

NRECA NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

1800 Massachusetts Avenue, N.W.
Washington, D.C. 20036/202-857-9500

SMALL DECENTRALIZED HYDROPOWER (SDH)

Program Status, January 1984

The following is a summary, updated each month, of activities undertaken by the Small Decentralized Hydropower (SDH) Program since June 1980 under a cooperative agreement between the National Rural Electric Cooperative Association (NRECA) and the U.S. Agency for International Development (USAID).

L. Resource Identification, Site Selection, and Project Design

A. Resource identification

Peru

In July 1980, NRECA sent a team of Spanish-speaking specialists to Lima, Peru to assist the AID Mission in formulating their project paper for a program in small-scale hydropower development. The program was designed to promote rural and regional social and economic development through reasonably-priced hydro-generated electrical energy and to provide technical assistance to the mini-hydro program within the Ministry of Energy and Mines.

The NRECA team consisted of an economist, a social scientist, an engineer, and two environmental specialists. Their task was to develop the following sections of the project paper: a. project activities; b. prefeasibility methodology; c. feasibility methodology; d. economic analysis; e. institutional analysis; f. social analysis; and, g. environmental analysis. In addition, the team helped supervise preparation of feasibility studies for two mini-hydro sites that ELECTROPERU, the Peruvian national electric authority, proposed to develop.

The team worked for more than five weeks in Peru contributing to the Project Paper. The project was approved for FY80 funding. The project proposed to lend the Government of Peru US \$9 million to finance feasibility studies, civil works, equipment, and local distribution systems for approximately 28 small-scale hydroelectric installations in the 100 to 1,000 kW range. In addition, a grant of US \$1 million was included for institutional assistance, prefeasibility studies, and a program for productive uses of electricity.

Prepared by the Small Decentralized
Hydropower (SDH) Program of the National
Rural Electric Cooperative Association,
1800 Massachusetts Avenue, N.W.,
Washington, D.C. 20036 (202) 857-9622,
under Cooperative Agreement AID/DSAN-CA-0226.



Panama

NRECA sent a micro-hydropower specialist to Panama in June 1980 to assist the AID Mission and the Panamanian Institute of Hydraulic Resources and Electrification (IRHE) in planning a country-wide, micro-hydropower program.

In November 1980, the SDH Program's principal engineer traveled to Panama to review the status of two micro-hydro demonstration sites. He provided technical advice on the electrical distribution design, project schedule, and program management. These units are now supplying power to rural technical schools.

Togo

In April 1981, NRECA sent a three-man team to conduct an assessment of small hydropower potential in Togo. The team, including a hydrologist, a small-hydro electrical engineer, and a socio-economist, undertook a field reconnaissance of ten potential sites identified by the government and international agencies and evaluated them based on technical and economic criteria. The SDH Program's principal engineer assisted in on-site team coordination and field evaluation.

Tasks accomplished by the team during three weeks included:
a. hydrological study of drainage basins; b. identification of sites with appropriate hydrological and topographical features; and, c. comparison of sites based on potential capacity, annual energy production, proximity to grid and/or advantageous loads, social considerations, and problems in site development. NRECA delivered the team's final report to the AID Mission in July, 1981.

At the request of AID, NRECA submitted to the AID Mission in June 1983 a more detailed economic analysis of two representative sites studied by the team in 1981. This subsequent report indicated that certain selected sites could make a considerable contribution of very low-cost electrical energy to Togo's national power network, and recommended that additional feasibility assessment is warranted.

Dominican Republic

NRECA sent a team to the Dominican Republic for five weeks during June and July 1981 to assist the USAID Mission in preparing the small hydro component of its Energy Conservation and Resources Development Project. The team consisted of a small hydro engineer, an institutional advisor, and a socio-economic analyst.

The small hydro component focused on consolidating and building existing institutional capabilities in designing, constructing, and operating small hydroelectric plants in the Dominican Republic. The team developed a country-specific methodology to set priorities and select suitable candidate sites for AID funding as demonstration projects.

