusive and broadly based strategy for longer term aid in this sector which is being formulated by the World Bank, based on its August 1980 study "Energy in the Developing Countries". It suggests an approach which should make coordination, among donors and with African governments at the individual country level, easier and more effective.

II. Energy Aid by Other Donors

A very large number of donors are providing assistance in the field of energy to Sub-Saharan African countries. One recent tabulation identifies 14 donors who are engaged in energy aid in Africa. Projects financed by these donors represented, by 1980, cumulative investments totalling some $940 million in West Africa and about $1.4 billion in East and Southern Africa. Annex A provides country

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by country details. (1)

The following list gives a general indication of the magnitude of energy aid by seven of these donors.

Country	$ Millions (2)
Canada	47
France	245
Germany	413
Netherlands	20
Sweden	108
United Kingdom	70
African Development Bank	89
IBRD/IDA	196

III. Sub-Sector Orientation

The primary orientation of aid by the largest donors has been a continuation of traditional energy lending, particularly for hydroelectric projects underway in 22 countries. To the extent that hydro projects provide an alternative to thermal-fueled power plants, they help to relieve the present oil-import dependence which is charactaristic virtually all Sub-Saharan countries.(3) In addition, however, other forms of power generation and transmission are also being supported. Energy assistance allocations were as follows for France, the UK, Germany, and Canada. (4)

Table A German Energy Aid by Region (1970-present)

	No. of Projects/ Programs Committed	*(No. of Projects/ Programs Planned)*[a]	*Amount Committed ($US Millions)*	*(Amount Planned— $US Millions)*[b]	*Sectoral Energy Aid as % of Regional Total (Committed only)*
Africa					
Power generation (including studies)					
Hydroelectric	10	(3)	252.590	(51.950)	61.2
Other (including fuel provision)	6	(1)	8.870	(1.390)	2.1
Transmission, distribution, and plant rehabilitation (including studies)					
Rural electrification	2	(2)	11.800	(8.000)	2.9
Other	20	(11)	104.208	(66.450)	25.3
Fossil fuels recovery (including studies)	1	(1)	2.300	(2.220)	0.6
Tech. assis./Energy planning	12	(2)	10.285	(1.745)	2.5
Renewable energy (including studies)	10	(7)	5.670	(8.780)	1.4
Forestry (GTZ)[c]	11		16.870		4.0
Regional total	72	(27)	412.991	(140.535)	100.0 (19.7% of total German energy aid)

SOURCES:
German data submitted to IBRD meeting on Assistance to the Energy Sector in Developing Countries, Paris, June 25-26, 1979.
Annex to *Report by the Working Party of the OECD Council to Develop a Coordinated Effort to Help Developing Countries Bring into Use Technologies Related to Renewable Energy.*
Interviews with German government officials.

[a]Numbers in parentheses indicate the number of additional projects planned (funds for these not yet committed) in each sector, based on BMZ projections in November 1979.

[b]Numbers in parentheses indicate the amount of additional expenditures planned (but not yet committed) in each sector, based on BMZ projections in November 1979.

[c]No information available to indicate what percentage of forestry projects are meant primarily for fuelwood production.

Table B CIDA's Energy Aid by Region (1978/79 and 1979/80)

	No. of Projects/ Programs	Amount ($US Millions)	Sectoral Energy Aid as % of Regional Total	
Commonwealth Africa				
Power generation				
Hydroelectric	1	16.40	69.3	
Other	0	0	0	
Transmission & distribution				
Rural electrification	3	2.30	9.7	
Other	10	3.09	13.1	
Power sector studies	2	0.39	1.6	
Fossil fuels recovery	0	0	0	
Tech. assis./Energy planning	2	0.26	1.1	
Renewable energy	2	0.21	0.9	
Fuelwood	7	1.02	4.3	
Regional Total	27	23.67	100.0	(25.9% of total CIDA Energy aid)
Francophone Africa				
Power generation				
Hydroelectric	1	1.770	7.7	
Other	0	0	0	
Transmission & distribution				
Rural electrification	1	0.026	0.1	
Other[b]	10	20.520	89.0	
Power sector studies	1	0.170	0.7	
Fossil fuels recovery	0	0	0	
Tech.assis./Energy planning	1	0.034	0.1	
Renewable energy[c]	0	0	0	
Fuelwood[c]	4	0.520	2.3	
Regional Total	18	23.040	100.0	(25.2% of total CIDA Energy aid)

SOURCES:
CIDA data submitted to IBRD meeting on Assistance to the Energy Sector in Developing Countries, Paris, June 25-26, 1979. Annex to *Report by the Working Party of the OECD Council to Develop a Coordinated Effort to Help Developing Countries Bring into Use Technologies Related to Renewable Energy.*

[b] Includes $13 million loan to CIMAO (Togo).
[c] "Renewable energy" and "Fuelwood" include projects of Canadian International Development Research Centre (IDRC).

Table C French Energy Aid by Region (1976-1979)

	No. of Projects/ Programs	Amount ($US Millions)	Sectoral Energy Aid as % of Regional Total	
Francophone Africa				
Power generation (including studies)				
Hydroelectric	6	149.00	61.9	
Other	4	26.20	10.9	
Transmission & distribution (including studies)				
Rural electrification	0	0	0	
Other	7	34.40	14.3	
Fossil fuels recovery	0	0	0	
Tech. assis./Energy planning	2	4.90	2.0	
Renewable energy				
Research/Development[a]	23	5.83	2.4	
Application/Production	46	17.00	7.1	
Fuelwood	1	3.40	1.4	
Regional totals	89	240.73	100.0	(86% of total French energy aid)
Commonwealth Africa and Other Africa				
Power generation (including studies)				
Hydroelectric	0	0	0	
Other	0	0	0	
Transmission & distribution (including studies)				
Rural electrification	0	0	0	
Other	1	2.9	74.4	
Fossil fuels recovery	0	0	0	
Tech. assis./Energy planning	0	0	0	
Renewable energy				
Research/Development[a]	4	0.2	5.1	
Application/Production	5	0.8	20.5	
Fuelwood	0	0	0	
Regional total	10	3.9	100.0	(1.4% of total French energy aid)

SOURCES:
French data submitted to IBRD meeting on Assistance to the Energy Sector in Developing Countries, Paris, June 25-26, 1979.
Annual reports, Caisse Centrale de Coopération Economique, 1976, 1977, 1978.
Interviews with Ministère de la Coopération and the Commissariat à l'Energie Solaire (COMES).
[a] Includes technical assistance and studies for renewable energy.

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Table D U.K. ODA Energy Aid[a] by Region (1973-present)

	No. of Projects/ Programs	Amount ($US Millions)	Sectoral Energy Aid as % of Regional Total	
Africa				
Power generation, transmission, and distribution (including studies)				
Hydroelectric	4	65.73	93.6	
Other	1	4.20	6.0	
Fossil fuels recovery	0	0	0	
Tech. assis./Energy planning	0	0	0	
Renewable energy				
Research/Development[b]	4	0.28	0.4	
Application/Production	0	0	0	
Fuelwood	0	0	0	
Regional total	9	70.21	100.0	(47% of total U.K. energy aid)

SOURCES:
Interviews at Overseas Development Administration Science and Technology Department.
U.K. data submitted to IBRD meeting on Assistance to the Energy Sector in Developing Countries, Paris, June 25-26, 1979.
[a] Includes projects financed from ODA funds and administered by other agencies (ITDG, etc.).
[b] Includes technical assistance and studies for renewable energy.

IV. Developing African Hydrocarbons

Little attention had been given by donors to the development in indigenous hydrocarbons in Sub-Saharan Africa before the sudden oil price increases of the 1970's. It was taken for granted that the pattern of substituting kerosene and/or cheap hydropower for traditional fuels, particularly fuelwood, would be followed in Africa as it had been historically in the industrialized countries. In any event, it was assumed that exploration and development could be expected to be conducted by the private oil companies and therefore official concessional aid would not be required.

This outlook has now drastically changed. Both the need for and the desirability of locating and developing indigenous hydrocarbons resources in Sub-Saharan countries has become an objective of economic development concern and priority.

Among the donors, the World Bank has moved the fastest and furthest to initiate programs to identify the potential of existing resources and has already launched substantial exploratory activities in Africa.

Studies and field surveys carried out by or for the Bank have identified 15 Sub-Saharan countries with a potential for natural gas production and 39 with ultimate recoverable oil reserves, as well as 38 with hydro potential and 10 with some supplies of coal.

In 1980/81, the IBRD financed $69 million in seven hydrocarbon projects in Africa. The countries involved were Guinea-Bissau, Liberia, Mali, Madagascar, Somalia, Tanzania and Congo. For 1982, 12 lending operations, totalling $230 million are in preparation

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for Africa, 11 of them for exploration. The projects are located in Kenya, Madagascar, Sudan, Tanzania (2), Benin, Chad (in abeyance), Equatorial Guinea, Ghana, Ivory Coast, Mauritania and Senegal.

In addition to these hydrocarbon projects, the Bank has under preparation other energy projects, including fuelwood, involving $516 million in Bank funding for Africa.

V. Developing Fuelwood and Other Renewables

Dependence on imported oil poses serious economic and financial problems for the modern commercial and industrialized sectors of most Sub-Saharan countries.

Equally, and perhaps even more serious is the growing scarcity of fuelwood. It has only recently been recognized that for virtually all of oil-importing Africa, fuelwood remains the primary source of all energy consumed -- rural and urban, commercial and non-commercial combined. In 19 countries with a combined population of 212 million, it makes up more than four-fifths of total energy used. In rural areas it is virtually the only cooking fuel for 80% or more of the urban populations as well.

Already demand vastly exceeds annual replenishment rates. FAO and IBRD studies estimate that for most Sub-Saharan countries annual planting for the next 20 years will have to be 10 to 15 times current levels. This means almost one million hectares of new planting a year, through the year 2000, even if very substantial savings - up to 50% - are made in greater efficiencies of use and in substituting alternate fuels. The assumed savings and substitute fuels will also require substantial resources.

Recognition of the growing seriousness of Africa's fuelwood/forestry problem has been increasing among both African governments and the donor community. Such recognition has led to a growth of effort and action along two lines. The first has been a marked increase in reforestation and fuelwood programs, emphasizing not only government-managed plantations but also local community and family level social reforestation activities. The second approach has been to identify, test and replicate appropriate technologies that will either increase the efficiency of fuelwood use -- e.g. improved wood burning stoves and charcoal kilns -- or will serve as substitutes for fuelwood, e.g. solar ovens, biogas digesters.

A. Reforestation and Fuelwood Supply

Although at the present time the combined African and donor efforts fall far short of the pace needed to achieve adequate fuelwood production goals, many of the elements of a potentially successful program are present.

Combined donor assistance for conventional forestry programs is quite substantial, cumulatively amounting to about $1.5 billion as of the beginning of 1980. Much of this is directed toward strengthening African forestry departments' infrastructure and land use management capabilities prerequisite to larger and stronger domestic fuelwood production programs. Only a few fuelwood planting projects are underway but several donors have had extensive experience in Africa with large-scale commercial forestry plantations, primarily in extraction for export, and this experience is at least partially transferable.

In addition to small scale village level projects by some dozen donors, Germany and the U.S. are engaged in a 1,300 hectare fuelwood plantation project in Gambia. France and the IBRD are cooperating in plantations to supply Niamey with fuelwood and in a proposed program of 2,000 hectares in Burundi. Germany, France and the IBRD are engaged in a project to supple fuelwood and lumber around urban areas in Upper Volta. Belgium has a five-year pilot plantation program of 1,000 hectares in Rwanda and has a smaller fuelwood program in Cape Verde. United States and Senegal are cooperating in a 3,000 hectare plantation designed to supply part of Dakar's future fuelwood needs. The United Kingdom has an ongoing woodlot project in Lesotho, which has resulted in the planting of 2,170 hectares in five years, and a fifteen year project in Malawi has produced a matured stand of 54,000 hectares in pine and eucalyptus. Originally intended for pulpwood, consideration is now being given to its use for alternate fuels.

Since 1977, the IBRD has funded fuelwood plantations for the following countries as part of wider forestry loans or as a component of agriculture or rural development sector projects, at costs estimated in the neighborhood of $76 million.

Country	Hectares of Fuelwood Plantations to be Planted
Niger	1,600
Mali	3,520
Malawi	12,000
Senegal	5,000
Nigeria	24,000
Burundi	2,000
Upper Volta	1,925
Tanzania	5,435
TOTAL	55,480

Based on calculations by the Bank's Renewable Energy Task Force, a possible five-year (1981-85) fuelwood plantation (and related wood energy project components) has been suggested for 39 African countries which, if fully funded, would finance

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440,000 hecatares of new fuelwood planting. The Task Force estimated total costs at about $680 million over the five years, suggesting that external financing might be required for about half of the total amount, or $350 million.

Fuelwood planting even on this increased scale falls well short of the Bank's own estimate of African requirements. Nevertheless, for the selected countries it would represent a very substantial increase in annual fuelwood planting, as compared with current levels, and could serve to galvanize and enlist African government commitment of resources for expanded manpower, training and related forestry infrastructure as well as for fuelwood planting and production programs on a much larger scale.

B. Solar and Other Renewable Energy Sources

Eleven bilateral donors and eight multilateral donors have solar research, development and/or demonstration programs underway or planned in 28 African nations. France, for example, has been fielding and testing SOFRETES and other solar-powered thermal and photovoltaic installations for drinking water, cattle watering, irrigation systems and electrification in Africa for more than ten years, with more than 15 using photovoltaic energy and 123 using thermodynamic energy; has tested and installed 22 photovoltaic powered educational television systems for remote rural areas in Niger, and has collaborated with the UNDP and the U.S. in supporting the Organization Nigerienne de l'Energie Solaire (ONERSOL), a regional solar energy research and solar equipment fabrication center in Niamey.

Biogas projects are being donor-supported or planned in Rwanda, Senegal, Sudan, Tanzania, Upper Volta and Zaire and wind-powered projects are underway in Benin, Ethiopia, Cape Verde, Kenya, Senegal and Upper Volta. Plans for developing geothermal resources are being assisted by Sweden in Tanzania; by Switzerland (with UNDP) in Cape Verde; by the World Bank, the African Development Fund, the United Kingdom in Kenya; and by Italy in Djibouti and Ethiopia. CNRET is also assisting in geothermal exploration in Kenya and Madagascar.

VI. Examples of Donor Energy Assistance Policies

All donors are giving greater attention to energy projects in their overall aid programs and a few have begun to formulate more comprehensive aid policies and strategies in this field.

Among those of special interest are France, Germany, Canada, the Netherlands, and the World Bank.

A. France

France, which is one of the largest single donors in the field of energy in Africa, has articulated an energy aid policy as:

> "an integral part of a global development strategy which is defined in the light of existing constraints and specific local conditions. The French program for energy development rests on three principles:
>
> - Energy cooperation must cover all stages of the energy chain, i.e. in addition to energy production also the essential emphasis of energy planning and distribution.
>
> - The choices of energy sources must be adapted to both local conditions and needs; there is no generally applicable solution, and all energy sources have a role to play.
>
> - The solutions found must be able to be implemented by the recipient countries themselves; this requires an adaptation of the technologies to local users as well as an important training effort (5).

In addition to substantial aid in conventional energy, France has sponsored an active research and development program in renewable energies, dating from the early 1970's.

Even before 1975, the French government sponsored an active solar research program. In that year, the Delegue aux Energies Nouvelles was established within the Ministry of Industry. At roughly the same time, the drought crisis in the Sahel prompted talks with Senegal, Mali, and Upper Volta, which led the Ministry of Cooperation (or FAC, for Fonds d'Assistance et de la Cooperation) to set up a special program to utilize renewable energy sources in Africa concentrated heavily but not exclusively in Francophone Africa. More recently, all solar-related renewable energy research and development in France has been brought under a new agency, the Commissariat a l'Energie Solaire (COMES), which also seeks out international cooperative ventures for the French solar industry (6).

B. Germany

Following the Bonn Economic Summit in July 1978, the German government decided to expand the scale of its energy cooperation with the developing countries. Measures focus on three sectors in accordance with the new policy guidelines of 1980: (1) promotion of conventional energy sources to reduce the dependence of developing countries on oil imports (this sector includes hydropower production and distribution); (2)

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support for afforestation programs; (3) promotion of new technologies in the field of new energy sources, particularly solar, wind and biomass.

A special feature of the German renewable energy program has been a deliberate policy of research and development of products including development of local manufacturing facilities, jointly with host country scientific agencies and/or private companies. Among African countries involved in these joint programs are Kenya, Mali, Niger, Senegal, Sudan, Tanzania and Upper Volta.

Funding in 1980 under the special renewable program totalled $34.8 million, as compared with $40 million for the previous five years (7).

C. Netherlands

Although the Dutch Directorate General for International Cooperation (DGIC) has limited project experience compared to the U.S. or the French, its concern with renewable energy sources dates from 1977. In November, 1979 the Dutch became the first agency to announce a radical redirection for energy lending to renewables. At the same time, the Dutch Foreign Ministry called for a boost of its development cooperation budget to 1½ percent of net national income annually.

The Dutch have promised to expand their renewable aid for developing countries by two principal measures. First the Dutch will increase the funding of their renewable program. They promised to provide over $13 million in the period 1980-1982 for financing research into the application of renewable sources of energy for developing countries. Also included is a pledge of $40 million annually to afforestation programs and dessemination of more efficient means of wood use, especially in the Sahelian region of Africa. The Netherlands also continues to augment its training programs, particularly by increasing emphasis on the energy planning capacities of aid-receiving countries.

D. Canada

Canada's policy of cooperation with developing countries in the energy sector is based essentially on the major principles outlined in a 1975-1980 strategy statement which stipulates that "the Canadian International Development Agency (CIDA) will focus its assistance to a greater extent on the most crucial aspects or problems of development - (particularly) ..... energy". Canadian strategy emphasizes the production of new energy supplies. The three major areas of Canada's bilateral aid program in the energy sector are (a) resource evaluation, (b) energy policy and sector management, (c) energy production (mainly hydroelectric generation) and transmission. Apart from hydroelectric projects, CIDA also

supports a number of small-scale projects, e.g. for windpower/waterpump research in Botswana and Ethiopia, and research into afforestation and production of firewood in several African countries.

As is the case with German energy policy, the Canadian government is supporting joint industrial cooperation, in this case enlisting private Canadian firms as partners with the developing countries.

In addition, the International Development Research Centre (IRDC) has financed, since its inception in 1970, 39 energy research projects totalling some $5 million. The projects currently under consideration include: crop, fish and meat drying; afforestation; firewood stove improvement; energy from aquatic biomass; rural energy/biogas production; solar energy/water distillation; rural; energy policy studies; and renewable energy information (9).

E. World Bank

The IBRD's expanded hydrocarbon development program is itself part of a broader, more inclusive energy assistance strategy which has emerged in recent years (10). It is the Bank's official view that responsibility for developing adequate energy policies and programs rests on the developing countries themselves. For any given country, the key elements of an adequate adjustment to the new energy era will need to include:

- a strategy for energy use integrated into a country's overall planning framework and development objectives;
- a vigorous program to substitute indigenous energy, including hydroelectric power, coal, fuelwood and domestic oil and gas, for imported oil, (the IBRD believes that domestic production of energy in the oil-importing developing countries can and should be doubled between 1980 and 1990);
- mobilization of the resources to carry out this vast program of domestic energy production;
- a major conservation effort, employing both price and nonprice policies; and
- formulation of appropriate domestic policies and investment strategies which will attract the necessary foreign private and public capital to supplement domestic resources.

For each of these components, the Bank believes that multilateral and bilateral assistance will be needed and can

materially accelerate the rate by which additional energy supplies are developed and more efficiently used.

Although the IBRD is taking a leading role in terms of total financing, it sees its role as a catalytic one, stimulating a major growth and redirection of investment resources in which ultimately the Bank's share would be 5 to 10% of the total. A midterm program covering 1981-85 identifies $25 billion in global energy investment in "desirable" projects, in which the Bank's share is likely to be closer to 30%. This is because a large volume of concessional aid is needed for preinvestment exploration to confirm prospects and to attract private and other investment for production.

An example of how Bank investment strategy may work can be found in a recent experience in Mali. A $1,000,000 project preparation advance by IDA in 1979 has led to the participation by two large oil companies in financing 100% of the $20 million costs of an exploration well in the north.

Foreign aid programs will be important for both their financial contributions and their technical advisory roles. Most important, however, in the Bank's view is the fact that to succeed, these efforts must be far more collaborative both among donors and between them and their African clients.

VI. Coordination and Collaboration

From a plethora of projects, and a collection of emerging donor policy concepts and ideas, it seems that one aspect of the problem has become clear: if energy problems and their solutions are country-specific, then coordinating efforts will need to be country-specific as well.

This is not to say that greater exchange of information and plans among donors at any level is not useful. A great deal of useful work along this line is being pursued within the framework of the Organization for Economic Cooperation and Development (OECD), particularly its Development Assistance Committee (DAC).

The CILSS and Club du Sahel have also contributed to an improvement in regional African/donor discussion and planning, particularly in the forestry/ecology and agricultural production sectors.

However, if energy aid is to be integrated with and contribute to more effective economic development programs, that integration should take place where development is taking place: within specific countries and through specific investments and activities in pursuit of national development goals.

The energy policies of the IBRD and other donors cited above suggest that country oriented, rather than sector oriented, energy strategies may be evolving in which African economic development plans and planning must play a larger role.

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The heightened concern over energy-related constraints on African development provides additional incentives for USAID missions to encourage host African governments to initiate more effective arrangements for coordination among donors in the energy sector as a part of their efforts to increase their capacity to plan and manage their own energy programs.

FOOTNOTES

1. Source: Thomas Hoffman, Brian Johnson, The World Energy Triangle: A Strategy for Cooperation, International Institute for Environment and Development, Ballingers, (Cambridge, Mass.) 1981.

2. Figures are cumulative through 1979.

3. The exceptions are Nigeria, Gabon, Cameroon, Angola and possibly the Ivory Coast.

4. These tables are from the Hoffman/Johnson report previously cited. The sources cited in the tables are those used by the authors.

5. DAC/OECD, Financial and Technical Assistance from DAC members for Energy Development in Developing Countries, with Special Reference to New and Renewable Sources of Energy, DCD/81.3, Paris, 19 May 1981. Hereafter cited as DAC (1981).

6. Hoffman/Johnson (IIED)

7. DAC (1981)

8. Hoffman/Johnson (IIED)

9. DAC (1981)

10. World Bank, Forestry: Sector Policy Paper, February 1978, 65 pp.
Ibid., A Program to Accelerate Petroleum Production in the Developing Countries, January 1979, 31 pp. plus maps.
Ibid., Energy in the Developing Countries, August 1980, 92 pp.
Ibid., Accelerated Development in Sub-Saharan Africa, 1981, 133 pp. plus annexes.
Ibid., World Development Report 1981; Chapter 4, "Energy a New Era", June 1981.

PREFACE

"Table 5 lists bilateral and multilateral energy assistance according to recipient country and region. It includes all of the projects of the following agencies for the periods as given:

Multilateral Aid

World Bank (1972 - December 1978)
.....
OPEC Special Fund (1977 - current)
United Nations Development Programme (to Jan. 1979)
United Nations Centre for Natural Resources, Energy and Transport (to Jan. 1979)
European Development Fund (to May 1978)

Bilateral Aid

Canada (1978/79, 1979/80)
France (1976-1979)
Federal Republic of Germany (1970-present)
Kuwait (FY 1973-FY1978)
Netherlands (1970 - present)
United Kingdom (1973 - present)
United States (1978-1980)

"..... This table also includes all energy projects of the U.N. system, and available data on projects of some other major donors (including Japan, New Zealand, Sweden, Switzerland).... Table 5 is not, therefore, meant to present a total picture of world energy aid, since for reasons of time and available resources, certain bilateral and OPEC aid programs (as well as smaller multilateral banks) were not included in this study. The comprehensiveness and accuracy of Table 5 may be limited by data-reporting systems of aid donors, but we believe that it provides a good general picture of comparative order of magnitude among countries and regions for energy aid projects after 1972.

"It must be emphasized that Table 5 takes a picture of a moving target: It does not cover one consistent chronological period for all agencies represented. Multilateral agencies compile statistical data on a fiscal year basis whereas the U.N. system present information on a "current project" basis. Bilateral agencies use both systems: It is possible to examine budget projections for many bilateral agencies on a fiscal year basis, but project disbursements are more often characterized on the "current project" basis. Finally, the information on multilateral agencies and the U.N. system is publicly available and comprehensive. Bilateral aid statistics are harder to obtain (although this is not true of renewable energy aid, which is well publicized), and as the Development Assistance Committee of the OECD points out, difficult to portray on a comparative basis. For these reasons, Table 5 tends to be biased in favor of renewable energy projects and in favor of recent projects."

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ANNEX A

INTERNATIONAL ENERGY AID BY RECIPIENT COUNTRY AND DONOR

This compilation was originally prepared by the staff of the International Institute for Environment and Development (IIED), Washington Office, as Table 5 for the report by Thomas Hoffman and Brian Johnson, The Energy Triangle: A Strategy for Cooperation, 1981. It covers current and planned projects of most major donors, approximately as of mid-1980.

It was updated by staff members of the International Science and Technology Institute (ISTI) as Annex B-1 of the Draft Project Paper: Energy Initiatives for Africa.

The following explanation is excerpted from the preface to Table 5, the original IIED compilation.

International Energy Aid by Recipient Country and Region

EAST AFRICA

	Donor	Year	Project	Amount $USmil
BOTSWANA				
Rural electrification	SIDA	1977	Rural electrification	1.12
Fossil fuel-exploration and recovery	UK	1974	Coal deposit study	0.039
National energy planning/Tech.Assistance	WB		Loan for Francistown development	3.0
	Neth.	1975-79	National Resources Study	0.092
	USAID	1982	Resource Planning & Mgmt.	.600
Renewable energy	USAID	1979-80	Small scale R & D	1.08
	Canada	1978-80	Wind/water project	0.035
	USAID	1980-83	Technology	2.304
Forestry/fuelwood	USAID	1980-82	Rural Sector Grant	3.780
BURUNDI				
Power generation, transmission & distribution	EDF	pre-1975	Energy Infra/Production	0.574
	EDF	1978	Ruzizi Dam study (w/Rwanda & Zaire, t = $1.62)	0.540
	Belgium	1978	Hydro project	0.79
	Belgium	1979	Hydro project	0.592
	UNDP	1974-77	Hydro potential studies	0.42
	Germany		Distribution-Mramuya	1.7
	Germany		Distribution-Ngozi/Kaganza	7.2
	Germany		Distribution-Bujumbura	2.2
	Germany		Distribution-Gitega	2.6
	Germany		Distribution-Nugyenga	2.5
Rural electrification	EDF	1978	Rural electrification	1.4175
	Germany		General Plan for Rural Elec.	0.78
Energy planning/TA	Germany		T.A.-- Advisor to REGIDESO	2.7
	Germany		T.A.-- Electric Provision Bujumbura	0.1
	Germany		T.A.-- Rural Electrification	0.44
Renewable energy	UN	1979	Solar advisory missions	-
	France	1977	Solar dryer	0.024

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Forestry/fuelwood	Ireland	1978-79	Peat	0.008
	USAID	1978-80	Peat	2.995
	WB	1979	Village afforestation	4.4
	USAID	1980-83	Peat	8.000
	USAID	1980-82	Bururi Forest	1.366

COMOROS

Power generation	France	1977	Vardjou Thermal	1.07
Renewable energy	EDF	1979	Energy for Microwave Relay	0.270

DJIBOUTI

Power generation	France	1976	Distribution	2.85
Geothermal	Italy		Geothermal	-
	UN/UNDP	1978-79	Geothermal fluid test	0.471
Renewable energy	UN		Short term solar advisory	-
	France	1978	Solar pump	0.12
Energy planning	USAID	1981-82	Energy Initiatives	4.000

ETHIOPIA

Power generation, transmission, distribution	Germany		Transmission Consortia	10.7
Geothermal	EDF	1978	Geothermal	5.535
	Italy		Geothermal	-
	UN/UNDP	1979	Geothermal investigation	0.52
	UNDP	1976	Geothermal exploration	0.206
	UNDP	1977	Geothermal exploration	0.08
	IDRC	1972	Awash valley geothermal studies	1.9
Energy planning/TA	CIDA	1978-80	Power training	0.043
Renewable energy	France	1979	Solar equipment	0.049
	IDRC	1976-79	Windmill studies	0.13
	Canada	1978-80	Wind/water	0.087

Forestry/fuelwood	WFP	1974-83	Terracing and reforestation	3.20
	Sweden	1975-79	Forestry	11.50

KENYA

Power generation, transmission & distribution	WB	1976	Gitaru hydroelectric	63.0
	EDF	1978	Upper Tana Dam	35.555
	EIB	1978	Upper Tana Dam	16.2
	Denmark		Hydro	0.05
	UK	1978-80	Tana Hydro	14.87
	SIDA	1975-	Kambura hydro	0.02
	SIDA	1974	Kambura hydro	6.0
	UK		Tana River Kyow	11.6
	CIDA	1979-82	LOC electrification	3.48
	FGR	1978	Upper Tana Dam	49.6
	WB	1981-	Geothermal	40.000
Rural electrification	SIDA	1973	Study for rural electrification	0.700
	CIDA	1979-82	Rural electrification	0.565
	SIDA	1977	Rural electrification	0.312
Fossil fuels	WB	1975	Oil products pipeline	20.0
Geothermal	UN/UNDP	1979	Geothermal exploration	0.073
	WB	1978	Dev.of geothermal resources	35.0
	UNDP	1976	Geothermal expl. and study	0.090
	UNDP	1970-75	Geothermal expl. and dev.	1.151
	AFDB	1979	Geo. dev. at Olkaria	9.71
	WB	1979	Olkaria geothermal	9.00
Energy planning/TA	UNDP	1979	Energy planning	0.413
	CIDA	1979-82	Planning engineers	2.48
Renewable energy	Germany		Solar pump	0.73
	UNIDO		Dev. of solar salt prod.	0.013
	Germany		Baking and cooling apparatus	0.28
	Germany		Subsidation of renewable research project	0.08
	USAID	1981-83	TA	4.800
	Germany	1981	Rural Renewable	-
	France	1977	Solar pump	0.49
	UK	1973-77	Geothermal Research	0.59
	UK		Micro hydro feasibility	0.126
	Neth.	1977	Wind Research	0.012
Forestry/fuelwood	WB	1975	2nd forestry plantation	20.0
	Canada	1975-79	Forestry/fuelwood	0.148
	USAID	1979-83	Arid & Semi-arid lands dev.	13.000

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KENYA - Cont'd.				
Miscellaneous	CIDA	1979-80	Acres mobilization	0.043
	WB	1978	Bura irrigation	5.4
LESOTHO				
Power generation	Canada (CIDA)		Hydro	0.73
Energy planning/TA	UNDP	1976	Oxbow Complex feas. study	1.864
	CIDA	1978-79	Thaba Tseka Mt. (TA)	0.26
	Neth.	1975-79	National Research survey	0.092
Renewable energy	Holland		Solar	-
	CIDA	1978-82	Renewable dev. project	4.0
	USAID	1979	Small scale hydro R & D	0.574
	USAID	1979-	Technology	1.600
MADAGASCAR				
Fossil fuels	UNDP	1978-79	Petrol & mineral resource study	0.238
Geothermal	UN/UNDP	1979	Geothermal development	0.069
Renewable energy	France	1976-79	Technical assistance	1.02
	France	1979	Solar pumps	0.49
	Switz.	1978-79	Solar	0.03
	France	1979	Microhydro	0.6
MALAWI				
Power Generation	WB	[illegible]73	2nd power: hydro	7.5
	WB	1977	3rd power: hydro	8.0
	EF	1978	Nkula Falls Dam II	11.475
	Canada	1979	Hydro	5.348
	UK	1979	Tadzani Falls	8.61
	WB	1977	Hydropower House	17.0
	AFDB	1975	Nkula Lilongire powerline	6.25
	EEC	1977	Hydro power production	9.7
	FGR	1978	Nkula Falls Hydro	6.66
	UK	-	Nkula Falls Hydro	20.79
Renewable energy	EDF	1978	Solar H_2O heating--Mangocho	0.135
Forestry/fuelwood	AFDB	1979	Kasungu fuelwood plant	7.28
	WB	1981-	Wood energy	13.8

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MAURITIUS				
Power generation	WB	1978	Power transmission	15.0
	EIB	1978	Thermal power station	2.7
	France	1976	Thermal	5.37
	UNDP	1976-79	Cascade Diamamoure, Hydro	0.250
	UNDP	1973	Quatre Soeurs Hydro	0.354
	AFDB	1975	Saptiste Dam	5.0
	France	1977	Transmission	7.32
Renewable energy	UK	1978-79	Seawave energy	0.084
	France	1979	Heliostats	0.024
Forestry/fuelwood	WB	1973	Rural dev. of fuelwood	2.7
MOZAMBIQUE				
Power generation/transmission/distribution	UNDP	1976	Elec. generation plant	0.122
	UK	1978	Quelnine oil thermal	4.2
	Neth.	1978-79	City diesel generator	8.25
	Neth.	1977	Diesel generator repair	0.25
	Neth.	1978	Elec.Material-Electricidad do Macambigou	1.0
Energy planning/TA	UN	1979	Technical assistance to Elec. Commission	0.178
RWANDA				
Power generation	EDF	pre-1975	Energy Infra/Production	20.7
	EDF	1978	Ruzizi Dam study (w/Burundi, Zaire, $t = 1.62)	0.54
	EDF	1978	Mukungwa Dam	27.0
	EDF	1978	Kigoma Mururu power line	5.26
	OPEC		Mukungwa hydro	2.35
	EDF	1962	Electric distribution (national grid)	20.79
	Germany		Giserieje Hydro	1.2
	"		Kigali Oil Thermal	2.1
	"		Study-Thermal Power	0.28
	"		Study-Ruhengeri/Gisenye Thermal	0.19
	"		Electric distribution	6.4
	"		Transmission Materials Kigali	0.67
	"		H.V. Distribution Line-Rulindo-Molendi	0.42
	"		Gisenye Electrical Materials	1.2

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RWANDA - Cont'd.

