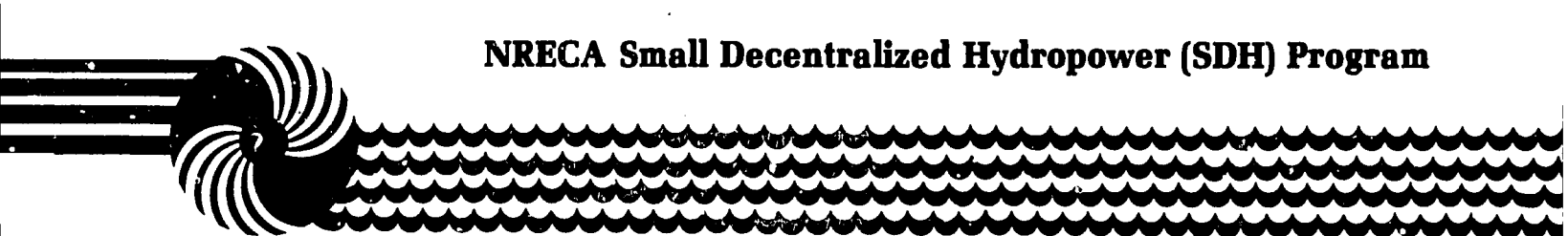
Status, Recommendations, and Future Directions for the SDH Program



NRECA Small Decentralized Hydropower (SDH) Program

PN AAP 518

Status, Recommendations, and Future Directions for the SDH Program

March 1983

Sponsored by the United States Agency for International Development
under Cooperative Agreement AID/DSAN-CA-0226

Small Decentralized Hydropower (SDH) Program
International Programs Division

National Rural Electric Cooperative Association
1800 Massachusetts Avenue, N.W.
Washington, D.C. 20036

SUMMARY

This report to USAID by NRECA consists of three sections—the first on the status of the projects undertaken, the second on lessons learned and recommendations, and the third on future directions for the SDH Program.

SECTION ONE

Under the terms of the Cooperative Agreement, NRECA has undertaken the following program of work:

- ADMINISTRATION:

  Workshops—Latin America 1980, Asia 1981, West Africa 1982, East and Southern Africa June 1983

  Talent Bank—150 specialists and 60 firms

  Reporting Procedure—monthly Program Status Reports, country reports, trip reports

- RESOURCE IDENTIFICATION:

  Assessments—completed for 14 countries (see Table 1)

- SITE SELECTION AND PROJECT DESIGN:

  Field trips—13 trips to 6 countries (see Table 2)

- SDH DATA BASE:

  Library holdings—3,000 items

  Slide Bank—1,500 slides

  Publications—45

  Publications requests fulfilled—over 2,800

- TRAINING:

  180 pp. Proposal—Decentralized Hydropower Training for Developing Countries

  Tours—manufacturers, small hydropower sites, and NRECA member systems for foreign nationals

  Seminars—on financing SDH development and private sector participation in SDH development overseas

- ASSESSMENT OF FACTORS IMPACTING UPON SDH PROGRAM DEVELOPMENT:

  Oil

  Development Banks

  Completion Times for project execution overseas

- STATUS REPORT ON USAID-FUNDED PROJECTS:

  Forty-three sites—two sites on-line; five sites under construction; thirty-six sites in the planning stage or proposed—totaling almost 14 MW

SECTION TWO

- LESSONS LEARNED:

  Management—centralized management becomes less viable as plant capacity decreases; central technical support services must be available

  Economic—feasibility studies must determine that adequate load is present or can be developed; adapting locally appropriate approaches can reduce costs

  Technical—the technical approach must be appropriate to the need

- RECOMMENDATIONS:

  Clarification of lines of governance within USAID to facilitate more efficient management of projects by NRECA; written agreement on scope-of-work and final report prior to field work; further efforts in informing USAID and the Missions of the variety of SDH services and alternatives by NRECA; participation of Mission energy officers in NRECA in-country training sessions; and greater creativity and flexibility in solving the problems of developing and funding small-scale hydro projects

SECTION THREE

Recommendations by NRECA for future directions for the implementation of projects:

- CONTINUATION OF PRESENT ACTIVITIES
- ACTIVELY FOLLOW UP SDH PROJECT DEVELOPMENT AND IMPLEMENTATION IN TARGETED COUNTRIES
- METHODS:

  Packaging—assistance in finding sources of financing; implementing water to wire schemes for small sites; planning for end uses of power

  Training—implementation of the Proposal; broadening of client-base for training

  Planning and Evaluation—selection of additional countries with resource potential

  Integrated Rural Development and Power Supply—continue efforts in both types of development with design and completion of model projects

  Management—build in-country self-sufficiency in long-term management goals, foster institution building for overseas national programs in small hydro development

TABLE OF CONTENTS

Background

Since the inception of the Cooperative Agreement between USAID and NRECA, it has been the intention of NRECA to adhere to the tenets of this agreement, to undertake the work in a creative and timely fashion, and to provide USAID with the most effective assistance possible. NRECA has fully addressed the various requirements of the Cooperative Agreement, far exceeding the first year objectives and in consideration of suggestions made by the evaluation team in May, 1982. The validity of the goals of this program has been positively endorsed by the Missions as a result of accomplishments to date. NRECA wishes at this midpoint to affirm its desire to continue to investigate additional projects in new countries and to bring to logical conclusion work begun in twenty countries.

This working paper reviews the status of projects undertaken within the terms of the agreement. NRECA would hope to establish realistic expectations for the timeframe for the completion of overseas projects and to articulate possible solutions to those constraints hindering a more effective implementation of the projects underway. At a certain level, these hinderances revolve around differences in approaches to SDH development, the solution to which must be worked through consultatively among SDH assessment teams, the USAID Missions, and the host countries. This can best be achieved in an atmosphere where the variety of choices are fully understood and explored.

NRECA believes that this paper is an accurate and timely record on the status of the Cooperative Agreement and NRECA's work on USAID-assisted programs of SDH development. NRECA will welcome an open discussion of the points raised herein to establish priorities for the next stages of project fulfillment.

Sources

The following resources have been used in preparing this paper: the SDH data bank, EPRI statistical figures, interviews with specialists listed in the talent bank, and calls to the Missions and to Washington desk officers at USAID.

SECTION ONE - STATUS

This discussion is divided into two subsections—Cooperative Agreement, in which we review the activities carried out by NRECA under the Agreement,* and Implementation, in which we review the progress of USAID-funded programs of assistance in small decentralized hydropower.

Cooperative Agreement

The activities carried out in the first two and a half years are grouped according to the requirements of the Cooperative Agreement. They are briefly summarized here. More detailed information may be found in such documents as the SDH monthly Program Status Reports and in original SDH reports.

AGREEMENT REQUIREMENTS FOR ADMINISTRATION

- o plan and manage workshops and/or seminars
- o identify and work with individual consultants
- o establish reporting procedure
- o carry out administrative and field support activities in response to Mission and host country requests for services and jointly formulate program activities. (See pp. 4-9.)

NRECA ACTIVITIES

Workshops

Three highly successful workshops have been held, with a fourth being planned:

Latin America and the Caribbean. 118 attendees from 13 countries, August 1980. The proceedings, in Spanish and English, have been distributed to over 1100 persons in more than 70 countries.

Asia and the South Pacific. Over 100 attendees from 15 countries, June 1981. 2000 copies of the proceedings are being printed.

West Africa. Over 90 attendees from 22 countries, March 1982. 2000 copies of the proceedings, including French and English versions, will be printed and distributed.

East Africa. A combined training session and workshop is planned for approximately 80 participants from 15 countries, 20-24 June, 1983.

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*/ Cooperative Agreement No. AID/DSAN-CA-0226-Small Decentralized Hydropower.

In planning for the East African workshop to be held in June 1983, NRECA has taken positive steps to incorporate many useful suggestions arising from the three previous experiences. Papers from the experts and proceedings from the Abidjan workshop for background information will be circulated to participants a month in advance of the meeting. Greater numbers of U.S. manufacturers with displays of hydro equipment have been invited to participate actively in the workshop. Problems of integrated rural development, long-term planning strategies and project implementation—costing and construction methods—are to be discussed in detail. Development methodology—labor vs capital intensive—will be reviewed. Site specific examples will be integrated into an intensified program of field visits. Design data will be made available to participants. Although the program will be of the same length as in previous workshops, more time will be provided for participants to seek advice from or to discuss their problems with the experts. Consideration is being given to extending an invitation to managers and policy makers from the participating countries to attend a one-day information briefing prior to the opening of the workshop; clearly their understanding of SDH projects is requisite to program implementation in their respective countries.

In all, approximately 400 planners, engineers, economists, electric system managers, administrators, and others will have participated in and received training at these workshops.

For the three workshops already held, approximately thirty-six resource specialists were identified, assigned workshop roles, and managed by NRECA. These experts came from Europe, the United States, and developing countries in Asia, Latin America and Africa.

A number of resource assessments have occurred concurrent with or following these regional workshops. Each of the workshops was attended by one and sometimes several representatives of the countries that subsequently requested assistance. The following is a list of these countries:

Latin America and the Caribbean: Peru, Dominican Republic, Honduras, Dominica

Asia: Bangladesh, Indonesia,*/ Pakistan, Thailand

Africa: Liberia, Burundi, Zaire, Lesotho, Sudan, Sierra Leone

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*/ Discussed plan of assistance with Indonesian contingent and USAID Mission engineer during workshop. Plans for assistance now under preparation.

In addition to those studies already carried out in Africa following the West Africa workshop, two requests are outstanding. The government of Ghana has asked for a survey of specific sites in the agriculturally productive Brong Ahafo Region. The Niger River Basin Authority (ABN) has requested both a workshop on small hydropower geared to the countries of the Niger River Basin, including portions of Guinea, Ivory Coast, Mali, Upper Volta, Niger, Benin, Nigeria, and Cameroon as well as a resource assessment of the river basin itself.

Talent Bank

The SDH Program maintains an ever-increasing talent pool drawn from resumes and brochures of 150 specialists and 60 firms. From this group, candidates are selected for our overseas work. The content of this talent bank is as follows:

Association	Number
Individual Consultants	74
Firms Involved with Small Hydro	60
Individuals with Firms	42
NRECA Member Systems	35

The range of disciplines for the members of the talent bank is as follows:

Discipline	Proportion
Electrical Engineering	30%
Economics, Accounting	20%
Management, Institutional Development	20%
Civil Engineering	10%
Other Technical Specialties	10%
Other	10%

Reporting Procedure

Routine reporting is carried out on a monthly basis by submitting an administrative letter status report to ST/EY accompanied by an updated Program Status Report. The latter, currently undergoing a format revision, has been approximately 15 pages in length and documents program activities since inception.

With few exceptions, reports are routinely prepared describing results of assistance provided to specific countries. Technical reports are available for:

Togo	Zaire	Honduras
Ghana	Lesotho	Pakistan (in draft)
Bangladesh	Liberia	Dominica
Morocco	Rwanda	Burundi
Thailand	Sudan	

A number of the early reports lacked adequate definition of the scope of work involved. Quality improvements have resulted from better preparation and planning prior to field work. This has been evidenced in the technically more coherent and comprehensive reports now being produced by NRECA.

Copies of trip reports by SDH staff are also submitted to ST/EY on a periodic basis to document persons contacted, subjects discussed, preliminary resource assessments made, and any attendant plans developed. Examples of these reports are those on Tunisia, December 1981; Sierra Leone, April 1982, Indonesia, July 1982; and Thailand and Philippines, November 1982.

AGREEMENT REQUIREMENTS FOR RESOURCE IDENTIFICATION

- o identify potential hydropower sites in LDC's for development
- o provide specific recommendations

NRECA ACTIVITIES

In-Country Assistance

In-country surveys were conducted in eleven countries. Of these countries, Peru, Pakistan, Panama, Dominican Republic, Honduras,* and Burundi were found to have substantial regional or national resource potential, and specific plans for development are underway. Togo, Ghana, Bangladesh, Sudan, and Lesotho were found to have certain potential. Although the potential exists and could possibly be developed in these countries, it is limited by a variety of factors: hydrologic patterns, economics, suitable physiography, uncertain demand for power, and lack of government or Mission interest.

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*/ The USAID Mission has recently decided not to proceed with the PID.

In-country preliminary assessments were made, for which reports were prepared, to determine the physical suitability and/or institutional interest in a future survey in three countries. Of these countries, Indonesia was found to be highly suitable for a broad range of services; Tunisia and Sierra Leone were found to be suitable for limited specific assistance.

Table 1 summarizes information on the countries and the various types of surveys undertaken by NRECA.

Table 1. Types of Assessments Carried Out by SDH Teams in Resource Identification Activities

		Assessment Type					Other Assistance	
Country	(*)	Prelimi-nary	Country-wide	Prefeasi-bility	Feasi-bility	Project Design	Institutional Analysis	Methodology Development
Peru	(1)				X	X		X
Pakistan	(1)					X	X	
Panama	(3)		X			X		
Dominican Republic	(1)		X		X	X	X	
Honduras	(1)		X			X		
Burundi	(1)		X				X	
Togo	(1)		X					
Ghana	(1)		X[1]				X	
Indonesia	(1)	X						
Bangladesh	(1)		X	X				
Sudan	(1)		X[2]					
Tunisia	(1)	X						
Lesotho	(1)		X					
Sierra Leone	(1)	X						

*/ Number indicates number of times SDH assistance was provided in-country.

1/ The survey was confined in Ghana to the Western Region. A request was recently received to examine specific sites in the Brong Ahafo Region.

2/ The survey in Sudan was confined to the Khartoum area and eastward toward the Ethiopian border.

It can be seen from Table 1 that most of the resource assessment services were at the initial stages of both site development and project development. Recommendations were provided to the Mission in each case. For project design services, the project design described in the report formed the recommendations. For country-wide assessments, each report recommended sites for further specific analysis.

AGREEMENT REQUIREMENTS FOR SITE SELECTION AND PROJECT DESIGN

- o furnish information to host governments to enable them to make site selections
- o develop, as needed, prefeasibility, feasibility, and equipment specifications studies

NRECA Activities

A range of in-country services was provided to six countries. Reports were prepared, on such topics as specific site selection and analysis, design layout, equipment manufacturing, project design, prefeasibility studies, and site "trouble-shooting". The countries assisted included Morocco, Thailand, Zaire, Rwanda, Dominica, and Liberia. Only certain of the above services were provided to each country. All but one country have direct or indirect Mission involvement in developing one or more small hydro sites. Zaire, after proceeding through the PID stage, has shelved plans for the time being.

Table 2 shows a range of services. Some of the assistance—region-wide resource survey, and prefeasibility assessment—overlaps with assistance described in Table 1. It should be noted that, at the more advanced project development stage shown in Table 2, SDH assistance has been requested more than once. Thus, although twenty countries have received in-country assistance in some fashion, twenty-nine technical assistance teams of one to five individuals have been assembled and managed by the SDH Program.

Table 2. Site Selection and Design Services Provided by SDH Teams

Country (*)	Site Select. & Analysis	Design Layout	Equipment Mfr.	Project Design	Prefeas. Studies	Site "trouble-shooting"
Morocco (3)	X	X				X
Thailand (2)	X		X		X	
Zaire (3)				X	X	
Rwanda (1)	X	X			X	
Dominica (3)	X				X	X
Liberia (1)						X

To summarize our field activities, SDH teams have responded fully to Mission requests for assistance in twenty countries according to both the scope developed with USAID and to the procedures for technical assistance as set out in the Cooperative Agreement.