Rural electrification	Switz.	1979	Electrification	7.94
Fossil fuels	UNIDO	1978	Rehabilitation of Lake Kivu gas	0.06
	UNIDO	1979	Rehabilitation equipment inspection	0.046
	UNDP/UNIDO	1971-77	Exploration of Lake Kivu gas	0.184
Renewable energy	France	1977	Solar dryer	0.024
	Belgium	1978-79	Solar	0.251
	France	1979	Biomass	0.049
	Belgium	1978-79	Biogas	0.269
	USAID	1979	TA	.488
Energy planning	USAID	1982	Rural works	.250
Forestry/fuelwood	WB	1979	Village afforestation	3.0
	WB	1981	Forestry Development	4.000

SOMALIA

Power generation	Kuwait Fund	1975	Expand Mogadiscio	21.7
Renewable energy	EDF	1978	Utilization of molasses	0.155
Forestry/fuelwood	UNIDO	1979	Dev. of charcoal plant	0.026
Energy planning	WB	1981-	TA	5.000

SUDAN

Power generation	WB	1975	Transmission and generation	23.0
	OPEC		Hydropower II	9.5
	Germany		Roseires Dam	40.8
Energy planning/TA	Germany		T.A.-Hydro Engineering	0.075
	Germany		T.A.-Central Electric & Water	0.56
Rural electrification	WB	1973	Irrigation and rural elec.	42.0
	WFP	1973	Commodities for above	2.3
Renewable energy	Denmark	1979	Solar	0.04
	France	1976-78	Solar pumps	0.459
	France	1979	Experts	0.105
	Germany	1979	Water Hyacinth Biomass	1.890
	EDF	1978	Utilization of Molasses	0.155
	Germany		Um Safari Oases-Solar Proj.	0.56

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SUDAN - Cont'd.				
Renewable energy	Germany		Exploration of Renewable Energy	0.83
	USAID	1981-82	Rural	4.588
	Germany	1981	Rural renewable	-
Forestry/fuelwood	Canada	1975-80		0.122
Energy planning	USAID	1980-91	Training	.200
	USAID	1981-82	TA	-
SWAZILAND				
Renewable energy	US	1979	Alternate energy resources	0.45
Energy planning/TA	Neth.	1975-79	National Resources Survey	0.092
TANZANIA				
Power generation	WB	1974	Kidatu supplementary	5.0
	WB	1976	Kidatu 2nd stage	30.0
	Belgium	1977-79	Hydro	0.725
	Canada	1979	Hydro	8.18
	Norway	1979	Hydro	6.0
	UNDP	1979	Strengthening electric distr.	0.143
	CIDA	1976	Hale Moshi Transmission line	6.52
	CIDA	1975	Great Ruaha Power Project	15.0
	SIDA	1974	Kidatu Hydro	4.0
	CIDA	1971-75	Hale-Moshi Line	0.031
	CIDA	1971-75	Hale-Moshi transline	7.26
	CIDA	1978-80	Great Ruaha	0.165
	CIDA	1979-82	Mwanza-Musoma	8.873
	SIDA	1977	Hydro	14.99
	Germany		Kidatu Hydro	38.8
	Neth	1979	Mbeya R.P.	4.75
Fossil fuels	UNDP	1978	Dev.of coal production	0.52
	Norway	1977	Gas/oil field feasibility study	0.075
	Neth.	1976	Mineral exploration	1.225
Geothermal	SIDA	1976	Geothermal potential study	0.02
Energy planning/TA	CIDA	1975	Study for primary elec. resources	0.600
	CIDA	1971-75	Tanesco-for dev.of resources	2.550
	CIDA	1979-80	Tanesco-equipment	0.039
	CIDA	1978-80	Power study	0.215

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TANZANIA - Cont'd.				
Renewable energy	Denmark		Solar	0.035
	Switz.	1978	Solar/wind	0.020
	UNIDO/UNDP	1979-80	Dev.of solar salt prod.	0.140
	Neth	1972	Wind research	0.01
	Ireland	1979	Peat	0.001
	Neth.		Gasification (SIDO/77U)	0.937
	Neth.	1977	Wind Mill Research	0.91
	UNIDO/UNIDF	1979	Biogas technology demonstration	
	Germany	1981	Rural Dev.	-
Rural electrification	Germany		Rural Elec. Transmission Distribution	11.1
Forestry	WB	1976	Sao Hill Forestry	7.0
	Sweden	1979-80	Forestry	21.08
	WB	1978	Mwanza-Shinyanga	2.0
Energy planning	USAID	1981-82	TA	1.500
	WB	1981	TA	1.000
UGANDA				
Energy planning/TA	UNDP	1978-79	Energy dev. overall assessment	0.121
	Kuwait Fund	1975	Hydro feasibility study, increased sugar production	0.800
ZAIRE				
Power generation	EDF	pre-1975	Energy Infra/Production	26.19
	EDF	1978	Ruzizi Dam study (w. Rwanda, Burundi $t = 1.62)	0.540
	EDF	1978	Butuhe power station	2.235
	EDF	1975	400 Km network feeding power	26.19
	USAID	1983	Rural Hydro	2.000
Fossil fuel	WB	1979	Enhanced oil recovery	4.100
Energy planning/TA	EDF	HEP	Tea processing study	0.209
Renewable energy	Belgium		Solar power	-
	Belgium		Biogas	-
	France	1978	Telecommunications by solar	0.049

ZAMBIA				
Power generation	WB	1973	Rafue Hydro	115.00
	WB	1974	Kariba Hydro	42.10
	Sweden	1977	Kydro dam	1.14
	Neth.	1977	Mongu Kalabu Line	2.05
Fossil fuels	AFDB		MAMBA Colleries-coal mining	6.07
	Neth.	1974	Mine technology	0.318
Energy planning/TA	UNDP	1969-76	Senior electr. engineer	0.181
	France	1979	Experts	0.002
Forestry	WB	1977	Industrial forestry	16.8

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WEST AFRICA

BENIN				
Power generation	UNDP	1979	Hydro feasibility study	0.310
	CIDA	1974-75	Ghana-Togo-Benin line	0.400
	CIDA	1978-82	Ghana-Togo-Benin line	1.320
Energy planning/TA	UNDP	1964-77	Energy supply and demand forecast	0.100
Renewable energy	UNIDO	1979	Solar/salt production	0.270
Forestry	USAID	1978	Charcoal production	0.350
	USAID	1979	Charcoal production	0.560
	USAID	1979	Wood charcoal	0.060
CAMEROON				
Power generation	EDF	pre-1975	Energy Infrastructure/Prod.	0.977
	EIB	1978	Songloulou dam	18.225
	EDF/EIB		Dam schemes	10.125
	Kuwait Fund	1979	Songloulou power	16.020
	Germany		Distribution/transmission Electric Network Southwest	1.700
	France	1976-79	Songloulou Hydro	45.030
	France	1978	Songloulou Transmission	4.880
Nuclear	UNDP/UN	1971-76	Nuclear materials pros.	0.165
Energy planning/TA	CIDA	1977	Energy study	0.020
	Germany		Power CAM Advisor	1.700
	Germany		West Cameroon Energy Plan (Study)	0.940
Renewable energy	EDF	1978	5KW solar pump	0.259
	France	1976	Solar pump	0.170
	France	1976-79	Technical assistance	0.268
	France	1976-78	Scholarships	0.070
	France	1979	Solar refrigeration	0.049
	France	1979	Solar pumps	0.146
	EDF	1979	5KW solar irrigation pumps	0.419
	WB	1977	Rice husk biomass	16.020
	Germany		Biogas	0.360
CAPE VERDE				
Power generation	EDF	1978	Distribution network	0.473
	Holland	1978	Electric supply-Porto Novo	0.510
	USAID	1978-81	Solar desalination	3.595

CAPE VERDE - Cont'd.				
Renewable energy	USAID	1978-79	Renewable	2.85
	Switz.	1975	Solar	0.05
	France	1978	Air generators	0.159
	France	1979	Wind generators & dryers	0.12
	France	1979	Solar pumps	0.073
	France	1979	Electricity production	0.29
	Switz.	1975	Wind	0.05
	France	1978	Heliostat and wind generators	0.16
	Neth.	1975	Wind research	0.013
	USAID	1980	TA, training	.500
Fossil fuels-Exploration and Development	Germany		Butane Bottling Plant	2.3
Geothermal	Switz.	1975	Geothermal	0.070
CHAD				
Power generation	Kuwait Fund	1975	N'Djamena power expansion	0.805
	France	1978	N'Djamena/Sack generator and study	2.684
Fossil fuel	UN/UNDP	1979	Petrol exploration	0.312
	UN	1979	Petrol advisory mission	-
	OPEC	1979	Oil refinery project	4.500
Renewable energy	France	1976	Solar pumps	0.24
	France	1976	Heliostat pumps	0.024
	France	1977-78	Solar station	0.46
	France	1976-78	Technical assistance	0.195
	France	1976-78	Scholarships	0.07
Forestry/fuelwood	WB	1978	Savannah woodlands management	0.400
	WB	1977	Sahelian reforestation	0.400
	Germany		Reed and charcoal study	0.06
CONGO				
Renewable energy	France	1976-79	Technical assistance	0.7
	France	1979	Methane fermentation	0.024

GABON				
Power generation, transmission & distribution	Germany		Study of water & electric provision	0.31
	France	1976	Ichembele Hydro	24.39
	France	1978	Assegue Transmission	4.88
Energy Planning/TA	France	1977	Quining Center Orlando	2.44
GAMBIA				
Power generation	UNDP	1978-79	Assistance to power generation	0.645
	AFDB	1975	Banjul diesel plant	2.5
	CIDA	1978-80	Hydro	0.33
	Germany		Banjul Power Plant	1.5
Energy Planning/TA	Germany		T.A.-Gambia Utilities	1.11
Renewable energy	UNIDO	1979	Solar salt works	0.027
	WB	1976	Biomass	—
Forestry/fuelwood	US	1979	Fuelwood	0.15
	USAID	1980	Fuelwood	1.188
	USAID	1979		
GHANA				
Power generation	WB	1977	3rd Power distr.	18.0
	WB	1977	Kpong Hydro	39.0
	EDF	1978	Kpong Dam	12.01
	EIB	1978	Kpong Dam	13.5
	EIB	1978	Interconnection of networks w/Ivory Coast (t = 14.85)	7.425
	CIDA		Hydro	29.9
	CIDA	1978-82	Kpong Hydro	23.65
	CIDA	1979-81	Ghana/Togo/Benin transmission line	0.065
	OPEC	1979	Bui Hydro	1.63
	OPEC	1979	Kpong Hydro	3.7
	Kuwait	1979	Pong Power station	31.93
	CIDA	1977	Hydro study	0.131
	CIDA	1977	Hydro	28.62
	Austrl.	1977	Hydro	2.22
	Germany		Distribution-Electric Network, Accra	15.2
	Germany		Distribution-Transmission Volta Reju	15.6

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GHANA - Cont'd.				
Energy planning/TA	Germany		T.A.-ECG Advisor	0.72
	Germany		T.A.-Electrification Plan	1.0
	USAID	1978		0.2
Renewable energy	Germany		Solar House Cooling	0.54
	USAID	1978	Pyrolitic converter	0.083
	USAID	1979	Pyrolitic converter	0.83
	*USAID		TA	3.500
Forestry	Canada	1977-80	Forestry/firewood	0.13
	UNIDO/UNDP	1979	Charcoal production	0.019
	WFP	1975-83	Forestry, wood and charcoal	1.35
GUINEA				
Power generation	UNDP/UN	1969-77	Electric power	0.216
	France	1978	Study-Grandes Chutes Hydro	0.316
Fossil fuels	UNDP	1979	Petrol production, distr.	-
Renewable energy	France	1978-79	Solar program	0.212
Forestry/fuel	*USAID	1091-82	Nursery	.500
GUINEA-BISSAU				
Energy planning/TA	UN/UNDP	1979-81	Dev. of electrical energy	0.248
	UN/UNDP	1975-78	Management electric supply	0.113
	Sweden	1977	Energy project	0.736
	Germany		T.A.-Electric Provision (Bissau)	0.89
Forestry/fuelwood	USAID	1980	Forestry management	0.05
	*USAID	1982	Management	1.000
IVORY COAST				
Power generation	EIB	1978	Distribution network	14.85
	EIB	1978	Interconnection of network	7.425
	CIDA	1978-80	Credit Bidi powerline	1.567
	CIDA	1978-82	Kassou Daloa line	3.03
	CIDA	1977	Electr. distribution	2.86
	France	1977	Hydro Buyo	51.22
	France	1978	Korbugo Feinkessdogou	3.9

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IVORY COAST - Cont'd.				
Rural electrification	CIDA	1978-80	Rural electrification	0.022
Forestry	WB	1979	Dev. of forest resources	18.0
LIBERIA				
Power generation	WB	1973	Power supplementary	2.9
	WB	1975	3rd Power	1.8
	WB	1978	4th Power	10.0
	EDF	1978	Mano river dam study	3.2
	EIB	1978	Bushrod power station	6.615
	Germany		Electric Dist.-Monrovia	11.0
	USAID	1978-81	Mini Hydro	.070
Fossil fuels	UN	1979	Petrol legislative advice	-
MALI				
Power generation	EDF	pre-1975	Energy Infra/Production	0.032
	EDF	1978	Selingue dam	25.86
	Belgium	1978	Hydro	-
	CIDA		Selingue dam line	8.399
	France	1978	Basundo Trans/Distr.	6.15
	France	1976	Selingue Hydro	8.54
	CIDA	1978-82	Selingue trans. line	8.545
	CIDA	1978-80	Plan director for transmission project	0.053
	Kuwait Fund		Selingue dam	17.8
	Germany	1977	Hydro-Selingue dam	19.4
	CIDA	1977	Transmission line	7.52
Energy Planning/TA	US	1978-79	General	0.03
Renewable energy	EDF	1978	Solar irrigation pumps	0.077
	EDF	1978	Yangasso solar	0.11
	EDF	1978	Tombouctou solar pump	0.09
	France		Mali/Senegal solar	2.9
	UNIDO/UNESCO	1978-79	Solar lab assistance	0.068
	CEAO	1979	Regional solar center	0.180
	France	1976-78	Technical assistance	0.16
	France		Scholarships	0.07
	France	1979	Tech. Asst. & Scholarships	0.24
	USAID	1978-80	Renewable R & D	2.7
	USAID	1978-82		4.100
	USAID	1978	Photovoltaic	.220
	USAID	1978	Photovoltaic	.220
	Germany	1981	Rural Renewable	-

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MALI - Cont'd.

Forestry/fuelwood	Canada	1974-79	Forestry/firewood	0.139
	WB	1975	Fuelwood	0.10
	WB	1979	Forestry	2.60
	USAID	1980	Village Reforest	.495

MAURITANIA

Power generation	UNDP	1979	Champagne hydro	0.19
	FGR		Nouakschott Diesel Power	0.9
Renewable energy	EDF	1978	Solar pump (10 KW)	0.041
	France	1977	Heliostat generators	0.049
	France	1978	Solar generator	0.37
	France	1977	Solar village pump	0.049
	France	1978	Solar distillery	0.146
	France	1978	Solar irrigation pump	0.12
	France	1976-78	Technical assistance	0.07
	France	1976	Missions	0.07
	USAID	1980		0.480
	France	1979	Solar pump	0.24
	France	1976-78	Solar center	2.07
	France	1976-77	Solar pump	0.15
	USAID	1981-83		1.070
Forestry/fuelwood	US	1978	Fuelwood	0.25
	USAID	1980	Village fuelwoodlots	0.209
	USAID	1978-83	Renewable Resource Mgmt.	2.000

NIGER

Power generation	EDF	pre-1975	Energy Infra/Production	0.537
	EDF	1978	Kandadji dam study	2.6
	Canada		Hydro	0.84
	CIDA	1974-75	Kainji-Niamey line	1.4
	France		Coal generation	17.07
	CIDA	1978-80	Poste Dosso	0.298
	CIDA	1980-82	Barrage West Hydro study	0.852
	CIDA	1978-80	Kainji-Niamey Line	0.54
	Germany		Dev.of fre.on 113 steam engine	0.159
	CIDA	1977	Elec. distribution	0.029
	AFDB	1977	Sonichar thermal	6.340
	Germany		Transmission-Niamey-Tillabery	4.3
Fossil fuels	UNDP	1979	Petrol. expert	0.03
	UN	1979	Petrol. legislative advice	-
	AFDB	1979	Sonichar coal mine	12.4

NIGER - Cont'd.

Nuclear	Japan	1977	Uranium prospecting	12.74
Energy planning/TA	Germany	1979	R & D	0.138
	USAID	1979-80		0.149
Renewable energy	EDF	1978	2 Solar pumps	0.743
	EDF	1978	2 Solar motots	0.743
	EDF	1978	Solar H_2O heater	0.006
	EDF	1978	Dev. of clean H_2O dept.	0.006
	Germany	1978-79	ONERSOL	0.33
	US	1978	Solar	0.5
	France	1976	Solar pumps	0.012
	France	1977	Heliostat generators	0.037
	France	1978	Central electro-solar	0.488
	France	1976-78	Solar power/education TV	0.12
	France	1976-79	Renewable tech. assistance	0.19
	France	1976-78	Mission	0.16
	France	1979	ONERSOL	0.12
	France	1979	Solar pump	0.488
	France	1979	Scolaire television	0.73
	Germany	1981	Rural Renewable	-
Forestry/fuelwood	WB	1978	Forestry	4.50
	WB	1978-79	Forestry	3.40
	Canada	1974-79	Forestry	0.104
	WB	1975	Maradi fuelwood component	0.20
	WB	1978	Forestry	1.00
	USAID	1980-82	TA	1.151

NIGERIA

Power generation	CIDA	1978-80	Kainji-Niamey line	0.104
	Germany		Transmission-Enlarge Network	17.3
	Germany		Transmission East	11.1
	Germany		Near East Electricity study	0.09
Forestry	Canada	1975-79	Forestry	0.20
	Canada	1977-80	Forestry	0.20
	WB	1977	Ayangna rural dev.-firewood	1.20
	WB	1977	Lafia rural dev.-firewood	0.90

SENEGAL

Power generation	Germany		Mantali dam	92.2
	CIDA		30KW line	-
	France	1976	Deshi	2.68

SENEGAL - Cont'd.				
Energy planning/TA	USAID	1979	General	0.500
	UN/UNEP	1978-80	Experimental energy center	0.268
	CIDA	1978-81	Electrical sector study	0.396
	France		Electrical training center	2.44
	WB	1981	TA	3.3
Renewable energy	EDF	1978	Kanel solar pump	0.098
	EDF	1978	Theis solar pump	0.33
	Germany		Solar	3.4
	France	1976	5 solar pumps	0.34
	France	1977	Pastureland irrigation pumps	0.37
	France	1977	Thermodynaic solar irrig.	0.73
	"	1976-78	Technical assistance	1.34
	"	1976-78	Scholarships	0.22
	"	1976-78	Missions	0.049
	"	1978	Solar electric station	0.24
	"	1978	Heliosolar station	0.12
	"	1978	Heliosolar pumps	0.098
	"	1978	Aerogenerators	0.17
	"	1979	Aerogenerators	0.73
	"	1977	Dakhar solar generator	3.66
	USAID	1979	Solar demonstration	0.5
	USAID	1979	Bakel solar pump	0.5
	USAID	1980		.300
	Germany	1981	Rural Renewable	-
Forestry/fuelwood	Canada	1974-78	Forestry/firewood	0.14
	USAID	1979-80	Village woodlots	1.0
	AID	1979-81	Fuelwood Production	3.133
	AID	1980	Africare Reforestation	.126
	WB	1980	Village woodlots	.211
	WB	1981		9.3
SIERRA LEONE				
Energy planning/TA	Germany		T.A.-Electrical experts	0.06
Renewable Energy	U.K.	1975-80	Solar water heater research	0.0072
TOGO				
Power generation	CIDA	1974-75	Ghana-Togo-Benin line	2.00
	CIDA	1975-76	Lome powerline and substation	5.28
	CIDA	1978-80	CIAMO poer	11.30
	Germany		Free Lines Electric Study	0.016
Energy planning/TA	UNDP	1964-77	w/Benin-supply forecast and demand	0.1

TOGO - Cont'd.				
Renewable energy	EDF	1978	2 Solar pumps	0.108
	USAID	1980	Rural Solar	.050
UPPER VOLTA				
Power generation	EDF	pre-1975	Energy Infra/Production	1.85
	EDF	1978	Electr. of secondary centers	1.418
	France	1977	Distribution	4.55
	France	1976	Noumbiel study	1.162
Renewable energy	Austria	1978	Solar	0.054
	Austria	1978	Solar	0.02
	US	1978	Solar	0.08
	EDF	1979	Solar station at Dori	1.35
	UN	1979	Solar advisory mission	-
	France	1976	17 solar pumps	1.83
	France	1979	Solar pumps	0.24
	USAID	1979	PV pump demonstration	0.150
	EDF	1978	Utilization of molasses	0.135
	UNIDO/UNIDF	1979	Biogas technology demonstr.	.56
	France	1977-79	Biomass	0.195
	France		Scholarships	0.07
	France		Missions	0.049
	France	1976-79	Technical assistance	0.54
	Neth.		Rural Telephone-solar power	0.55
	Germany	1981	Rural Renewable	-
Forestry/fuelwood	Switz.	1977-80	Forestry	0.790
	USAID	1979-80	Village woodlots	0.700
	WB	1979	Forestry	1.90
	France	1976	Reforestation	3.41
	USAID	1979-82	For. Educ. & Dev.	4.468
	USAID	1980	Village For.	.056
	USAID	1980	Agri. For.	.056
	WB	1980	TA	14.5

AFRICA REGIONAL

Rural electrification	ECA	1979	Small scale electr. production for rural use	.022
	ECA	1979	Symposia on dev.of rural elec.	.012
	ECA	1979	Study of factors affecting rural energy development	.012
Nuclear energy	ECA	1979	Est. of Afr. Inst. of Nuclear Physics	-
	ECA	1979	Study on est. of African Petrol. Inst.	-
	ETA,UN ATCD		Forecasting demand in Africa	.022
	ECA, UN	1979	Training inst. for electr. engineers	.022
	ECA, UN	1979	Feasibility studies	.068
	ECA, UN	1979	Assistance in connecting African electr. system	.044
	UNEP	1979	Workshops on energy options in Africa	.015
	ECA, UN	1979	Dev. of energy resources	.150
Fuelwood	USAID	1979	Firewood	1.607
Renewable energy	ECA	1979	Small scale elec. prod. advisory	.022
	ECA	1979	Seminar on small scale ele. generator	.012
	ECA/ France	1979	Dev. of non-conventional energy	.042
	ECA	1979	Dev. of non-conventional sources	.035
	France	1976-78	Renewable Exports	.73
	UNEP	1979	Solar energy workshops	.015
	UNESCO	1979	Coord. of regional solar research	.024
	Germany		Club du Sahel Solar baking and cooking	.19
Energy Planning/TA	Germany		Club du Sahel - T.A.	.056
	Germany		Club du Sahel - Energy Experts	.175
	USAID	1978-80	General	4.452

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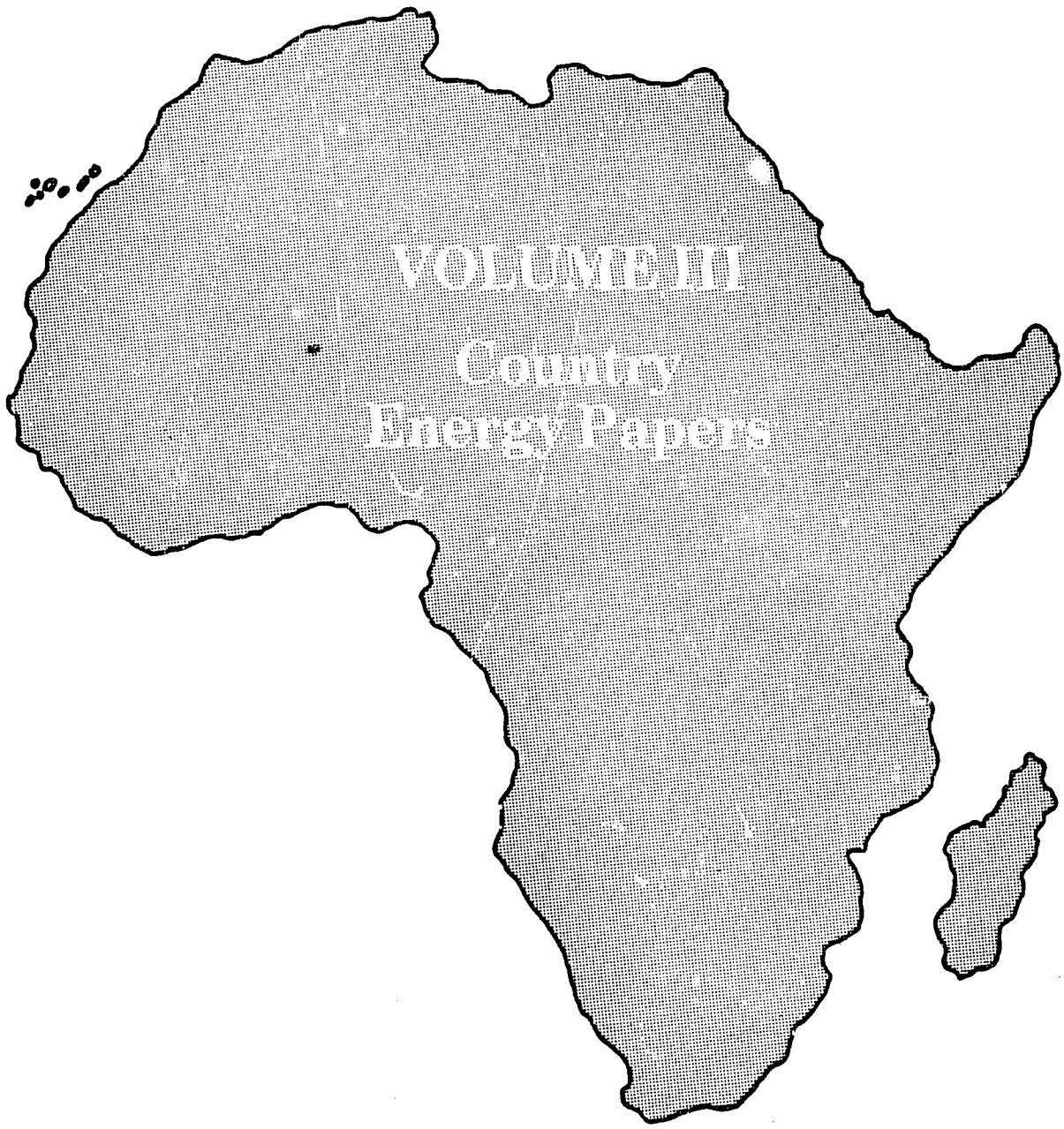

Bureau for Africa
Agency for International Development

April 1982

Proceedings of
Workshop on Energy, Forestry and Environment

Volume: I Workshop Summary

Volume I includes the Workshop Report as prepared by the participants, a strategy for action and recommendations to the Assistant Administrator of the Bureau for Africa for implementing the strategy. In addition, there is information on the history of the Bureau for Africa's energy, forestry and environment programs.

Volume II: Discussion Papers/Case Studies

Volume II includes the 41 discussion papers and case studies which were prepared for the workshop.

Volume III: Country Energy Papers

Volume III includes the energy profiles of 21 African countries. The papers were prepared by energy, forestry and environmental officers of AID field offices.

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VOLUME III: COUNTRY ENERGY PAPERS

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INTRODUCTION

The Workshop on Energy, Forestry and Environment was held in Nairobi, Kenya during December 6-11, 1981. In order to encourage the participants to look objectively at the energy situation in their respective countries, each Mission was asked to prepare a "mini" energy assessment. A comprehensive outline of what to look for was cabled to all African AID missions by AFR/DR. In effect, the participants were being asked to think the through the entire energy assessment process.

The outline called for a review of the existing energy sources, in conventional and traditional terms. It then asked what the possibilities were for augmenting these energy sources with resources (both conventional and renewable) from within the country. In addition, energy consumption patterns, government energy policy and the involvement of the private sector were addressed.

At the Workshop, the participants were organized into four discussion groups based on regional and ecological similarities. Each participant was given the energy papers of his/her colleagues within the group. A leader helped each of the four groups focus on key energy, resource management and forestry issues. Consensus statements were drafted by each group which were incorporated into a Workshop Report (see Volume I, page 39).

This volume includes the country energy papers which were prepared for the Workshop by 21 USAID Missions. The quality and comprehensiveness of these papers vary from country to country depending on the energy data and information available to the Mission personnel.

BOTSWANA

I. Introduction

Botswana is a landlocked, semi-arid country with an area of 582,000 square kilometers and a population estimated at 800,000. Much of the country is relatively featureless with gentle undulations, occasional rocky outcrops and a mean altitude above sea level of 1,000 meters. Eighty percent of the land is covered with Kgalagadi sand, supporting savannah-type thorn bush vegetation. Rainfall is erratic, averaging 700 millimeters in the extreme north to 200 millimeters in the extreme southwest. In the Northwest the Okavango River drains inland from Angola to form an extensive swamp, while in the central Northeast lies a large area of calcrete plains bordering the Makgadikgadi Pans. The eastern margin of the country, adjacent to the Limpopo drainage system, has a somewhat less harsh climate and more fertile soils than elsewhere and it is here that the bulk of Botswana's population is concentrated.

Energy resources used in Botswana reflect the economic and social structure of the country with 80% of the people living in rural areas and an average rural income of approximately $388 per year. The majority of the people use wood for heating and cooking and either candles or kerosene for lighting. It was estimated that half of the energy consumed in Botswana in 1975 came from wood collected in the vicinity of major villages.

Most electricity consumption is by towns and mining operations. The Botswana Power Corporation (BPC) is the major supplier using both oil and coal-fired generators. The BPC's total generating capacity of some 80 megawatts reflects the small size of the economy.

Exclusive of electricity generation, oil is used by the railway, by some 5,000 water boreholes and by vehicles. Botswana produces no pertroleum or natural gas and has virtually no potential for hydroelectric power. National supplies of firewood are under heavy pressure around all sizeable villages, with demand increasing as these villages continue to grow. On the other hand, the country has vast supplies of coal and the climate is ideally suited to the use of solar energy.

II. Source of Energy

A. Conventional Energy

The main sources of conventional energy in Botswana are coal and petroleum products. There are almost unlimited reserves of coal (estimated at 17 billion tons) but for various reasons (i.e. Development, Transportation/Distribution) the country cannot rely on this reserve to meet all the present requirements for energy. Nevertheless, the production of coal is on the increase and does provide a very significant proportion of total domestic energy consumption, both through the generation of electricity and in some industrial processes

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associated with the mines. Total primary sources of energy produced or imported into the country in 1980 had an energy equivalent of 4055 million kilowatt hours. Almost 60% of this was domestic coal production with the remaining 40% coming from imports of petroleum products.

Petroleum products are wholly imported in refined form, largely from the Republic of South Africa and any disruption of imports through either political or economic means would have a drastic effect on the economy. Since 1974-1975, Botswana's imports of petroleum products have grown at an average annual rate of 16% while the annual growth rate of the gross domestic product for 1979-1985 is forecast at 10%. The percentage of total imports of petrol-fuels increased from 4.6% of the import budget in 1972 to 11.32% in 1978 and is considerably higher today despite a greater domestic electricity production from coal. Table I illustrates total petroleum and coal imports.

TABLE I

Imported Sources	Quantity	
Liquid Petroleum	2,267	Tons
Petrol and aviation fuel	48,783,000	Liters
Diesel and gas oil	94,704,000	Liters
Kerosene	5,620,000	Liters
Fuel oil	1,094,000	Liters
Coal	14,1,3	Tons

SOURCES: MMRWA Planning unit, 1981

B. Traditional/Renewable Energy

The basic fuel of the majority of the people is wood which is primarily used for cooking and heating. In some areas people have to travel considerable distances to collect wood, as firewood is fast becoming a scarce commodity. In towns and villages wood is brought in from the countryside and sold at markedly high prices. The data on firewood consumption are incomplete, but estimates indicate that each person in the rural areas uses an average of about 1/2 to 3/4 ton of wood per year -- one of Africa's highest wood consumption rates. Deforestation is clearly a prime factor contributing to the increasing threat of desertification in Botswana's more populated areas, which are located just short distances from the Kalahari Desert.

Other forms of renewable energy include solar-powered water heating, water pumping by windmills and solar electricity generation for small loads in rural areas. The total number of kilowatt hours supplied is extremely low but further development is steadily advancing.

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III. Energy Consumption

Data on energy consumption by both the industrial and agricultural sectors is extremely sketchy. It is known, however, that the majority of electricity produced in the country is consumed by the mining sector and by the towns. In the agricultural sector, most energy consumption is through traditional means such as animal draught power but tractor power has been increasing steadily over the past five years.

IV. Energy Resources

Large deposits of low-grade coal have been discovered in Botswana, estimated at approximately 17 billion tons. In order to minimize dependence on imported oil, the Government has initiated plans to substitute domestically produced coal for imported oil in the generation of electricity. An expanded power station is in the planning stage and it is anticipated that Botswana will eventually generate nearly 100% of its growing demand for electric power using local coal.

As stated earlier, the principal source of energy for the majority of the people is wood. It may be possible to substitute for wood in some situations, either by cheap solar devices or local coal. However, there are potential difficulties of cost, air pollution and acceptability. More promising is the development of efficient stoves for burning wood and the establishment of woodlots outside villages.

In response to the above situation, USAID and the Government of Botswana, have embarked on a Renewable Energy Technology Project to introduce renewable energy technologies (RET's) at the village level. The $4.7 million project will research, develop and put into use RET's which can reduce Botswana's dependence on vulnerable supplies of increasingly expensive fossil fuels. Village-level RET's will focus primarily on the improved use of wood or its substitution. (e.g. solar ovens, wood stoves, windmills, solar earthen batch water heaters, thatch insulation). In addition, RET's will encourage reforestation through other USAID/B activities such as the Rural Sector Grant which is providing funds to the Brigades to promote reforestation. As wood continues to become an increasingly scarce resource, it is evident that there is an urgent need to reduce wood use and increase wood production if severe environmental degradation is to be avoided.

V. Government Energy Policy

The Government of Botswana's objectives for the energy sector are:

- To minimize dependence on imported oil, due to the unreliability of supply and rising price. This will be done by substituting domestic coal for oil in electricity genera-tion and industrial use, by substituting wind or solar power for diesel in water pumping, and by encouraging conservation

in the use of petroleum products.

- To safeguard essential oil supplies by maintaining adequate reserves and developing contingency plans to cope with any interruption to normal supplies.

- To provide electricity to meet the demands of the new mines and industries needed to fulfill major production and employment goals. This will be done through the completion of existing projects and by adopting a long term programto provide a flexible abundant power supply for the late 1980s and beyond.

- To minimize the costs of electricity to industrial and private users. This implies both minimizing the production costs of electricity and ensuring that the conditions of its supply are not onerous.

- To avoid subsidizing private urban electricity consumers. The present element of intra-urban cross-subsidy will be retained because it favors low-income consumers who use electricity mainly for lighting.

- To increase the energy available to the majority of rural people, and to reduce the time and ecological damage involved in firewood collection. This will involve support for organizations which can implement programs of extension and marketing of solar energy and of more efficient wood and coal stoves, as well as woodlot programs.

- To minimize fossil energy consumption by designing buildings that require less heating and cooling, by substituting solar energy for electricity in water heating where this is economical and by investigating heating and cooling systems, using coal, for government buildings.

Oil import policy is the responsibility of the Ministry of Commerce and Industry, while electricity and other energy matters are generally the responsibility of the Ministry of Mineral Resources and Water Affairs (MMRWA). The Botswana Renewable Energy Coordination Committee has recently been organized, chaired by MRWA, to bring together different governmental and parastatal units to discuss energy policy.

Major efforts will be required to safeguard and develop supplies of firewood, to develop the national coal resources and to introduce the more extensive use of solar and wind power. Government and parastatal development expenditure on energy is expected to total P123.6 million ($139.6) over the next five years. These expenditures are summarized below:

Parastatal (BPC)	P Million
Generation and transmission	108.4
Other BPC capital expenditure	4.2
Government	
Rural Power supplies	1.3
Utilization of solar energy	1.0
Expansion of electrical department	2.4
Oil Storage	6.3
	123.6

This picture is not complete, as it excludes projects for woodlots and windmills. It also ignores expenditure by non-governmental organizations which are important for development of rural energy sources. Recently, a new petroleum and exploration law was enacted and ESSO is now in final negotiations for exploratory rights in large area of the Kalahari desert.

VI. Private Sector Involvement

Private sector and Non-Government Organizations (NGO's) are very active in the energy field. There are several small sources of solar water heaters within the country. Small solar businesses, are manufacturing batch and thermosyphon types of active and passive solar water heaters. Commercial solar water heating systems are in evidence in Gaborones, on Botswana Housing Corporation (BHC)-owned houses, on private residences and institutions (a convent) and prominently atop dormitories of the national university.

I. The Impact of Geography, Economics and Demography

Burundi is a relatively least developed country with roughly the same size and population as Maryland. It is overwhelmingly rural (less than 5 percent of the population of 4,022,000 people lived in agglomeration of village size or larger in 1979), with nationwide average population density of 161 people per square kilometer in 1979. Ngozi, Muramvya and the rural portion of Bujumbura provinces average densities between 246 and 286 people per square kilometer. Burundi has a per capita income of 180 dollars in current prices. Inflation has reduced average per capita consumption of kerosene for lamps from one liter a year per person in 1972 to half that level in 1980. The World Bank statistics indicate that Burundi has the 2nd lowest per capita consumption of energy measured in kilograms of coal equivalent.