Table 3 summarizes activities since in-country assistance was provided by SDH technical assistance teams. Two countries have developed PID's, one country has developed a PP, six countries are at various project stages, two countries plan projects for indirect USAID funding, and five countries are undecided. Bangladesh has decided not to go forward at this time and Ghana has recently submitted a request for additional assistance. Indonesia and Burundi are making decisions for future action and the five undecided will likely require follow-up assistance to develop projects for funding by USAID or by other sources.

*/ Number indicates times SDH assistance was provided.

Table 3. USAID-Funded Activity Following Provision of SDH Assistance

Country	Status: Plan Further Assistance	PID	PP	Project	Undecided
Dominica				X[1]	
Sierra Leone					X
Panama				X	
Indonesia	X				
Pakistan			X		
Thailand				X	
Rwanda				X[2]	
Dominican Republic				X	
Morocco				X	
Honduras		X			
Burundi	X[3]				
Liberia				X[4]	
Tunisia					X
Sudan	X				
Peru				X	
Zaire		X[5]			
Ghana	X				
Togo					X
Lesotho					X
Bangladesh*					

1/ Site to be funded by Caribbean Development Bank (with USAID funds).
2/ CEAER, an AID-funded, government energy center, plans to develop a site.
3/ Recent telex from Mission has asked for suggestions for funding from Energy Inititatives in Africa (a USAID-funded program).
4/ Site was already co-funded by USAID, NRECA made construction-related recommendations, which were carried out.
5/ Project Paper was not completed, PID was shelved due to present unavailability of Mission funds and inability of government to spare human resources.
*/ The Mission has not expressed interest in going forward with the survey recommendations, although there does appear to be some government interest.

AGREEMENT REQUIREMENTS FOR SDH DATA BASE

- o determine the state-of-the art
- o identify and assess capabilities of turbine manufacturers
- o organize a base of skills resources (see Talent Bank, p. 3)
- o prepare directories of technology applications, economics and implementation methodologies

NRECA ACTIVITIES

In developing an SDH data base, the staff has made efforts in all phases of its work to collect relevant documents to expand our holdings, and to contribute on a recurrent basis to data files which are the basis for writing directories and methodologies. Information on manufacturers and products, on existing sites in the U.S. and overseas, and published and unpublished works are continously solicited. Our publications reflect field work undertaken and the cumulative building-blocks of the data base in all its facets: the library, the slide bank, and our data files. For ease of reference, these publications have been broken into the following categories in date order: Country Reports; Workshop and Seminar Proceedings; Case Studies; Sourcebooks, Handbooks, and Directories; Methodological Guidelines; Special Studies; and Conference Papers and Journal Articles.

SDH Data Base

Library

We have established a comprehensive small hydro library with over three thousand items consisting of books, periodicals, journals, manufacturer's brochures, bid specifications, U.S. standards manuals, maps, articles, proceedings, methodologies, directories, and country files containing detailed information on hydro sites. Extensive sub-holdings occur in training, end-uses, site evaluation, and equipment manufacturers-performance specifications, technical data, equipment, and ordering information.

Slide Bank

SDH engineers have visited numerous small-scale hydro projects in the U.S. and in the developing countries to study various approaches undertaken, using conventional as well as unconventional technologies. The staff has gathered photographic documentation of small hydropower sites in six Asian countries. Indonesia, Nepal, Pakistan, Papua New Guinea, and Thailand, two African countries, Rwanda and Burundi; and three Latin

American countries, Dominica, Honduras and Panama. The collection now consists of over 1500 slides, documenting various aspects and stages of small hydropower installations. This slide bank has helped to provide the basis for recommending appropriate, decentralized hydropower technology for developing areas, and has been used in the SDH workshop series to provide participants with examples of methods that have proven successful in typical rural settings in the developing world. Recently, the slide bank was used to conduct a one-day technical training session for the AID-funded Training in Alternative Energy Technologies Program at the University of Florida, and to present an overview briefing for engineers at the International Finance Corporation (IFC) of the World Bank at their request. Each time trips are made by SDH teams, an effort is made to record whatever is seen in the field to augment this collection, the value of which is inestimable. An effort is being made to keep a master set at NRECA, and only to use duplicates for training sessions, workshops seminars, conferences, and publications.

Publications

Country Reports

1981

Thailand, Everett Hosking, June 1981, 22 pp.

Zaire, Joseph Howe, Songathara Om-Kar, July 1981, 81 pp.

Togo, Walter Lawrence, Paul Kirshen, Tobie Lanou, July 1981, 66 pp.

Ghana, Lawrence Cooley, Fred Key, Daniel Boyle, September 1981, 85 pp.

Morocco, Allen Inversin, October 1981, english text: 27 pp; french text: 31 pp.

Cape Verde (desk study) David Rubin, November 1981, 27 pp.

Bangladesh, John Topik, Al Mercer, November 1981, 63 pp.

Tunisia, David Zoellner, December 1981, 20 pp.

1982

Rwanda, Bard Jackson, John Topik, January 1982, 55 pp.

Dominica (assessment), Walter Lawrence, Jeff Folts, Keith Oberg, January 1982, 72 pp.

Sierra Leone, Daniel Boyle, March 1982, 11 pp.

Liberia, Allen Inversin, Walter Lawrence, March 1982, 33 pp.

Sudan, Ralph Brooks, Samuel Bunker, Ronald Domer, David Zoellner, July 1982, 80 pp.

Zaire, John Topik, John Scoltock, Thomas Graham, July 1982, 15 pp.

Indonesia, David Zoellner, July 1982, 30 pp.

Pakistan, Walter Lawrence, Mark Gellerson, Allen Inversin, draft September 1982, approx. 60 pp.

Honduras, Bard Jackson, John Topik, October 1982, 11 pp.

Lesotho, Bard Jackson, Martin Johnson, December 1982, 30 pp.

1983

Dominica, (prefeasibility) Bard Jackson, January 1983, 17 pp.

Burundi, Robert Zimmerman, Allen Inversin, February 1983, 56 pp.

Workshop and Seminar Proceedings

Small Hydroelectric Powerplants: An Information Exchange on Problems, Methodologies, and Development—ed., M. K. Rotermund, proceedings of the small hydropower workshop held in Quito, Ecuador, August 19-21, 1980, sponsored by the SDH Program (in cooperation with USAID), the Instituto Nacional de Energia and the Instituto de Electrificacion; available in English and Spanish. Dual text, Spanish and English, 333 pp.

"Private Sector Participation in Decentralized Hydropower Programs in Developing Countries"—ed., Paul Clark, report of a seminar held July 27-28, 1982 in Washington, D.C., 47 pp.

Small Hydropower for Asian Rural Development—ed., Colin Elliott, proceedings of a regional workshop held in Bangkok, Thailand, June 8-12, 1981 on small hydropower sponsored by NRECA, in cooperation with USAID, the Asian Institute of Technology (AIT), and the National Social and Economic Development Board of Thailand (NESDB), April 1983.

Small-Scale Hydropower in Africa—ed., Barbara Shapiro, proceedings of a regional workshop held in Abidjan, Ivory Coast, March 1-5, 1982 under the joint sponsorship of NRECA, USAID, the African Development Bank (ADB), and the Union of Producers, Conveyors, and Distributors of Electrical Energy in Africa, in preparation.

Case Studies

Allen Inversin of the SDH Program staff has prepared case studies on Pakistan and Nepal. These discuss unusually low-cost ($350-700/installed kW) approaches being used

to install hydropower plants up to 50 kW in the remote mountainous regions of these two countries.

"Pakistan: Villager-Implemented Micro-Hydropower Schemes, A Case Study"—Allen Inversin, December 1981, 38 pp., discusses the unusually low-cost approach used to install hydropower plants in remote regions in northern Pakistan.

"Nepal: Private Sector Approach to Implementing Micro-Hydropower Schemes, A Case Study"—Allen Inversin with Robert Yoder, October 1982, 26 pp., discusses unique approach using local resources to implement small hydro systems.

Sourcebooks, Handbooks, and Directories

NRECA has developed a file, listing U.S. manufacturers of small hydroelectric equipment. Site visits to all manufacturers have been made by the SDH staff. The manufacturer's products have been classified by appropriate applications and the file is continually updated to reflect market changes. It is this file which is utilized to produce the turbine directory, now in a second edition. The entries are annotated and provide performance specifications, prices, and other technical data. Information on obtaining quotes and the availability of equipment is also provided.

Directory of Sources of Small Hydroelectric Turbines and Packages—Allen Inversin, 33 pp. descriptions of U.S. and developing country manufacturers and their equipment lines as well as information on packaged units; second edition, October 1981 (to be available in French).

Evaluating Electrification Experience: A Guide to the Social Evaluation of Small Hydroelectric Units in Lesser Developed Countries—AMARU IV Cooperative, Vol. 1, 1982, 101 pp., development of criteria from which to build a methodology for evaluating small-scale energy systems.

Micro-Hydro Sourcebook—Allen Inversin, to provide a wide range of information useful in implementing micro-hydropower schemes, in preparation.

Small Decentralized Hydropower Economics Handbook—Paul Clark, presents material in conducting cost analysis, end-use planning, financial planning, and socio-economic analysis of small hydro projects in developing countries, in preparation.

Methodological Guidelines

The SDH Program staff have developed guidelines for field assessment tasks. Copies of these documents have been circulated widely. These and other less formally-packaged methodologies (those developed in Peru and Dominican Republic) have proven useful to Missions, host government engineers, and SDH teams during in-country assistance.

Country Assessments of Mini-Hydropower Potential: A Methodology—SDH Staff, November 1980, 12 pp., from a country's physical characteristics, conclusions can be

drawn on the need for and feasibility of a national mini-hydro program; also available in Spanish and French.

Prefeasibility Studies of Candidate Mini-Hydro Sites: A Methodology—SDH Staff, March 1982, 21 pp., for analyzing specific sites to assure that there is sufficient hydraulic and economic potential to justify more detailed investigations; the methodology can be used to rank a group of sites under consideration; also available in Spanish and Franch.

Hydrologic Estimates for Small Hydroelectric Projects—Norman Crawford and Steven Thurin, September 1981, 49 pp., for estimating stream-flow duration and peak flows in regions where very little data is available.

Environmental Methodologies for Small Hydropower Projects—Gene Willeke, March 1982, 34 pp. A revised assessment of the environmental impacts of a prospective mini-hydro project.

Special Studies

Environmental Assessments of Small Hydropower Projects—Glenn Cada and Frank Zadroga, March 1981, 47 pp., for assessing environmental impacts of a prospective mini-hydro project.

The Contribution of Legislative Initiatives Such as PURPA towards Involving the Private Sector in the Development of Small Hydroelectric Powerplants in Developing Countries—Donal O'Leary, January 1981, 22 pp., analyzes effects of PURPA on the private sector's involvement in developing small hydropower plants in developing countries.

Centralized vs. Decentralized Management of Small Hydropower—Richard Brown, January 1982, 28 pp., an analysis of issues of centralized versus decentralized management approaches.

Conference Papers

Small Hydro Potential in Developing Countries—David Zoellner, 22 pp., paper presented at OAS Energy Conference, September 1980, Sao Paulo, Brazil.

Small Hydro Potential in Developing Countries—David Zoellner, Connie King, Allen Inversin, 18 pp., paper presented at the UNITAR Conference on Small Energy Resources, September 10-18, 1981 in Los Angeles, California; outlines potential for small hydropower development in developing countries.

NRECA's Small Hydro Activities in Developing Countries—Bard Jackson, 12 pp., paper presented at the UNITAR Conference on Small Energy Resources, September 10-18, 1981 in Los Angeles, California; outlines efforts by SDH Program staff in developing small hydro potential in developing countries.

End-Use of Small-Scale Energy Systems in Rural Areas—Paul Clark, Daniel Boyle, and Karen Davis, 8 pp., paper presented at First U.S.-China Conference on Energy, Resources, and Environment, November 1982, Beijing, PRC; discusses options for baseload and load-leveling uses of small isolated hydropower plants.

Journal Articles

"Rural Power Schemes in Pakistan"—M. Abdullah and A. R. Inversin, International Water Power and Dam Construction, November 1981, pp. 23-25, an article summarizing the work of the Appropriate Technology Development Organization in implementing micro-hydropower schemes in Pakistan.

"Use of Alternative Energy Technologies by U.S. Rural Electric Systems"—SDH Staff, ELECTRORURAL, November 1981, 11 pp., an article outlining efforts of U.S. rural electric systems in renewable energy technologies (wind, solar, hydroelectric, biomass, peat, and geothermal).

"Thinking Small—When the Oil Crunch Hit, Pakistan Turned to Small Hydropower"—Allen Inversin, Agenda, January-February 1982, pp. 28-30.

"Cost Implications of Micro-Hydropower in Developing Countries"—Paul Clark, National Development/Modern Government, in press.

Publications Requests

NRECA has received an average of fifteen to twenty requests per week for general and specific information on small hydro systems. These requests come from USAID Missions, developing country governments, private sector businesses both in the U.S. and abroad, universities, private individuals, and from training programs. We have satisfied these requests by drawing on materials as outlined in the six categories of publications. (See p. 10.)

A significant proportion has been distributed to assist in training activities and programs around the world. We have provided proceedings and other SDH Program publications, as well as selected publications developed by other organizations on small hydro, such as the Tudor manual, and the EPRI manual to the following training programs:

SDH Program's workshop, Small Hydropower for Asian Rural Development, Bangkok 1981
SDH Program's workshop, Small Hydropower in Africa, Abidjan 1982
University of Florida's, Training in Alternative Energy Technologies, Gainesville 1983
Denver Research Institute's, Small Hydropower Resource Development Management Workshop, October 1982
VITA/ETMA* program, Energy and Environmental Management Needs in Somalia, February 1982

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*/ Volunteers in Technical Assistance/Environmental Training and Management in Africa.

VITA/ETMA program, Energy and Environmental Management Needs in Rwanda, January 1983
AID's REDSO/EA* workshop, Energy, Forestry, and the Environment, December 1981
Appalachian State University (small hydro courses)
Colorado State University (hydrology/small hydro courses)
VITA workshop, Micro-Hydropower Workshop, Dominican Republic, October 1981

Table 4 indicates the numbers of requests from nine types of sources for SDH publications by category.

*/ Regional Economic Development Services Office for East Africa.

Table 4. Publications Requests

	AID	U.S. Private Sector	U.S. Individuals	Libraries/ Universities	Development Organizations	Overseas Individuals	Overseas Private Sector	Overseas Governments	Training Programs	TOTAL
Country Reports	348	3	16	2	2	17			388	
Workshop and Seminar Proceedings	542	99	15	7	74	14	26	133	288	1278
Case Studies	84	12	21	31	63	61	3	26	221	522
Sourcebooks, Handbooks, Directories	82	26	5	20	7	3	2	6	209	360
Methodological Guidelines	84		6	7	13	3		7	156	276
Special Studies			2	2	1					5
TOTALS	1140	137	52	147	174	83	33	189	874	2829

It is estimated that half of the numbers of publications forwarded to USAID (570) ultimately are distributed by the Missions to interested parties in the developing countries. When joined to the numbers of publications sent overseas (1,353), a total of 68% of the publication requests go to developing countries.

AGREEMENT REQUIREMENTS FOR TRAINING

- o develop a training program plan for graduate engineers at universities and government institutions
- o the training provided should be both academic and hands-on in nature

NRECA ACTIVITIES

Training

Decentralized hydropower can be an attractive, cost-effective option, as a substitute for or a supplement to expensive diesel electric power generation. National programs have sprung up all over the developing world. Applications also exist for integrated rural development schemes. Unfortunately, many are not as effective as they could be because of lack of expertise in technical and/or managerial areas. Training is often the missing link. Many of the international training programs available do not adequately assess the training needs or the level of technical expertise available in a given country. Nor do they take the developing country context into account, or provide sufficient flexibility to respond appropriately to those needs.