Burundi is more than 1,400 kilometers from Dar es Salaam and 2,000 kilometers by road through Uganda to the port of Mombasa. Much of Burundi is a shield-shaped plateau gradually rising to the Zaire Nile divide and then dropping sharply down to the escarpment of the Western rift to Lake Tanganyika. The average daytime temperature on the crest is 17° to 19°C with nights often below 11°C and occasionally dropping to near zero. It is wetter on the crest with 1,600 mm rainfall a year compared to 800 to 1,000 mm in the Ruzizi plains near Bujumbura.

The heavy population density has resulted in marginal lands, some sloping more than 45°, coming under permanent cultivation thus encouraging erosion. Interplanting of small fields, harvested over time, reduces the period during which the soil is bare. Cultivation and clean weeding with hoes can cause devastating erosion problems.

II. The Modern Sector

A. Petroleum, Oil and Lubricants

Burundi imports all its petroleum and must continue to do so. Imports are mostly diesel fuel and gasoline for transportation, thus limiting the chances of substituting other forms of energy. Diesel and gasoline accounted for 62 percent of petroleum imports for 1973 and 77 percent in 1979. Diesel fuel imports increased 223 percent between 1973 and 1979. The results are summarized below:

	1973	1976	1978	1979	1980
Total Petroleum Imports (MT)	22,144	24,180	27,300	30,385	35,501
Francs Bu(million)	176.9	442.7	644.3	1,287.8	2,294

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Although Burundi had only 1.3 vehicles per thousand people in 1979, the GRB assumes that growth petroleum requirements will increase about 8 percent a year.

Burundi can store about four months' supply of petroleum products. Supplies may be interrupted by transportation bottlenecks at the port of Dar es Salaam or civil unrest problems in Uganda.

In 1979, petroleum imports amounted to $14.4 million, or nearly 14 percent of export earnings, and accounted for about half of the price increase in imported goods. In 1980, the value of petroleum imports was $25.6 million, and 39.1 percent of export earnings (Burundi's exports fluctuate widely from year to year depending on the coffee crop and prices). The impact of petroleum price increases has been disastrous upon rural development programs and sustained growth in Burundi is dependent on improving productivity of food and export crops (56 percent of GDP at factor cost). It is clear that the rising fuel and transportation costs involved in improved distribution of agricultural inputs and collection and marketing of crops has resulted in a far lower internal rate of return to development projects than when they were planned. The cost of fuel is a major reason behind smallholder tea projects becoming uneconomical as well as soaring recurrent costs of future agricultural production programs.

B. Electricity

Bujumbura accounts for 95 percent of Burundi's electricity consumption. Gitega and Bururi towns consume most of the remainder of electricity. During the past five years electricity usage has grown by 9 percent and a growth rate of 8 percent a year is projected for the next decade.

The Ruzizi hydroelectric station in Zaire supplies Bujumbura with peak power of 8.5 megawatts via a 115 kilometer high tension line The city has a backup diesel generator dating from the 1950s which can only supply peak power of 2 megawatts. Bujumbura suffers from periodic brownouts and breakdowns of electricity. It will continue to do so until the Chinese-built Mugere hydroelectric station comes fully on stream in 1982 (total power at 8 megawatts, with a guarantee of 2.3 megawatts in the dry season). Gitega has an old diesel generator which was used until the West German built hydroelectric station (1.3 megawatts peak production) came on stream in 1980. Bururi Town has a 100 kilowatt diesel generator which will soon be replaced by a hydroelectric generator.

Because of Burundi's geography and climate, the GRB has deliberately launched a program to use hydroelectric plants within Burundi to supply the country's electricity needs for urban areas. Work must begin on a network of hydro generators

producing peaks of 6.0 to 18 megawatts. Consequently the GRB has proposed the Rwegura project (18 megawatts guaranteed power) in northwestern Burundi to supply Bujumbura, Ngozi and Kayanza using a 700 kilometer long high tension line. Ruzizi II in Zaire will also supply hydroelectric power. Neither project will be completed before 1987 and the regional Akagera dam will be later still.

The GRB has a program to install micro-hydroelectric plants with power of less of 100 kilowatts which supply water as well as electricity. These will be financed by private funds (i.e. the missions) or the Government, at an estimated cost of $110,000 to $168,000 each, and will supply local Government centers, schools and clinics. Another program for plants of 250 to 300 kilowatts peak load is planned for Muyinga, Kirundo and Bururi.

C. Other Urban Fuel Requirements: Peat

Artisanal industries, commercial enterprises and institutions have traditionally relied on charcoal. Charcoal meets most urban daily fuel requirements. Estimated total wood/charcoal usage in Burundi vary considerably, but the GRB estimates consumption at one stere* per person per year or roughly four million steres annually (estimates vary considerably according to source). If we assume that rural fuel consumption is 0.5 steres of wood per person per year, then all urban usage including light industry institutions and households require about 2,000,000 steres a year. (Burundi charcoal making methods require 7 kilos of wood to make one of charcoal). The price of charcoal increased sevenfold between 1970 and 1980 and threefold from about 8 FBu/kg retail price in 1976 to 23 FBu/kg today.

Burundi has substantial peat reserves. The urban domestic market should be the major target group for conversion to peat. In the GRB's view substituting peat for charcoal will give time for plantations to mature. Peat is an incomplete solution and temporary palliative to the overall energy problem.

Beginning in 1978 with the AID project, Alternative Energy: Peat I ($490,000), AID has financed experimentation with peat production and usage. A European Development Fund activity opened up the Kisozi bog soon after the CRS program began. Production reached 4,000 tons in 1980 and about 6,000 tons in 1981. Primary uses for peat include bakeries, light industry, institutions and the Burundi army. We estimate that the peat produced during the 1981 season will be completely used by

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* A cubic meter of stacked logs.

March/April 1982 (well before production starts in May) because its price is attractive compared to charcoal. In the Peat II Project Paper, it was assumed that about 136,400 MT of peat would be produced between 1980 and 1985. The quantity of peat will be the energy equivalent of clean cutting 9,500 hectares of forest, or cropping 45,700 hectares. Projected demand may be as much as 52,100 MT in the last year of the project, assuming the requirements of 7,000 MT for institutions, 5,300 MT for industries, 12,800 MT for commercial/artisanal use and 27,000 MT for urban domestic needs (or 60 percent of the urban household market). The project evaluation now under way will probably indicate that urban domestic usage was over estimated while institutional/industrial/commercial requirements were under estimated.

III. Rural Fuel Requirements

The dominant fuel of rural Burundi is wood. It is used inside the house for cooking and for heating at higher altitudes where it has the additional benefit of driving insects away and preserving food such as maize hung from the roof. Women in Burundi are responsible for gathering fuel and preparing food, in addition to food crop production. Men make charcoal and work on peat bogs, in nurseries and on afforestation programs. In the most densely populated parts of Burundi, wood is no longer regarded as a "free good". In the lightly populated province of Bururi, field interviews indicate that women, as well as men, are interested in planting their own seedlings to produce firewood (and poles for construction).

While usage estimates vary considerably, rural fuel usage is probably half a stere per person per year. Burundi will need about 200,000 cubic meters of saw wood by 1990 and about 1,230.000 cubic meters for firewood.

Although Burundi was almost entirely covered in forest during the 17th century, in late January 1981 the GRB estimated that total forest cover had been reduced to 88,000 hectares. The IBRD estimated the total forest cover at 90,000 hectares in 1978/1979 or 3 percent of Burundi's total area. There was then about 40,000 hectares of tropical highland forest, 20,000 hectares of savannah woodlands, 25,000 hectares of existing forest plantations and the remaining 5,000 hectares was in new plantation. Even with current reforestation programs, it is estimated that tree cover will be reduced to about 40 percent of present area by 1986.

Even if the lowest wood consumption estimates are used, the ecologists are greatly concerned about its implication. If corrective action is not taken, Burundi's remaining forests will disappear entirely in another decade or less. This will not only be disastrous for the rural population who depend on wood for fuel, but also for the ecology of the land itself. Without the protection supplied by forests and woodlands in the form of ground cover, soil erosion and run off will accelerate as well as the

degeneration of watersheds. Erosion also causes silt fill and other problems with hydroelectric installations, thus necessitating actions to maintain cover in order to reap full benefit from the capital investment.

The GRB has long recognized the seriousness of its forestry resource problems. Thus the Second (1973-1977) and Third (1978-1982) Five Year Plans list an improved forestry sector as one of their goals, along with improved soil and water conservation. In an extensive publicity campaign, 1979 was the "Year of the Tree" and 1980 was the "Year of Soil Conservation". The most urgent priority is stopping the degradation of the natural forest and its eventual disappearance. The next priority is producing wood, predominantly firewood. The third priority is tree planting for erosion control and watershed protection along the crest.

The GRB should reach its goal of 240,000 hectares of new plantations of quick growing species in 25 to 30 years, if its current annual planting rate by donors and by the Ministry of Agriculture's Department of Water and Forests are sustained. Since trees require 5 to 8 years to reach exploitable size, it probably will not meet fuel requirements unless peat is substituted promptly for charcoal in a substantial portion of the "modern sector" and in urban areas. Most of the donor supported programs are for increasing saw timber production rather than improving firewood availability. This has left the GRB to use its own scarce development resources for fuelwood development programs for the most part, especially the seedling distribution and extension programs which farmers to plant trees on their homesteads as well as to develop community plantations.

Forestry research programs have concentrated almost entirely on timber production rather than fuelwood. Although the forestry programs use mostly exotic species, growth trials have been conducted on indigenous trees regarding saw wood potential. It should be noted that most Leucacena species do not grow well at altitudes over 800 meters and are therefore not successful in most of Burundi. Callitris, the old standby for high altitudes (above 1,800 meters and steep, rocky slopes) is excellent for erosion control but is slow growing. Currently, the standby for individual woodlots and small communal plantations are Eucalyptus species.

The most ambitious donor project, and the only existing one with a fuel component, is the $8.8 million IBRD-led forestry program that began in May 1979. It includes support from an IDA loan, French technical assistance, UNDP training grant and additional funds from the European Economic Community (Special Action Account). It includes establishing two plantations (5,000 hectares of pine in the south and 2,000 hectares of eucalyptus in the north); 30 communal seedling nurseries; technical assistance to the Department of Water and Forests; and financing research and study on energy needs and sources including new techniques for charcoal production and cooking stoves. Additional donor projects include:

- The European Development Fund's 3,200 hectares plantation for saw timber, begun in 1978;

- The Belgian-implemented, Saudi financed 12,000 hectare plantation of pine, eucalyptus and Callitris in southern Burundi;

- A three year UNDP/FAO forestry training program for eight team foresters and 85 forestry technicians.

The forthcoming IDA-led Ngozi III rural development project includes $2.4 million for forestry and erosion control. It will have 4,300 hectares of plantation for firewood, coal, communal plantations and planting of private and individual woodlots for farmers. The proposed Kirimiro project has $1.5 million for forestry and erosion control (1,200 hectares of protection plantation, 600 hectares fuelwood and pole plantation, 200 hectares of saw timber, 400 hectares for rehabilitation of communal plantations, 300 hectares of new communal woodlots and 250 hectares of project woodlots).

Another planned firewood project is AID's proposed Bururi Forest Project (see below).

IV. GRB Strategy and Program Implementation

Energy and fuelwood have been a major concern of the GRB for some time. Part of this is because of the seriousness of the forestry/erosion/fuelwood conundrum, and the remainder caused by being landlocked, totally without petrocarbons, and dependent on external hydroelectric sources. Energy problems and requirements are discussed as a whole from petroleum products hydroelectricity, peat and wood. The GRB realizes that solar, wind, and biogas resources will be unable to meet substantial requirements for some time to come, although a small appropriate technology energy research unit has been set up in the University of Burundi's Faculty of Science. Peat is, at present, a temporary aid (it is not renewable), and, if used properly, will give fuelwood programs the necessary lead time.

Petroleum products will be used primarily for transportation, while hydroelectric installations of all sizes and types must be relied upon for electricity generation. Widespread rural electrification is out of the question, due to cost, but small to micro-scale hydroelectric turbines must be increasingly relied upon to supply provincial and communal centers, hospitals, clinics and other services, even agricultural research stations (where possible). Public works programs are evaluated in terms of their energy requirements.

Energy programs are implemented by several GRB agencies. Hydroelectricity and diesel generators fall under the General Directorate of Energy (Ministry of Public Works, Energy and Mines). The trinational Energy Commission of the Great Lakes (now part of

CEPGL) handles regional programs and installations such as Ruzizi I and II. Peat, as a non-renewable resource, has its development agencies report to the General Directorate of Mines. Firewood and forestry are the responsibility of the Ministry of Agriculture's Department of Water and Forests, except for the large rural development projects which come under regional development societies (the forthcoming Kirimiro and Ngozi III projects). Some timber production programs have been spun off into a National Wood Office. The new Director General of conservation of natural resources in the Presidency is the former Director of the Department of Water and Forests. He still maintains a major interest in the Bururi Forest project along with other energy and conservation policies.

V. AID Strategy

AID's strategy in Burundi, as presented in the FY 1983 CDSS, is to help solve the land/food/population dilemma faced by the rural poor possessing a small resource base. The U.S. is a relatively minor donor of economic assistance, and has a few carefully selected projects within three strategy objectives:

- Increasing food availability to the rural poor, particularly densely populated areas;
- Reducing the rate of loss of arable land to soil erosion and increasing the availability of alternative energy sources to the rural and ruban poor; and
- Improving the delivery of health and family planning services.

Within the soil conservation/afforestation and energy strategy objective, AID has the following bilateral projects:

- Alternative Energy: Peat II (695-0103) (1980) is the second phase of a long term program to increase Burundi's use of peat as fuel and reduce the strain on dwindling forest resources (LOP $8.0 million).
- Bururi Forest (proposed for FY 1982) combines preserving one of two high altitude antural forests with fire and construction wood production (LOP $1,144,000).

Regional programs include various regionally financed energy sector training programs and proposed forestry/natural resources training programs; participation in CDA (ex. CADA) programs, particularly for forestry extension training.

I. Background

Cameroon has often been described as a microcosm of Africa. Within its 475,000 square kilometers (about the size of France) can be found tropical rainforests, coastal mangrove swamps, mountainous highlands, savannah grasslands and Sahelian regions. Its population of approximately 8,600,000 is ethnically diverse with more than 200 different tribes speaking 24 major African languages. As a confederation of previous French and English dependencies, Cameroon is officially a bilingual country. The French language and influence predominate, however. The major religious groups are Muslims, Christians and Animist. Although primarily agricultural, Cameroon is also developing coastal port facilities, minerals, natural gas, oil and hydroelectric power.

II. Energy Resources

A. Petroleum

Recent discoveries and development of off-shore oil resources are presently providing great impetus to the growth and development of Cameroon's economy. As late as 1977/78 the mining and petroleum sector accounted for less than one percent of the GDP. With an estimated production of three million tons in 1980/81, the sector now accounts for slightly more than nine percent. Nor is the end in sight. The most conservative estimates for petroleum production for 1985 place the level at five million tons.

The implications for Cameroons's future development are, of course, profound. At present prices and with the most conservative of production estimates, the revenues accruing to the GURC from its 40 percent share in oil operations should be approaching 500 million dollars annually by the end of 1984. This figure represents more than one-half of the GURC;s total revenues for the fiscal year just completed. A refinery has been built to supply domestic requirements of approximately 700,000 tons of refined petroleum products per year. The refinery's eventual total capacity is 2 million tons which will allow Cameroon to export refined petroleum products to neighboring West African nations.

PROVEN RESERVES OF OIL AND OIL PRODUCTION

Proven reserves as of 1/1/81 in 10^6 barrels	Estimated oil production (000 barrels/day)			
	1977	1978	1979	1980
200	-	12	34	57

B. Natural Gas

In order to exploit Cameroon's 150 billion cubic meters of

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known natural gas reserves, a study is currently underway to determine the feasibility of building a plant which could begin liquifying natural gas, mostly for export, by 1987. If expectations are realized, liquified natural gas exports could make a significant contribution to the GDP by the end of the decade.

C. Electricity

Electrical energy accounts for less than two percent of the GDP. Capacity has grown slowly for years owing to the large initial output of the dam at Edea on the Sanaga. That structure was completed in the mid 1950s. Its capacity was so large that it continues to supply well over half the nation's total demand for electricity. The situation is in the midst of change, however. The dam at Edea expanded its production from 240 to 260 megawatts between 1977 and 1980. The newly completed dam at Song-Loulou, also on the Sanaga, will initially generate an additional 192 megawatts. This figure will be doubled to 384 megawatts after 1983. The Lagdo dam, situated on the Benue close to Garoua in the North Province, will add an additional 72 megawatts of generating capacity when completed in 1983.

ELECTRIC POWER CAPACITY (MW)

	1980	1981	1982	1983	1984
Hydroelectric power stations	265	457	553	625	721
Thermal (diesel) power stations	54	72	92	102	114
TOTAL	319	529	645	727	835

Overall, a total of 83 percent of Cameroon's electric power is generated from hydroelectric sources. Both the remaining potential and requirements for the future are vast. At 115 billion kilowatt hours, only one percent of which is presently in use, the country's estimated potential for hydroelectric power is second only to that of Zaire on the African continent. Systematic prospecting for sources and sites of hydropower is underway and a completed study is expected in 1983. Demand is certain to increase significantly in the future as well, as industry expands and rural communities - only two percent of which presently receive electricity - are added to the national grid.

D. Forestry

The Cameroonian forest covers between 15 and 20 million hectares of land and is located, for the most part, in the southern region of the country.

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EXPORTS OF WOOD (IN 000 TONS)

1976	1977	1978	1979
551.1	578.1	564.5	564..0

According to Ministry of Mines and Energy officials, the major source of energy for Cameroon is wood (70%), followed by oil (20%) and hydroelectricity (10%). The exportation of wood products from Cameroon in 1979 provided 11 percent of the total value of exports. Although Cameroon's forestry resources are significant, the arid Sahelian zone in the North of Cameroon is beginning the early stages of the fuelwood crisis that so many African countries have already experienced. As a result of population growth, the need for agricultural land and fuelwood is increasing. This has caused shortages of fuelwood, especially in densely populated settlements. Now people in rural areas of the North Province's Sahelian region spend more time on fuel collection at the cost of productive activities.

In recognition of the importance of forestry resources to economic development, Cameroon has sought to assure continued supplies of forestry products for industry and fuelwood. In the North Province, reforestation activities are underway with assistance from the regional Sahel Vert program. A major project to expand the contribution of the forestry sector to the national economy through the establishment of plantations and the strengthening of the government agencies responsible for forestry regeneration is being developed with the IBRD. This proposed project will include up to 20 pilot village wood lots for the production of fuelwood and building poles. Private voluntary organizations have also undertaken development of projects to address the fuelwood shortage problem in the North Province.

The Ministry of Mines and Energy is responsible for identifying activities to be undertaken and formulating energy plans and policies. Other institutions such as the University of Yaounde (National Superior Polytechnical School), General Delegation for Scientific and Technical Research (Institute for Geological and Mineral Research) and the National Center for Studies and Experimentation of Agricultural Machinery are responsible for research and field testing of new energy sources such as biomass, micro-hydropower, wind and solar energy. Of the aforementioned, micro-hydropower and solar energy are being given the greatest attention as potential power sources for isolated users of electrical energy. A recently completed AID-assisted report on household consumer energy in the North Province confirmed that kerosene is the fuel of choice among the urban population. It is expected that the percent of Cameroon's energy coming from wood will continue to decline as the proportion of the population living in urban centers increases.

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On balance, then, it would appear that energy availability, both at present and within the foreseeable future, will not be a constraint to the country's development objectives.

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GAMBIA

I. Background

The Gambia is a country of 600,000 people and is the smallest independent state in Africa. It has a land mass of 4,300 square miles (11,000 square kilometers) making the density of population the fourth highest in Africa. The Gambia is part of the Sahel zone with over 70% of the population living in the rural areas. Its conventional energy is derived primarily from fuelwood and groundnut hulls. The country has no fossil fuel deposits, and all oil and gas are imported. Most of the commercial energy is utilized in the urban areas for the production of electricity and the operation of vehicles and machinery. Present electrical power generation capacity is 12.6 megawatts.

II. Fuelwood and Reforestation

Fuelwood: Recent statistics show that fuelwood accounts for 84% of the total primary energy consumption of the country (i.e., 320,000 tons of oil equivalent). Average per capita consumption of this energy source is 1.5 m^3 per year. The cost of fuelwood per kilogram is 0.003 dalasis (0.0150 US$)*. This is the opportunity cost on collecting fuelwood in the rural areas. The market price is 0.05 D/kg ($0.025) in the provinces and 0.1 D/kg ($0.05) in the urban area. This makes the total value of fuelwood production of 27 million dalasis ($13.5m) or 7% of the total GDP.

Over 50% of the total fuelwood was consumed in the form of charcoal (production of charcoal is now banned in The Gambia). Charcoal was produced mainly for urban consumption -- cooking, ironing, gold and silver smithing. The charcoal consumed in the rural area, mainly for silver smithing, was minimal. Traditionally, energy for cooking in the rural areas has always been in the form of firewood. Price of charcoal also limits its use in the rural area. A bag of 50 kg costs D5.00 ($2.50). This is beyond the earning capacity of the rural populace.

The method of charcoal production (open kiln) in The Gambia was proven very inefficient. Not only was the energy loss in the conversion process from wood to charcoal, but environmental degradation and deforestation was accelerated by the felling of trees. This prompted the Government of The Gambia to take measures in order to reduce the per-capita wood consumption. The charcoal ban and the introduction of more efficient stoves were among the measures taken.

Gambia's extensive reliance on wood, coupled with drought prior to 1981 and an increasing population, caused some concern. A reforestation program was initiated in the Banjul Declaration of 1977. The present estimates indicate that by the year 2000 the demand for wood cannot be met by replanting trees.

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* 1 dalasis = US $.50

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A search for alternative sources of energy must be initiated.

Reforestation: The Forestry Department had embarked on schemes to increase the supply of fuelwood by reforestation through large-scale plantations, village woodlots and the National Tree Planting Festival.

Plantations: The main species used in plantations in the Gambia is Gmelina arborea which was introduced in the early 1950's when the first seed was brought from Sierra Leone. At the end of 1980, there were 1204 hectares of established plantations mostly consisting of Gmelina arborea.

Wood Lots: A pilot village wood lot project started in 1980 with the establishment of two one-hectare wood lots of Gmelina by each of two villages, Kembuji in the Western Division and Illiasa in North Bank Division. It is planned to extend the number of villages by two each year over the five year life of the USAID-funded Forestry Project. The Forestry Department provides advice and guidance, fence posts, barbed wire, staples and the necessary planting stock. The villagers provide the necessary labor inputs. Control of the management of the wood lot and ultimate disposal of the products lies entirely in the hands of the villagers.

National Tree Planting Festival: This festival, which takes place annually during the second week of July, was started in July 1978. There have been three festivals "to foster a national consciousness of the value and importance of forest cover, to maintain and improve the environment; both rural and urban, by a tree-planting campaign carried out by the people of The Gambia."

The main species provided are: e.g. Gmelina arborea; Azadirachta indica and Anacardium occidentale. Tree seeds and seedlings for the first three campaigns have had to be supplied without the use of nurseries, as there are presently no tree nurseries in The Gambia. Thus Gmelina arborea root/shoot cuttings were taken from the plantations, Azadirachta indica were obtained up where available and cashew nuts were provided for direct seeding.

III. Alternative Sources of Energy

Gambia has shown a great effort to create alternative energy sources particularly from groundnut shells. This energy source accounts for 3.7% of the total energy balance (i.e., 14,000 tons of oil equivalent). It is primarily used in the industrial power supply G.P.M.B. oil mill) as well as in the household. The pilot plant has a capacity of 6 tons/h. The shells make up 30% of the groundnut weight. The calorific value is approximately 4000 k cal/kg compared to fresh wood of 2000 k cal/kg. The results of this project have been very promising and can give a substantial input to solve the fuelwood problem.

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Biogas production from cow dung has potential in The Gambia. It is estimated that there are 293,000 head of cattle head in the country. One cow gives an average of 10 kg of dung a day. Approximately 20 kgs of dung produce $2m^3$ of gas a day. With so many cattle in the Gambia biogas is both a short term and long term solution to the fuelwood problem.

Solar energy utilization has hardly been investigated. However, some measurements pertinent to solar energy potential have been carried out by the Department of Hydrometeorological Services. The Gambia receives over 3,000 hours of sunshine per year, mostly via direct radiation, except in August when the radiation flux is less than 400 Langleys per day. A significant use is already made of solar energy in the production and processing of agricultural products. For example, over 130,000 MT of groundnuts and over 70,000 tons of cereal, mainly millet, sorghum and rice are dried yearly by stacking or spreading them in the sun before thrashing; and up to 20,000 tons of marine products caught locally, of which 50 percent are exported, are usually sun-dried. Plans for economic and social development call for increased output of smoked or dried fish.

IV. Oil Imports

The Government of The Gambia imports 100% of its petroleum needs, primarily from Venezuela. Oil exploration attempts to produce oil domestically have met with little success.

Importation of petroleum products is left to the private sector with the government providing foreign exchange and price control. There is no subsidy in the price of petrol, however, LPG is duty free.

Shell Corporation has been the dominant importer and distributor of all petroleum products. However, in October 1981, Gambia Utility Corporation imported 7,500 MT of gas oil. The storage facility provided by Shell is the only fuel installation in The Gambia.

The petrol retail trading is predominately in the hands of service station dealers who work on a commission set up by the Ministry of Finance and Trade. It is expected that the private ownership may phase out fuel importation due mainly to government price control. It is likely that future role of distributors (service stations) will remain in the private sector.

V. Energy Policy

The Energy situation in the country has necessitated The Gambia to formulate an Energy Master Plan as a guideline for the efficient development and management of its energy resources. The Plan defines an investment program for resource development and energy conservation, energy pricing, taxation and other related policies.

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A. Objectives of the Plan

1. To make projections of a supply/demand energy balance for the periods 1981-90 and, tentatively, 1990-2000, in order to evaluate:

   a. future energy availabilities and needs of the economy;

   b. options for reconciling the two; and

   c. the budgetary and balance of payments impact of the energy sector under the projected conditions.

2. To formulate energy pricing policies aimed at:

   a. stimulating more efficient energy use, using conservation and substitution of domestically produced energy for imported energy;

   b. stimulating the production and use of indigenous energy resources;

   c. strengthening the financial structure of energy enterprises in the public sector; and

   d. ensuring that the basic energy needs of the poor are affordable.

3. To evaluate development options and define investment priorities for the energy sector for the period 1981-1990.

4. To analyze alternative sources of energy in connection with the Plan of Action to combat desertification with emphasis being placed on rural energy.

5. To analyze and make recommendations on the institutional, administrative and managerial issues related to energy planning.

6. To analyze and make recommendations regarding contingency planning for petroleum and other fuel shortfalls.

7. To review, analyze and make recommendations on health and safety factors relating to existing and planned petroleum product usage and storage; and

8. To train qualified Gambian nationals in energy planning and analysis.

GUINEA

I. Introduction

Guinea, with an area of almost 246,000 km², is well endowed with arable land, water and mineral resources. Its terrain is varied, and its broad range of eco-climatic zones permits diversified farming in addition to livestock raising, forestry and fishing (see figures 1 and 2).

Before independence in 1958, the country was a major exporter of bananas, coffee, pineapples and palm oil and was practically self-sufficient in basic foodstuffs. Since then, Guinea's choice of agricultural development strategy has not sustained these production levels. Consequently, despite vast potential, agricultural exports have all but vanished and Guinea is a net importer of its own food -- rice.

With respect to mineral resources, bauxite reserves are estimated at 29 percent of known world reserves. Bauxite and aluminum exports are Guinea's major source of foreign exchange. Considerable high-grade iron ore deposits have been identified and geological propects for uranium and offshore oil are good.

The three major rivers in West Africa originate in Guinea: the Gambia, the Senegal, and the Niger. These and numerous other sources provide significant potential for hydroelectric power.

Guinea's ample endowment of natural resources nothwithstanding, overall economic performance has been disappointing. Real growth of GNP from 1958-1973 was estimated at 2.5 percent. Guinea has a population of more than 5.5 million, of which 85 percent is rural. Domestic food production is not keeping pace with population, which is growing at an annual rate of 2.9 percent. Despite revenues from mineral exports, food and energy importation is placing a large and growing burden on the struggling economy: oil imports almost tripled between 1976 and 1979 (See Table 1). Increased use of marginal lands (and reduced fallow periods) is leading to serious deforestation, soil erosion, and silting of major tributaries.

TABLE I

Fuel Imports ($ millions)

1976	1977	1978	1979	1980	1981
13.1	17.9	26.0	36	N/A	N/A

Source: World Bank Study, 1980, and unpublished sources.

II. Conventional Energy and Power Resources

A. Statistical Overview

Although data for the energy sector are incomplete, it is estimated that firewood and charcoal provide 65 percent of the

approximately one million tons of crude oil equivalent (TOE) energy consumed as primary energy by households, transport and state-run industry. Increased use of firewood, the most important fuel source for most of the Guinean population including urban households, is leading to significant depletion of forests, particularly in the savannah region of the north. Total power generation in Guinea in 1978 was about 150 GWh 1/; approximately 88 percent was hydrogenerated and the balance was thermic (diesel) generated. In 1979, Guinean imports of petroleum products (40% of total imports from all sectors) reached $36 million. 2/ From 1979 to 1985, it is anticipated that electrical consumption will grow by 12 percent per annum. (See figure 3.)

B. Hydroelectric

Guinea's most abundant energy resource with potential for substituting for imported fuels is hydroelectric power. Power potential of these resources is estimated to amount to at least 6000 NW with an average output of about 35,000 GWh (3 million TOE). Not all of this potential may be economic to realize. Forty (40) MW of hydro-potential have so far been developed with average energy production of about 245 GWh (21,000 TOE). Feasibility studies have been financed and the GOG has approached foreign aid donors for the financing of the 750 MW Konkoure hydroelectric project. Funding requirements for this undertaking are estimated at close to 2 billion dollars.

C. Mini-Micro Hydro Generators

There are 65 sites in Middle Guinea alone that are suitable for the installation of mini or micro hydro-generators. With only 3 to 4 percent of Guinea's rural population served by electricity, it is easy to see why the GOG is extremely interested in developing this potential. Cost per installed kilowatt at 1980 prices was estimated at $3,000. Many studies have been conducted or are planned. A ten volume study of hydroelectric sites in the Fouta Djallon was completed by a Czechoslovakian study team. The World Bank has sent and VITA will be sending experts to plan additional feasibility studies.

D. Thermal

Thermal electric production in the public sector is estimated

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1/ GWh: gigawatt, one million kilowatt hours (KWh).

2/ An additional $35 million was imported directly by two (2) mixed enterprises.

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at 25 MW with 10 MW supplementing Conakry's grid and the balance spread among seven urban centers up-country. Mixed enterprises generate approximately 70 MW at three bauxite mining sites.

III. Non-Conventional Energy

A. Windpower

Wind speeds in Guinea have been measured at 11 locations in Guinea. Wind speeds are low; analysis of these data indicate wind energy potential is very small. Nonetheless, a Savonius wind machine has been installed and two wind-powered water pumps are slated for installation.

B. Solar

Sunshine duration is measured at 12 stations; four stations are equipped to measure total insolation. Complete data are lacking, but preliminary analysis indicate this resource as considerably less than neighboring Senegal and Mali.

C. Biogas

Biogas is being tested at the Foulaya National Research Institute and there is considerable interest in biogas experimentation at state collective farms. Funding and technical problems do not dampen Guinean enthusiasm for biogas, but replicability is questionable.

D. Ethanol

Good supplies of starch and/or sugar wastes exist (oranges, mangos, and pineapples). It is estimated that 400,000 liters of ethanol could be produced from orange wastes alone. (There is a 20% waste factor at the orange peel oil refinery plant). However, use of land for energy farming will compete with land use for essential food crops, limiting larger scale ethanol production.

E. Agricultural/Forestry Wastes

Coconut shells, sawdust, rice hulls and rice straw are being used in a limited manner in lower Guinea. Briquetting or other processing may be feasible and is under study.

F. Geothermal

Two (2) geothermal sources exist in Northern Guinea with temperatures at about 60 degrees centigrade. The GOG is seeking financing for the visit of a geothermal expert in order to determine potential of these two sources.

G. Ocean Thermal

The GOG is interested in exploiting this resource along its three hundred kilometers of Atlantic coastline. Three monitoring stations have been installed; two more are planned. The Oceanographic Institute in Conakry which is responsible for such studies was financed and built by the Soviet Union.

H. Animal Power

Guinea has emphasized farm mechanization in order to achieve rapid agricultural progress. Draft animals are not numerous. Increased use of animal power has economic benefits for small farmers and will be systematically explored by USAID and other donors.

IV. Forestry and the Environment

A. Background

The Fouta Djallon plateau is the source of the three great West African rivers. A deteriorating ecological balance could have disastrous implications for the ten African nations whose agriculture depends on their flow. Given low agricultural yields and high population growth, more and more marginal land is being put into production. Arable land is becoming less available and there has been a corresponding decrease in the traditional fallow period. Brush-burning for livestock grazing is widespread. Soil erosion and silting in most of the tributaries in Middle Guinea is widely evident.

Between 1960 and 1977, approximately 30 percent of the Guinean forest cover was destroyed principally as a result of slash-and-burn agriculture. It is estimated that more than 1000 hectares of trees must be planted annually in a typical 500 km^2 area in order to offset the 6000 tons of wood harvested annually from a site of identical size.

Fuelwood costs between $.05 and $.75 per kilogram; annual consumption is put at 1,100,000 tons. Charcoal costs $.06 per kilogram. Fuelwood costs alone can consume as much as 20% of a Conakry family's income. Rural families pay less but spend much time and energy gathering increasingly scarce firewood, particularly in Middle Guinea.

While at present only one institution is experimenting with improved woodstoves, government interest is high. The GOG is seeking assistance from UNICEF and the FAO for a 21-month improved woodstove project. A VITA proposal recommends the introduction of adaptation and testing of improved stoves in Middle Guinea.

B. GOG Policy

The GOG clearly recognizes its major, international role in protecting its forest resources. (The Five-Year Plan earmarked the largest share of the national budget, 21 percent, for investment in Agriculture, Water and Forestry). Numerous decrees and proclamations have been issued: tree planting is required at births and weddings; five hectares of trees must be planted before permission is granted for visits to Mecca; only deadwood can be harvested; charcoal is produced only under license; brush-burning is punishable by death. Despite these decrees, enforcement is lax; the deforestation problem grows.

V. Donor Assistance

Table II shows donor assistance to the development of Guinea's energy sector:

TABLE II

Donors		Amount ($ MM)	Project
(i)	IDA	$ 28.5	To improve electrical distribution in Conakry.
(ii)	African Development Fund	2.3	Pre-investment study for elec./water supply to eight towns.
(iii)	W. Germany	14.4	Rehab. of Conakry's elec/prod dist.
(iv)	Caisse Centrale de Cooperation Economique (CCCE), France	4.5	Feasibility study of Konkoure Dam.
(v)	Various	Approx. 1.0	Mini hydroelectric power studies.

Donor assistance includes the FAO's five-year, $5 million Watershed Management Project which covers a 500 km² area of the Kokoulo River Basin which traverses the Pita/Labe region in Middle Guinea. The USAID Community Forestry AIP, signed August 1981 for $460,000 will coordinate with FAO and work with two arrondissements in the Pita region as well.

VI. Summary

Guinea does not have the financial resources to exploit the potential of its sizeable hydroelectric and forestry resources. Moreover, it faces increasingly large foreign exchange costs for

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fuel importation. Further neglect of the deforestation could threaten not only Guinea, but its many neighbors.