USAID solicited, and the SDH Program developed in September 1982, a 180-page training proposal, Decentralized Hydropower Training for Developing Countries, A Proposal, by Elizabeth Graham, to provide training to developing country nationals, both overseas and in the U.S. Power capacities of systems to be considered range from a few hundred kW to approximately 15 MW. A U.S. based six-week overview course of 15 units, with subject outlines and class exercises has been developed. The overseas training described in the proposal is country specific and tailored to the individual country's training needs in decentralized hydropower whether for site assessment, hydrologic analysis, civil works, design, socio-economic issues, or management approaches. It is designed to provide the SDH Program maximum flexibility in course content, timing, and location in order to respond to these training needs. The U.S.-based training includes all aspects of hydropower development essential to effective management of decentralized programs. Comprehensive in scope, this training is designed to encourage the manager or project

engineer of a small hydropower program to view it in its entirety and not as disjointed units. The SDH Staff look forward to implementing this training program as a means of disseminating acquired expertise and building the existing data base of information. Faculty are to be drawn from the SDH staff, NRECA staff and member systems, engineering firms, manufacturers, private developers and others.

Tours

NRECA has conducted tours of manufacturing plants and sites for visiting engineers from developing countries interested in U.S. equipment. In the spring of 1982, Panamanian engineers were escorted on a three week tour by NRECA, with USAID assistance. They were interested in receiving equipment bids for four sites in Panama. The opportunity was also taken to provide the Panamanian engineers with insights into the management of rural electric systems in the U.S. Sites under construction and in operation were visited. They viewed the facilities of the following manufacturers, small hydropower sites, and NRECA member systems:

Manufacturers

Allis-Chalmers Corporation, York, Pennsylvania
Canyon Industries, Deming, Washington
Cornell Pump Co., Portland, Oregon
Energy Independence Research*, Bellingham, Washington
Independent Power Developers, Inc., Sandpoint, Idaho**
Little Spokane Hydroelectric, Spokane, Washington
Small Hydroelectric Systems and Equipment, Acme, Washington
The James Leffel & Co., Springfield, Ohio
Thompson and Howe*, Kimberley, British Columbia, Canada

Small Hydropower Facilities and Sites

Cornell Pump Test Lab Facilities, Portland, Oregon
St. Anthony Falls Hydraulic Lab, University of Minnesota
4 sites in Idaho
3 sites on the Apple River in Minnesota
2 sites in Oregon
2 sites in Washington
2 sites in California
1 site in Nevada

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*/ Electronic load-controller manufacturers who were present at discussion in Acme, Washington.

**/ IPD was mfg. ten 300kW units for installation in Guatemala when the tour arrived.

NRECA Member Systems

Adams Electric Cooperative, Gettysburg, Pennsylvania
Plumas-Sierra Electric Corp., Portola, California

As a result of the spring 1982 tour, at least two U.S. firms submitted bids for four turbines to Panama, which have since been purchased. A spring 1983 tour is being organized for three Equadorian engineers, and additional plans are under discussion to bring groups from Morocco and the Sudan to undertake similar tours. As countries make determinations to implement SDH projects and programs, it will be important to provide them with the opportunity to undertake tours of manufacturers and sites in the U.S.

Seminars

In 1981 NRECA conducted a one-day workshop on financing SDH development. Speakers from private and multilateral banks, NRECA, and AID Regional Bureaus presented their views on key problems facing developing countries in locating financing for SDH projects and programs.

In July 1982, NRECA hosted a two-day seminar on private sector participation in small hydropower development overseas. The seminar brought together representatives from the U.S. small hydro manufacturing sector with U.S. government and multilateral development agency officials to discuss means of expanding the role of the private sector in furthering small hydro programs in the developing countries. The private sector representatives were briefed on overseas activities in the field of small hydropower, followed by extensive discussions during which ideas to coordinate private and public sector approaches to small hydro development in the developing countries were explored. Seminar proceedings were circulated widely in the U.S. and overseas to U.S. Trade Offices and Commercial Attache's. Representatives from each of the following participated: Engineering News Record (1), the United Nations Renewable Energy Program (1), U.S. government agencies (17), equipment manufacturers (8), small hydropower site developers (7), and consulting engineers (4).

Workshops

(See pp. 1-3.)

Implementation Of Small Decentralized Hydropower Programs

KEY GLOBAL FACTORS IMPACTING UPON THE DEVELOPMENT OF SMALL DECENTRALIZED HYDROPOWER PROGRAMS

Factors such as the cost of oil, the concerns of development banks, and project execution time effect decision-making to finance and implement small hydropower programs.

Oil

A developing country's interest in indigenous renewable energy resources is proportional to the price of oil and inversely, proportional to its availability. During the 1979 "fuel crisis", interest in alternative sources of energy in developing countries was high. Currently, the world oil prices are dropping and availability is high, resulting in less urgent demands for fuel displacement remedies. In remote, rural regions however, this phenomenon of current low prices and relatively high availability has less impact because of the sheer magnitude of logistics for fuel distribution; the need for alternative energy sources remains high.

Development Banks

Development banks have been slow to fund small-scale, renewable energy projects, although this is beginning to change in fields such as biomass and hydropower. In the case of hydropower, development banks are presently or soon will be funding mini- or small-scale projects in Comoros, Papua New Guinea, Philippines, Indonesia, Malaysia, Burma, and Nepal.

A number of issues relating to finance and energy in the development of isolated, small hydropower schemes appear to be of concern to bankers and developing country ministries.

> Should the purpose of small-scale hydropower development be to displace oil and increase national power supplies or to serve remote, isolated communities through integrated rural development schemes?
>
> Is small-scale hydropower too expensive on a unit cost basis or is it inexpensive if the correct approach to its development is taken?
>
> Should a small-scale hydropower project be allowed subsidy until it gets on its feet or should it be developed only if it can show a rapid payback of at least 10%?

Should small-scale hydropower be developed only at sites where a load already exists or should sites with a potential for load development also be considered?

If large-scale hydropower projects are too expensive for many debt-ridden developing countries to undertake, what difference does it make if, on a conventionally developed basis, unit costs for large-scale hydropower are less than those for small-scale hydropower?

There are no simple answers to these issues. Depending on circumstances, they could all be right or all be wrong. The point for the financial community is that small-scale hydropower is not a panacea. It can be complex and often requires a special, non-conventional way of thinking.

Conventional education and large-scale hydro development experience are two factors that can lead to widespread abuse of figures and assumptions regarding costs when considering smaller systems. When it comes to small-scale projects and unconventional approaches, banks become more cautious than ever. Some development bank staff view micro- and mini-hydro projects as an administrative "nuisance factor" as it costs as much in time, effort, and resources for the bank to process a loan for two to three mini-hydro sites as it does for a 100 MW facility. Conventionally prepared studies for micro- and mini-hydro installations carried through the feasibility stage can cost more than actual site develoment. In this case, banks are quite interested in methodologies (World Bank) and computer programs (Inter-American Development Bank) to short-cut costs.

Bankability continues to plague small hydro projects—one individual at the Asian Development Bank indicated that until NRECA could prove that mini-hydro projects could give a return of ten percent, he was not interested. He is disenchanted by the eight sites the Bank is developing in Burma which are too expensive. To reinforce a previously stated problem, when bank engineers and their consultants lack experience in mini-hydropower and maintain a strong belief in conventional engineering, the results can be costly, overdesigned projects.

Project Execution

To further understand the nature of construction projects, it is necessary to realistically understand both the timeline from initial survey to switching power on-line as well as the fact that projects, particularly those requiring civil works undertaken in developing countries, will require longer periods to completion.

Table 5, Comparison of Approximate Completion Times for U.S. and Overseas Projects, is presented to show broad comparisons between types of projects as well as the relatively longer time to completion overseas. The values used to develop these percentages include planning as well as construction time. Information was obtained from written sources and orally from specialists with overseas experience.

Table 5. Comparison of Approximate Completion Times for U.S. and Overseas Projects

Project	Time (%) Increased for Completion Overseas
Water Supply	167
Irrigation	140
Mini-hydropower	67
Micro-hydropower	40
Solar	40
Wind power	33
Small hydropower	20
Diesel power	1

Once the decision is made to develop a particular site, technical construction time lines (e.g. exclusive of planning and assessment), typically take two or three years.

It is instructional to observe the DOE-funded small hydro demonstration sites in the U.S. Power typically did not begin to come on line until after four years. In many cases, that was only with agressive pursuit of the project, by the site owner and the developer.

Substantial bureaucratic delays within USAID are often compounded by delays with the government agency co-developer of the project—in Peru it has taken over two years just to get from a funded Project Paper to agreement on conditions precedent for the loan. Dominican Republic took one and a half years and it will be another two or three years before any of these demonstration projects come on-line.

Small hydropower demonstration projects* in the U.S. have taken as little as two years (Lawrence, Massachusetts, a retrofit project) and as long as six to seven years.

USAID-FUNDED PROJECTS: STATUS

Given the realities of the factors briefly discussed above, there are a number of USAID-funded projects planned or underway. The following listing briefly summarizes their current stage of implementation.

Pakistan. Mission, with the assistance of a consultant, is in the process of finalizing the PP. The Project will involve institutional assistance to provincial government which is building up its capacity to implement micro- and mini-hydro projects. The PP is expected to be approved in the Spring of 1983.

Panama. The Mission is funding equipment for four sites which are currently under construction. The sites are expected to be completed by September, 1983. Two sites are already operational.

Thailand. Mission and government have selected engineering firms for a short list. Procurement for technical assistance to government small hydro programs should occur this Spring. Objective is to develop twelve sites, six sites in the first phase. Construction of the first six is to begin in mid-1983 and be completed in early 1985.

Dominican Republic. Mission and government are currently reviewing proposals for technical assistance to the government's small hydropower program. According to the project schedule, at least one of the three to four demonstration projects should be on-line in two years: this does not include some of the preliminary survey work.

Morocco. The three Mission-funded sites are currently under development, by ONE with technical assistance from CDER. Equipment specs are being prepared, and the civil works are under preparation. At the present rate, power should be on-line within two years.

Liberia. Although assistance from NRECA resulted in improved design, the future of the project is uncetain due to a lack of qualified, on-site expertise. It is difficult to measure rate of progress and estimate when power will come on line; at the current rate, the project is lagging.

Peru. Arrangements are currently underway between Mission and ELECTROPERU to obtain service of a U.S. consultant Resident Advisor. One of the sites is in the construction stage. Entire project is to be completed by 1986.

Zaire. Recent communications from the Mission indicate the PID will be shelved until the Mission has sufficient funds and the host government can spare the people

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*/ Projects funded by the U.S. Department of Energy, Small Scale Hydroelectric Resources.

and time. If a current project is successful as a prototype for r/e with hydropower, the Mission may reconsider.

Dominica. NRECA submitted a proposal to the Caribbean Development Bank in February 1983 for developing an old mill site, surveyed in January 1983. The Bank is currently obtaining written government permission to proceed. The Bank expects to complete the retrofit project by June 1984.

Rwanda. The CEAER is anxious to rehabilitate and develop the site of Nkora if sufficient load can be found. Further technical assistance is needed, particularly in reworking the plan.

Table 6 provides an estimate by country of the power to be produced by USAID-funded SDH projects currently planned or under construction. There are other countries with the resource potential for development by USAID and/or other sources of funding.

Table 6. Estimate of Power to Be Produced by USAID-Funded SDH Projects

Country	Sites	Average kW Capacity	Total kW
Panama	6	80	480
Thailand	12	250	3,000
Dominican Republic	4	400	1,600
Morocco	3	350	1,050
Liberia	1	30	30
Peru	15	500	7,500
Dominica	1	30	30
Rwanda	1	150	150
TOTAL	43		13,840

In summary, the following statements can be made regarding the implementation of small hydropower facilities:

1. The price and availability of imported petroleum and petroleum products has a direct effect on the interest in indigenous renewable energy resources for developing countries.

2. Development banks have been slow to fund small scale renewable energy projects, due in large part to a number of issues which may never be completely resolved to everyone's satisfaction until the banks develop some experience of their own.

3. The time required . the implementation of small hydro projects is long and even more so when they are undertaken overseas.

4. There are a number of USAID-funded projects which are in varying stages of completion—two sites with power already on-line; five under construction; and thirty-six which are either in the planning stage or proposed—totaling almost 14 MW.

SECTION TWO - LESSONS LEARNED AND RECOMMENDATIONS

Lessons Learned

A number of factors govern the success or failure of small-scale rural electrification projects, including small hydropower projects. NRECA draws from these lessons, and applies them to newly assigned overseas development projects. Many countries attempting to implement small hydro schemes begin from scratch and repeat the mistakes of others without benefitting from years of experience in other countries. This results in programs which are unnecessarily costly and which perform below the expectations of their developers. NRECA has a wealth of knowledge and experience to share with countries seeking to overcome the problems of ineffective project management, inadequate understanding and participation by the local community, poor planning, inferior or ill-adapted technical designs, improper equipment design, inefficient use of the power once the plant is built, and faulty operation and maintenance procedures.

MANAGEMENT CONSIDERATIONS

Centralized management of small hydropower development becomes less viable as plant capacity decreases. Implementing a number of small schemes in remote rural areas requires complicated logistical arrangements, and can clearly be more cumbersome than installing a single large scheme. Each small scheme needs numerous levels of costly and time-consuming studies for implementation. A large scheme feeds power into the national grid, where the power always finds a market. With smaller isolated schemes in areas with little prior experience of the benefits and uses of electrification, it is difficult to undertake active productive-uses planning, which must be an integral part of overall planning.

The Philippines is undertaking a program for joint central and local development of mini-hydropower projects. There, the National Electrification Administration (NEA) uses a network of rural electric cooperatives. Donor funds from numerous international sources and development bank resources available to the NEA are used to design and construct small hydropower sites. The local cooperatives are responsible for construction management, operations, routine maintenance, and payment of the debt service.

In Nepal, the Agricultural Development Bank is funding a program to install micro-hydro units in remote areas primarily for milling. In some cases, generators are added primarily to serve a lighting load. Here, the mill owner has authority to provide electric service to nearby residents as he sees fit and has the responsibility for paying the debt service. This program has been quite successful.

An important element in the success of these programs is the fact that the local management has been well qualified. In the Philippines, the cooperatives are large enough to support a full-time, trained, electric utility manager. The capacity of these units is generally over 500 kW. In Nepal, the systems are controlled by a local businessman, the mill owner, and are operated as a commercial enterprise. These units are generally in the 5-10 kW range.

Central technical support services must be available. Although smaller systems should have the support of and input from the local communities they serve, they cannot be expected to have access to technical, operational, training and maintenance specialists. Many of the earlier, privately developed sites in Indonesia suffered from lack of technical support for construction and for system maintenance and repair. These services are essential at some time in the development of many small hydropower schemes and should be available on an as-needed basis from a central pool or national organization.

Programs need to be adequately funded to provide on-going specialized technical support. This assistance can be costly. It is often not included in demonstration projects. For example, in Liberia, USAID provided Integrated Rural Technology funding for a 30 kW installation to be constructed by villagers with supervision from a Peace Corps Volunteer (PCV). The funding covered the capital cost of the materials and equipment. The PCV, although dedicated and enthusiastic, had neither the experience nor the training to handle inevitable design modifications and construction adjustments that arose during site development. No in-country backup support was available, and long delays and numerous cost increases resulted.