Donor assistance and GOG effort are increasing as are the number of projects aimed at increasing farm yields, developing small hydropower plants, increasing reforestation and improving environmental education.

Although increasing in magnitude, the Guinean energy development program remains inadequate to meet even short-term needs. Much work remains; larger (and costlier) programs must be mounted and donor coordination must improve to avoid costly overlap and ensure efficient implementation.

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KENYA

I. Background

Kenya is suffering both from rapidly increasing prices for imported oil on which it is heavily dependent, and from increasingly severe pressures on its biomass resources. The country has one of the fastest growing populations in the world, the overall growth rate of about 4% being even higher in two of its most populous and largely rural provinces. With over 83% of the country's land area being arid or only marginally productive, the land frontier is rapidly closing in. The energy crisis affects both urban dwellers in term of higher prices and occasional fuel shortages, and has far reaching effects in rural areas through loss of arable land and consequently decreasing food production.

This paper summarizes the issues, problems, and potential of Kenya to face and resolve its energy crisis, and the current status of GOK and donor efforts. Summary statements are supplemented with references to more complete studies and reports.

II. Sources of Energy

A. Conventional Energy

Sources of conventional energy used in various sectors are petroleum (imported), coal and coke (imported), and hydropower (imported and domestic). Of the total amount of 3,561,100 tons of oil equivalent produced in or imported to Kenya in 1980, 41% consisted of hydropower generated in Kenya, 8.7% was imported hydropower from Uganda, 0.5% from imported coke and coal, and the balance of 49.8% was imported petroleum. Table I shows relative amounts of these sources for 1976 thru 1980.

B. Traditional/Renewable Energy

Fuelwood and charcoal are the primary sources of energy for the population living in rural areas (total rural population is estimated at 13 million) and more than 50% of the population living in urban areas (population approximately 4 million).

Estimates of charcoal production range from 170,000 - 310,000 tons in 1975 to 1,100,000 tons in 1981. Most charcoal is produced in primitive earth kilns by people living in rural areas who either scavenge or bootleg the wood supply, with little effort at replenishment.

III. Energy Consumption

A. Sectoral Patterns in Use of Commercial Energy

Table II shows conventional energy demand by sectors. Transportation alone consumes 53% of fuel used in Kenya, one-half by private autos and one-third by air travel. Industries use 21% of the fuel, 11% is used in thermal

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generation of electricity, 9% in agriculture, and the remainder of 6% is used in buildings, residences, and for construction.

Forty-five percent of electrical power is used by industry, and 48% is used in buildings and residences. The remaining 7% is used for energy production, agriculture and construction.

Conventional energy provides approximately 20 to 30% of all energy consumed in Kenya. Conventional energy from petroleum, coal and electricity increased by 2% in 1979 and by 4% in 1980. Petroleum product consumption increased by 5.6% in 1980 -- faster than the increase in the Gross Domestic Product.

B. Balance of Payments

The new oil bill for commercial energy consumption rose from Kenya Pounds 33.9 million in 1976 to Kenya Pounds 68.8 million in 1979 to over Kenya Pounds 116 million in 1980. As of 1979, the cost of oil amounted to 18.1% of the value of total exports, rising from 1.1% in 1972.*

C. Biomass Resources

The population of Kenya consumes a great deal of fuelwood for its domestic needs. Fuelwood provides, directly or indirectly (through charcoal), approximately 80 to 90% of all the domestic energy consumed in the country but the average consumption per head of fuelwood (including charcoal) is not known with any degree of reliability. Estimates of average per capita consumption range from 0.8 m^3 to 1.5 m^3. Even if the lower estimate is used it would represent an annual consumption of at least 13 million m^3 for fuelwood and charcoal. It is not clear where all this fuelwood is coming from, but a substantial amount must come from forest land, whether gazetted or not; the rest must come from scrubland, farmland, scattered trees and shrubs. Since annual consumption far outstrips wood regeneration, fuelwood consumption is clearly leading to significant deforestation. The dimensions of the phenomenon, however, are only dimly known, The Ministry of Environment and Natural Resources (MENR) survey of 1979/1980 found acute scarcity in Kitui, Turkana, Machakos , and parts of Kakamega Districts and in much of Nyanza Province. Crop residues and manure are widely used in these areas to substitute for fuelwood; richer families are able to afford kerosene. Rapid loss of forest cover is noticeable in areas peripheral to Nairobi which furnishes the capital with charcoal.

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* One Kenya Pound = U.S. $2.00

IV. Energy Resources

A. Potential of Conventional Energy Resources

1. Hydroelectric Power

The development of hydroelectric power is the responsibility of the Ministry of Energy. The Tana River Basin is the main source of hydroelectricity. At present, five generating stations with installed capacity of 335 MW are in operation and the construction of one more (Kiambere Valley) generating station with a power potential of 130 MW is expected to commence soon and come into operation in 1987. The Master Water Plan estimates the total potential at a little more than 3,000 MW sufficient to meet Kenya's requirements up to the year 2000. The Tana River accounts for 1,230 MW and the Athi/Sabaki Rivers for 370 MW.

Expansion of mini-hydropower potential is being conducted in Western Kenya, supported by Finland. In total, this potential is estimated at 1,200 MW of which 750 MW can be economically harnessed at current market prices.

2. Fossil Fuels

The GOK is encouraging the exploration for oil believed to exist off the coast and possibly in the Rift Valley near the Sudan border. Kenya has no known coal deposits.

3. Nuclear

Although preliminary indications of finding uranium in southeast Kenya are promising, development of nuclear power is not being considered at present.

B. Potential of Alternative Energy Resources

1. Geothermal

This is the most important new source of energy in Kenya for the immediate future. The maximum and minimum potential has been estimated at 1400 MW and 170 MW respectively over a 25 year period for the Olkaria region along, where one 15 MW plant is already in operation and another 15 MW plant is expected to be in operation in 1982. Exploration on two other geothermal fields -- Eburru and Lake Bogoria -- will begin soon.

2. Alcohol

Two plants are under construction. One at Kisumu will be operational by mid-1982, the other at Muhoroni will be operational by 1983/4. The design capacity of each of

these molasses-based plants is 60,000 liters/day. The proposed Riana Ethanol Project, which will use sugar cane juice directly to produce 150,000 liters/day, is expected on line by 1984/5. However, construction costs for the two plants at Kisumu and Muhoroni are exceedingly high and the economic viability of these plants has been subject to considerable discussion.

3. Solar

Solar radiation data indicates average insolation rates of up to 30 to 45 watts per square centimeter. Drying of agricultural commodities and salt production are both practiced. The second most widespread application is in commercial water heating. Flat plate collectors of varying sizes and qualities are being manufactured and/or assembled locally and are priced approximately K.Shs. 2,000 per square meter. GOK is actively seeking to install solar water heating in hospitals, schools, clinics, etc., especially in isolated areas. There is potential for solar water desalination units to provide water for some areas. Also, GOK is interested in applied photovoltaic devices when costs become competitive with alternative energy sources.

4. Wind

Used in Kenya for the past 100 years, wind power technologies have met with little success because of (1) data on prevailing winds are insufficient for design purposes, (2) mill design and component materials have not been adequately field tested and changed as required, and (3) costs are prohibitively high. Government does plan to gather more reliable data on prevailing winds and to promote development of cheap but reliable local hardware.

5. Biogas

Biogas technology was first used 30 years ago. Manufacture of biogas digesters began in 1958; results have been disappointing. However, estimates of potential for biogas range from (a) sufficient energy to completely replace the use of firewood plus 5840 x 10^{10} kcal to spare, to (b) sufficient energy to replace half the use of firewood.

6. Solid Wastes

Large quantities of waste materials are available for conversion into usable sources of energy. Examples are coffee husks, sugar bagasse, rice husks, sawdust, and maize cobs. A new Kenya Planters Cooperative Union annually converts 20,000 tons of coffee husks into 7,000

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tons of charcoal briquettes, but the selling price is presently over twice that of wood charcoal. (KSh 2.75 vs. KSh 1.00 per kilo). Because of its greater convenience in use, however, "Kahawa Coal" is popular with the urban expatriate community.

7. Fuelwood Energy

Kenya's natural and man-made forests total 2.35 million hectares. Gazetted forests (with officially marked boundaries) total 1.57 million hectares, the remaining 0.78 million hectares are ungazetted. Indigenous forest produces very little biomass for sawmilling and pulpwood production compared to exotic tree plantations. (Industrial plantations produce up to 150 times more wood than natural forests.)

Natural forest areas are being depleted, first to make more land available for agriculture, and second, because in many areas wood is being taken faster than new growth is achieved. Numerous studies on fuelwood supply and demand conclude that existing and planned production of fuelwood from forests and woodlands is inadequate to meet present demand on a sustained yield basis. Estimates of the rate of depletion indicate that at least half of the remaining "wood cover" would be stripped over the next three decades, and possibly as early as the coming decade. The need for fuelwood conservation has been recognized and several groups and individuals are beginning to develop, and trying to distribute the use of improved cookstoves.

C. Monitoring Environmental Effects

AID assistance through the Environmental Training and Management Project (a regional project) has enabled GOK to produce a series of district environmental profiles which can be used in monitoring the environmental status, especially the effects of deforestation. A siltation model is also being developed under this project.

V. Private Sector Involvement

At present, importation, refining, and distribution activities (except a pipeline) of petroleum products are owned and managed by the multinational oil companies. However, the Government has recently established the National Oil Corporation of Kenya which will be responsible for procuring and refining 50% of the crude oil. The government sets controlled prices.

Generally, the private sector operates production and distribution of charcoal subject to government control of prices.

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In the private sector, relatively large businesses appear to have an interest in conserving energy if it will save money. Firestone has been instrumental in introducing energy-efficient measures at its plant. Major hotels seem interested in using flow restrictors to save hot water. A parastatal pyrethrum processing board in Nakuru has added new steam valves, instrumentation, insulation on steam pipes, and installed a sawdust burning boiler to complement the existing oil boiler. Further initiatives to save energy in the commercial sector are possible but management must deal with tariffs and restrictions for imports of conservation and solar water heating equipment, lack of expertise to retrofit existing equipment, lack of trained staff (competent engineers are often fully occupied -- and indeed overworked -- simply keeping the plant functioning), and the demands of other parts of their operation.

Private Voluntary Organizations (PVOs) are very active in renewable energy activities. Thirty-six PVOs are involved in the fuelwood area. Most are doing tree planting; others are developing seedling nurseries; some are involved in information dissemination. Eighteen groups are working on solar, 21 on wind, and 14 on biogas. These groups are also involved in other conservation such as improving cookstove insulation and efficiency.

VI. Donor Involvement

Several donors are active in Kenya. Donor participation includes assistance in power generation, transportation, distribution, rural electrification, fossil fuels, geothermal, energy planning, and renewable energy including forestry/fuelwood. Donors include World Bank, EEC, Denmark, United Kingdom, Sweden, Canada, FRG, several UN organizations, AFDB, France and USAID. Donor response is more than adequate at present. GOK is constrained by a limited capability to absorb the present assistance.

VII. GOK Strategy and Policies

Planning and Coordination: In 1979 Government established the Ministry of Energy (MOE) charged with energy planning and providing advice on energy policy. Besides policies on pricing, production, and distribution of conventional fuels and electricity, MOE has the task of developing consistent and workable strategies to increase use of renewable sources of energy.

Petroleum: Government controls the prices charged by multinational oil companies. Since June 1980, petroleum prices have been raised four times. Motor fuel prices have increased approximately 50 percent. However, one-half of the increases merely reflect costs that have been passed on to consumers. Kerosene prices, kept relatively low for the benefit of the Kenyans, are subsidized by petrol prices. Government also plans to increase the efficiency of the Mombasa refinery in order to increase crude oil requirements. Refined petroleum products are re-exported to neighboring countries and Government plans to increase Kenya's role in this activity which has been an important source of foreign exchange.

Education: Government has also started a radio and television campaign to educate the public on conservation measures such as economical driving habits -- but the effort is spotty and needs improvement by seeking a wider audience on issues relevant to their daily lives (such as improved cookstoves).

Government has considered but not implemented conservation measures such as a ban on Sunday driving, and shortened lunch periods to reduce lunchtime commuting.

Import tariffs on coal and coke are lower than that for petroleum. Charcoal prices, also set by government, are lower than prices for kerosene. Duties on larger luxury automobile have recently been raised in further effort to discourage use of high fuel-consuming vehicles.

Hydropower: Government intends to maximize the utilization of Kenya's hydropower potential and has constructed, and plans to construct several more, large hydroelectric generating plants. Development of small scale hydropower sources is now under study.

Renewable Resources: Government has been changing its focus in recent years from industrial plantations for sawmilling and pulp production to fuelwood related projects. The Rural Afforestation Extension Service of the Ministry of Environment and Natural Resources (MENR) was established in 1971 to work in all forestry activities outside gazetted forests. However, still over 70% of the MENR budget is for maintenance and development of industrial forest plantations.

The Ministry of Agriculture (MOA) offers extension services to the division and location levels, to run nurseries and encourage tree planting for erosion control, and for increasing wood production to satisfy the needs of the tobacco and tea industries. This effort is not well organized.

The Ministry of Energy (MOE) is attempting to establish policies for promoting renewable energy use. Part of this task involves coordinating the efforts of MENR and MOA. MOE has begun by trying to coordinate the establishment of six fuelwood agroforestry extension centers variously located in different climatic zones. Much effort at coordination will be needed if these centers are to be successful.

MOE also plans to encourage the use of more efficient cookstoves and charcoal kilns, and to develop applications to utilize biogas, solar, wind and solid wastes. Again, MOE has hardly begun and much effort will be required before a workable coordination mechanism for the many pilot projects becomes effective.

VIII. USAID Activities

USAID, through the Renewable Energy Development Project, is assisting the MOE by (1) conducting initial planning and surveys, (2) providing staff support for institution-building and (3) providing staff assistance and finances for an Energy Development Fund. This assistance is to help MOE develop relevant policies in conservation and renewable energies, and to promote demonstration and extension programs.

Based on MOE's present and projected capabilities, the magnitude of its responsibilities and on the need to establish in the field viable renewable energy applications, Mission believes that future involvement in energy assistance is possible. Many donors are already involved in development of conventional energy resources. With AID expertise in renewables and GOK's need for developing renewable energy resources, it is possible that future assistance would be in this area, in particular for fuelwood.

TABLE I

PRODUCTION AND CONSUMPTION OF PRIMARY COMMERCIAL ENERGY IN KENYA

Source of Energy	1976	1977	1978	1979	1980
Coal & Coke Imports ('000 tons) oil equipment	44.9	43.8	34.8	11.3	16.9
Imported petroleum oil on '000 tons	2446.7	2556.5	2369.2	2471.5	3075.5
Consumption of petroleum products in Kenya in '000 tons oil equivalent	1563.5	1607.8	1659.9	1669.3	1768.2
Hydroelectricity (GWH) Domestic	1080	1085	1357	1543	1461
Imported	242	272	217	160	315

Source: Economic Survey, 1981

TABLE II

DEMAND FOR COMMERCIAL ENERGY BY SECTOR IN 1979

	Fuels	Electricity
Transportation	53%	-
Industry	21%	45%
Energy Production	11%	4%
Agriculture	9%	2%
Buildings & Residences	5%	48%
Construction	1%	1%
TOTAL	100%	100%

Source: Schipper et.al., Energy Conservation in Kenya: Progress, Potentials, Problems.

LESOTHO

I. Overview

Lesotho is a small landlocked enclave within the Republic of South Africa with a total area of 30,350 km² and 3,548 km² of arable land. The climate has a moderate to minimal rainfall. The country has a strip of "lowlands" along the western border. These lowlands are rolling hills, foothills and plateau upon which two-thirds of the country's 1.2 million live. The remaining one-third of the population live in the rugged Maluti, Central and Drakensberg Mountains, and along the Senqu (Orange) River Valley. The terrain in the mountain is mostly rangeland covered with grasses and scrub brush except where over grazing has completely removed the vegetation and erosion exposes bedrock. The lowland valleys contain growths of trees and support farms with both fields and pastures. In recent years, migration pressures and population growth have resulted in heavy cutting of trees and small brush in the lowlands which has increased erosion under the infrequent but torrential rains. Lesotho has no known commercially viable sources of conventional fossil fuels such as coal or oil. A very thin seam of coal and low grade uranium ore deposits have not been deemed worth mining at present. Due to the terrain, small-scale hydroelectric installations are a possibility. The Taiwanese Government is building two small hydroelectric plants for Lesotho.

II. Sources of Energy

A. Conventional

As shown in Table I, the sources of energy imported into Lesotho are shown to have increased three-fold in half a decade.

TABLE I

C.I.F. Value of imports by Major Commodity for the Period 1974-1978: Mineral fuels, lubricants and related materials (000's of Rands; R1=$1.30 in 1980)

1974	1975	1976	1977	1978
5,381	7,131	11,742	17,636	17,901

Listed by commodities, the pattern is shown in Table II:

TABLE II

	1978 C.I.F. Value (000's)	Consumption 1978/79	Consumption 1980/81 (liters)
Coal	R 455	-	-
Petrol	6,057	4,543,751	27,532,656
Aviation Petrol	216	56,724	1,191,213
Paraffin Oil	4,748	102,042	15,792,529
Diesel Oil	2,890	4,609,823	19,612,001
Lubricating Oils, Greases	544	-	-
Petroleum Jelly	568	-	-
Other Coal Products	566	-	-
Domestic Gas	383	82,373	216,629 kg
Electricity	1,474	84,000,000	99,000,000 KWHR
	R17,901,000		

Firewood imports were listed as R266,000 in 1978 and R1,329,000 in 1979, although this rise may be due to accounting procedure changes.

The rise in imported liquid fuels is shown as:

TABLE III

Annual Sales (Million of Rands)	1977	1979
Petrol	4.7	6.0
Paraffin Oil	4.5	4.7
Diesel Oil	2.3	2.9

The rise in fuel costs is seen in the Retail Price Index as exceeding any other category of purchases.

TABLE IV
Low Income Households
Retail Price Index & Percentage Changes, Oct. 1972=100%

Commodity Group	1975	1979
Food and Drink	156%	285%
Rent and Home	138%	188%
Fuel, Light & Heat	184%	506%
Clothing	127%	164%
Transport	112%	318%

The average all-electric household in the capital city, Maseru, used about 27 kilowatt-hours per day in 1978 or 97 megajoule (MJ) per day. This is 3.5 x 10^4 MJ/year. In

contrast, an average Lesotho household uses about 90,000 BTU per day for cooking, lighting and heating which is equivalent to 95 MJ per day or 3.5×10^4 MJ per year. Thus, based upon the 1976 de facto number of household in Lesotho, 240,308, total national household energy consumption is about 8.5×10^9 MJ. These numbers are subject to closer scrutiny in light of "non-official" informal economic activities such as beer brewing. The traditional fuels, firewood, small shrubs, grasses and field stubble, and dung are under pressure from increasing population growth and increasing herd size. There is no charcoal production.

B. Renewable

The Lesotho Woodlot Project data on tree planting show a total of 2,976 hectares planted in 1981. The desired annual rate is 550 hectares, although that has not always been met. The trees are valued at about 8,000 Rand per hectare but the wood is used more for construction material than as fuelwood. There are many trees planted by the public on Tree Planting Day each year and other ongoing programs such as through the soil conservation division of the Ministry of Agriculture. In contrast, it is frequently noted that there are large numbers of recently felled trees along river banks and public lands, leading to the observation that the total tree population is either steady or declining.

Since the terrain varies enormously from the lowlands to the mountains, it is difficult to obtain meaningful figures for the biomass potential of the country. Ranging from 50 kg/ha on severely eroded land to a measured 546 kg/10 m x 10 m woodlot in the mountains 'Malefiloane region (54,000 kg/ha), the average estimated biomass potential may be around 5,000 kg/ha in the mountain rangelands. The lowlands estimate is at least three times that. Mr. Marc Best reports an annual firewood consumption of 1.5×10^3 kg for households in 'Malefiloane. At a measured 23.26 MJ/kg, this is 3.5×10^4 MJ/year equivalent to the urban household in Maseru. He also reports the combustion of 1.35×10^3 kg of dung/household. At an average calorific value of 13 MJ/kg, this represents 1.7×10^4 MJ/year/household. In the same area, a typical household would also burn about 27 liters of paraffin oil per year. At 38 MJ/litre, this is an additional 1×10^4 MJ/year, making the household total energy consumption 5.3×10^4 MJ/year. Since this village area is at an altitude of 2680 meters and ranges from a June temperature of 5°C to a December temperature of 17°C, it represents the colder end of the climatic spectrum of Lesotho. Mr. Best interviewed the villagers and found that 73% of the women reported that collecting wood is a problem and 80% responded that the collection of wood has become worse. The average walking distance from the village to the wood collecting areas was found to be 3.5 km. Thirteen hours and 50 minutes was spent weekly in the collecting of wood amounting to an average of 95.2 kg. Within these villages,

the collection of fuel follows a seasonal pattern. Much of the cooking is done with three-legged cast iron pots above the fire. Little of the potential heat from the fuel heats the contents of the pot, but when cooking fire is indoors it contributes to space heating. The distribution of energy in this village is approximately 68% for cooking, 30% for heating and only 2% for lighting. The per capita annual fuel consumptions were found to be 6.7×10^3 MJ of wood, 3.4×10^3 MJ of dung and 0.2 MJ of paraffin. At 5.2 persons per household, this is 5.3×10^4 MJ/year.

Although the prices of bundles of wood varies from 30 cents to 1 Rand, at an average of 50 cents per bundle of wood which has a mass of 21 kg, this is about 500 MJ per bundle or an energy price of 1 Rand per 1000 MJ. People have expressed concern on the reduction of wood supplies as they are either paying more for wood or are spending more time in fuelwood collection. The supply of dung has remained constant or has slightly increased with increasing herds, although families without cattle are a severe disadvantage. Fuel efficient stoves and village woodlots can play a large role in this area.

III. Energy Policies and Priorities

Energy is addressed in the Third Five-Year Development Plan, but no separate official Lesotho Energy Policy exists. The Ministry of Water, Energy and Mining commissioned a German team to help formulate policy two years ago, but this has not yet been implemented. Policies are being created piecemeal by other Ministries to deal with their internal decision making processes. The Ministry of Cooperatives and Rural Development is participating in the Renewable Energy Technology (RET) Project (USAID-funded) and is drawing up a rudimentary energy policy.

Lesotho has an active program of economic development which encourages all businesses, including the multinationals, to invest in the country with tax reliefs. Many of the larger commercial establishments account for the bulk of the formal sector energy consumption. For example, out of the nominal 30 MW imported electricity, three resort hotels use about 2 MW, or 7% of the national total. Since many of the commercial establishments can pass on the energy costs to consumers, they are not highly motivated to initiate energy conservation or use alternative energy sources unless pushed by outside forces. Because Lesotho is an enclave within the Republic of South Africa and on the energy trade routes for coal and liquid fuels, and is attached to the R.S.A. electrical grid, the prices for these energy sources are among the lowest on the African continent. For example, electricity is sold at 4 to 5 U.S. cents per kilowatt hour, petrol is available for 63 U.S. cents per liter (U.S. $2.38 per gallon), and coal is U.S. $4 per kilogram bag (or U.S. $73 per ton). Thus, with ample and cheap energy supplies, Lesotho has not perceived any major needs to introduce energy conservation or energy alternatives until recent years as R.S.A. prices rose.

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The energy priorities in the next five years are to encourage large-scale hydroelectric with smaller installations. Taking a demonstrated electrical demand growth rate of around 15% per year, both large-scale and mini-hydro plants are planned.

Subsidies on energy appear only on paraffin and diesel for agriculture. The "Common Fuel Fund", jointly administered by Botswana, Lesotho and Swaziland, raises funds from taxes on petrol and diesel sales.

At present, policies for conservation include restricted hours of sale of petrol and diesel and a 90 Km/hr speed limit.

IV. The Role of the Private Sector

Several private companies were formed to deal with the manufacturing and installation of solar water heaters. The financial history of these has not been outstanding and problems with installation and maintenance have increased. In certain instances, people have remarked that "solar water heaters don't work, because I know someone who has one on their house and it's not in operation". A priority for the RET Project is to identify these faulty units and train artisans or repair crews to perform retrofit services. (Certain heaters properly installed and maintained have given flawless service.)

There is a potential role for the cooperatives and credit unions to help promote and finance energy systems and to encourage small-scale entrepreneurial efforts. The RET Project is collaborating with the cooperatives in this area as well as with the Basotho Enterprises Development Corporation (BEDCO), a parastatal which encourages medium-scale businesses.

BEDCO is examining the possible production of kits for solar cookers and the possibilities of concentrating on solar collectors for commercial and institutional water heating in conjunction with the RET Project. One of the major constraints to implementing small businesses is the lack of entrepreneurial skills and the lack of start-up capital. Short-term loans to entrepreneurs closely coupled with business advice is desperately needed.

V. The Role of New Technologies

The potential for several technologies such as producer gas and small-scale Stirling engines and biogas need further evaluation, especially in comparison to draft animal power. Price reductions on producer gas and Stirling engines may help reduce the demand on imported fuels for both stationary and mobile power sources. Since the draft animal is part of the Lesotho "cattle culture", its total replacement by mechanized traction even at the small-scale levels seems remote, although mechanical power sources introduced for other purposes may be accepted.

The use of small engines or other mechanical systems with renewable fuel sources may appear attractive based upon capital costs and overall efficiency numbers, compared to draft animals. However, it must be stated that mechanical aptitude and the concept of routine maintenance is sorely lacking, as demonstrated by about half of the Lesotho tractor fleet being out of service at any one time. Still, under an established repair and maintenance scheme, these small power sources may have possibilities for Lesotho which should be investigated further in concert with forestry biomass production.

TABLE V

Technology	Fuel	$/kw	Overall Efficiency 1/	Scale 2/ kw	End Use 3/	Status
Draft animal	cattle feed	240	3.5%	0.1-0.5	M,S	Available
Producer gas engines	dry biomass	200	12-21%	2	M,S	Available
Stirling engines	dry biomass	350	4-4%	0.1-0.5	M,S	Under Development
Biogas	animal manure & crop residues	150[4]	7%	0.1-0.5	S	Available
Photovoltaic	sunlight	7K-50K	-	0.1	S	Under Development
Water Pump-windmills	wind	4K-10K	-	0.2	S	Available

1 raw material to mechanical output
2 practical minimum size
3 M=mobile, S=stationary
4 excludes digestor costs

Lesotho Government involvement with renewable energy planning policy is mandated through the Ministry of Water, Energy and Mining and the Central Planning and Development Office. The Ministry of Agriculture (MINAG) has a Home Economics Unit which has been teaching the construction of mud stoves, solar dryers, and other renewable energy systems. MINAG also is looking into a biogas program. A Ministry official has returned from overseas training program in biogas. The OPEC Fund has provided $250,000 for a biogas and solar energy development scheme. The Anglo De Beers Forest Services have been establishing woodlots since 1973, with 2000 hectares planted to date. The Ministry of Cooperatives and Rural Development oversees the RET Project which has fuel efficient stoves, solar heater building design, pedal power, solar greenhouses and growholes, and building insulation and weatherization as major components, with research and demonstration in biogas and

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micro-hydroelectric. The RET Project is collaborating with the Ministry of Works and with several private architectural firms in providing design guidelines for solar heated buildings.

A possible role of USAID and other donors is to 1) assist in energy conservation and building retrofit equipment; 2) help expand the existing woodlots program and start village woodlots; 3) provide photovoltaic purchase assistance for remote clinics and schools; 4) assist in providing or purchasing small mechanical energy sources such as producer gas and Stirling (both biomass and direct solar); and 5) provide financial assistance as small business starter loans coupled with expert business advice for construction and maintenance of energy systems. The development of human resources ranges from the needs of the village energy technician, through the small-scale manufacturer, to the national energy policy planners. This total energy related package mentioned above may require 3 to 5 million dollars per year for 10 years to assist Lesotho in becoming more energy independent. Another possible role is to assist in the forestry program which could use 10 foresters, one in each district, plus three assistants each. Gully and erosion control plantings can provide local village energy sources. This would cost about 2 million dollars over a 5 year period. This should be looked at in terms of regional cooperative programs including SADCC.

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LIBERIA

I. Sources of Energy

Liberia imports all of its fossil fuel through five multinational commercial distributors of oil and oil products. The government-owned Liberia Petroleum Refining and Distributing Company has the capacity of 15,000 Bbl/day; the refinery is now working at full capacity. Plans are underway to expand capacity and to develop contracts with other parties for refined products. Fifty percent of the refinery's output is fuel oil, most of which is used by the iron ore companies. Twenty-one percent is diesel fuel, 14 percent is gasoline, eight percent is jet fuel, three percent fuel gas, while less than one percent is produced in the form of asphalt and LPG. Less than half of one percent of its product consists of intermediaries (kerosene and naptha).

Petroleum imports are becoming a major foreign exchange cost, rising from $5.5 million and 6.3 percent of total imports in 1970 to $118 million, or 20 percent of imports in 1980. Liberia's 1981 oil bill is expected to exceed $130 million. Its monthly payments to the oil financing facility average $11 million and this has become a major foreign exchange problem.

The Liberian Electricity Corporation (LEC), a government-owned corporation, generates and distributes electricity to several communities in Liberia. The LEC operates a power grid within the Monrovia area consisting of 11 MW diesel, 64 MW gas turbine and 64 MW hydro installation (Mt. Coffee Hydroelectric Facility). In 1980 it added a 26 MW marine diesel generator and added two 13-MW units in 1981. The LEC also operates nine stations in towns in the interior which are separate from the Monrovia system. The diesel generators in these towns range in capacity between 300 KW and 2 MW. Smaller towns reportedly have small diesel set in the 10-1000 KW range, owned and operated by private entrepreneurs. Demand strains supply at all facilities.

A major constraint to effective year-round use of hydropower is the lack of storage for the dry season (Mt. Coffee Facility has no reservoir) which lasts six months of the year. Plans are underway for a major hydro project along the St. Paul River in Central Liberia, which will increase hydroelectric capacity by 414 MW by 1990, with storage. This is to be accomplished in several phases.

Liberia has a considerable supply of firewood for domestic consumption. Approximately 43 percent (4.8 million hectares) of the country is heavily forested. Although in areas near urban centers firewood is a market commodity with availability relatively unassured, wood is collected by family members and used for cooking over open fires in rural areas. In urban areas, charcoal (made in the interior and transported daily to urban markets by pickups and trucks) is the favored residential fuel for cooking and water heating.

A German study indicates that Liberia's forest reserves can provide up to 3.4 million cubic meters of wood annually; this is equivalent to over 600 GWH of electricity annually. The country has ongoing reforestation programs and this theoretically assures the wood resource as an energy reserve.

II. Consumption of Energy

The consumer list for petroleum products is headed by the mining concessions (mostly for electricity generation) which consume 62 percent of total in the form of fuel oil and diesel, followed by land transport at 15 percent (gasoline), commercial electricity generation of 11 percent (diesel and fuel oil), air transport at nine percent (jet fuel), and the refinery itself uses three percent in the form of fuel gas.

Monrovia's demand for electricity (both petro and hydrogenerated) is such that installed capacity is becoming strained. Illegal hookups and non-payment of electricity bills causes LEC to operate at considerable annual loss.

As a result of escalating prices of petroleum products and electricity, there has been a shift to more traditional sources of energy (charcoal) in urban low-income households. In Monrovia, the average per capita use of wood is 0.4 m^3/annum of which 48 percent is in the form of charcoal. In rural towns, up to 5.5 m^3 of wood per year is used per capita. Of this figure only 0.15 percent is in the form of charcoal. The cost of firewood, charcoal and kerosene for a typical family of five is about $280 per annum, which means that 20 percent of a typical family's budget is spent on energy.

III. Energy Resources

Apart from hydroelectric potential, of which Liberia has a considerable amount, the country has no other conventional resources; there are no known oil deposits or coal. Alternative energy sources are being investigated (wind, solar, biomass) but are not yet being developed.

The country's forest resources are approximately 4.8 million hectares. From this, 3.4 million m^3 of wood could be harvested. Currently the annual use of wood is 236,000 m^3.

Liberia's forest reserves are ample and its offtake is currently limited to logging concessions, shifting agriculture and firewood cutting. Timber concessions operate under agreements which require them to replant logged-over areas. The Forestry Development Authority (FDA) monitors offtake and reforestation. Under the shifting agriculture system which prevails in Liberia, only two percent of all arable land is under cultivation at any given time. The rest lies fallow for up to 12 years in rotation cycle or is virgin land. Fuelwood conservation therefore has not yet become a perceived need; nor is there a movement afoot to improve cook

stoves to make them more fuel efficient. There is a potential problem if wood is to be used in any major way for combustion or lumber since much of the thin tropical soil's fertility is incorporated in the standing crop. If this is not recycled, soil fertility will decrease and deforestation could become a problem.

IV. Government Energy Policy

Liberia's new government is planning programs to benefit the rural farming population and the urban poor. The most pressing immediate issue is the financial stability of the Government. It is concerned with large and rapid development projects. In the energy sector, projects include offshore oil exploration (under IBRD funding), major hydropower development on the St. Paul River and additional studies on the Mano and Cavalla Rivers, and major wood combustion for electricity generation. There are also attempts to collect and analyze data on fossil resources and to develop fuel storage and supply strategies.

In 1978 the Government created the National Energy Commission which has as its operational base the Bureau of Hydrocarbons in the Ministry of Lands, Mines and Energy (Natural Resources). With the encouragement of this commission, government is becoming more sensitized to renewable and alternative energy issues. The Forestry Development Authority (FDA) is experimenting with medium-scale technologies for charcoal production; the University of Liberia's Engineering School is constructing simple flat-plate solar collectors; the Chinese have displayed examples of their micro-hydro technologies and the Germans are being encouraged to participate in a demonstration of wood to wood-waste combustion for electrification in one of their timber concessions.

The cost of the monthly oil import bill and the foreign exchange contortions through which government has to go each month to pay these bills are such that development of expanded hydroelectric generating capacity is one of the most urgent priorities of government.

Unfortunately, there has been little energy planning in most ministries of government. The previous tendency was for the midterm plan to be the sum of the major projects underway. The Ministry of Planning is hoping to change that, but their first priority is to get a second four-year plan financed and implemented. Another institutional problem inherited from the past is the lack of data; this is particularly critical in the energy sector where there is very little information on many of the country's renewable energy resources. This is coupled with a shortage of Liberians trained in several of the fields necessary for planning and implementing these plans.

The newly formed National Energy Commission has as its main task the production of a National Energy Plan. In order to assist this effort, USAID has recently signed a project agreement with the GOL

to make a long term advisor available to work on a National Energy Assessment and help prepare the National Energy Plan.

V. Private Sector Involvement

In the conventional energy sector, private oil companies handle the commercial distribution of refined products from the Government-owned refinery (Shell, Texaco, Mobil, BP and AGIP). The refinery is managed on behalf of Government by a private (US) refinery management company. Since the prices are officially fixed there is little competition among distributors/marketers. The Government-owned LEC generates and distributes electric power throughout the country, except in the three iron ore mining concessions which generate their own electricity from fuel bought from the Government Refinery. A private company (not US) is carrying offshore oil explorations on the Liberian continental shelf under the World Bank funded oil exploration loan.

In the traditional energy sector, private individuals, companies and cooperatives are responsible for making and distributing charcoal, while market women retail the coal in the traditional markets. These are all small-scale undertakings. Firewood production, distribution and marketing are also in private hands. The world's largest rubber plantation (Firestone) is a major source for Monrovia firewood, as they regularly cull old/diseased Hevea trees which are then cut up and sold as cordwood to private distributors and sales outlets. The traditional energy generation process is about as efficient as it can be from a commercial point of view.

Traditional energy use, however, is inefficient and there is considerable scope for private entrepreneurs to develop and market more fuel-efficient wood and charcoal stoves. There are no political or institutional constraints.