ECONOMIC CONSIDERATIONS

Feasibility studies must determine that adequate load is present or capable of being developed. Planning should begin with a clear understanding of how the energy is to be used. From a financial point of view, a system's viability depends on its being able to pay

for itself. For all decentralized hydropower schemes, uses for that power must be identified. Unlike grid-connected hydropower schemes, isolated schemes do not have the advantage of permitting excess power to be dumped into the grid to offset the cost of imported oil. In some cases sites have been selected on the basis of technical merit, followed by a search for a potential load to serve. This approach to site development without a perceived need wastes manpower and program resources. In Rwanda, extensive studies and preliminary designs were made of a 20 kW site at Kaviri Falls, yet no clear use for the power has yet been identified.

In Nepal, several private-sector small hydropower initiatives have been successful because adequate load is available. There, modern water-powered turbines have been providing power to mill grain, hull rice, and expel oil from seed—tasks which had been done by hand for millenia. Formerly, milling was done using slow but simple wooden waterwheels and diesel-powered mills. The newly-constructed hydropower mills can pay for themselves in four to seven years.

Adapting locally appropriate approaches can significantly reduce small hydro costs. Economies of scale are frequently held as an argument against the implementation of small hydropower schemes—the results are not worth the effort. As plant capacities decrease to below several hundred kilowatts, costs per installed kilowatt can quickly rise to $3,000/kW and beyond. But experience around the world tends to support this argument only if conventional approaches to implementing hydroelectric projects are extended down into the range of small hydropower. New realities are often encountered when serving remote areas with small decentralized hydropower plants, and these should have an effect on the design and cost of the overall scheme. Here the term "design" is used in a broader sense than civil design. It also includes, for example, overall system configuration, management structures, turbogenerating equipment design, and tariff structure.

At the low end of the capital spectrum are 5-15 kW schemes being installed in Pakistan ($400-$500/kW) and Nepal ($700/kW). These low costs are conditioned by numerous factors: local manufacture of turbines; villager initiation, implementation, operation, and management of schemes; and an overall system configuration designed to meet the needs of the communities they serve and not some largely irrelevant industrial standard.

TECHNICAL CONSIDERATIONS

The technical approach to development must be appropriate to the need. Micro-hydro schemes should not be scaled-down versions of large hydro systems. Several programs have attempted to implement micro- and mini-hydropower using the same approaches, and control and quality requirements as would be appropriate for large-scale developments or for small scale developments in the industrial nations (e.g. efficient, but complex). These approaches lead to very high costs for the electromechanical equipment, over-designed civil works , and inappropriate distribution systems. Examples exist in Honduras, where bid specifications were written requiring expensive, custom-developed turbine types and sizes rather than obtaining pre-engineered units; in Liberia, where the identified loads would have been better served by mechanical power rather than electrical power; and, in Malaysia where long, imported steel penstocks were recommended when simple earth canals with shorter penstocks may have sufficed.

It is also inappropriate to treat mini-hydro units as scaled-up versions of micro-hydro schemes. Installation designs that did not include proper electrical protection for ground faults or lightning strokes have resulted in complete system failure in both the United States and Rwanda. Negligence in obtaining guaranteed operating efficiencies during the bidding and purchasing process can lead to the installation of incorrect equipment as was the case in Panama.

Recommendations

The Small Decentralized Hydropower Program could operate more smoothly and effectively if NRECA and USAID could resolve several areas of uncertainty. These are given below, with suggestions for solutions.

1. Administratively, it is unclear to the SDH staff how the specific internal, procedural, and authoritative responsibilities of ST/EY, Regional Bureaus, and Missions differ, and how they fit together. In our role of managing a centrally-funded service for USAID, a clearer understanding of these separate responsibilities is important.

Suggested Solution: USAID provide a brief oral orientation on specific procedural and authoritative responsibilities of directly relevant USAID offices accompanied by useful descriptive text, organization charts, program descriptions, and internal authorities.

2. At times there may not be agreement between ST/EY, the Mission, and/or the Regional Bureau on the service to be provided by the SDH team, or the type of report to be developed as a result of the assistance. The consequences of this dilemma can have an impact on timing, coordination, team effectiveness, quality control, and ultimately, the evaluation of NRECA's effectiveness.

Suggested solution: NRECA should insure before team departs the U.S. that there is written concurrence from all key participants on team make-up and on the scope of work to be undertaken and ultimately to be described in the final report. This activity would be carried out by NRECA in close coordination with the SDH Technical Monitor in ST/EY.

3. Depending on scale, small hydropower can be thought of relative to integrated rural development or relative to the total power supply, as described in Lessons Learned above. Obviously, electricity generation is the objective in both cases, but how it is used, how it is funded, how the quantity is to be generated, and how the government chooses to manage its development and its operation are often quite different. Often, the technology of small hydro may have been oversold and both Mission staff and host government engineers are, thus, often misinformed on the realities of what the technology can provide. As a result, project planning and requests for assistance may not be well-conceived and dissatisfaction with the team and with the survey may result.

Suggested Solution: NRECA could develop material describing the applications of small hydropower, giving examples of both isolated use for integrated rural development and tie-ins to the national power supply. This information could then be conveyed via briefings to appropriate USAID offices in Washington and to Missions by SDH teams. We would also propose to target a number of specific countries and offer assistance, based on our knowledge of the potential for development and on their expressed interest. When an SDH team arrives at a Mission to provide assistance it will present a briefing, with slides, on the general subject of SDH and on special topics, such as productive end uses, economic analysis, and hydrologic estimates.

4. If, after a preliminary survey identifies a resource potential, but capital funding for SDH projects does not exist in a Mission's budget, it is sometimes difficult to generate interest in capturing other bilateral or multilateral resources to which may be attached a smaller amount of technical assistance such as training.

Suggested Solution: NRECA could provide information on other in-country sources of funding to Missions. When the SDH program begins to offer in-country training, Missions could send energy officers to these sessions. It would be of particular importance that those officers from Missions with projects planned or underway take advantage of this service.

5. Missions often find that 1 MW, 5 MW or 10 MW projects ($2 million to $20 million) are not affordable, and that the 50 kW to 500 kW projects ($100,000 to $1 million) may be more attractive. The dilemma comes when the host government usually the Ministry of Energy or the parastatal is not interested in the "small stuff" for many different reasons.

Suggested Solution: We have learned that it is very important in these cases to change our approach and seek creative solutions, as described above in Lessons Learned. For smaller projects in rural development, it has proven best to work with the Ministries of Rural Development, Cooperatives, Water Resources, and Irrigation.

Finally, we would like to note that we have continued to maintain the role as Managers of SDH services, despite occasional misconceptions that our staff are in all cases the sole source of expertise in the field of small hydro development. We have a talent bank of over 150 specialists and 60 firms—engineers, economists, institutional analysts, energy planners, and others for use in short-term assignments. It is not necessary, nor would it be cost effective, to keep them in our permanent employ. The Cooperative Agreement is explicit in stating that its purpose is to allow the NRECA to develop expertise in SDH that will then be passed on, independent of USAID, to developing countries at the end of the five years of the Cooperative Agreement.

SECTION THREE - FUTURE DIRECTIONS

We plan to continue carrying out most of our present activities—country surveys, site selections, workshops, data and information documentation, and special seminars; these have proved extremely useful services. At the same time, with USAID's concurrence, we will become more active in the follow-up phases of project development and implementation. The following additional activities would form the basis of a more detailed Action Plan for implementation. The basis for the presentation of these ideas is their relevance to program implementation; they are also subjects with which NRECA is very familiar and is well-suited to carry out. Over the past twenty years, NRECA has assisted many countries in implementing programs of rural electrification using skills in financial packaging, site development, end use planning, training, planning and evaluation, rural development, and power supply, and management.

Packaging

This would involve identifying and then working with a few countries with resource potential that can be packaged for funding and development. As a first step here NRECA would propose to follow-up in countries where assistance had been provided but where no clear direction has yet been indicated. (See Table 1, page 6.)