VI. Donor Efforts

Germany	Rural Electrification Study Bomi Hills Ctr. (Forestry/Timber) Demonstration Project on Wood Combustion Technical Assistance to Forestry Development Authority Monrovia Power Grid Extension
Netherlands	Wood Processing Industry
European Development Fund	Mano River Union Hydroelectric study UPDEA Electricity Production Training
European Investment Bank	Power Loan to LEC to expand fuel-generated capacity

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USAID	LOFA County Mini-Hydro Pilot Project Energy Assessment and Planning Advisor
IBRD	Fourth power loan (LEC-expand fuel generated capacity) Forestry Loan (IDA-Forest Development Authority) Petroleum Development Study
African Development Bank	Feasibility Study for St. Paul Hydroelectric Projects Reforestation Loan
Saudi Fund	Power Loan (LEC-Expand fuel generated capacity)
Badea	Power Loan (LEC-Expand fuel generated capacity)
UNDP	Water Resources Policy, Management, Legislation (TA)

VII. Conclusion

In view of the rising cost of imported oil to meet Liberia's energy needs, and the consequent drain of the nation's foreign exchange, Liberia should place major emphasis on the development of hydroelectric power and on new and renewable energy technologies as part of its rural and urban development programs. A quick review of the energy sector reveals the following:

A. There is no integration of Liberian energy activities into the overall national development planning efforts. This means that non-industrial (rural) areas remain comparatively disadvantaged in energy development.

B. There has never been a complete inventory of Liberia's energy resources, taking into account their potentials, possible development and utilization, as well as the needed manpower in the energy sector. Liberia is largely unaware of the country's energy resource potentials. Therefore alternative energy resource use is low and the necessary technology has not been developed.

C. Liberia relies heavily on imported crude oil (and some refined product) for its energy needs. This constitutes a heavy drain on scarce foreign exchange and affects domestic savings.

D. Liberia has considerable scope for introducing conservation activities, but the population remains unsensitized.

E. Liberia has considerable hydroelectric energy generating

potential, but the public investment cost of major schemes are unaffordably high. Mini-hydro technology is now being tested and many prove cost effective and replicable elsewhere. Wood, charcoal, wind, solar and biomass all present potential sources of additional energy. Their technologies must be developed and utilized.

TABLE I
LIBERIA'S OIL IMPORTS

YEAR	TOTAL CRUDE IN BARRELS	PERCENT INCREASE	COST IN US $M	PERCENT INCREASE
1975	1,498,712	-	48.3	-
1976	1,559,850	4.6	59.5	18.8
1977*	-	-	68.8	15.6
1978	2,904,808	46.6	84.6	29.7
1979	3,807,558	23.7	116.0	37.1
1980	4,927,500	22.7	118.0	1.7

* Refinery not operating because of breakdown/repairs.

TABLE II
LIBERIA'S PETROLEUM IMPORTS FOR 1979

PRODUCT	IMPORT (BARRELS)
Premium Gasoline	159,680
Regular Gasoline	-
Gas Oil	704,101
Jet Fuel	73,331
Asphalt	2,424
Fuel Oil	115,818

TABLE III
ENERGY DEMAND
(000 of Bbl of Crude Oil Equivalent) Annual

DEMAND CATEGORY	TOTAL ENERGY	PERCENT
Direct Heat		
-Industrial	1,905.0*	28.81
-Domestic	2,139.0	32.4
Transport		
-Road	541.4	8.2
-Ship	31.0	.5
-Air	319.7	4.8
Electricity Gen.		
-LEC-Petro	382.8	5.8
-LEC-Hydro	705.5	10.7
-Private	452.0	6.8
Other		
-Naptha	16.4	.2
-Asphalt	19.1	.3
Refinery	95.4	1.4
TOTAL	6,607.3	100.0

* Data on industrial wood use not available; this figure should be larger.

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MALI

I. Sources of Energy

A. Conventional Energy

Mali's modern sector is fueled mainly by imported petroleum. No coal is imported and no electricity generated elsewhere is imported. The hydraulic generating capacity at three locations amounts to 50 Kw.

B. Traditional/Renewable Energy

The main sources of traditional energy other than human is biomass in the form of fuelwood and charcoal. The sun has been a renewable energy resource which will probably grow in importance if proper technologies are introduced in the future.

There has been little attempt to produce fuelwood in plantations. Most fuelwood is gathered or cut in the natural forests by either women or by professional cutters. There also exists a small class of professionals who process wood into charcoal. The production of biomass in plantations centers mainly on industrial scale activities using exotic species in the vicinity of Bamako. The total area planted probably does not exceed 2000 ha.

II. Energy Consumption

All petroleum products are imported. For 1979, 182,765 metric tons were consumed (See Table I). Almost all petroleum products are consumed in the urban areas. (See Table II for a breakdown of energy consumption in Bamako). Greatest use of petroleum products is in the transport sector, 69% for 1979. It should be noted also that very little of imported petroleum goes for agricultural activities. The main source of energy for agriculture remains human. The impact of oil imports can be seen in Table III. It has of course, a devastating effect on the balance of payments.

TABLE I
Consumption of Petroleum

Year	MT	% Increase
1973	118,533	-
1974	121,848	2.8
1975	130,085	6.7
1976	140,394	7.9
1977	150,549	7.2
1978	167,980	11.6
1979*	182,765	8.8
1980*	189,410	3.6

* projection
Source: Ministry of Industrial Development

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TABLE II
Energy Consumption by Sector in Bamako

	Wood	Electricity	Petroleum Products
Domestic	89%	36.6%	8%
Artisanal	5%	N/A	N/A
Industry	5%	63.4%	21%
Collectivities	1%	N/A	N/A
Transport	N/A	N/A	71%

TABLE III
Volume and Cost of Imported Petroleum Products by Year

Year	Volume M^3	Cost (billions MF)	% of total imports
1974	N/A	7.6	8.8%
1975	147,765	8.6	11.5%
1976	160,614	10.5	14.3%
1977	173,684	14.0	17.9%
1978	187,665	17.0	N/A
1979*	211,760	23.0	N/A
1980*	224,480	35.0	N/A

* estimates
Source: Ministry of Industrial Development

Energy consumption varies from urban to rural environments in Mali. However in both cases domestic energy (for cooking) is supplied overwhelmingly by wood. More wood is consumed by urban dwellers per capita because they have less access to agricultural wastes. Generally one can estimate per capita consumption at between 0.8 and 1.3 m^3 per year. The Forestry Service estimates fuelwood consumption for 1977 to be 539,818 steres. This is an increase of nearly 150% over 1973 consumption.

The overwhelming use of wood for cooking has been the major factor leading to deforestation. The increased unavailability of wood in some areas has lead to fewer cooked meals and the use of dung as fuel. Available data is insufficient to calculate the rate of deforestation, but it is considerable.

III. Energy Resources

A. Conventional Energy

Mali has very little in terms of indigenous conventional energy resources although there is some hydroelectric potential and oil exploration is continuing.

1. Hydroelectric. Present generating capacity amounts to 50 Kw with plans for an additional 250-325 Kw and potential for another 145 Kw. Unfortunately the potential sites,

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although they may be technically good sites, are generally far from population centers and industries. In addition some of the sites are on relatively flat land which means that large areas must be flooded to provide power. Although Mali is actively pursuing a hydroelectric policy the future possibilities after the Manantali dam is built are uncertain.

2. Petroleum Products. French and American oil companies are exploring for oil, especially in the northern areas of Mali. Although Mali has not yet produced any oil, rising oil prices and the continued interest of oil companies may mean that some oil may be produced. To date all petroleum products have been imported. Oil shale resources have been known to exist in western Mali since 1945 and in Nara since 1960. They have never been exploited. An estimated 10 billion tons exist with a 10% oil content.

3. Uranium. Good prospects for uranium discovery appear in two sites in Mali and intensive research is being undertaken by the Japanese and French. Uranium, however, should probably not be considered an energy resource for Mali in the short run but as a source of export earnings.

4. Coal. There do not appear to be any significant reserves of coal in Mali.

B. Traditional/Renewable Energy

Mali's traditional nonhuman energy source is wood. Wood accounts for approximately 90% of rural Mali's nonhuman energy consumption. Although deforestation is a major problem the biomass potential in Mali is fairly good. Solar and wind energy are of some potential also.

1. Wind. Limited data exists on the wind regimes in Mali. The northern areas look the most promising but are also the least populated except along the Niger river. In these areas some potential for irrigation and perhaps the production of electricity exists.

2. Solar. The solar energy resource in Mali appears to be very large given the semiarid and arid conditions. However reliable measurements of insolation are not available. These measurements, when available, may show that the percentage of diffuse radiation is relatively high due to dust and other particles in the atmosphere. If this is the case, the potential for using concentrating solar energy systems, which only use direct radiation, may be limited.

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3. Biomass. It is extremely difficult to estimate the biomass resource of Mali. The World Bank has estimated that 43% or about 533,200 km^2 of Mali is in rainfall zones where natural forest productivity is estimated at between 50 and 200 $m^2/km/year$. Whatever the resource, it is a clearly diminishing one by most accounts.

The major causes of deforestation seem to be herding, clearing for agriculture and cutting to satisfy domestic cooking needs. Of these three, the third has the largest effect.

Natural regeneration cannot keep up with the deforestation rates. Present planting rates do not make up the difference. Hence there is a great awareness on the part of both the GRM and villagers of the need to address this situation. Programs involving improved cookstoves and charcoal conversion processes are being highly promoted and although fairly recent, seem to be gathering momentum.

The investigation and development of alternative energy technologies, although still in its infancy, is being actively pursued by the GRM. After an unsuccessful experiment with windpower in the late 1950s, several organizations are developing local wind machines and about 50 have been installed. A program of solar water heater production was started several years ago and continues albeit cautiously. Research and development have started on solar drying, solar distillation, biogas and other alternative technologies. A significant number of photovotaic solar pumps have been installed and photovoltaics as a power source for hospitals has also been promoted.

IV. Government Energy Policy

Unfortunately the GRM does not yet have a comprehensive energy policy. Energy matters are being handled in a piecemeal fashion; a parastatal handles electricity; the National Direction of Mines handles oil, coal and gas; the National Direction of Hydraulics and Energy handles hydropower and solar energy; and the Rural Engineering Department handles biomass. However, the new five-year plan calls for the setting up of a National Direction for Energy which would have the mandate for substantial energy planning and coordination.

At this point most broad energy issues are dealt with by the Ministry of Industrial Development. The priorities that they express in conjunction with the Ministry of Plan include the development of hydroelectric power, continued support for petroleum research and the development of renewable energy resources; especially solar. It must be stressed, however, that the GRM is

interested in any kind of outside support for energy activities. In this regard the GRM's relationship with the multinationals is improving and will probably continue to do so.

GRM policy regarding fuelwood and reforestation has undergone a major change in the last few years and appears to be more coherent than the energy policy. In brief, the GRM is prepared to deviate from its long-standing policy of the protection of the natural resource base by the fining of people for illegal hunting, fishing and cutting, and the controlling of these activities through permits. The GRM has realized that in some instances this has been counterproductive and now wishes to create one tree nursery within every county in the country and implement village level forestation activities. This coupled with industrial plantations around the major urban centers is hoped to counteract the deforestation process while the forestry service continues activities oriented towards the preservation of the environment.

In addition, a Forestry Fund has been set up. This allows the Forestry Service to keep its revenues from the sale of the wood and charcoal produced under its auspices and revenues from the sale of permits. Previously these funds were sent back to the National Treasury but now can be used for reforestation efforts.

V. Private Sector Involvement

The involvement of the private sector in the energy sector is extremely limited. In terms of conventional energy, the involvement seems constrained to petroleum exploration by multinationals and the presence of some oil distribution companies who are constrained to sell at the government-set price. At the other end of the scale, private sector artisanal entrepreneurs are involved in the distribution of fuelwood and charcoal and the fabrication of charcoal stoves.

Given Mali's financial constraints, lack of resources and weak technological infrastructure, it is hard to say whether a larger role for the private sector would contribute to a more effective approach to energy problems. Certainly the electricity utility, a parastatal, could be made more efficient and perhaps private involvement could achieve it. If some promising renewable energy technologies are developed, the private sector should be involved in their production. Private entrepreneurs have already expressed a great interest in energy devices but practically no proven devices capable of in-country manufacturers have been developed.

There are political and institutional constraints to private sector involvement. After independence, Mali moved towards the public sector and many state enterprises were created. Although the GRM is moving away from dependence on state enterprises this shift institutionally as well as politically is liable to be cautious.

VI. Mali's Approach to the Energy Problem

The energy crisis in Mali is so severe and the financial situation such that the GRM is forced to continually look to the donors for financing of a whole array of energy projects. The donor community is helping the GRM address its energy problems at all levels. In addition donors are involved heavily in conventional energy, including petroleum exploration and hydroelectric power.

The GRM is making a step towards increasing the effectiveness of its own response by the proposal to set up a new coordinating and planning body. Although opinions vary about the adequacy of the donor response in most energy areas, it meets the ability of the GRM to absorb it. The forestry sector, however, stands out as one area where the donor response has been timid and GRM capacity to absorb assistance has not been reached.

MAURITANIA

I. Background

Mauritania's energy position is weak because of a narrow energy resource base with a heavy dependence on imported petroleum products and rapidly depleting forestry reserves for meeting energy demands. A long-range investment plan for the sector has yet to be prepared and there remain some deficiencies in energy pricing.

Mauritania is the Sahel country most severely affected by drought and environmental degradation. The 400,000 square miles of territory and its 1.6 million people have suffered the effects of diminishing rainfall, crop dessication, soil erosion, and the loss of valuable pasture and agricultural land. Deforestation has been particularly severe.

In times of drought, herders stripped trees for forage when nothing else was available for their animals. An expanding urban population is increasing demands for more fuel. Trees are being exploited for charcoal production without being replaced through reforestation. As more ground cover and protective tree species disappear, soil erosion accelerates and resource productivity declines dramatically. Many sand dunes, which less than a generation ago were stabilized by growth of trees and other vegetation, have been denuded of all protective covering and are moving into agriculturally productive zones.

II. Energy Resources

Forests covering 1,500 square kilometers in the south (or 1.3% of the national territory) are the most important known domestic energy source. Drought and growing over-exploitation have reduced the area along the Senegal river formerly devoted to Gonakier *Acacia nilotica* trees (ideal for producing charcoal) by almost a third from 20,204 hectares before 1970. Protection and reforestation activities will be needed to assure the adequacy and durability of continued charcoal production.

The biomass potential is difficult to tap because of the wide expanse of the country's territory. The total cultivated area is about 140,000 hectares and the goats, sheep, camels and other animals number about 4.0 million UBT. Wind energy is potentially significant since the wind velocity along the coast and in a few interior regions often exceeds five meters per second, but a couple of trials during the 1950's failed because of improper maintenance. Three stations are now performing an evaluation of wind energy potential in Aleg, Mederdra and Keur Massene in the southern part of the country and an aerogenerator has been set up in the national coastal park, with a rated power of one kilowatt. With 3,000 hours of sunlight per year, the potential for solar energy is great and is being tested in several sites. A one-kilowatt solar pump, a Rankihe thermodynamic system with a capacity of 50 cubic meters per day, has been installed at Chinguetti. A 12 kw pump, financed by a grant of $500,000 from the European Development Fund, has also been

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installed to provide irrigation for a rice field of 22 hectares, located along the Senegal river. This pump has a capacity of 200 cubic meters per day.

There has also been installed at N'Taket a one peak kilowatt photovoltaic-powered pump with a capacity of 25-30 cubic meters per day. During the early 1960's, a desalinization plant was installed in Nouakchott, but the technology was not well adapted, and the plant was abandoned when an abundant fresh water source was found by Chinese experts in 1962, some 40 kilometers east. A UNDP-funded feasibility study is evaluating the prospects of small solar stills to help solve the water supply problem for fishermen along the sea coast.

Hydropower potential exists along the Senegal river, some 500 kilometers away from the major load center. Mauritania is considering participating in the Manantali dam scheme - on the Mali frontier - but serious questions need to be resolved about its timing and economic viability. Minor hydrocarbon shows have been encountered on- and offshore, but more exploration is needed to assess the country's potential.

The World Bank is assisting the Mauritanian government's efforts to induce multinational firms to participate in intensified hydrocarbon exploration and such efforts have already led to a couple of contract signings and other expressions of serious interest on the part of multinational firms. The other area where private enterprise is significantly involved is in the production and distribution of wood and charcoal with several hundred private entrepreneurs.

III. Energy Consumption

Overall energy consumption was estimated at 320,000 tons of oil equivalent in 1979 or 207 kilograms per capita. Imported petroleum products account for 40% of overall energy consumption and wood and charcoal for 60%. Electricity use, some 106 kwh in 1979, is equivalent to about 16% of final energy use. Generation is based entirely on small diesel units with an installed capacity totalling about 60 Mw, of which about 25% is captive.

The domestic consumption of petroleum products was about 137,000 tons in 1980. Demand increased during the period 1971-1977 by about 3.5% per annum. In 1978-1979, demand fell by nearly 15% per annum because of the closure of a copper mine and Mauritania's withdrawal from the Western Sahara war, but in 1980, demand resumed its growth at 5.6% per annum. Gas oil is by far the most important product, accounting in 1979 for over 70% of petroleum product consumption. Among end-users of petroleum products, transportation accounts for 48%, mining and industry 31%, power generation 19% and residential/commercial use 2%. While the cost of petroleum product imports averaged $20-25 million per year over the 1975-1978 period, this cost jumped to $37 million in 1979 and perhaps $56 million in 1980 (or 25% of Mauritania's export earnings).

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The total removals of wood during 1980 for such uses as cooking wood, charcoal, timber poles, housing, fencing and nets was about 730,000 tons. Some 700,000 tons was used for cooking purposes alone, divided into 300,000 tons of firewood and 79,000 tons of charcoal (the wood equivalent of 395,000 tons).

IV. Future Prospects and Governmental Policies

Energy-related investment for the 1981-85 period is expected to amount to $75 million, mostly financed by foreign aid. About 80% of the investments will be in the power sector where projects underway include the installation of 32 MW of additional diesel-based generating capacity (financed by French assistance) in Nouakchott and new units at the Guelbs iron mines (partially financed by the World Bank). These investments together with other increases in energy consumption could boost the cost of imported petroleum to over $100 million annually by 1985. The main demand stimulant is the new units at the Guelbs iron mines. While the purity of the iron in the present mines is 65%, in the new mines it is only 35%. The consumption of fuel at the mines will accordingly more than triple from the present 37,000 tons annually to 124,000 tons. The ability of Mauritania to meet this much higher petroleum import bill is contingent upon a more favorable movement in iron ore export prices than has occurred during the last several years and on such other developments as much more intensive exploitation and local benefits from fisheries. The dilemma for Mauritania's economy is that iron ore exploitation presently yields 85% of the country's foreign exchange export earnings and constitutes 13% of the country's GDP; the loss of iron ore production would therefore be serious for the economy.

The GIRM is acutely aware of the environmental and energy problems facing the country. In August 1980, the GIRM Council of Ministers approved and fully endorsed a national strategy for desertification control which deals with three related sectors: forestry and ecology, agriculture and water management, and livestock and pastoralism. Actions to improve the efficiency of woodstoves and charcoal production and the effective management of forest resources are included in the proposed steps to implement this strategy. The GIRM appeal for donor support has been particularly insistent on broad action programs consistent with an integrated approach to questions of resource management which will affect traditional fuel sources.

The prospects for meeting local cooking needs are brighter. The consumption of wood for cooking purposes is calculated to rise to 1.35 million tons by 2,000. On the other hand, rational production from Mauritania's forests could yield more than three million tons of wood presently on a sustainable basis. If the planned measures of protection and reforestation are implemented successfully, exhaustion of Mauritania's forests will be prevented and sufficient wood made available for all of Mauritania's cooking fuel and other consumption needs for many years to come. A major corollary benefit would be maintenance of a significant defensive barrier

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against soil erosion and creeping sand encroachment. UNSO and USAID are the lead donors in the on going efforts at forest regeneration, costing several million dollars.

A principal feature of these activities is localized training activities to promote local participation in resource management and to involve lower-level personnel of the Environment Protection Service to re-orient the staff from a repressive role to one of outreach and extension.

A planning unit is to be established and energy studies launched so that the government will be in a position to elaborate and implement the national resource management strategy and to develop appropriate energy policies.

The Directorate of Mines and Geology of the Ministry of Mines and Energy is in charge of hydrocarbon exploration and supply while that Ministry's Energy Unit is in charge of renewable energy and energy planning. The Environment Protection Service of the Ministry of Rural Development is responsible for forestry and pasture management and the Ministry of Water and Housing supervises the State Power and Water Utility Company, SONELEC, a parastatal organization. The policy making process has been hampered by a poor data base, insufficient staffing of the agencies in charge and inadequate communication among concerned ministries.

Fuel prices in the aggregate reflect total costs, although there is a proliferation of preferential prices for government entities, fishing vessels and several other favored users. For example, the retail prices of kerosene and gas oil are 30% and 17% less, respectively, than the gasoline retail preice even though their CIF import prices are higher than that of gasoline. Electricity tariffs were raised in November to the equivalent of 22 to 26¢ per kwh in a major step to stem the massive losses which had reached $2.5 million in 1980. The costs of wood and charcoal (17¢ per kilogram for the latter are also officially controlled at artificially low levels.

When the GIRM completes its recently initiated comprehensive studies complementing the national resource management strategy and the formulation of energy policies and development priorities, a long-range investment plan for the energy and forestry sectors can be prepared. Environmental degradation has already proceeded so far and the local energy deficit become so great that substantial donor assistance will be needed to help Mauritania achieve the goals of this long-range investment plan.

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NIGER

I. Energy Sources

In Niger, firewood accounts for 85% of the rural and urban energy sources and is used mainly fr cooking and heating. Butane gas is next; 250 tons of gas were imported in 1972 and 500 tons in 1979. The total amount of gas used is relatively small and much of what is used is for commercial and industrial purposes. Kerosene, electricity and charcoal are also used in small quantities for cooking.

Most of the firewood gatherers are individual merchants who buy firewood from farmers and laborers. There are very few collective activities in regards to firewood gathering. All of the commercial firewood is transported by trucks, camels, and donkeys.

The GON Forest Service has very little control over the sale of firewood. Merchants are supposed to buy permits at 35 FCFA/stere which is way out of line with regards to what a stere sells for on the open market (approximately 5,000 FCFA in Niamey). This price is rising at approximately 6% per year.

II. Firewood Consumption and Deforestation

Total fuelwood consumption for 1980 was 3.9 million cubic meters (1.8 million tons). This figure greatly exceeds the exploitable average annual increment of exploitable natural forest which is 2.0 million cubic meters per year (.4 m^3/hectare/year x 5 million hectares).

Estimates of between 60,000 (CILSS 1981) and 80,000 (Lanly 1980) hectares of firewood capital are lost each year through cutting. A combination of overcutting, overgrazing, drought and other ecological disturbances (termites, rodents, etc.) have resulted in a severe decrease of the country's biomass in certain regions. The USAID Forestry Land Use and Planning Project (683-0230) is currently studying deforestation by comparing aerial photos from as early as 1955 with photos taken in 1979. Certain areas that show once to have been uniform areas of dense vegetation and trees are now severely degraded "brouse tigree", composed mainly of Combretum-type species. We feel that overgrazing is a more important factor in soil degradation than wood cutting. It is forbidden to cut live wood for selling purposes, and although this law is not strictly adhered to, there is not much evidence of live trees being cut in the particular forest that we studied. There was, however, much evidence of heavy grazing pressure and termite activity which seems to have "opened" the forest to the patchy vegetative type which is now present.

Very little study has been done in Niger with regards to biomass loss or exact causes of this loss from an ecological standpoint. The present weight of firewood (biomass forest resources) is estimated at approximately 3,024,000,000 kg. (average 1440 kg/hectare x 2,100,000 natural forests).

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Land clearance for agriculture can be a problem and is also a function of the methods used to clear and plant. Much of the agriculture carried out in the northern pastoral zone causes very little physical-mechanical disturbance of the soil (little or no tillage). This type of planting has little effect on the habitat even in relatively dry years. More intensive cultivation on marginal lands does, however, seem to reduce habitat potential and increases the chances of desertification (especially if this is done in a particularly dry year).

Agriculture can in some cases be of benefit to the habitat as it cuts down on overgrazing (an effect that is evident in most of the National Forests where agriculture is forbidden).

III. Natural Regeneration and Plantation Versus Utilization

According to a recent CILSS report the total projected firewood potential of Niger (plantations and natural) by the year 2,000 will be approximately 5,802,500 steres/year, and the total firewood needs will be 14,510,000 steres/year. These figures are approximate however, and recent production-oriented sampling in areas previously thought of as "useless brush" are showing a much higher potential than the 0.5-1.5 steres/hectare/year generally accepted for natural vegetation production. Example: The area around Niamey has been cited as being "completely wiped out" through overcutting, overgrazing, etc. Recent trials in a National Forest only 22 kms from Niamey have shown as many as 30 steres/hectare of Combretum which is the main firewood species for Niamey. A fenced plot of Combretum was cut in 1974 and grew to maturity within 4 years. These vast stands of "useless brush" could provide alot more than 0.5-1.5 steres/ha/year if managed properly on a selective coppice sustained-yield rotation with some site improvement work done where the deterioration is worse. If nothing is done with these forests they will continue to deteriorate beyond the point of repair, but fenced-in plots indicate that with proper protection they can still be salvaged.

Figures for production yields on dry and irrigated plantation are not available. The irrigated plantation installed by the 1st Phase of the World Bank Forestry Project are costing more than $6,000/hectare. Plantations in general do not seem to be succeeding in Niger and have actually done more harm than good in areas where National Forests have been bulldozed to plant fast growing exotics.

IV. Fuelwood Conservation

Experiments are being carried out in Niger with solar cookers and solar hot water heaters. The hot water heaters seem to be more successful than the solar cookers which are clumsy and not adapted to the Nigerien kitchen.

Woodstoves are being experimented with and have shown themselves to work although certain technical, social, and economic problems

still remain to be resolved. The Church World Service has been working with the Women's Association of Niger to produce, distribute, and evaluate the performance of several models of woodstoves which have worked already in Niger and in Upper Volta. The 2nd Phase of the World Bank Forestry Project will also be studying the social and economic factors relevant to woodstove development.

V. Role of GON Regarding Fuelwood and Reforestation

The GON's policy regarding fuelwood and reforestation is very loose ended. The Director of the Nigerien Forest Service depends on reports and advice from CILSS and other donors in formulating policy. The USAID Forestry Land Use and Planning Project will produce a 20 year plan for the Forest Service. In the meantime however, the main objectives of the GON Forest Service are the following:

A. Increase fuelwood supply by managing natural forests, planting irrigated plantations of fast growing exotics, and planting rainfed plantations of fast growing exotics.

B. Encourage the local populations to plant trees in village woodlots and mini-nurseries run by family units or individuals.

C. Improve the quality of the Forest Service with more and better personnel through long-term education, recycling schools, seminars, etc.

The GON Forest Service has always been hampered by political and institutional constraints. This situation is gradually changing and the President recently delivered several major speeches on desertification and deforestation.

VI. Role of the Donor Community in Fuelwood and Reforestation

The following are a list of the ongoing forestry projects in Niger:

A. World Bank Forestry Project: 1st Phase, 1978-1981, $4.5 million; The 2nd Phase (1982, approximately $16 million). The program consists of irrigated tree plantations, rainfed tree plantations, education, research, extension work, fire and erosion control.

B. USAID Forestry Land Use and Planning Project (683-0230), 1980-1984 for approximately $4 million. The program has four main sections of activity; model sites (research and applied forestry techniques applicable to the rest of Niger), human resources (education, recycling programs, extension, seminars, etc.), resource inventory (aerial photography, mapping, Landsat imagery), and the creation of a documentation center.

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C. UNSO-Greenbelt, around Niamey, 1981-1983, $184,500.

D. D.D.A. (Swiss) Management of ronier in the Dallol Maouri - 1981-1983 for $900,000.

E. D.D.A. Management around wells in pastoral zone - 1981-1983 for $736-000.

F. F.A.C. Acacia Albida Project in Dosso - 1981-1985 for $400,000.

G. C.A.R.E. Reforestation in the arrondissement of Bouza - 1976-1981 for $725,000. Program is to stabilize sand dunes, fix river banks in Bouza, and create Windbreaks in Majjia Valley. (Note: The windbreak activity has been cited as one of the most successful forestry projects in the Sahel. The final analysis is that 6% of land was taken out of production for the windbreaks and a net gain of 23% in the production of millet was recorded on land between the windbreaks versus land without windbreaks. See Report by Els-Bogneheau, 1980, Majjia Valley Windbreak Study).

H. C.R.D.I.: Village Woodlots in Zinder, - 1981-1983 for $141,200.00.

I. F.E.D.: - 1973-1981, "3M" Development Project in Zinder, for $142,000. Program is village woodlots, live fencing, windbreaks and rainfed plantations.

J. C.A.R.E. Small gardens and live fencing project at Balleyara for $120,000.00. Program is to diversify agriculture in small gardens and protect gardens with the fencing.

The USAID Forestry Land Use and Planning Project is doing an evaluation of all past and ongoing forestry related projects. The results of this evaluation show very few projects have succeeded due to lack of attention to socioeconomic factors and poor practice of basic Sahelian forestry techniques. Village woodlots show little promise in Niger, and work with families and individuals has proven to be better suited to Nigerien ways. Irrigated plantations are too costly, and to take land out of agriculture for dryland plantations or to plow up natural vegetation in favor of rainfed plantations has failed more often than not. In general, donors seem to place too much emphasis on costly fast growing exotic species plantations and too little emphasis on the potential that exists in the natural forests.

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RWANDA*

I. Introduction

The two major sources of energy currently supplying Rwanda's needs are hydroelectric power and fuelwood. The former supplies a very limited market, including industries, the administrative and service sector, and a relatively small number of urban consumers. The degree of market concentration for electricity is illustrated by the number subscribers - approximately 4,500 out of a total country population of 5 million. Although the distribution network has been considerably extended in the past 3 years, and further extensions are planned, the dispersed settlement pattern in conjunction with low rural incomes will prevent widespread domestic use of electric power for many years to come.

Forecasts of electrical energy requirements indicate that there will be an adequate margin between supply and demand if the new power stations - Mukungwa, Ruzizi II and eventually, Rusumo, come into production as scheduled. The future supply and demand balance could be upset by large-scale industrial development arising from the exploitation of methane gas in Lake Kivu. According to present Government policy, the proposed heavy industries will be obliged to fulfill their energy requirements by the use of hydroelectric power. If this policy is maintained and enforced, demand forecasts will have to be revised and a strategy developed to satisfy the increased requirements.

A far more widely used source of energy is fuelwood, which is employed by over 90% of the population, mainly for cooking but also for heating in high altitudes. According to recent surveys supplies of fuelwood are rapidly diminishing, despite efforts by the Government and agricultural projects to engage in reforestation. While these efforts may prevent a deterioration in the situation, it is not likely to undergo a dramatic improvement since a growing population is requiring more and more land to cultivate food crops.

Dwindling fuelwood supplies in Bugesera will have a particularly marked effect on the supply of charcoal, which is produced in that region. It is planned to market peat as a substitute for charcoal, which is presently used by approximately 95% of the population of Kigali, in addition to consumers in other urban areas.

Two potential new energy sources, methane gas and peat, are at relatively early stages of development and many uncertainties exist regarding their exploitation and use. Three peat marshes are presently being exploited in Rwanda on a small scale. Two of these marshes are drainable and the technology for extracting the peat is fairly straightforward. The peat produced is used industrially for pyrethrum drying and cement production. A third marsh, Busoro, in

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* Adapted from a paper prepared for AID/Rwanda by Mary Reintsma, August 1981.

southern Rwanda is not drainable and the Ministry of Natural Resources is presently undertaking experiments to find the most appropriate technology for extraction of the peat. The Ministry intends to establish a Peat Office to administer the commercialization of peat for domestic use and a consumer education program is underway to facilitate this.

II. Imported Fuels

The economic viability of developing Rwanda's internal energy resources depends partially on the availability and costs of alternative imported fuels. The rapidly increasing bill for imports, particularly gasoline, diesel and kerosene, is already placing a considerable burden on the meager national budget, and the situation threatens to deteriorate.

In absolute terms, the costs of imports of these fuels has risen almost 300% in the past five years; 10 million in 1976 to $28 million in 1980. The bill for gasoline and diesel imports alone has risen by 2,500% over the past ten years; $1 million in 1970, to $25 million in 1980.

Of even more significance than the absolute increase in the cost of fuel imports is the relative increase vis-a-vis export earnings. For instance, in 1976, 12.0% of export earnings went to purchase imported fuels, while in 1980 the corresponding figure was 37.5%. The pertinent data is summarized in Table I.

TABLE
Imported Fuels *
Total Value as % of Total Imports and Exports

Year	Tons	Value (million RWF)	% of Total Imports	% of Total Exports
1976	34,071	948.9	10.1	12.0
1977	32,585	947.9	8.9	9.4
1978	37,911	1,210.5	7.2	14.9
1979	38,323	1,705.6	9.4	15.3
1980	43,049	2,535.6	11.5	37.5

* includes gasoline, diesel and kerosene; no aviation fuels
Sources: Ministry of Finance
Ministry of Plan, Statistics Bulletin No. 60.

III. Fuelwood and Charcoal

A. Introduction

In Rwanda, wood is the most widely used source of energy for domestic purposes. Its primary use is for cooking, although it is also used for heating in high altitudes.

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B. Supply and Demand

The supply of fuelwood in 1977 was estimated as between 100-130,000 hectares of natural forest, and 25-26,000 hectares of planted woodlots. 1/ The forested area is mainly comprised of the Gishwati and Nyungwe natural forests which, according to MINAGRI statistics, declined in area from 162,000 hectares in 1957 to 130,000 hectares in 1977, i.e. 1600 hectares per annum.

A third area of natural woodland is located in Bugesera in southern Rwanda. This has been a major charcoal producing area, supplying Kigali and other urban markets. However, in two of the three Bugesera communes the wooded area has been almost completely destroyed and in the third it is rapidly becoming depleted.

Of the planted woodlands, the vast majority, amounting to 60 to 70% of the total area, is owned by communes. A further 15 to 20% belongs to individuals or private groups, 10% is state land, and 2% is roadside planting. The commune woodlands are made up of approximately 5,000 lots, of which 2,300 are smaller than two hectares and only about 500 are over 10 hectares.

The rapid diminution in the area of wooded land, particularly in Bugesera and the Nyungwe and Gishwati forests indicates that the demand for wood far exceeds the supply available through natural regeneration. This contention is supported by recent estimates that demand per person (1 m^3) is equal to the natural regeneration rate of .1 hectare, while actual forested area is .04 hectare per person. In other words, the forested area is equal to only 40% of the area which would be required to fulfill the demand by natural regeneration.

C. Charcoal

A relatively large component of the total demand for wood is derived from the Kigali charcoal market. It has been estimated that the annual consumption of charcoal in Kigali is 63,000 sacks (of approx. 50-60 kg.) for which 780 hectares must be deforested. Most of this wood comes from the Bugesera reserve. According to a recent survey, 95% of Kigali households use charcoal for cooking. There is also a fairly high industrial demand for charcoal to be used in processes such as firing bricks and tiles and in traditional forges. It is preferable to fuelwood because of its higher calorific value and because it produces less smoke and cinders.

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1 WB study - 100,000 ha forest and 26,000 planted woodlots.
MINAGRI - 130,000 ha forest, 25,000 planted.

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The deforestation of the Bugesera region to provide charcoal for Kigali and other urban markets was exacerbated by immigration into the region and consequent burning of large tracts to clear land, eradicate tse-tse flies, and generate new growth for livestock grazing. The rate of influx of settlers into the region is reflected in the change of population density from 20 persons per km² in 1960 to 120 persons per km² in 1978.