FINANCIAL PACKAGING

The key to this effort in most cases would involve matching a project with the appropriate source of financing. In this sense, NRECA would not serve as a "broker," but rather, would help to identify a number of sites that have characteristics attractive to appropriate funding organizations and assist in securing financing and developing them. Micro- and some mini-hydro sites could be funded by the UN, other bilateral sources, EEC, local agricultural development banks, regional sources, such as the Andean Fund, and Arab funds. Some mini- and small hydro sites could be funded by development (ADB, IDB, AFDB, WB, CDB) and commercial (Chemical Bank, Chase Manhattan) banks. Coordination with U.S. domestic assistance to overseas business ventures such as TDP, Ex-Im, and OPIC would be included. To assist in this effort it may be necessary to conduct additional supportive research such as: a) evaluating the effectiveness of present short-cut methodologies for resource assessment and b) documenting of developed small hydro sites that give a return of at least 10%.

PROJECT IMPLEMENTATION

NRECA would be involved in "water to wire" services for a small number of sites and would serve as both the source of technical assistance as well as the expeditor for completion. Our anticipated role in Dominica is a case in point. The importance of these projects would be that their key to success was a range of development assistance objectives that are consistent with host government policies on local participation and management, counterpart training for technology transfer, and institution building.

END USE

In recognition of the important, yet difficult, aspect of planning for and developing end uses of power, particularly in isolated, previously unelectrified areas for which micro-hydro units are appropriate, NRECA would foster the development of complete packages that would include not only the turbo-generating equipment but also a complete end use plan. Packaging projects in this way helps to ensure a satisfactory load on the plant, particularly in the beginning. This will demonstrate what can be done to increase rural economic productivity. It will also make funding of equipment for productive uses, often a stumbling block in rural communities, an integral part of the capital costs of the project.

Training

Training is not a new function to the NRECA. Each year more than 12,000 directors, managers, attorneys, and key employees attend its U.S. training programs. Overseas, since 1961 more than 375 representatives of 34 countries have received organization and management training tailored to meet their needs. Many of the international training programs in small-scale hydropower currently available do not adequately assess the training needs, level of technical expertise available in a given country, take the developing country context into account, or provide sufficient flexibility to respond appropriately to those needs.

The USAID/NRECA SDH Program would provide training to developing country nationals both overseas and in the U.S. Capacities of systems considered would range from a few hundred kW to approximately 15 MW. The overseas training described in the proposal is country specific and tailored to the individual country's training needs in decentralized hydropower whether for site assessment, hydrological analysis, civil works design, socio-

economic issues, or management approaches, etc. NRECA would market its training services, to three basic groups of clients:

USAID-FUNDED PROJECTS

NRECA would provide in-country or U.S.-based training to complement USAID projects, current or as planned, in Morocco, Panama, Ecuador, Peru, Dominican Republic, and Thailand.

OTHER BILATERAL OR U.N. PROJECTS

NRECA, with Mission coordination, would provide in-country training services to complement other development assistance projects in Burundi, Sudan, Ghana, Peru, Indonesia, and others.

DEVELOPMENT BANK PROJECTS

NRECA would provide in-country or U.S.-based training oriented to programs of large numbers (40-50+) of projects—e.g. WB in Malaysia and Indonesia and to small numbers (2-10) of projects—e.g. WB, ADB and AFDB in Nepal, Papua New Guinea, Indonesia, Burundi, Comoros, and Sudan. These services would be coordinated through the host government, the Mission, and the bank.

We would also continue to provide study tours to manufacturing plants and sites and, if needed, we would arrange internships with manufacturers and develop other specialized training assistance. The internships could be co-funded by the SDH Program, the Mission, and perhaps the manufacturer. The time period would be for whatever was mutually agreeable, one month, six months, or one year.

Planning and Evaluation

As a means to design a greater number of financially attractive and efficient in-use projects for the future, NRECA, with USAID approval and coordination would select a reasonable number of new countries with likely resource potential, visit the Mission and key host government staff, and discuss the technology of what can and cannot be accomplished, NRECA's role in the various approaches, and problems of funding. The focus would be on specific sites to be developed and on assisting programs that may be

already underway via site construction or via follow-on assistance in training, management assistance, institution-building, and eventually, program evaluation.

Rural Development and Power Supply

It is important that SDH be viewed not only in terms of national goals and objectives, such as increased economic development through exports, foreign exchange, and decreased fuel imports, and increased energy sources; but also in terms of the specific program and project objectives, and the purpose served: power supply, small scale industries, and agricultural development.

In the case of agricultural development, particularly, there are opportunities for SDH. In irrigation schemes, widely used in developing countries, there lies a substantial opportunity to integrate the development of small hydropower units at the diversion barrage and in canal drop structures. Power is then available for other agricultural uses such as pumping, crop drying, hulling, grinding, oil extraction, freezing, and other processing uses. Two opportunities exist for applied research: the use of the electric arc to manufacture nitrates for fertilizer and to manufacture calcium carbide from which acetylene gas would be generated. Each of these applications has potential for an economically productive end use of SDH-generated electricity.

INTEGRATED RURAL DEVELOPMENT

NRECA would promote micro-hydro development as an important element in integrated rural development consistent with housing, agriculture development, including irrigation and water supply, small industry, health clinics, and schools. One approach would be to solicit support for this technology within organizational divisions that deal with these topics at the UN, the development banks, and USAID. NRECA could apply models identified as successfully operating today (Pakistan, Nepal) with appropriate adaptations to other countries, then select one or more countries, and design, and carry out one or more projects. The SDH staff would prepare papers on the application of small-scale hydropower to irrigation and water supply systems, to integrated rural schemes and to the application of existing models.

POWER SUPPLY

For systems with 1MW-10MW capacity, although out of the reach of most Missions' pocketbooks, NRECA can provide technical assistance in preliminary work, and training

to help the host government get funding. These sites would be mainly grid-connected and their purpose would be either additional capacity, fuel substitution, or both. We recognize that there will be situations in which sites with capacities less than 1MW will be used for power supplies. In such cases, usually a large number of these "smaller" sites would be developed in order to have significant cumulative impact and NRECA could be involved in the implementation of 2 or 3 as demonstration and training efforts for future replication by the host government.

NRECA could also work directly with banks or their contractors to assist in the development of one or more methodologies for assessing a large numer of small hydro sites with the objective of showing the economic feasibility of several, so that a development bank could fund a program of 20, 50 or 100 sites, instead of 5 or 6.

Management

NRECA should bring more influence to bear on the SDH Program from the management strengths which it has applied overseas for twenty years. As indicated in Lessons Learned, management is of equal critical value to the ultimate long-term success of SDH implementation as in the most appropriate engineering for a given site. Follow through efforts in institution building for the local level must be a part of the original planning stages of every project. The objective is to build in-country capability for management and, therefore, to eliminate the continous need of the host country to be dependent on outside assistance. This is best fostered at the lower end of the infrastructure through such organizations as small hydro development boards, local cooperatives, or regional and local offices of the parastatal.

RURAL ELECTRIFICATION SPECIALIST

In order to provide assistance in the matter of how isolated sites will be managed, an r/e specialist could assist with insights on institution-building for a national program on small hydro development and on power system planning and development as done by U.S. rural utility experts. When appropriate, NRECA would add an r/e specialist, funded by the USAID Core Support Grant or other appropriate sources to SDH country survey teams.

SPECIALIZED MANAGEMENT AND OPERATION ASSISTANCE

NRECA could provide specialized assistance in circumstances unique to the management and operation of small, isolated systems. For example, a program, designed and developed by NRECA for use on a hand-held calculator, can allow a single individual to perform the kinds of tasks that normally require several people and other equipment in routine local system managment—this skill could be taught either in-country or in the U.S. Other areas would include end use planning, load growth projections, and tariff setting.