D. GOR Policy

In recent years, the government has attempted to implement a forestry management policy which takes into account the state, communal and private woodlots, as well as the natural forests. At the National level the administrative responsibility for forestry development lies with the Department of Water and Forests in the Ministry of Agriculture, while at the commune level agronomists are responsible for the technical aspects of forestry resource development and the bourgmaster has administrative authority over commune woodlots.

In the natural forests there has been a drive to replant areas between the actual boundaries of the forested area and the official boundaries. Both in the natural forests and in the state woodlands, guards are employed by the government to control cutting activities.

E. Contribution of Aid Agencies

Many of the organised forestry activities are being undertaken by foreign aid projects. The first such project was the Swiss-financed Pilot Forestry project in Kibuye. Started in 1967, this project incorporated training, research, extension work and reforestation in Kibuye prefecture and on the borders of the Nyungwe forest. By early 1980, 2,250 hectares had been reforested.

The FAO Agricultural Intensification Project in Gikongoro aims to replant 750 hectares per annum; 1268 were planted between 1977-1979.

A large reforestation program was implemented by the Nyabisindu agro-pastoral project, financed by Germany. Between 1975 and 1978 a total of 4,200 hectares were planted, of which 145 were fruit trees.

The BGM project in Bugesera planted approximately 870 hectares between 1977-1979.

Future projects include: reforestation of the Gishwati forest with 5,000 hectares of pine and 5,000 hectares of eucalyptus, financed by the World Bank: reforestation of 5,000 hectares

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in Kigali prefecture and 3,000 hectares in Butare, also financed by the World Bank: reforestation of 1,000 hectares, bordering on Nyungwe, financed by Belgium; and projects on the Zaire-Nile crest financed by FED.

IV. Hydroelectric Power

A. Introduction

Hydroelectric power is the primary source of energy for Rwanda's industries, administrative sector and a small part of the urban population. Although hydropower has been exploited since the 1950's, it is only recently that the network has been extended to include most of the major towns. Production is increasing at an average 10 to 13% per annum - a trend which is likely to continue for at least the next decade in view of the fact that imported substitutes (e.g. diesel) are extremely expensive, and local substitutes such as methane gas or solar energy are still at a very early stage of development.

B. Production

The majority of Rwanda's hydroelectric power is presently supplied by two main stations, with a third to open in late 1981. By far the largest supplier in 1980 was Ruzizi I, jointly owned by Rwanda, Burundi and Zaire, (28.2 MW) which satisfied 66.5% of Rwanda's total consumption. This plant is located 5 km from Lake Kivu on the frontier with Zaire, and supplies the Katana region of Zaire as well as Rwanda.

The second major supplier is the Ntaruka station (11.25 MW) between Lake Ruhondo and Lake Bulera in Ruhengeri. In 1980, 30% of Rwanda's total consumption came from here. This station reached maximum capacity in 1969 and due to a decline in the level of Lake Bulera annual production has since decreased. A twin station to Ntaruka, Mukungawa, which will have an estimated annual out put of 48 GWH, over twice that of Ntaruka, is almost completed on Lake Ruhondo and will open in late 1981.

Several smaller stations complete the inventory. The Gisenyi hydroelectric station which began production in 1958 was out of operation during 1979 and a part of 1980 but reopened in December 1980 and will produce about 6 GWH in 1981.

This station supplies the town of Gisenyi, the Nyundo mission and Bralirwa, as well as part of the town of Goma in Zaire. Two other plants, one near Ruhengeri and one near Gisenyi, are privately owned and have very low production levels.

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C. Distribution

The present distribution system relies on two high-tension lines; one (123 km) from Ntaruka to Kigali and into the mines of Rutongo, Musha, Rwinkwavu and Bugarama, and the other, (185 km) linking Ruzizi with Kigali. Several medium-tension lines extend this network to major urban centers. On the Ruzizi-Kigali line there is a link from Kigoma to Butare and Gikongoro, and another from Kigoma to Gitarama & Gatumba. There are several shorter MT lines linking Ruhengeri, Kibuye, Ngoma, Byumba & Mulindi with the HT network. Thus eight of the 10 major towns (prefectural centers) are supplied by this system. Gisenyi has its own station, and a MT line linking it to Ruhengeri is planned. Kibungo is presently supplied by diesel-generated power, but Belgian funding has been obtained for a MT line linking it with the major HT network.

D. Present Supply and Demand

The potential and actual supply (in GWH) of hydropower available to Rwanda in 1980 is shown in Table II:

TABLE II
Supply of Hydroelectric Power

Source	Potential Supply	Actual Supply
Ruzizi I	53[1]	44.8
Ntaruka	22	20.5
Gisenyi	5.4	.7[2]
	80.4	66.0[3]

Notes: 1 Total production is 160; Rwanda, Burundi and Zaire are each entitled to share equally.
2 Out of operation during part of 1980.
3 An additional 1.4 Kwh supplied by diesel brings 1980 total production to 67.4.

Source: Ministry of Natural Resources, Water and Energy Section, 3rd 5-year Plan, June 1981.

Effective demand for electricity is heavily concentrated geographically and sectorally. Major consumers include the mines and tea factories, the service sector (administration buildings and hospitals) infrastructure (radio relay station, roads & airport) and private consumers in Kigali. (Kigali consumption is approximately 65% of total consumption in the country.)

E. Future Supply and Demand

The production and annual rate of increase over the past 5 years is shown in Table III.

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TABLE III
PRODUCTION AND ANNUAL RATE OF INCREASE
IN HYDROPOWER 1976-1980

	1976	1977	1978	1979	1980
Prod. (GWH)	40.4	45.7	48.4	53.3	59.6
Rate of Inc. (%)		13%	5.8%	10.2%	11.7%

Assuming an annual increase in demand for energy of 11.7%, the needs over the next year will be as follows:

	1980	1981	1982	1983	1984	1985	1986
Demand (GWH)	59.6	66.6	74.4	83.1	92.2	103	115

The present supply of 80 GWH will be increased at the end of 1981 by the new station at Mukungwa (12 MW) which will have a potential annual output of 45 GWH, thus increasing the total supply to 125.4 GWH. Allowing for 10% loss in transmission and distribution this will be insufficient by 1986.

Total supply will be further increased by Ruzizi II, which should be operational in 1985. Annual output is estimated at 140-200 GWH. This power station will supply Zaire as well as Rwanda and will be managed along with Ruzizi I by a yet-to-be formed power board consisting of representatives of the countries concerned.

Also planned to start production in 1985 is the Gihira station (Gisenyi II) with an estimated output of 15 GWH per year. The other major new source of energy is Rusomo on the Tanzanian border, planned to come into production in the 1990's with a capacity of 100 MW.

F. Small Hydropower Schemes

The potential exists for the development of small hydropower schemes. Four sites have been considered economically feasible by the 1980 Klock report. All the sites are located in western, or southwestern Rwanda in the Zaire-Nile crest where rainfall is high and where suitable waterfalls exist.

The smallest, Nkora site (1.0 MW) has a hydropower station which is at present in a state of disrepair, but which can be made functional by a relatively minor investment ($10,000-$15,000). The construction costs of the other three stations Akanyaru II (2.7 MW) Karundure (2.5 MW) and Kamiranzovu (1.1 MW) are estimated at $3.7 million, $2.4 million, and $1.6 to 2.2 million respectively, including the cost of transmission lines. A study presently being undertaken by Swiss aid is examining the question of small hydropower schemes should be available in April 1982.

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G. Donors

FED has been the principal donor ($16 million) partially financing the Mukungwa station and a number of HT & MT lines and studies. The BADEA ($9 million) has also financed equipment for Mukungwa, Swiss, German and Belgian aid have financed studies & extensions of the distribution network.

Other interested donors include the BAD, and French aid. A meeting is scheduled for early 1982 at which it is hoped firm commitment will be made by donors to finance the extension of the present distribution network.

H. GOR Policy

The development of hydropower resources including planning, financing, and policy considerations is the responsibility of the Ministry of Natural Resources. The actual management and maintenence of installed stations is performed by the parastatal "electrogaz".

The exploitation of hydroelectric power is strongly supported by the Government. In the past, priority was given to the construction of large power plants, but more recently the Government has expressed a desire to develop smaller hydropower plants serving local needs. As far as distribution is concerned, proposals have been drawn up by the Government for approximately 30 new MT extension lines for which financing is being sought.

GOR policy regarding power to be used for industries related to the methane gas in Lake Kivu, could have a profound effect on the energy situation. Official policy is that the heavy industries envisioned, e.g. production of urea fertilizer or methanol, which have high energy demands, must use hydroelectric power for the transformation processes. If these industries are developed in the next 5 to 10 years there could be problems ensuring adequate energy supplies.

V. Methane Gas

A. Introduction

Since the discovery of methanc gas in Lake Kivu in 1936, a large number of scientific and technical studies have been carried out with financing from Belgium, Germany, the U.N. (UNIDO) and the U.S. (Woods Hole Oceanographic Institute). These studies indicate the existence of 50 to 60,000 million cubic meters of methane gas, at depths of approximately 300 to 500 meters, in water which, though warmer than surface water, is more dense due to a high level of salinity. There is no conclusive evidence of the origin of the gas, though it is generally believed to result from biological rather than chemical activity, and to be renewable.

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B. Exploitation of the Resource

The only existing project is a small extraction plant, built by Belgium in 1962, at Cap Rubona, 8 km southeast of Gisenyi. This was originally intended to be a 5-year pilot project, but actually functioned for 10 years relatively efficiently and for another 2 to 4 years intermittently. Since 1977 it has been under repair (with U.N. financing) and it is due to reopen in December 1981.

The degassed, but otherwise untreated saline waters are returned to the surface of the lake. The gas, which is then composed of 24.9% methane (CH_4) and 73.5% carbon dioxide (CO_2) as well as some inert gases, is purified, mainly by removal of the CO_2 to a 70 to 80% methane content. Water used in this process and containing the excess CO_2 flows onto the surface of the lake. The ecological effects of this are unknown.

C. Uses of the Resource

At present the methane gas is only used to provide power for the Bralirwa brewery in Gisenyi. The gas is compressed at Cap Rubona and pumped through a 3-km pipeline to the brewery. Two other potential users of methane gas are located in Zaire. The first is the Katana Cement factory which has not been functioning since 1962, but if renovated and reopened could absorb up to 16 million m^3 of gas per year with 80% methane content. The second potential user is the Pharmakina (quinine treatment) enterprise at Bukavu which would take 375 to 600,000 m^3 per year.

D. Donor Agency Contributions

Several countries are presently interested in implementing projects to extract and transform methane gas.

Belgium has completed a pre-feasibility study on a methanol plant and is planning to provide 25% financing for a $50,000,000 plant to extract and transform methane gas into methanol. The proposed capacity of this plant (30 million m^3 per year) will be 15 times greater than the existing Cap Rubona plant. It is estimated that the price of methanol will be competitive with that of peat.

The U.N., in addition to financing and supervising the renovation of the Cap Rubona gas extraction plant, is presently studying a project to dry the residue of malt and yeast from the Bralirwa brewery in order to produce animal feed. This project would be financed by UNCDF and supervised by FAO technical assistance. The animal feed produced would satisfy 80% of the total food needs of the FAO livestock breeding project at Kabuye. The major cost of this project is derived from the high energy requirements to dry the brewery

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wastes which have an initial 80% water content. AIDR is studying the possibility of using methanol for this process.

The FED has also financed studies and plans a small project to compress gas (for possible use on motor cars in the Gisenyi area) in 1982 and a urea factory in Gisenyi in 1986.

GOR Policy

The Government of Rwanda and Zaire have formed a "Societe Mixte" for the exploitation of methane gas. An agreement was reached in 1978 that 47.2% of production would belong to Rwanda, and 52.8% to Zaire.

VI. Peat

A. Introduction

It is estimated that peat reserves of from 5 to 50 million tons exist in Rwanda, of which 10% are believed to be of high quality. Peat was first used in Rwanda in the 1960's, when the Gishoma marsh (located in the extreme south west of the country) was exploited to provide peat for the Katana cement factory in Zaire. When the cement factory closed, peat extraction was terminated. Since 1974, peat from the Cyabaralika marsh in Ruhengeri has been used by OPYRWA for drying pyrethrum. Peat from Kiguhu marsh in Ruhengeri is presently used in the Belgian Project - pouzzolanes-chaux-tourbe (PPCT), which will produce cement using volcanic material. The most recent peat bog to be exploited is that of Busoro in southern Rwanda, where a pilot extraction project is being undertaken.

B. Formation

In Rwanda, the marshes in which the peat is found are located in the bottom of river valleys at various altitudes and with areas of from a few hectares to several dozen square kilometers. Since these marshes are stream fed they contain impurities and the peat is generally of low quality.

C. Exploitation

Peat is extracted manually, with drainage of the marshes in Cyabaralika and Kiguhu, and without drainage in Busoro. Where drainage is necessary main and lateral drains are first excavated and peat is cut from the sides of the lateral drains and deposited beside them for partial drying. It is then transported to the drying area, dried, turned, and stacked in piles. The excavation normally takes place at the time of year when the water level is lowest. The rate of production depends on the size of the drying area and the rate of drying, which in turn depends on climatic conditions. A similar

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process is followed where drainage is not required or not possible. The main difference is the absence of drainage structures. In Busoro geological conditions do not permit drainage of the marsh, making exploitation extremely difficult.

The quality of peat extracted manually is inferior to that which would be obtained by a mechanized or semi-mechanized process. However, this must be weighed against the problems inherent in importing, setting up and maintaining equipment. Only where the peat is beneath several meters of water is mechanization essential.

Peat of high quality (i.e. with low ash and moisture content) may be transformed into coke, which has a higher calorific value. This product would be important primarily for industrial uses, since dried peat as such is adequate for domestic purposes.

D. Donor Involvment

Three donors have been involved in the development of this resource: Ireland, Belgium and the UN (UNIDO).

Following two 1978 reports by a UNIDO consultant, an agreement was reached in early 1980 between the Rwandan Ministry of Natural Resources and the Irish Foreign Ministry to implement the first phase of a peat exploitation project. This consisted of investigating posible peat production areas, evaluating the quality of the peat by laboratory analysis, and implementing a pilot exploitation to test techniques and produce a preliminary 1,000 tons of dry peat.

As a result of this agreement, a survey was undertaken, starting in the environs of Kigali, particularly the Nyabarongo and Akanyaru valleys. The nearest site to Kigali suitable for exploitation was found to be Butaro marsh, on which some trials had been made by the Ministry of Natural Resources in 1979. During 1980, only 150 tons of sod peat were obtained, due to technical difficultues in exploiting the peat. The production cost of this peat was estimated as 1,050 Frw per dry ton, on the basis of labor costs of 100 Frw per 8 hour day. In 1981 it was planned to produce 500 tons of peat from Busoro between mid July and the end of October by using a semi-automatic machine for macerating the peat. The production target for 1982 is 1,000 tons.

Belgian aid produced a report on the exploitation of peat in 1980 and is interested in contributing to the development of the resource at the preparatory stages, - identification of reserves and sampling and analysis of peat. They also intend to use the peat from Cyabaralika for the PPCT cement-making enterprises.

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E. GOR Policy

The Ministry of Natural Resources is responsible for the development of peat resources in Rwanda. They are presently engaged in a comprehensive survey of the country's reserves. Exploitation of the Busoro marsh is being accompanied by an education campaign on the uses of peat as a preliminary measure to its marketing as a replacement for charcoal in Kigali and other urban areas. The main objective of Government policy is the replacement of charcoal as far as economically feasible in order to alleviate the fuelwood problem.

VII. Non-Traditional Energies - Solar, Biogas, Geothermal and Wind

A. Introduction

In order to exploit the potential of the non-traditional energy sources in Rwanda, the Government instituted in 1974, the "Centre d'Etudes et d'Applications de l'Energie au Rwanda" (CEAER) which is part of the National University of Rwanda. This institution is responsible for studying potential new small-scale energy sources and for designing and testing appropriate technologies for its exploitation. The Center is presently organized in four departments which specialize in biomass, solar energy, meteorology and mini hydropower plants.

B. Solar Energy

The CEAER has been carrying out research on solar energy since 1874, and has collected meteorological data since 1977. Statistics are collected from 30 stations covering all the climatic zones of Rwanda. This information will provide the basis for planning the future development of this resource.

In addition to research, the Center has developed solar equipment including waterheaters, distillers, cookers and dryers. So far 27 water heaters have been installed, two in hotels (Guest House Gabiro and Hotel Akagera), one in Kigembe Hospital, one family unit in Kigali, 11 in the SOS Village, Kigali and 12 in the UNR houses. Two water distillers have been installed, one in Kigembe Hospital and one in Gisagara health center. Cookers and dryers are being tested at the Center and initial results are positive. Refrigeration units have also been tested and 10 are to be in place by 1982.

Because of its potential widespread use, most research is now concentrated on the solar cooker. The major problems to be solved relate to the fact that it does not operate at night and that these is no temperature control. The former point is particularly important since most Rwandan families have their main (often only) meal in the early evening.

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Apart from the work being undertaken by the CEAER, two other projects are of interest. The first is a radio relay station on Mount Kinanira near Cyangugu for short wave transmission beyond the Zaire-Nile crest. This installation is powered by a solar generator and includes 52 m^2 of photovoltaic pannels. It was constructed in early 1981 by a German company (AEG - Telefunken).

Plans for the future development of solar energy are mainly concentrated on increasing the number of solar generators in rural health centers. The Government in the 1981 development budget provided 50% finfncing for generators in two health centers, and the FED will contribute the other 50%. The energy produced will be used mainly for lighting and refrigeration. The Government plans eventually to provide a further 100 health centers with solar energy. There is also a proposal to equip 100,000 households with solar power for lighting: a project which would be spread over 8 years.

The first biogas digester was tested in late 1977 using cow manure and papyrus wastes from the Zaza paper-making project. Experiments using papyrus alone produced only half as much gas as when combined with a small amount of manure. Animal wastes alone produced the greatest amount of gas.

Three digesters are currently being used to produce gas as a substitute for wood or charcoal. The CEAER, in collaboration with the authorities of the Ecole Technique Agricole de Butare (ETAB) designed and installed a 12 m^3 digester which produces most of the energy for cooking meals at this school. A second digester is used in Butare prison, also to provide energy for cooking, and a third, small (2m^3), installation provides gas for a house used by French volunteers.

Financing from several donors has been obtained for the further development of this resource. Since 1979, USAID has been providing funds for CEAER activities; a German society, BORDA, is supporting a project for the installation of 210 household digesters; and the FED signed an agreement in 1980 to aid experimental production of biogas.

D. Geothermal

Geothermal energy is generally found in regions which experience, or have in the past experienced, volcanic activity. Several thermal springs are known to exist in Rwanda in the area of Lake Kivu, in proximity to the volcanoes, with temperatures in some cases in excess of 60°C. No studies are known on this source of energy in Rwanda.

E. Wind

There does not seem to be much potential for the development of this source of energy in Rwanda since the wind is irregular

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and generally not strong. Howver, in Kibungo Prefecture, Makarange Parish, a small installation is in place and produces about 100 W. Wind speed here averages around 4m/sec, slightly above the minimum required of 3m/sec.

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SENEGAL

I. National Energy Policy

One of the goals of Senegal's sixth four-year plan (1981-1985) is to further develop and strengthen a national renewable energy program as a response to rising oil prices and accelerating deforestation. In the short-term, emphasis will be on exploiting new and renewable energies which address the basic needs of rural population. Five priority needs have been identified:

- water pumping,
- more efficient use of firewood/charcoal,
- food preservation,
- identification and exploitation of fuel substitutes,
- production of electricty in secondary centers.

II. Institutional Framework

Organizational responsibilities for planning, coordination, R & D, and commercialization are summarized below:

Function	Organization 1/
Coordination of R & D	SERST
Formulation of National R & D Program	Centre National de l'Energie (includes representatives from the following Ministries: MDIA,SERST, E & F, Hydraulique, Equipment, Finances, Cooperation).
Research and Field Testing	• CERER • IUT • EPT • ISRA • Faculte des Sciences, Universite de Dakar.
Installation and Commercialization	SINAES
Exploitation of Conventional Energy	MDIA

1. Note key to acronyms in Appendix.

III. Energy Consumption

About 60% of total energy consumed in Senegal is derived from wood. Petroleum accounts for the remaining 40% and is the major energy source in urban and semi-urban areas. Currently Senegal imports all its petroleum, although deposits have been discovered at Dome

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Flore in the Casamance. Senegal's petroleum bill has increased tenfold in less than a decade; in 1980, Senegal paid 47 billion CFA for imported oil, which represented 42% of the country's receipts.

La Societe Africaine de Raffinage (SAR) has a monopoly on all imports and refining of petroleum and petroleum products. Refining capacity, currently 900,000 tons/year, will be increased to 1,200,000 tons/year by 1983. In addition to supplying its own needs, Senegal exports refined products to Mauritania and Mali.

Petroleum use by sector in 1980 is summarized below:

Electricity	24%
Transport	30%
Industry	20%
Other	26%

A. Electricity

In 1980, Senegal consumed 534 GWH of electrical energy. Consumption is heavily concentrated in the west central portion of the country with the main focus on Dakar. Secondary centers consumed 6.2 GWH, or slightly more than 1% of the national total.

Power plants on the Cap Vert peninsula supply Dakar, Thies, St. Louis, Diourbel and Kaolack. Towns in the rest of the country rely on individual power plants, of which there are 21. In most cases these stations use diesel generators. A recent study concluded that there is no justification for attaching the secondary centers to the Cap Vert grid, with one possible exception, and recommended that Senegal continue to decentralize its generating capacity. Electrical energy production is subsidized by supplying fuel oil below cost. The cost of production is 3¢/kwh at Cap des Biches, 6¢/kwh at Bel Air, 19¢/kwh at Matam and 52¢/kwh at Dahra. These would presumably be higher if fuel were not subsidized.

IV. Energy Resources

A. Conventional Energy

Natural Gas. Reserves are estimated at 70 million cubic meters, sufficient to produce 90 million kwh. Produced at Diam Niadio, it is piped 15 kilometers to the Cap des Biches electric power plant. No other economically exploitable gas deposit is known.

Peat. Concentrated in the Niayes, peat reserves are estimated to be 50 million m^3, or enough to fuel two 30 Mw thermal power plants for 30 years. A company is being formed to exploit the peat. Partners will include the GOS, Senelec, Caisse Centrale, Canada, France and Germany. Feasibility studies and further research will be undertaken before mining begins.

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Lignite. Evidences of lignite resources in Senegal were detected during a 25-year period of oil exploration by several organizations, who identified organic materials, identified as lignite, in the cores of drill holes. A significant deposit is thought to exist in the vicinity of M'Backe; the seam is 4 meters thick with an overburden of 50 meters and could be exploited by conventional mining technology. The validity of the available evidence needs to be confirmed by new drilling.

Petroleum. Petroleum deposits have been discovered at Dome Flore off the coast of Senegal. Between 100 to 200 million tons are thought to exist. Of this, about one million tons is light crude.

B. Renewable Energy Resources

Hydropower. The potential of Senegal's hydropower resources in the Senegal and Gambia river basins is considerable:

Senegal River and tributaries	550 Mw
Gambia River	140 Mw

This resource will be exploited in cooperation with Senegal's neighbors within the context of regional development organizations which are the OMVS (Organization pour la Mise en Valeur du Fleuve Senegal) and the OMVG (Organisation pour la Mise en Valeur du Fleuve Gambie). Given the remote location of the proposed dams, long transmission lines will be required.

Small hydropower sites are thought to be few.

Biomass from Agricultural Wastes. No exhaustive studies have been undertaken of Senegal's biomass resources (rice hulls and straw, peanut shells, bagasse). However, Molle 1/ makes the following estimates of collectable agricultural wastes in Senegal:

1979	12,300 TEP 2/
1984	22,000 TEP
1989	58,800 TEP

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1 MOLLE, J.F. "Sur les potentialites de la Biomasse au Senegal". Compte rendu de Mission au Senegal, du 7.8.79 au 25.8.79, GRET and CNEEMA.

2 Tonnes Equivalent of Petroleum (TEP) is calculated by equating 2.5 kilograms of dry vegetable matter to 1 kilogram of petroleum.

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By 1989 agricultural wastes could replace about 7% of petroleum imports assuming this remains at the 1980 level of 900,000 tons.

Solar Energy. The solar energy resource in Senegal is reasonably large. However, with the exception of Dakar, accurate measurements of sunshine duration, intensity and insolation, are non-existent. Dakar has an average of 3,066 sunshine hours per year, and an average insolation of 605 cal/cm^2/day. In north-central Senegal, insolation probably approaches 700 cal/cm^2/day, while southern Senegal could be expected to receive approximately 13% less than Dakar.

Wind. Senegal's wind energy resource is limited to a narrow coastal strip between Dakar and St. Louis. Strong winds occur in this area during the spring when water pumping requirements are at their highest. Measurements of wind speeds and wind distributions are available for major cities.

V. Renewable Energy Projects

Research,development and field testing of a range of renewable energy technologies are well underway, and are summarized in Table I.

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TABLE I: SUMMARY OF RENEWABLE ENERGY ACTIVITIES AND PROJECTS IN SENEGAL

TECHNOLOGY	NUMBER OF PROJECTS	LOCATION	AGENCY FINANCING	AGENCY IMPLEMENTING
Passive Solar Heaters	14	10 Dakar 1 Somone 1 St. Louis 1 each, Thies, Nianing	Individuals Fonds National de l'Energie	SINAES
Photovolataics	11	Dakar/Baback/Bambey/Affiniam Samane/Ndioudiouf/Gourou/Aere/ Lao/Kanel/Montrolland	FAC FED CARITAS	SINAES IUT
Thermovoltaic Pumps	7	Dakar-IPM/ONUDI/IUT/Medina Dakhar/Niakene/Meouane/Bondie Samb/Bakel	FAC FIRST USAID	SINAES IUT
Bioconversion (Biogas Digestors)	5 (Prototypes)	Nianing/Ndiouk Fissel/Bambey/ Badiatte	CATWELL FIRST	CARITAS ISRA
Windmills (Multipale, Savonius, Aerowatt)	30 (that have been accounted for)	(17) Cap Vert Region/Diagle/ Saou Mbodienne/Keur Bacar/Louly Bentegne/Mboro/Peycouck/Dakar/ Mbaye/Fandene	FAC FED CARITAS CEE FIRST	IUT SINAES LVIA
Woodburning Stoves (Ban-Ak-Suuf)	2,000	Fleuve/Sine Saloum/Casamance	USAID/FNE CEAO/Promotion Humaine/ SODEVA	CERER/Peace Corps/Promotion Humain PVOs (Private Voluntary Organizations), SODEVA
Solar Dryers	2	Dakar/St. Louis/Mbour/Joal	USAID/ FIRST/ CIDA	ITA CERER
Meules Casamancaises (improved Charcoal Making)		Foret de Tobor/Casamance	USAID MRD	Ministry of Rural Development

Source: Benjamin, Danielle: Survey of Renewable Energy Activities and Programs in Senegal. November 1981.

Table 1: SUMMARY OF RENEWABLE ENERGY ACTIVITIES AND PROJECTS IN SENEGAL

TECHNOLOGY	NUMBER OF PROJECTS	LOCATION	AGENCY FINANCING	AGENCY IMPLEMENTING
PASSIVE SOLAR HEATERS	14	(10) Dakar (1) Somone (1) St. Louis (1 each) Thiès, Nianing	Individuals Fonds National de l'Energie	SINAES
PHOTOVOLTAICS	11	Dakar/Baback/Bambey/Affiniam/Samane/Ndioudiouf/Gourou/Aéré/Lao/Kanel/Montrolland	FAC FED CARITAS	SINAES IUT
THERMODYNAMIC PUMPS	7	Dakar-IPM/ONUDI/IUT/Medina Dakhar/Niakène/Méouane/Bondie. Samb/Bakel	FAC FIRST USAID	SINAES IUT
BIOCONVERSION (BIOGAS DIGESTORS)	5 (Prototypes)	Nianing/Ndiouk Fissel/Bambey/Badiatte	CATWELL FIRST	CARITAS ISRA
WINDMILLS (Multipale, Savonius, Aérowatt)	30 (that have been accounted for)	(17) Cap Vert Region/Diaglé/Saou Mbodienne/Keur Bacar/Louly Bentégné/Mboro/Peycouck/Dakar/Mbaye/Fandène	FAC FED CARITAS CEE FIRST	IUT CARITAS SINAES LVIA
WOODBURNING STOVES (Ban-Ak-Suuf)	2,000	Fleuve/Sine Saloum/Casamance	USAID/FNE/CRAO/PROMOTION HUMAINE/SODEVA	CERER/PEACE CORPS PROMOTION HUMAINE PVOs (Private Voluntary Organizations) SODEVA
SOLAR DRYERS	2	Dakar/St.Louis/Mbour/Joal	USAID/FIRST/CIDA	ITA/CERER
MEULES CASAMANCAISES (Improved Charcoal Making)		Forêt de Tobor/Casamance	USAID/MRD	MINISTRY OF RURAL DEVELOPMENT

Source: Benjamin, Danielle: Survey of Renewable Energy Activities and Programs in Senegal. November 1981.

Table 2

MAJOR FORESTRY/CONSERVATION PROJECTS IN SENEGAL - 1981

Project Title	Donor	Classification	($ 000) Estimated Total Cost	General Description
1. Senegal Fuelwood Production	USA (USAID)	Reforestation	3,912	Industrial-scale reforestation around urban centers in Western Senegal (685-0219)
2. Management & Reforestation of the Eastern Central Forests	FRANCE (FAC) World Bank (1.1.82)	Reforestation and Integrated Development	13,000	Intensified management of existing forests with industrial reforestation included. Similar to Senegal Fuelwood production.
3. Village Woodlot Development	USA (USAID & AFRICARE, Peace Corps)	Reforestation	337	Community woodlot development in Diourbel and Thies regions with and without Peace Corps forest technicians (685-0243)
4. Teak and Gmelina Production	FAO/UNDP	Commercial	18,669	Commercial Development of Southern regions timber and pulp industry including milling & export facilities
5. Cashew Production	GERMANY (GTZ)	Commercial	N.A.	Commercial development of cashew nut and oil industry with industrial and village level plantations
6. Title III Dune Fixation	USA (USAID)	Conservation	6,900	Stabilization of coastal dunes and protection of truck farm regions from roving dunes in west-central Senegal
7. Gandiolais Dune Fixation	UNDP	Conservation	4,435	Same objectives as above in north-western Senegal
8. Amelioration of the Sylvo-Pastoral zone	GERMANY (GTZ) USA (USAID)	Reforestation/ Integrated Development	5,510	Reforestation & range improvement of north-central region. Forestry efforts emphasize an Albida production, managed primarily by Germany
9. W fire Control	CANADA (ACDI) IBRD AFDB	Conservation/ Integrated Development	7,840	Wildfire control in Southern Senegal's timber and farming regions. Forest problems handled by ACDI exclusively. Equipment procurement and training

Source: Compiled by David Gibson

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APPENDIX

KEY TO ACRONYMS

SERST	Secretariat d'Etat a la Recherche Scientifique et Technique
MDIA	Ministere du Developpement Industriel et de l'Artisanat
E & F	Secretariat d'Etat aux Eaux et Forets
CERER	Centre d'Etudes et de Recherches sur les Energies Renouvelables
IUT	Institut Universitaire de Technologie
EPT	Ecole Polytechnique de Thies
ISRA	Institut Senegalais de Recherches Agricoles

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SIERRA LEONE

I. Introduction

Sierra Leone is a small country with a humid tropical climate. Annual rainfall, almost all of it received in the period May-October, can exceed 150 inches. The total area is 72,500 sq. km; the population is roughly 3.3 million and growing at 2.3 percent per year. GNP per capita, currently about $250, has not experienced any real growth in recent years. Annual per capita commercial energy consumption has been recently estimated at 89 kg. of coal equivalent, and growing at 4.5 percent annually.

An upwardly spiraling oil import bill, a stagnant domestic economy and reduced prices for its exports have recently brought the energy crisis home to Sierra Leone and stimulated the Government's first hard look at the country's energy situation and prospects. Results include an attempt to institute a national energy plan and to encourage increased energy-related research, both economic and physical.

While most of the attention is focused on oil (imports, utilization and production prospects) and hydroelectricity, biomass, particularly fuelwood, is a major component of the total energy picture. Over 80 percent of the population relies exclusively on fuelwood for food preparation. Deforestation and consequent land resource degradation, while not a major problem at present, could easily become one over the next decade. Improved, small scale fuelwood production and harvesting technologies, integrated with improvements in the crop production system, are definitely needed. It is in this area that AID may be able to make significant contribution.

II. Energy Sources

The country's primary energy sources are petroleum (all imported at present) and fuelwood. Hydropower, though largely unexploited at present, appears to have considerable potential. Imports of crude oil for local refining were roughly 240,000 and 250,000 metric tons (MT) in 1979 and 1980 respectively; 20 to 30 percent of this was subsequently reexported, mostly as bunker and jet fuels. Between 1978 and 1980 the country's oil import bill more than doubled; in 1980 $71 million (35 percent of total foreign exchange earnings) was spent on oil. Offshore oil exploration is now underway; promising geologic formations have been located and the first test well is now scheduled for early CY 1982. However, even if exploitable reserves are located, commercial production is still two to three years in the future.

In terms of fuelwood and timber resources, roughly 5 percent of the land surface is "closed high forest", most of which is under government protection/management in constituted forest reserves. The total volume of timber in these forests has been estimated at 3.7 million cubic meters, nearly all of which is natural growth;

forest plantations are negligible. The variety of tree species found in these primary forests (roughly 200) is greater than in any other West African country. The offtake goes almost entirely into sawn lumber and pole wood.

Another 50 percent of the land area at any one time is in various stages of regrowth forest stemming from the prevailing bush fallow cultivation system. It is from this regrowth that the bulk of the country's fuelwood is supplied. The fact that fuelwood production is basically a byproduct of the farming system means that this important activity is almost exclusively in the hands of individual small farmers. Most (perhaps 80 percent) of the total fuelwood offtake is for subsistance use. However, where access to markets exists this activity is commercialized (the value of fuelwood can come close to the value of agricultural produce on some upland farms), and it is, of course, in these areas that the tendency toward over exploitation of the regrowth forest resource is encountered. Also, an increasing population with no corresponding improvement in agricultural productivity is beginning to necessitate shorter fallow periods and extension of cultivation to marginal areas, e.g. steep hillsides, with serious long-term implications for both agriculture and fuelwood production.

The most promising renewable energy resource for Sierra Leone is undoubtedly hydropower. The theoretical hydroelectric potential is estimated to be greater than 2000 MW, of which 1100 MW may be technically/economically realizeable. At present only 2.4 MW of hydroelectric generating potential exists, with another 4 MW facility under construction. Design work has been completed for the proposed Bumbuna Hydroelectric Project (total installed capacity of 305 MW), and funding is now being solicited. Phase I, with an installed capacity of 70 MW, is targeted for completion in 1987.* Design work for other projects, both large and small scale, is underway.

Other energy sources are generally considered insignificant. Lignite deposits do exist, but their extent and quality have not been assessed. Biomass (other than timber) is negligible, as is biogas, the latter largely because of the scarcity and low concentration of livestock. Wind and solar energy may have some potential. Direct solar energy is now used for drying most agricultural produce. Limited research into improved solar applications, particularly in drying, is underway. However, solar energy is limited by the heavy cloud cover during much of the year.

III. Energy Consumption

As noted above, 80 percent of oil imports are for the domestic

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* The estimated cost, including distribution system, will be roughly $3.5 million per MW of installed generating capacity, an extremely high figure. GOSL officials, however, are of the opinion that there is no alternative but to proceed.

market. Of this, 60 percent is for the industrial sector, primarily electricity generation, 22 percent for transport, and 18 percent kerosene and cooking gas for household use. Demand for petroleum-derived energy is increasing at an annual rate of 4.5 percent, led by households and transport at 7 percent. Under even conservative assumptions Sierra Leone's import bill for petroleum could reach $150 to $170 million by 1986 which, if mining output remains in its current depressed state, could claim 45 to 50 percent of projected export earnings, clearly a critical situation.

Sierra Leone is served by a total installed electricity generating capacity of 95 MW, 93 of which is oil or diesel-powered. Of this, 38 MW (40 percent) are in "captive" plants directly serving the mining operation. The balance is owned and operated by the Sierra Leone Electricity Corporation (SLEC), 80 percent of which is concentrated in the Western (Freetown) Area. For the year 1979/80 SLEC reported sales of 94.7 million KWH, roughly 25 percent of which was for household use. A conservative projection for the rate of annual growth in demand for electricity, not including requirements of proposed mining operations or any increase in rural electrification, is 5 percent. At this rate, the domestic demand would more than double by 1994, and installed generating capacity would be reached by 1984.

Energy for agricultural production in Sierra Leone is supplied almost entirely by human labor. The number of working tractors probably does not exceed 300 and draft animals are essentially nonexistent. Use of chemical fertilizers is also very low; annual imports over the past 10 years have averaged only 3,200 MT.

Fuelwood consumption is estimated at 2.5 million m^3 per year, 95 percent of the total harvest. Approximately 80 percent of the population relies exclusively on fuelwood for its household energy needs (confined almost entirely to food preparation). Fuelwood demand is expected to increase somewhat slower than the population growth rate. perhaps in the range of 1.8 to 2.0 percent per year. Charcoal is insignificant; total production in 1978 did not exceed 10,000 m^3. Consumption is mostly confined to Freetown.

IV. Energy Pricing

The retail pricing of petroleum products basically reflects their real cost; there is no overt subsidy except for kerosene, which is probably socially justifiable as it is used almost exclusively by lower income families. Electricity pricing, however, is subsidized at approximately 4 cents per KWH, a saving that accrues almost exclusively to businesses and upper income families.

While accurate, detailed marketing and price data for fuelwood do not exist, it appears that the fuelwood market is dominated by small entrepreneurs, with prices determined solely on the basis of supply and demand. A 1978 study found that prices received by fuelwood producers varied between 6 and 12 dollars per cubic meter

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depending on quality and location, while end user prices in Freetown ranged from 16 to as high as 40 dollars. 1/ The substantial price spread (almost 200 percent) reflects the high local costs of transport and an apparently inelastic demand; it also seems to indicate the presence of gross market inefficiencies. A major study into the fuelwood market now underway should clarify the situation.

V. GOSL Energy Policy

A national energy committee, comprised of representatives of the Ministeries of Energy and Power, Agriculture and Forestry, Development and Economic Planning, Trade and Industry, the Sierra Leone Electricity Corporation, and the University of Sierra Leone, has recently been instituted. This committee is charged with formulating a national energy policy and coordinating energy-related activities; policy guidelines will be formulated in such areas as conservation, control of energy resources, priorities in energy use, investment, and regional cooperation. The committee is now undertaking an assessment of the energy situation and is also following-up on recommendations of the recent ECOWAS Energy Symposium regarding development of short and medium term project proposals.

Over the period of the next Five Year Plan (1982-1986), the largest share of energy-related investment is programmed for hydroelectric development, primarily the above-mentioned Bumbuna Project. Development of fuelwood plantations and increased charcoal production are also planned.

VI. Other Donor Activity

In hydroelectric power, financing for the Bumbuna Project is the primary concern at this time. The GOSL is attempting to line up a consortium of multilateral and bilateral donors; likely participants include the World Bank, the Italian and West German Governments, and the Kuwait Development Fund.

In forestry, the West German Government is involved in assistance to the timber industry; however, this does not yet extend to fuelwood production or marketing. A major sectoral study was recently funded by the EEC, which included pre-feasibility analysis for fuelwood plantation. The EEC and West German Government are reportedly considering further assistance along this line.

The Soil and Water Division of the Ministry of Agriculture and Forestry (initiated and assisted by UNDP/FAO) is undertaking research in integrated watershed management, attempting to analyze

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1/ These figures appear overstated. Current fuelwood costs in Freetown are in the 15-25 dollar range.

and improve agricultural production (including fuelwood) while preserving the soil resource.

VII. Commercial Activity

Commercial activity in the energy field is presently limited to offshore oil exploration by Mobil Oil Company. Mobil reportedly is prepared to invest up to $14 million in this endeavor. Planning for increased electricity generation for Freetown is underway, including consideration of possible use of domestic lignite or imported coal rather than oil.

VIII. AID Program

The AID program in Sierra Leone is quite small ($2-3 million annually over the past few years), with one major project in Adaptive Crop Research and Extension (ACRE) as its centerpiece. ACRE attempts to take an integrated "farming system" approach rather than considering specific crops or inputs in isolation, with particular emphasis on the upland farms that account for the bulk (perhaps 80 percent) of Sierra Leonean agricultural output. Because fuelwood production is an integral and often valuable component of this upland farming system, and is carried out by the small producers AID is directed to assist, it is logical to address the issue within the context of ACRE. Specifically, ACRE can investigate the potential for fast-growing, legumenous tree crops (e.g. *Leucaena sp.*) to stabilize and enrich upland soils, both under mixed cropping and modified bush fallow (clear-burn-farm-fallow) regimens.

AID has also received requests for assistance in other energy-related areas, especially rural micro-hydroelectric generation. This is an area where we may be able to make real contributions with relatively small inputs under regional or centrally-funded projects, e.g. in inventory of possible sites and support of pilot or demonstration activities, and which accords well with our rural development focus.

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SOMALIA

I. Sources of Energy

A. Conventional Energy

The primary source of conventional energy in Somalia is imported petroleum. Fuel imports into Somalia in 1980 consisted of 210,400 metric tons of petroleum and petroleum products. Diesel fuel (both locally refined and imported) comprised 56 percent of the total imports and was the largest single component. During the first half of 1981 (January - June) a total of 116,000 metric tons of refined petroleum products was imported. The country's refinery was not in operation during that period due to the unavailability of Iraqi crude oil.

B. Traditional and Renewable Energy

The main sources of traditional and renewable energy in Somalia are charcoal and firewood. The estimated consumption of 5.6 million cubic meters of wood per annum represents in the order of 86 percent of the total national energy consumption. Annual consumption of charcoal is estimated at about 80,000 tons. Fuelwood and charcoal represent 96 percent of the country's total wood consumption. Charcoal producers are organized into cooperatives by the government; there are over 100 such businesses in the country. Licensed producers account for about 80 percent of the country's production according to the National Range Agency. Traditional charcoal production methods in Somalia are estimated to be about 10 percent efficient. Other sources of renewable energy include a hydroelectric facility in the Juba River which produces 5 MW of power generation. A number of windmills were introduced into Somalia in the 1960's, but many of these are no longer functional due to lack of maintenance, upkeep and spare parts. Potential for wind power development is highest along the coastal areas.

Some experimentation has been undertaken with photovoltaic pumps for shallow wells. By the end of 1982 approximately 36 such pumps will be in place. The pumps are used primarily for supplying water from rivers to the refugee camps. The initial cost of the pumps is high and it is not known yet whether they will prove to be economically feasible.

II. Energy Consumption Patterns

Approximately 80 percent of the electrical power generated is consumed in Mogadishu. Sixty percent of the public power generation goes to state organizations, the other 40 percent is provided to private customers. Energy consumption by industry probably amounts to about 6 percent of the total produced. The

total national consumption of energy is 15.6 x 10^{12} kilocalories per annum.

Electrical energy sales increased at a rate of 10.2 percent from 1965 to 1978. The current overall growth rate is about 12 percent. Fuel imports consume 56 percent of export foreign exchange earnings and as such it is one of the main contributors to the persistent balance of payment deficit.

III. Energy Resources

Although several oil companies have searched for both gas and oil reserves in Somalia, no economically viable supply has been located to date. The geology is encouraging, however, and several companies are continuing to explore.

The Federal Republic of Germany, after conducting a three-man fact finding mission late 1979, is funding a one million dollar Phase I prospecting program to determine the extent of coal and bituminous shale in a region between Berbera and Alulu. This program is to start in mid-1982 when field personnel are expected to arrive. Initial estimates of reserves show resources of sufficient quantity (2.5 million tons) and quality (net calorific value greater than 3500 kilocalories/gram) to supply a 20 Mw power station for at least 15 years. The resources in the area include Jurassic bituminous shale, Cretaceous hard brown coal (subbituminous) and Tertiary lignite.

Alternative energy technology development has not been explored to any great extent in Somalia. This condition is changing as PVO's and other international organizations introduce solar power, wind power and hydroelectric schemes. However, these activities are on a very small scale in relation to the size of the problem.

The present annual consumption of wood in Somalia is 5.6 million m^3 and total growing stock is estimated at 81 million m^3. With a population growth rate of 2.8 to 3.1 percent and a continually-growing refugee population, the demand on wood reserves will triple by the year 2010. Land clearing and agricultural techniques contribute to the reforestation problem, and this coupled with overgrazing precludes regeneration of the forest. It has been estimated that the carrying capacity of the range is exceeded by three times.

Fuelwood conservation is a perceived need in Somalia at the policy making level. However, the lack of trained technicians and funding has severely limited the Government's capability for initiating conservation programs.

Proposals for improved cookstove projects have been submitted but not funded. A pilot charcoal conversion project, funded by UNIDO will explore kiln production methods.

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The environmental implications of the deforestation problem are ominous. No formal Environmental Protection Agency exists in Somalia, however the functions of such an agency are partially performed by the Ministries of Agriculture (land allocation) the Ministries of Livestock (National Range Agency land use planning) and the Ministry of Planning (Energy Coordination.)

IV. Government Energy Policy

The Ministry of National Planning has recently been given authority for coordinating all ministries with energy-related functions and will undertake an EEC funded 2-3 person month study of manpower requirements for an energy planning unit to be established within the ministry. The Somalia Petroleum Agency (a public agency) is responsible for the purchasing, storage and distribution of petroleum and petroleum products. Electrical power delivery is managed by the National Agency for Electrical Energy (ENEE) which is a parastatal agency under the Ministry of Public Works. Energy resource exploration and development is overseen by the Ministry of Mineral and Water Resources.

Diesel fuel is subsidized by the Government in an effort to encourage farmers to increase agricultural productions; gasoline is not subsidized.

The Ministry of National Planning has compiled a Five Year Development Plan (1982-1986) which proposes to combat desertification through a program of research, training, coordination of surveys and implementation of forestry projects.

Specific projects proposed for funding are strengthening the Forestry Department, improvement of charcoal production methods, village forestry lots, improvement of frankincense and myrrh production and strengthening and intensification of sand dune fixation. These projects will be added to an already established National Range Agency program of nursery establishment, sand dune stabilization and shelter belt construction. The National Range Agency is a parastatal agency under the Ministry of Livestock, Forestry and Range and overseas forest management and government replanting schemes.

V. Private Sector Involvement

Multinational company involvement in the conventional energy field is limited to oil exploration and a recent crude oil supply contract. Cooperatives are involved in the production and distribution of charcoal as described previously.

A larger role for the private sector would most likely contribute to the efficiency of energy distribution and maintenance systems, however, both the scarcity of foreign exchange for capital investment and the dominance of parastatals in the economy preclude such involvement at present. This may change in the near future as

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the Government has stated that the private sector will henceforth assume a larger role in the country's economy.

VI. The Government's Strategy

The Government of Somalia is in a difficult position in the energy section. Demand for electrical power and petroleum increases yearly, (average growth rates in sales of electricity for private lighting show a 12 percent increase) and the total supply is met with foreign exchange. Foreign exchange accumulation is based primarily on livestock sales which fluctuate with the drought cycle. The continual degradation of the range may limit exports in the future. The Government's activities in the Five Year Plan (1982-1986) are aimed at stabilizing the supply of petroleum through refinery reconstruction and retrofit of power generation equipment. In addition the country will attempt to increase hydroelectrical power generation on the Juba River, re-examine energy tariffs in an effort to promote regional development and initiate renewable energy utilization project. Donors are assisting in both the forestry and energy sectors, however, the thrust of their assistance is in the research and analysis areas in an attempt to improve an extremely weak data base and allow for long range planning.

Of primary interest in energy data collection is the World Bank's National Energy Assessment and Planning Study ($261,000; commencing November 1981).

The EEC has agreed to provide short term assistance to establish the new Energy Planning Unit in the Ministry of Planning. By mid-1983 enough data should be accumulated to enable the Government to set long-range energy development goals.

Exploration will continue in groundwater development, geothermal resources, oil field drilling, and lignite deposits.

The Somalia response is weakened by lack of technical specialists in both the energy and forestry fields. It is doubtful that current government staff will have the capability of implementing the projects in the Five Year Plan without additional technical assistance.

VII. USAID assistance in 1982 will include:

A. ETMA- sponsored 3 day awareness workshop on energy and environment.

B. IRT- windpower development ($100,000).

C. CDA Forestry Sector Grant (several million) to include a food-for-work program, institution building and training in range and forestry.

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Even with a weak data base for analysis, it is evident that Somalia is on the brink of an energy crisis. Current efforts to date in this sector have been meager outside of the research area. The recently launched CDA program is intended to accelerate donor strategy development and permit a more extensive transfer of donor funds.

SUDAN

I. Introduction

Energy, in its various forms, is the backbone of the economy of any country in the world. It reflects the state of health of the economy. The consumption of energy is taken, in many cases, as a measure of the development of human communities. In a recent survey, the Western world and Japan produced about half the total electrical energy of the world, while they comprised less than one third of the world's population.

The Sudan is one of the 25 least developed nations of the world. This is easily verified by the fact that the per capita average consumption of electrical energy in the Sudan is 50 kWh, which is far below the 2,500 kWh of the developed world. In 1979/80, 95 percent of the Sudan's foreign exchange was absorbed by its oil imports.

II. Sources of Energy

Regarding fossil fuels, the Sudan annually imports 1.2 million metric tons of petroleum products, which constitute about 98 percent of the commercial energy used, or about 21.63 percent of the total energy. The skyrocketing prices of petroleum products prevent the adequate import of these products, with consequent adverse effects on industry and agriculture and eventually on the whole economy.

Hydropower, as a source of renewable energy, has been developed in the Sudan to a considerable extent. It produces about 78 percent of the total electrical power. The installed capacity of hydropower is about 250 MW, while its estimated potential is over 3,370 MW.

Fuelwood is the major source of renewable energy used in the Sudan, wither as direct firewood or as charcoal. In 1979/80, about 13 million metric tons of wood fuel was consumed, mainly as household fuel in rural areas. This huge consumption, together with the low rate of afforestation (7,000 hectares annually) would seriously affect the balance of supply and demand of fuelwood, and if no steps are taken to obviate this imbalance, then fuelwood will be deficient by 1985.

Less than 4 percent of the 3 million metric tons of crop residues now available is utilized. Ambitious plans to produce ethanol from molasses for the purpose of blending with gasoline are under serious consideration by the Government.

Solar energy has been used in the Sudan, in a primitive way, for many decades in such applications as the drying of agricultural products. In 1955, scientific research was begun at the University of Khartoum on power generation and measurements of solar energy. The National Council for Research, through its organ, the Institute of Energy Research, has been involved in research and the

development of solar energy technology since 1970. The geographical situation of the Sudan means that it is in a most favorable condition for collecting and exploiting this boundless source of energy. Duration of sunshine is about 11 hours and the solar flux amounts to 80 calories per hour per square centimeter.

Wind energy was introduced in the Sudan in 1950, when 250 windmills were installed in Gezira Province to pump water from artesian wells. Unfortunately, the operation of these windmills was abandoned for a number of reasons. Improper repairing and bad maintenance were some of the reasons.

The average wind speed in most areas of the Sudan is about 10 mph. There is thus great hope that wind energy will meet part of the increasing demand for energy in the Sudan.

III. Government Plans

Sudan has ambitious plans and projects to make the maximum use of these new and renewable energy sources and direct them into commercial utilization, but there are a number of obstacles. The production of alcohol from sugar residues, for example, needs financing. The improvement of charcoal production needs advanced technology. Also, the field of research and training is still in its infancy in the Sudan, which also presents an obstacle.

In order to overcome these difficulties and develop new and renewable energy sources effectively, the Government is undertaking a number of steps, namely:

- Organization of the energy sector to enhance and accelerate the effective implementation of new energy technologies, and to avoid duplication of the efforts of various organizations working in the energy sector;

- Energy strategies and planning: the Sudan is embarking on a project for the assessment of the energy situation in the country; on the basis of the results of this assessment, the country will formulate plans and strategies that will focus on the development of the energy sector;

- International cooperation and bilateral agreements: the Sudan needs the cooperation and help of developed countries that have taken the lead in new and renewable energy research. The field of cooperation may include the financing of projects, the training of personnel, and the donation of demonstrating equipment.

Bilateral cooperation between the Sudan and neighboring countries in research fields of common interest is also very important. The following joint projects are good examples of such cooperation:

- Sudan/Uganda: improvement of charcoal kiln production;

- Sudan/Kenya: development of biogas and geothermal energy;

- Sudan/Ethiopia/Somalia: forest plantations.

It is a challenge not only for the Sudan but for the whole of Africa to devote every effort to acquiring the necessary technology of new and renewable energy sources in the remaining part of the twentieth century in order that these sources may contribute to the continent's energy needs in the twenty-first century.

SWAZILAND

I. Introduction

While Swaziland is more fortunate than many other countries in that it has a number of alternative energy sources, it is not currently energy independent and there is little likelihood that it will ever be a net energy exporter. However, it may be able to avoid increasing external dependence.

A. Physical Setting

Swaziland is a small, landlocked country located in south-southeastern Africa. It is bordered by the RSA except for a small area on the east which joins Mozambique. The country has a maximum north-south length of 193 km and a maximum east-west width of 145 Km. Swaziland covers approximately 17,400 sq. km and is divided into four geographic regions going from west to east: Highveld, Middleveld, Lowveld and Lebombo. The Highveld covers nearly one third of the land area with elevations over 1000 meters, and many steep slopes. The Middleveld covers nearly 30% of the country and contains hilly country and well-watered valleys with undulating grasslands on the eastern side. The Lowveld is one third of the land area, between 182 and 364 meters above sea level, with very gentle slopes. The Lebombo region covers less than 10% of the land area and is a plateau over 600 meters above sea level.

The climate varies from the subtropical, near humid Lebombo region, to the dry, hot Lowveld to the humid, near temperate Highveld. Rain varies with altitude and is seriously deficient in one year out of ten.

Swaziland forms part of the eastern watershed region of southern Africa and has an extensive network of rivers. The Lomati/Komati system drains the extreme northwest. They originate in South Africa, flow through Swaziland and then discharge back in South Africa. The Mbuluzi river originates in Swaziland and discharges in Mozambique. The four major tributaries of the Great Usutu river originate in the RSA, combine to form the Great Usutu in central Swaziland and discharge into the RSA eventually flowing into Mozambique. The Ngwavume river rises in souther Swaziland. It discharges into the RSA.

B. Economy

The economy is agriculturally based and export oriented. It is well diversified but highly dualistic with a modern capital intensive sector and a traditional sector engaged primarily in subsistence agriculture. Approximately 70% of the population is dependent upon traditional agriculture. Maize is their principal crop, but increasingly this sector is growing some cash crops. Modern agriculture involves primarily sugar,

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citrus, pineapples and cotton production. The manufacturing sector includes the processing of agricultural commodities plus a lumber and mining industry. Tourism is also a significant sector in the economy. The lumber plantations are primarily in the Highveld, with plantation type agriculture in the Middle and Lowveld.

II. Current Energy Resources

A. Coal

Coal is the only fossil fuel source available in Swaziland. The one producing coal mine is in the Lowveld at Mpaka. In 1980 it produced 180,000 tons, and has reserves to last 50 years at the current extraction rate. However, the entire eastern fourth of the country is a coal seam covering about 2000 sq. km.

Current estimates of mineable coal resources in this area total just over 100 million tons, with potential reserves of 550 million tons. In 1980 coal provided 28.3% of the energy available for use in Swaziland, however 87% of coal production was exported, primarily to Kenya. Thus, Swazi coal contribution to Swaziland's energy use was only 3.7% of total energy used.

B. Hydroelectric Power

The topographical structure of the country is characterized by a progressive decrease in elevation from West to East and most rivers follow the same west to east trend. Despite an average level difference of about 1000 meters between the Western mountainous valleys and the eastern plains, there are only a few sites combining significant discharge with concentrated head. One generally optimistic report indicated 21 possible sites for hydroelectric power plants. However, the increasing number of dams in South Africa has already reduced the amount of water available since many of the best sites use rivers that originate in South Africa.

If the proposed dams in South Africa are constructed, this would result in severe shortages of annual discharges of these rivers at the Swazi border.

Currently there are two hydro plants, both operated by the Swaziland Electricity Board (SEB). They presently generate 130 GWh; 1/ or 2.1% of the energy used in Swaziland in 1980. There are many locations that could produce electricity with micro-hydro stations but generally the cost per kilowatt is high.

Of the 21 proposed sites for hydro stations, 12 have been eliminated because of high investment cost or unduly large water abstractions upstream. Of the nine remaining, two are

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considered most promising and one is currently under construction.

The Lupohlo/Ezulwini scheme, on the Little Usutu River, is under construction and should be able to produce 93 GWh annually; the "Lower Scheme" is on the Great Usutu and it is hoped to have it commissioned in 1986. It is downstream from one of the existing dams and should be capable of producing 53 GWh per year. These two dams will increase hydroelectricity production in country by over 100%; but they will still only provide a small percentage of total energy needs within the country.

C. Wood

One of the largest man-made forests (over 60,000 ha) in Africa is to be found along the Usutu River in the Highveld. Another large forest area is in the northern Highveld at Pigg's Peak (approximately 32,000 ha). In addition to these there are approximately 8000 ha of man-made forests on Swazi Nation Land.

The plantations along the Usutu River process wood mainly into pulp for export. Those in the Pigg's Peak area process their wood into lumber which is used for construction and the making of small crates, both mainly for export.

Wood as an energy source, in the form of firewood, is only of minor commercial importance. It accounts for 0.5% of total commercial energy production. There are only a few small dealers selling firewood for domestic consumption. Employees at the wood factories are supplied with waste wood.

Most of the firewood for domestic purposes is put to use in the rural areas and collected and/or cut there by the rural population. This unregulated collecting of wood has increased steadily with the growth in rural population and price increases for alternative fuels. This has resulted in some wood shortages so that people must travel greater distances to gather wood. Wastewood resulting from felling and processing can supply some of domestic fuelwood needs, but problems with collection and distribution appear to make this economically nonviable.

D. Bagasse and Sugar Cane By-Products

In 1980 approximately 2.8 million tons of sugar cane was processed into sugar and molasses producing 840,000 tons of bagasse. This was used by the sugar industry for generating the steam necessary for processing the cane, and also to meet their own electricity needs. While the efficiency can be improved, there are technical difficulties in moving the surplus amay from the sugar mills.

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Cane and molasses can be used indirectly as an energy source via the manufacture of ethanol. Aside from economic considerations, there are political questions about using potential sugar cane areas with the necessary irrigation or produce an "energy crop".

E. Agricultural Wastes, Biogas

The use of organic wastes for the generation of gas and fertilizers has a long tradition in some developing countries. In Swaziland the production of biogas could be of interest not only for small-holding farmers but also for major livestock enterprises, slaughterhouses and food processing concerns. At present there are only minor scattered examples of biogas generation and detailed cost estimates to determine economic viability have not been undertaken.

F. Solar

Swaziland is located between the 25th and 28th parallel of latitude in the Southern hemisphere, where insolation is exceptionally high. Data accumulated by the Water Resources Department for the average hours of sunshine per day reveal a practically constant insolation when expressed in terms of hours of sunshine per day. There is little seasonal variation as monthly averages vary by no more than 13% from the yearly average.

Solar panels have been installed in only a few places so far. The largest, at Tambankulu Estates, is used to provide hot water for showers. The performance is satisfactory and the quantities of hot water produced are acceptable even in the winter months without supplementary power.

G. Non-Sugar Company Sources

The Havelock Asbestos Mines at Bulembu in extreme northwestern Swaziland generates 80% of its electrical energy itself, purchasing the remaining from SEB. The electricity is used to operate the caleway that transports the asbestos ore to Barberton, South Africa, to dry the asbestos ore and for underground and domestic use. The generators use South African coal.

The Usutu Pulp Company's power plant produced 65% of the mill's electrical requirements. It is the largest single electrical self producer in the country. Ninety-six percent of its power source is from waste by-products, and 4% comes from heavy fuel oil. Peak Timbers, in the Pigg's Peak area has four turbine generators with a 2500 kW capacity, using waste wood. The company supplies free firewood for domestic use to its employees. SEB supplies residual electrical needs.

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III. Energy Imports

A. Petroleum

As Swaziland does not possess oil or natural gas resources and does not have its own oil refinery, the necessary liquid and gaseous fuels are imported, almost without exception, from South Africa. The oil refineries in Capetown and Durban ship refines products to Maputo where they are transported by rail to the main depot at Matsapa.

The importation and distribution is under the direct control of the oil companies of South Africa. In 1980, imported oil represented 22.3% of total energy used in Swaziland.

B. Coal

While Swaziland exports almost all of its coal, it still imports 12.8% of its energy needs in the form of South African coal. The imported coal is better suited for industrial application such as firing in boilers.

C. Electricity

The domestic sources of supply for the Swaziland Electricity Board have remained unchanged in the past few years. Thus the proportion of total electricity use which is locally generated has dropped to 39% in FY 79/80. The balance is purchased from South Africa and comes through two 87-km overland transmission lines.

IV. Energy Consumption

A. Domestic and Commercial

This comprises all rural and urban energy consumption for households, commercial users and government. It is estimated that commercial users consumed 597 TJ of energy in 1980, 46% of which was electricity and 44% coal, and 4% LPG. The remaining amount of energy consumed for commercial purposes was diesel, paraffin and heavy fuel oil.

In rural areas the main domestic source of energy is firewood but coal is also important. Paraffin and LPG play a secondary role. Access to electricity is limited.

In urban areas electricity and coal constitute the main sources of energy, while the contribution made by wood, LPG and paraffin are small. Coal is used to a considerable extent only in company towns. The estimated energy breakdown in rural and urban areas is shown below:

Source	Rural Consumption in TJ	% of Total	Urban Consumption in TJ	% of Total
Firewood	944.00	60.5	24.67	5.5
Electricity	5.04	0.3	184.86	41.6
Coal	498.40	31.9	216.89	48.8
Paraffin	90.50	5.8	15.55	3.5
LPG	23.49	1.5	2.76	.6
TOTAL	1561.43	100.00	444.73	100.00

Subtracting out self-generation of electricity the total energy consumption of the domestic sector (rural and urban) is 1,992 TJ.

B. Transportation

This is the most important oil consumer in Swaziland's energy system. Almost 63% of all the petroleum products were used for transport in 1980.

The energy consumed in the transport sector is split into gasoline (40.4%), diesel (38.6%), coal (17.7%), aviation gasoline (0.3%) and jet fuel (3.0%) with total energy consumption in 1980 of 3,283 TJ. By making assumptions based on the registration of private vehicles and commercial vehicles, stimates can be made of the use of transport energy.

Thus, 57% of the gasoline is consumed by individual vehicles and 26% is consumed by panel vans. Fifty-nine percent of the diesel is consumed by small trucks.

C. Industry

The Swazi Chemical Industries consumed SEB electricity and coal imported from RSA. The petrol and diesel consumed is counted under the transport sector. Total energy consumption in 1980 was 246 TJ.

Altogether the mining sector consumed 1,046 TJ of energy almost all of which used by the Havelock Asbestos Mines.

In 1980, the Swazi mills consumed approximately 5,828 Tj of energy with over 90% being bagasse. The balance is coal (mainly imported) and SEB electricity.

The food and beverage industry consumed approximately 185 TJ of energy, exclusive of transportation requirements. Over 84% was in the form of coal, and over two thirds of this was imported coal. Fourteen percent of energy needs came from SEB electricity.

The pulp industry was second only to the sugar industry in energy consumption. Its total energy consumption was 4,801 TJ with 77% being in the form of waste products. Just over 2% of needs was provided by SEB. It was the only large consumer of heavy fuel oil in the Kingdom.

The timber industry consumed approximately 776 TJ of energy in 1980, being 97% of which was wood waste and black liquor solids. The balance was diesel and SEB electricity.

D. Agriculture

In agriculture two forms of energy predominate:

- electrical energy is used mainly for driving irrigation pumps;
- diesel fuel is used primarily for tractors and harvesters primarily.

Sugar cane is the main irrigated crop but some irrigation is used in cotton, vegetable and citrus farms. Around 650 TJ of energy is used in this sector split about equally between electricity and diesel.

E. Power

The electric utility sector is represented solely by SEB. It used 26 TJ of energy in the form of diesel to operate the Edwaleni generating station.

V. The Energy Balance for 1980

A. Domestic Production

Energy Input	TJ	% of Total
Mpaka coal	5,501	32.7
SEB hydro electricity	412	2.4
Bagasse	5,545	33.0
Black liquor solids	3,120	18.5
Waste wood, firewood	2,244	13.3
TOTAL	16,822	

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B. Energy Imports

Energy Import	Source	TJ	% of Total
ESCOM electricity	RSA	677	9.0
Petroleum Products	RSA	4,329	57.7
Coal	RSA	2,494	33.3
TOTAL		7,500	

C. Energy Exports and Losses

The only energy export was Mpaka coal and it amounted to 4,788 TJ.

One hundred and five tera joules of energy were lost in electrical transmission and distribution.

Thus the total energy available for use in Swaziland is equal to domestic production plus imports, minus exports and net losses. This totals 19,429 of which 38.6% was imported for RSA.

D. Energy Consumption

As discussed earlier the energy is consumed in the following sectors.

Sector	TJ	% of Total
Domestic	1,992	10.2
Commercial	597	3.1
Transportation	3,283	16.9
Chemical	246	1.3
Mining	1,046	5.4
Sugar	5,828	30.0
Food & Beverage	185	1.0
Pulp	4,801	24.7
Timber	776	4.0
Agriculture	650	3.3
SEB	26	0.1
TOTAL	19,430	

VI. Energy Comparisons

A. Energy and GDP

Detailed GDP estimates have not been done on the Swazi economy since 1975/76. However, the Swazi Central Statistical Office is currently attempting to estimate GDP for the intervening years. A preliminary estimate is that GDP at factor costs was E249.7 million or U.S. $345.1 million in 1980. Pricing the

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energy used, without excise tax, gives an estimate of the value of energy used of E55.3 million or U.S. $66.9 million. The non-commercial energy sources such as firewood, bagasse and black liquor were not taken into account since they are waste products from industrial processes. Since the value of the waste products is already incorporated in GDP at market prices we do not need to increase GDP when we value the waste products. However, if we place a value on the firewood collected we must also increase the value of GDP by the same amount. The result is that the value of energy used, including firewood and waste products is E69.1 million or U.S. $83.6 million, and GDP is raised to E252.8 million or U.S. $305.8 million. Twenty seven percent of GDP at factor costs went to energy costs.

In 1980 82% of all energy expenditures were for petroleum products; including the value of waste products and firewood reduces this to 65%.

B. Energy Consumed Per Capita

The World Bank's World Development Report for 1981 reports energy consumption per capita in kg of coal equivalent per capita. Converting tera joules to of coal equivalent per capita in 1980 yields 1,228 kg per capita.

In 1970 other southern African countries consumed:

Country	Kg. of Coal Equivalent Consumed Per Capita	
Malawi	70	
Mozambique	139	
Angola	208	
Zimbabwe	791	(was 1,346 kg per capita in 1960)
Zambia	858	
South Africa	3,479	

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The World Bank lists Swaziland's income per capita as U.S. $650. The comparable kg of coal equivalent consumed by countries with roughly comparable income per capita is:

Country	Income Per Capita	Kg of Coal Equivalent Per Capita
Bolivia	550	470
Cameroon	560	148
Thailand	590	376
Philippines	600	356
Congo	630	213
Swaziland	650	1228
Nicaragua	660	455
Papua New Guinea	660	299
El Salvador	670	351
Nigeria	670	83
Peru	730	737
Morocco	740	315

Swaziland consumes considerably more energy than other southern African countries, with the exception of South Africa, and also consumes considerably more energy than countries with comparable income levels.

C. Ability to Pay for Energy Inputs

The other comparable figures that the World Bank reports are for energy imports as a percent of merchandise exports (both figures for 1978). In 1978 Swaziland imported E25.8 million (U.S. $29.6 million) worth of minerals, fuels and lubricants, and its merchandise exports were E170.6 million (U.S. $196.2 million). Thus the ration of energy import to merchandise exports is 15.1%.

Only Malawi and Zambia report comparable figures among the southern African countries and they are 22% and 11% respectively. Thus while Swaziland uses much more energy per capita than these countries it is less dependent on imported energy than Malawi, although more dependent than Zambia.

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Among the countries with comparable income levels the results are:

Country	Energy Imports as % of Merchandise Exports
Bolivia	1%
Cameroon	9%
Thailand	28%
Philippines	32%
Congo	1%
Swaziland	15%
Nicaragua	14%
El Salvador	13%
Nigeria	2%
Peru	20%
Morocco	28%

The spread among the numbers is great, but once again, Swaziland's ability to pay for imported energy out of merchandise exports is roughly average.

VII. Government Energy Plans and Objectives

The objectives of the third five year plan (ending 1982/83) are economic growth, self-reliance and social justice with stability. Energy is specifically mentioned under the first two objectives. That is, "Steps will be taken to ensure as far as possible that no irrigation, hydroelectric, or industrial projects are held up or restricted in scope because of inadequate water supply; in addition to the dams and storage schemes planned for these five years, the feasibility of longer range water development schemes is to be investigated." And for self-reliance, "Under study is the possibility of establishing a thermal power station fueled by Swaziland's coal reserves; this would end dependence on a foreign source of electricity."

The objectives of the power sector for the third plan are:

- To continue to expand and reinforce electricity supply to meet the growing demand throughout the country.
- To make the base use of Swaziland's coal and water resources for power generation.
- To achieve independence of electricity supply as quickly as is economically feasible.

In 1978 when the Third Plan began the total amount of gigawatt hours generated or purchased came to 224.0 GWh; of which 102.1 GWh was purchased from RSA, or 45.5%. For 1980, 305.2 GWh was generated or purchased with 187.87 GWh coming from RSA, or 61.5%. While the new hydroelectric plant at Lupohlo/Ezulwini will probably only be able to take care of the planned increases in energy uses

and it is not expected that the dependence on foreign electricity will be reduced. However, it is hoped that this new plant will preclude any increase in the dependency on RSA.

While domestic production of energy by SEB has not been increasing over the plan period, it has been able to meet the increased demand through expansions in the capacity of the ESCOM link and through purchases from them. Thus the amount of electricity sold has grown by 10-15% each year during the plan period.

Other hydroelectric stations are being discussed, as are possible expansions of coal production. The government has recently commissioned an energy sector review that will lay the groundwork for a master plan in the energy field. This is to be tied in with work being done by the U.S. Army Corps of Engineers, to advise the Swazi government on the impact on planned and proposed new dams by South Africa on rivers that flow through Swaziland. It is hoped that within a year there will be an energy master plan for increasing domestic production which will not result in unnecessary increases in the cost of energy.

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TANZANIA

I. Introduction

The Republic of Tanzania has a land area of about 365,000 square miles (945,000 square kilometers) and a population of nearly 18 million people, with a growth rate of approximately 3.4% per annum. The country currently imports all of its petroleum products. Tanzania's current economic crisis is, in part, due to the country's extreme dependence upon imported crude oil as an energy source. It is estimated that over 50% of the country's export earnings in 1981 will be devoted to purchases of crude oil and its refined products.

II. Sources of Energy

A. Petroleum

In 1979, Tanzania spent U.S. $149,700,500 (T.Shs. 1,250 million) for importation of 570,652 MT of crude oil. In 1980, the country spent U.S. $180,500,000 (T.Shs. 1.48 billion) for importaion of 756,930 MT of crude oil and another U.S. $90,371,257 (T.Shs. 754.6 million) to import 225,204 MT of refined petroleum fuel products. In addition to crude oil imports in 1980, the country also imported 36,184 MT of other petroleum products (i.e. bitumen, lubricants, greases, etc.,) at a cost of U.S. $1,904,191 (T.Shs. 15.9 million). Tanzania did however re-export to Rwanda, Burundi and Eastern Zaire a total of 12,043 MT of various petroleum products valued at U.S. $6,395,209 (T.Shs. 53.4 million). The country also exported 92,740 MT of residue fuel oil valued at U.S. $12,718,562 (T.Shs. 106.2 million). Residue fuel oil exports in 1981 are projected to be minimal due to substantial increases in the consumption of fuel oil in the country as a result of the commissioning of two new cement factories. Tanzania also sold 45,333 MT of fuel oil to foreign ships in 1980 earning the country U.S. $6,227,544 (T.Shs. 52.0 million) in foreign exchange. However, the country's projected petroleum import needs in 1981 are estimated at U.S. $359,281,437 (T.Shs. 3,000 million). - over 50% of the country's export earnings.

B. Natural Gas

Tanzania has embarked upon an ambitious energy program to reduce its dependence upon imported fossil fuels. Field explorations and drilling activities are underway at various locations in the country, as well as, offshore to ascertain the country's potential hydrocarbon reserves (gas and oil). One test well drilled offshore has shown some promising signs of potential large natural gas deposits. The government is in the process of negotiating with several oil companies for further exploration activities in the prospective areas.

C. Coal

Tanzania has some fairly rich known coal reserves in the southwestern and southern areas of the country. The major coal fields are Ketewaka-Mchuchuma, Songwe-Kiwira, and Ngaka. Exploitation investigations have begun at the Songwe-Kiwira and Ketewaka-Mchuchuma fields. It is estimated that these fields have an estimated total geological reserve of 1.24 million tons of coal with a BTU value equivalent to most good African coals. At present, only one (Ilima Colliery) of Tanzania's known nine coal fields is in production. The Ilima colliery produces about 7,000 metric tons of coal per year. The national demand for coal is expected to rise to 150,000 tons per year by 1982 due to energy requirements of new industries, such as the Mufindi Pulp and Paper factory, Mbeya cement plant, and the proposed iron and steel factory expected to be developed near the Ketewaka-Mchuchuma fields.

D. Fuelwood

Approximately 90% of Tanzania's population live in rural areas. In rural Tanzania, fuelwood is the dominant source of energy utilized in the domestic households for cooking and heating. Wood is also utilized in the rural industrial sector for brick kilning, baking, tobacco and tea drying. The demand for fuelwood is estimated to range from 1 m^3 to 3 m^3 per capita per year. In areas where trees are scarce, wood is supplemented by cattle or sheep dung, grass, sorghum, and corn stalks. The extensive use of firewood and charcoal for energy in the rural areas of Tanzania has started to show serious environmental degradation. Tanzania has approximately 8,000 villages each requiring an average of 3,000 m^3 of fuelwood per year. The growth increment of 40 m^3 per hectare would require 75 hectares of consolidated forest per village per year. Although Tanzania has some 11.2 million hectares of woodlands, the country has an estimated afforestation deficit of 18 million m^3 per year. It is predicted that large parts of Tanzania will be desert in 60 years if urgent afforestation and forest control measures are not taken soon. The indigenous forests are shrinking quickly and most villagers get their firewood outside the boundary of the village. It has been reported that in areas of East Africa and Tanzania fuelwood gathering round trips of up to 100 kilometers are not uncommon. The traditional practices of utilizing wood fuel to cure tobacco and drying tea take a tremendous toll on the country's woodlands. It takes one hectare of savanna wodland to cure one hectare of tobacco. Tobacco growing in Tanzania is expanding at the rate of 20% annually, and the savanna is disappearing at that rate. Urgent conservation measures are needed to control this degradation process.

E. New and Renewable Energy Sources

Tanzania has made some significant progress in its

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investigations on the use of other indigenous energy resources which are renewable and abundant in the country, such as biomass, sunshine, wind and small streams. Solar dryers, stills, water heaters and photovoltaic prototype devices are being developed and field-tested at various locations throughout the country. To date only solar water heaters are under commercial production on a very limited basis.

Biogas units for cooking, and some lighting, are being introduced in several regions in Tanzania. The Arusha Appropriate Technology Project (AATP), supported by the Small Industries Development Organization (SIDO) has started production of a 2 m^3 methane generator system using oil drums which currently cost U.S. $90 (T.Shs. 700). A larger biogas plant is planned for a residential area of the Dodoma city as a solution to refuse collection and as a measure to help meet domestic energy requirements.

F. Hydroelectric Power

Tanzania's hydroelectric potential is estimated to be between 3,000 MW and a potential firm yield of about 20,000 Gwh. Presently, only 246 MW of Tanzania's potential hydroelectric power has been developed and provides power to the country's existing electricity grid system. Tanzania's hydroelectric potential is found mainly in the Kagern River Basin in northwest Tanzania and in the major rivers draining into the Indian Ocean. Tanzania's largest individual potential hydroelectric site exists in the Rufiji River basin area at Stiegler's Gorge. It is estimated that this station would be capable of producing between 300 MW to 3,000 MW of electricity.

The government has estimated that approximately 10% of the country's oil import requirements can be replaced by hydroelectric energy. This reduced oil requirement will occur mostly in area where diesel driven electric generators would be replaced by hydroelectric networks.

G. Geothermal

Studies are underway to investigate Tanzania's known geothermal resources. Over seventy thermal springs have been located in the Ngorongoro, Mbeya, Dodoma and Rufiji River basin areas in the country. Most of the thermal springs are found in the vicinity of the Rift Valley and along the known fault zones in the country. Further exploration is needed to estimate and prove the country's geothermal resources.

III. Government Energy Policy

Realizing that there are no immediate solutions to the country's current economic and energy problems, Government of Tanzania has introduced energy curtailment policies of fuel rationing, pricing,

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and other conservation measures. Although the program appeared to be technically sound, lack of policy coordination between the government's energy producing and consuming agencies have offset the expected achievements of the energy conservation program. For example, while one agency of the government was trying to promote fuelwood conservation measures to check the environmental degradation of the country's woodlands, another agency of the government was encouraging rural as well as urban communities to use burnt bricks rather than cement blocks in building - since cement factories utilize fuel oil for operation purposes. The government has, however, launched many campaigns to educate the people about the necessity of protecting the natural forests and replacing the dwindling forest resource. The government is mounting a special country-wide campaign on village afforestation. The Government has also commissioned the International Institute for Environment and Development from London, England with assistance from the Middletown Associates, Toronto, Canada, to review the existing energy situation in Tanzania and assist the government in the formulation of national energy policies.

IV. Private Sector Involvement

The Government of Tanzania is currently negotiating with two oil companies, AGIP and Amoco to further investigate the country's oil and gas potential. Tanzania has also signed a participation agreement with an American firm, Agrico, for the construction of an ammonia/urea plant to produce 345,000 MT per year of ammonia and 520,000 MT per year of urea, mainly for export. The American company will acquire 26% shares in the venture and the remaining 74% will be owned by the Government of Tanzania through the Tanzania Petroleum Development Corporation (TPDC).

UPPER VOLTA

I. Introduction

Upper Volta is an arid, landlocked country of some 274,000 square kilometers. Rainfall varies from more than 1,000 mm per annum in the southwest to less than 600 mm per annum in the Northest. Vegetation ranges from Sudano-Guinean open forests and bushland in the southwest to Sahelian grasslands in the northeast. The resident population is estimated to be 6.2 million. The vast majority of the population live in rural areas and there is considerable population pressure on the central (Mossi) plateau.

II. Sources of Energy

The only source of conventional energy in Upper Volta is imported petroleum. Imports of petroleum products into Upper Volta doubled over the last five years for which statistics are available. The total imports were 145,673 MT in 1979. (Table I gives quantities and value, 1975-79). There is no coal, nuclear or hydroelectric energy either produced in or imported into Upper Volta.

Traditional energy sources are fuelwood, charcoal, crop residues and animal wastes. Fuelwood is by far the largest source of energy in Upper Volta. Production is almost entirely by regeneration of natural forests. Harvesting is done by final users in rural areas and by small-scale entrepreneurs near urban areas.

III. Consumption of Energy

In spite of a doubling of retail petroelum prices in the last three years (Table II), consumption of petroleum products has continued to rise sharply (more than 10% per annum) in recent years (Table III). Principal uses of petroleum products are for transportation, electricity (all of which is generated by oil), and light industry. Agricultural uses are minimal.

In 1979 petroleum imports of more than 7 billion FCFA accounted for about 11% of all imports and represented 45% of the value of Upper Volta's exports. The cost of petroleum imports represented half of Upper Volta's current account deficit in 1979.

Approximately 94% of all energy consumed in Upper Volta comes from a traditional source - fuelwood the bulk of which is used for cooking. Annual per capita consumption of fuelwood is estimated to be 1.0 m^3/year in rural areas and 1.3 m^3/year in urban areas. This translates into about 6.8 million m^3/year nationwide. As the estimated annual natural regeneration of the nation's forests is about 5.4 million m^3, there is an annual shortfall of 1.4 million m^3.

The impact of this shortfall on the nation's biomass is devasting, particularly on the Mossi plateau. Although the rate of deforestation is not readily measurable, the magnitude and

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seriousness of the problem is evident even to the most casual observer.

Beyond the physical impact of deforestation, the process has substantial social and economic consequences. Other important uses of forest products such as foodstuffs, medicinal ingredients, shade, construction materials, forage and fencing are necessarily diminished as forest resources dwindle. Families, and particularly women, must spend an ever increasing proportion of their time gathering firewood. What is more, to the extent that deforestation contributes to declining soil fertility, food production suffers.

In the urban setting the need to buy firewood for cooking is becoming a crushing burden on poorer families who spend 20 to 30% of their incomes on firewood. One donkey cart, which may last 2 months, costs from 4,500-6,000 FCFA. The impact this cost has on resources available to the family for food, health, education or small investments is clearly major and negative.

IV. Energy Resources

Upper Volta has no known oil, gas, or coal potential. There is a modest potential for development of hydroelectric power, although this has yet to be realized.

A number of alternative energy schemes have been investigated including improved woodstoves, biogas, windmills, solar cookers, and a variety of other solar energy activities. None of these alternative technologies has been disseminated on a wide scale.

The country has an estimated 246 million m^3 of forest resources on 13 million hectares of forest area, exclusive of wildlife reserves and farmers' fields. As noted above, replanting and natural regeneration fall substantially short of utilization.

There are three principal sources of pressure on the country's forest resources: land clearing for agricultural production; fuelwood cutting; and animal browsing. All contribute to the deforestation problem. While there is widespread recognition in heavily populated areas that the disappearance of the forests is a major problem, there is no consensus among rural users of forest resources of the steps which need to be taken to resolve the problem. Forest resources are generally perceived as a public good in Upper Volta -- available for exploitation by the first comer -- so that there is little or no incentive for potential private users to exercise constraint or conserve forest resources. At the public level, there is a perceived need to address the problem of fuelwood conservation, but, as with other development problems facing Upper Volta, there is no well-defined plan for dealing with problems, nor are adequate resources available to finance such a plan.

The environmental implications of Upper Volta's deforestation problem are immense. These are principally declining soil fertility through erosion, degradation of the nations's range and

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forests, and ultimately a lowering of the water table. As a primarily agricultural country, the probable consequences of these trends are no less than catastrophic. While efforts are underway to monitor the extent of the deforestation through remote sensing and other survey technologies, there is as yet no reliable and consistent source of information on the problem.

V. Government Energy Policy

Energy matters are handled by three different ministries. Conventional energy concerns fall under the jurisdiction of the Ministry of Commerce, Industrial Development and Mineral Resources. Forest resources fall into the domain of the Ministry of Environment and Tourism (MET), although any efforts to promote agroforestry techniques and other village-level interventions must rely on the Ministry of Rural Development for extension.

Multinational oil companies (Shell, BP, Total, Mobil, Texaco) are the major importers and retailers of petroleum products into Upper Volta. These companies purchase from the Societe-Ivorienne de Raffinage (SIR) (of which the Government of Upper Volta (GOUV) is part owner) for importation and sale of a price fixed by the government (SEE Table II for SIR and retail prices). Until recently there was a subsidy on the price of gasoline although this has now been phased out due to the high cost of subsidizing an ever-increasing demand for petroleum products. Electricity is not subsidized.

The MET policy on fuelwood and reforestation is diffuse, and therefore difficult to define as a precise strategy. Some of the principal elements are as follows:

- Promotion of the planting and use of local species
- Promotion of village-level reforestation efforts
- Better control of bush fires
- Support to decentralized production of seedlings at the level of each sub-prefecture
- Improvement and intensification of the management of the forest reserve system
- Promotion of soil conservation and erosion control through agro-forestry techniques
- Promotion of energy-efficient woodstoves
- Increased support to Forest Service personnel (housing, vehicles, operating expenses)
- Improved data collection and analysis of wood production and consumption
- Increased wood production on industrial plantations for urban areas.

VI. Private Sector Involvement

As noted above, the role of oil companies is circumscribed since they buy from a refiner partially owned by the GOUV and sell at prices fixed by the GOUV. Electricity production is controlled by

a parastatal monopoly. Therefore, apart from experimentation by energy companies with alternative energy sources (some of which is already taking place), there does not appear to be a major role for multinational oil companies in addressing Upper Volta's energy problems.

A more promising avenue for a private sector contribution to resolving Upper Volta's energy problems is the potential for artisan production of fuel-efficient woodstoves. Masonry is a well established trade in rural Upper Volta and training institutions exist which can teach traditional masons the new woodstove techniques. A number of woodstove-promotion schemes are already trying to build on this traditional base.

VII. Response to the Problem

In terms of conventional energy utilization, the GOUV has taken a rational approach to limiting consumption by setting prices at predominating market levels. In this way not only will consumption be curbed, but scarce financial resources will be conserved.

Concerning traditional fuels, the Ministry primarily responsible for the most important fuel -- forest products -- receives about 1% of the national budget resources, or $2 million/year, the bulk of which goes for salaries. Consequently, any investment will inevitably be financed by outside donors. Current efforts, which will certainly fall short of needs, are summarized below:

Agency/Project	Hectares
Ministry of Environment	2,000
Village Reforestation:	
USAID/Peace Corps	200
Swiss funding	480
Dutch funding	220
German funding	1,000
Africare	150
World Bank	400
Large-scale Reforestation	
German	3,950
French	3,500
FAO/UNDP	1,800
Other	1,200
TOTAL	16,250

In addition, USAID is involved in a major training effort at the Dinderesso forestry agent training center under the Forestry Education and Development project (686-0235). The project is both training agents at the school and developing a model forest management plan for the nearby Dinderesso Forest Reserve.

Due to its complete lack of conventional energy resources and resulting reliance on firewood as a source of energy, Upper Volta's energy strategy must (and does) concentrate on its forest resources. Areas to which priority should be given over the next five years are as follows:

- Research: Basic research is needed to select and develop sound local species. Applied research is needed to learn more about how rural dwellers perceive their forest resources and about how private incnetives can be developed to promote public forest conservation objectives.

- Management of National Forests: Vast forest resources are available in the National Forests which, if properly managed and harvested, could significantly reduce the fuelwood production/consumption gap. USAID is gaining experience in such management techniques at Dinderesso. This effort should be followed by larger scale implementation of these techniques.

- Institutional Development: The capacity of the MET to analyze and address the nation's forest crisis is extremely limited. This capacity should be augmented through continued management and technical training, as well as through financial support for operations.

TABLE I
Import of Petroleum Products into Upper Volta 1/
1975-1979

	1975	1976	1977	1978	1979
Volume (in metric tons)	75,090	65,406	85,971	119,911	145,673
Value (CIF in millions of CFA Francs)	2,864	2,700	4,357	4,347	7,236

1/ Source: BCEAO, Statistiques Economiques et Monetaires, No. 294, May, 1981, p. 27.

TABLE II
Prices of Petroleum Products (1978-1981) 1/
(In CFA Francs/liters)

Import Prices (f.o.b. Abidjan)	March 1978	April 1979	February 1980	August 1981
Premium gasoline	33.18	44.66	63.68	108.00
Regular gasoline	31.80	43.28	63.15	105.00
Kerosene	34.08	36.06	34.08	60.00
Diesel	29.70	39.03	61.95	102.50
Retail Prices (Ouagadougou)	**February 1978**	**February 1979**	**February 1980**	**August 1981**
Premium gasoline	110	125	165	238
Regular gasoline	102	117	156	225
Kerosene	77	89	95	124
Diesel	79	93	133	198

1/ Sources: Ministere du Commerce, du Developpement Industriel et des Mines, BUVOGMI; and Direction Generale du Commerce et des Prix, Secretariat Permanent a l'Homologation des Prix.

TABLE III
Consumption of Petroleum Products In Upper Volta 1/
1976-1980

	1976	1977	1978	1979	1980
		(in cubic meters)			
Premium gasoline	4,159	5,657	7,282	8,483	9,395
Regular gasoline	41,410	47,100	52,171	58,480	61,778
Kerosene	12,121	11,870	12,464	13,162	13,629
Diesel	17,149	21,296	24,455	25,050	27,913
		(in metric tons)			
Light Distillate	19,764	22,881	25,998	23,256	25,611
Fuel Oil	5,838	4,581	5,765	14,612	17,362

1/ Source: BCEAO, Statistiques Economiques et Monetaires, No. 294, May, 1981, p. 27.

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ZAIRE

I. Summary

Zaire relies primarily on wood, charcoal and imported petroleum for energy. Deforestation has begun to occur near population centers; no firm government policy exists for reforestation. National policy calls for hydropower to substitute increasingly for traditional and imported fuels. Exported crude oil helps to offset the import costs of refined petroleum. Electricity and petroleum distribution are managed by parastatal corporations; the remainder of most energy production and distribution is in the private sector.

II. Energy Sources

A. Petroleum

Petroleum is imported in refined form to supplement that which is pumped offshore from Zaire's short coastline. Zaire spent $240,000,000 in 1980 to import petroleum products. The offshore reserve is proven at 60 million barrels; a joint Zairian-Italian refinery processes the crude. Processed fuels are distributed by SEP Zaire, a parastatal which allots supplies and assists in setting retail prices. In 1979, nearly 75 percent of all petroleum fuels was consumed in the metropolitan Kinshasa area.

B. Coal

Coal is mined in three locations of Shaba region. Most of the output goes to smelting and cement production.

C. Electricity

Hydroelectric generation provides 92 percent of Zaire's electrical production. The remainder is produced mainly by diesel generators. While large urban centers are electrified, rural distribution lines exist only in portions of Bas-Zaire and Shaba regions. The majority of small towns, villages, and rural installations depend on power generated by diesel or small hydro facilities. Mining absorbs 60 percent of all electricity in Zaire; metropolitan Kinshasa accounts for another 18 percent.

The Inga Dam, located on the Zaire River where it cascades down the African escarpment, has 1,620 mw of Zaire's 2,382 mw installed capacity. Expansion of distribution to rural parts of Bas-Zaire and southern Shaba is planned. Power is available from the Inga-Shaba transmission line but expansion is constrained by the costs of equipment and technology and inadequate numbers of trained personnel.

Electrical generation and distribution is controlled by the Societe Nationale de l'Electricite (SNEL), a parastatal

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corporation. Trained professionally in the U.S. and Sweden, SNEL personnel operate and maintain the major hydroelectric plants, including Inga, and the distribution network. With a limited capital budget, existing plants and lines have been maintained but not renovated or expanded.

D. Wood and Charcoal

Firewood is the major source of cooking and heating fuel. Zaire has approximately 100 million hectares of rain forest and 21 million hectares of lightly forested savannah. The majority of the population is located in the savannah areas, placing a significant demend for fuelwood on limited resources. Deforestation is becoming evident around the cities and the more densely populated rural areas.

Charcoal is preferred for cooking and artisanal use, especially in cities. Traditional methods of wood conversion yield about 20 percent by weight in charcoal. Despite a higher price, charcoal is chosen for its convenience.

Consumption of wood and charcoal is estimated at one cubic meter of wood and 36 kg of charcoal per capita per year. National consumption in 1980 was estimated at 25 million cubic meters of wood and 450,000 metric tons of charcoal. The demand is projected to rise to 48 million cubic meters and 836,000 metric tons, respectively, by the year 2000. Demand will be concentrated in the lightly forested savannah and the mountain areas of the Great Lakes.

E. Solar Energy

Solar Energy has been used traditionally for drying crops. Small solar collectors are installed in selected areas to supplement diesel-powered generators. No large installations of collectors are foreseen at present.

F. Alternative Fuels

Alternative fuels available in Zaire include some ten million tons of economically recoverable shale oil near Kisangani. In Bas-Zaire, a deposit of 300 million tons of 20 percent tar sands was exploited until 1958. Two hot springs are found on the eastern border. Methane has been discovered in economically usable quantities under Lake Kivu. Lastly, a large sugar company drives a 4 mw generator in Bas-Zaire region with mill wastes.

III. Environmental Implications

A. Fuelwood

Demand for fuelwood in the populated areas of the southern

savannah and eastern mountains has already begun to exceed natural regrowth. Young trees are cut along with mature trees, and no organized replanting is being done. Major cities already are ringed by belts of cleared land up to 50 km wide.

The practice of cutting nearly all trees except palms is exacerbated by the traditional practice of burning the savannah grass each dry season. Young trees are killed; older trees are damaged; wildlife disappears. The loss of ground cover encourages rapid erosion of the sandy clay soils, with large, steep gullies resulting. Soil losses of up to 160 tons per acre annually have been recorded in Kivu province. There, the rich volcanic soils on steep slopes are especially vulnerable. Terracing has been tried and found successful as an erosion deterrent, but is not widespread.

B. Shifting Agriculture

In the rain forest of the Cuvette Centrale, farmers slash and burn new fields every two to three years. Without the constant replenishment of organic nutrients from the forest cover, the soil quickly loses its source of natural nutrients. The abandoned fields grow up into bush, but do not return to the tall forest. The Cuvette is very lightly populated and does not need to support intense agriculture at present.

On the savannah, soils have little organic matter and are prone to erosion and loss of nutrients. Natural release of phosphorus and potash can support light cropping, but intense agriculture cannot be practiced without substantial external infusions of nutrients. Farmers traditionally clear all plants from an area before cultivating. The resulting bare soil is easily leached and eroded, necessitating a shift to another place after several years.

IV. Zaire Energy Policy and Implications for A.I.D.

A. Energy Policy

Zaire's developing energy policy rests on the development of electrical generation and distribution, efficient use of wood resources, and reduction of gasoline usage. Pricing policy for retail gasoline sales, and customs duty on large cars, act as a disincentive for gasoline use. Diesel fuel receives more favorable treatment. With other donor assistance, some efforts have begun to improve the efficiency of charcoal conversion. Some private sector interest has been shown in reforestation. Plans exist for extending electrification to selected areas of Zaire, but implementation is inhibited by the large foreign exchange requirements.

Zaire's energy policy is an unofficial and evolving one. Various state agencies are engaged in analyzing the energy

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sector and developing recommendations for a national policy. This activity gained some momentum in 1980 with the convening of all concerned agencies to begin a concerted dialogue on the numerous issues and options. This dialogue is continuing, but a coherent and comprehensive official national policy has not yet been defined. Wherever such a policy might point, Zaire's general economy at present is in no condition to permit the undertaking of any aggressive energy development program. Few additional GOZ inputs to the energy sector are anticipated over the next several years.

B. Implications for A.I.D.

USAID continues to include energy in its dialogue with the Government of Zaire. Selected energy sector officials are preparing for short-term participant training in the U.S. USAID is assisting the development of a small rural hydropower facility and is designing a larger project to help the GOZ establish an institutional capability for rural hydroelectric development. Some assistance also is being provided for the installation of solar panels in rural areas. USAID's and other donors' capacities to assist Zaire's energy sector development will be constrained for the immediate future by the GOZ's very limited capacities in this sector (as in others). USAID's strategy is based on limited assestance to the GOZ, within the latter's very limited absorptive capacities, and corollary assistance to the private sector where the motivation and capacity for energy development exist. The major energy sector role presently envisioned for USAID will be in small rural hydroelectric facilities development. This will take advantage of a widespread natural resource and will permit the major load of development to be carried by the private sector where appropriate assistance can be absorbed. At the same time, this activity will help lay an institutional base, within the GOZ, upon which longer term rural power development can grow.

ZAIRE ENERGY STATISTICS

Energy Sources

Wood and Charcoal	86%
Petroleum Fuels	9%
Electricity	4%
Coal	1%

Coal Production (metric tons)

1977	127,955
1978	106,646
1979	109,190

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Petroleum Consumption (000 cubic meters)

	Gasoline	Diesel	Kerosene	Fuel Oil
1977	181	326	73	73
1978	192	379	59	69
1979	178	377	80	62

Petroleum Imports (metric tons)

	Gasoline	Diesel	Kerosene	Fuel Oil
1977	87	196	14	1
1978	96	290	14	-
1979	83	175	-	-

Hydroelectric Production (Gwh)

	Shaba	Kivu and Haut-Zaire	Bas-Zaire	Imports	TOTAL
1977	2,755	152	962	40	3,919
1978	2,548	165	1,051	7	3,782
1979	2,584	178	1,036	13	3,815

Note: 1979 diesel generated production estimated at 673 Gwh.

Hydroelectric Consumption (Gwh)

	Industry	Urban	Exports	TOTAL
1977	2,567	928	91	3,919
1978	2,322	972	140	3,782
1979	2,408	1,046	106	3,815

ZAMBIA

I. Introduction

Zambia is a sparsely populated, landlocked country with eight border states. It is situated on a high plateau with an elevation of 3,000 to 5,000 feet above sea level. According to the 1980 census, there are 5.7 million Zambians living in a country slightly larger than the state of Texas. Although sparsely populated, currently there are 40 percent more Zambians today than 10 years ago, and the present growth rate of 3.1 percent per annum implies a doubling of the population in 23 years. Approximately 40 percent of the population lives in urban areas.

The economy is dominated by copper mining. During the first 16 years since independence (1964) the copper industry accounted for over 90 percent of Zambia's export earnings, between one third and one half of the GNP and over 50 percent of the total government revenue receipts. However, a steep decline in world copper prices beginning in 1975, the war in Zimbabwe, foreign exchange shortages, rising costs of production (including oil prices), a shortage of expertise and transport problems have seriously affected Zambia's mining sector during the past several years. As a result Zambia has a policy to restructure and diversify the economy to lessen its dependence on the mining industry.

Since independence, Zambia has moved from complete dependence on external sources of energy to a high degree of self-sufficiency. By the late 1970's Zambia had achieved self-sufficiency in both electrical power and coal production, and, although still dependent on a significant amount of oil imports, it had established a new oil supply line and refining capacity.

II. Sources of Energy

Zambia's three major energy sources are hydroelectricity, coal and oil. Hydroelectricity, which supplies 58 percent of Zambia's energy needs, and coal, which supplies about 12 percent, are produced domestically. Imported oil constitutes approximately 26 percent of Zambia's annual energy needs, coking coal from Zimbabwe supplies 1.5 percent, and wood and charcoal supply approximately 2 percent.

TABLE I
Sources of Energy (%)

	1977	1978	1979	1980
Hydroelectricity	57.7	58.2	58.2	58.1
Oil	14.5	12.6	12.4	13.0
Coal	25.4	25.8	26.8	26.4
Coke	2.0	1.4	1.1	1.0
Other (Wood, Charcoal,etc.) 1/	0.3	2.0	1.5	1.5

1/ Source: Bank of Zambia.

A. Hydroelectricity

Hydroelectric power is by far the most important source of Zambia's energy supply. Approximately 93 percent of Zambia's total electrical generation is by hydropower (5 percent gas turbine, 1 percent waste heat and less than one half percent diesel). Total generation for 1980 was approximately 9,635 million KWH. Domestic production of hydroelectricity exceeded consumption by (5,726 million KWH) 3,909 million KWH or 30 percent of production. This surplus energy, minus a loss during transmission, is exported to Zimbabwe and Zaire.

B. Coal

Zambia's second most important energy source is coal, of which there are abundant supplies in Southern and Western Provinces. Presently it is estimated that Zambia has 21 million metric tons of recoverable coal using the present "open cast" method of mining (24 million metric tons if the underground method is used as well). Coal production was as high as 930,000 MT in 1972, but with the increased availability of hydroenergy demand has fallen steadily since 1975. Approximately 520,000 MT was produced in 1980. The main users of this form of energy are the mining industry, Chilanga Cement factory and the Nitrogen Chemicals of Zambia, Ltd. plant.

Although plentiful at present, Zambia's coal is of low quality with a high ash content, and quality coke is therefore imported from Zimbabwe's Wankie deposit (just across Zambia's borde near Livingstone) which is said to have up to a 100 years supply recoverable coal at present extraction rates.

C. Oil

The state-owned Zambia National Energy Corporation currently imports roughly 15,000 barrels per calendar day of spiked, Saudi Arabian crude oil through the 10.7 inch TAZMA pipeline which runs 1,705 kilometers from the harbor tank farm in Dar es Salaam to the Ndola Storage Facility in Zambia's cooperbelt. The crude oil is refined at the Ndola Refinery which operates at only 50 to 60% capacity. Roughly seven percent of the oil which Zambia imports is exported to Shaba Province in Zaire with small amounts sporadically to Malawi and Burundi. Erratic supply at Dar es Salaam, pipeline maintenance problems and chronic shortage of foreign exchange have reduced Zambia's oil stocks down to a relatively low level. Although the volume of oil imports dropped somewhat between 1975 and 1980 due to higher prices and compression in the Zambian economy, the volume of oil imports for the 1970-1980 decade doubled and foreign exchange expenditures on these oil imports increased four-fold in constant dollars.

D. Wood/Charcoal

With Zambia's sparse population and vast tracts of wooded lands, there are at present adequate supplies of firewood and charcoal, which are important sources of fuel for rural villages. Wind and solar power although as yet undeveloped, are viewed as important future sources of supply which can supplement power in the rural areas.

III. Energy Consumption

Below are estimates of Zambia's energy demand by sector and year in order of importance.

TABLE II
Energy Consumption (%)

	1977	1978	1979	1980
Mining	62	59	47	54
Commerce & Services	18	24	26	24
Manufacturing & Construction	16	12	19	16
Transport	3	3	5	4
Agriculture	1	2	3	2

The mining industry is by far the largest energy consumer, using at least 50 percent of the total energy supply in Zambia. Since 1975, when copper prices and production dropped there has been a slight reduction in the amount of energy used by the mining industry, but mining is expected to remain the dominant energy user in the foreseeable future.

Although imported oil provides only about 12 percent of Zambia's energy needs, at present the demand for oil is relatively inelastic. The mines consume about 40 percent of all oil imports and the transport sector consumes 27 percent. Since the mines earn virtually all Zambia's foreign exchange, and since transport is critical to this large landlocked nation, the relatively small amount of oil imports is an indispensable minimum. Transport and mines would cease to function if there was a major oil supply disruption.

IV. Development of Domestic Energy Resources

A. Hydroelectric Power

Zambia's greatest potential lies in further development of its hydroelectric resources. It is well endowed with sites for

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hydroelectric development mainly on the Zambezi River (its border with Zimbabwe) the Kafue river (wholly within Zambia) and the Luapula river (its border with Zaire). Over the past decade growth has been rapid, and the Third National Development Plan (TNDP) anticipates a 4.3 percent growth rate through 1983.

The dramatic increase in the cost of imported oil during the 1970-1980 period focused attention on the need for Zambia to reduce oil consumption. High oil costs have eroded the profitability of the mining sector, weakened the financial viability of the already inefficient state-controlled manufacturing sector and strained the government's budget. As noted above, prolonged disruption in the TAZAMA oil supply would paralyze the mining sector and cripple the transport sector. Given this economic and strategic vulnerability, the major thrust of Zambia's energy development plans call for increasing hydropower and substituting it for oil. Key to this effort will be the extent to which the mines and the Zambian railway systems can be switched from an oil power base to an electrical one

Electrification of the mines is not only important as a means to hold down oil imports, but electrification would reduce costs significantly and help Zambia's ailing mines remain internationally competitive. Unfortunately it would also reduce production at the oil refinery which is presently operating at 50 percent.

The World Bank's Third Railways Rehabilitation Project is in process, and it is making limited efforts toward electrification of Zambia Railways (ZR). Some funds to study electrification of ZR are also being provided by the EEC under Lome II. Progress on electrification of ZR will proceed slowly in the next few years, however, primarily because both domestic and international finance is lacking and because ZR's human infrastructure is weak.

B. Coal

Present coal production comes from one open pit mine with reserves that should last at least another 30 years. New coal deposits have been discovered recently in Western Province, however no estimates of these reserves have been made yet. The Government plans to increase coal production by an annual rate of 2.4 percent over the five year period ending 1983. Shortage of capital and expertise are constraining factors. As previously noted Zambian coal is low in quality and is not suitable as coke. The possibility of a coal liquefaction or gasification plant is being considered for study, but the feasibility of such a project is unknown.

C. Oil

There are no known exploitable deposits of oil or natural gas in Zambia. The government is considering allowing some aerial surveying, mostly in Western Province.

D. Nuclear

Zambia's uranium potential is not well measured. An airborne radiometric survey of the entire country was conducted in 1977. The radiometric anomalies are currently being investigated by thre private companies holding prospecting licenses. The most active is AGIP/SpA (Italian) which has spent $25 million since 1970 and presently is spending approximately $5 million annually on exploration. One estimate puts known deposits of uranium at 10,000 tons and estimated reserves at between 30,000 and 100,000 tons. There are four prospecting sites and numerous unprospected regions with uranium potential. Even the most optimistic plans, however, do not anticipate any mine development before 1985. Nuclear energy will probably not play a role in Zambia in the 1980's, but the potential exists further in the future.

E. Solar

Although the potential for solar energy in Zambia is good, the TNDP mentions the development and testing of solar energy (for water heating) only briefly. Over the course of five years $132,000 is earmarked for solar development. Much movement in the direction of solar energy use over the next decade is unlikely unless donors come forward and aggressively encourage a solar program.

F. Windpower

Wind-generated water pumps are commonly deployed on farms and in rural communities. There are very little data on the extent of windpower use. It is probably small, but significant for rural areas. The TNDP allocates only $125,000 for study of wind resources.

G. Ethanol

In mid 1981 Jager Associates of Zimbabwe began a feasibility study for a plant to produce ethanol from molasses which is currently available. (Jager has done similar work for ethanol plants in Malawi and Zimbabwe). Zimbabwe presently uses some ethanol in its petrol. At present Zambia has an annual output of about 40,000 tons of molasses at the state-owned Nakambala Sugar Estate. The proposed plant is designed to produce 16 million gallons of alcohol fuel annually. The IFC and World Bank have expressed interest in financing of the project. A second phase of the Jager study will look at the viability of using other agricultural raw materials to produce ethanol. If

present GOZ plans are realized ethanol could save up to 5 percent of Zambia's present oil bill.

H. Wood/Charcoal

Firewood and charcoal are major fuels for domestic household use. Although there appears to be some localized deforestation near the major urban areas, abundant supplies of wood are available in Zambia. The Department of Forestry has plans to reforest near urban areas, but lack of funds has hindered progress. Improved efficiency of fuelwood utilization has received some research attention (e.g. improved conversion ration of wood to charcoal), but little is known about significant actions taken to date. Although Zambia has a good deal of surplus electrical energy to replace firewood and charcoal for domestic consumption, the high installation costs are a major constraint to expansion of this service to individual domestic households.