The report included technical, economic, financial, social environmental, and institutional analyses of the sub-project. In addition, it contained two site-selection studies conducted by professionals from the Dominican Republic using the methodology developed by the team.

The team found that small hydro is an extremely attractive option for the Dominican Republic now for both oil displacement and new capacity additions. There are approximately 40 potential sites identified in the Dominican Republic with the possibility of many more as the Government begins to seriously consider the future role of small hydro in its overall energy picture. An AID-supported program to construct three to four demonstration projects as part of a long-term mini-hydro development effort in the Dominican Republic commenced in 1983.

Ghana

In August 1981, at the request of the Government of Ghana, NRECA sent a three-man team, including a mini-hydro specialist, an economist, and a rural electrification specialist, to assess the mini-hydro potential of the Western Region of Ghana, including technical, organizational, and socio-economic aspects of its development and to consider rural electrification options in general for the area. The team found that small hydro does not appear to be a viable technology for a program of decentralized electrification of rural towns in the Western Region.

Bangladesh

At the request of the AID Mission in Dhaka, NRECA sent a two-man team, including a hydrologist and a small hydro engineer, to Bangladesh in October 1981. The team assessed the potential for small hydro in Bangladesh and looked at particular applications of low-head installations. The team visited four areas where small, low-head hydroelectric projects are feasible and in its report recommended six sites for prefeasibility studies. A prefeasibility study was conducted on one barrage. Feasibility of these installations would depend considerably on the agricultural benefits of the irrigation aspects of the projects.

Tunisia

In December 1981, the SDH program manager led a fact-finding mission to Tunisia at the request of the AID Mission. The three-man team, including a small hydropower expert, a solar specialist, and a wind expert, prepared a report which evaluated the renewable energy potential in Tunisia. The report's findings indicated limited small hydro potential in Tunisia, centered mostly in the northern region of the country on barrages previously developed for irrigation and water supply. The team recommended that more detailed study of these and other potential sites be conducted.

Sierra Leone

In March 1982, an SDH program engineer visited Freetown, Sierra Leone at the request of AID to make a preliminary assessment of the interest in and potential work for small hydro development in that country. A report was

submitted to the Mission stating that there is both interest and potential in Sierra Leone for the development of small hydropower. The United Nations, the Canadian Energy Development Systems International (CEDSI) and the People's Republic of China are currently engaged in resource assessment, site inspection and project development of small hydropower in Sierra Leone. The report recommended that the Government await the results of this preliminary investigative work before moving ahead with new project funding.

Sudan

The administrator for NRECA's International Programs Division and the program manager for the SDH Program traveled to the Sudan in May, 1982, as part of a four-man team to survey decentralized hydro potential in the Sudan. In addition, two staff members of the Tennessee Valley Authority, the assistant manager of Civil Engineering Design and the director of the Division of Water Resources, assisted with the three-week assessment. In reviewing potential sites throughout the Sudan, the team conducted an aerial reconnaissance of several rivers and irrigation systems and made ground visits to a number of sites in the northern part of the country. In addition, the team collected and reviewed an extensive number of reports to assist in their evaluation of hydro potential of existing and planned dams and within existing irrigation systems.

The team's report concluded that much of the decentralized hydro potential lies in the southern Sudan along the existing mainstream Nile and certain secondary rivers; that further site-specific evaluations are needed on selected irrigation barrages; and that there is some potential for hydropower development on at least one of the existing mainstream dams and at least one of the existing mainstream cataracts. All of the potential sites need further study.

Indonesia

In June 1982, the SDH Program manager traveled to Indonesia to assist the AID Mission in developing a scope of work to be carried out in the near future by a team conducting a regional assessment of small hydropower potential.

The trip report recommended a scope of work requiring four projects for assistance: a. resource assessment to select up to six sites for prefeasibility studies and two for feasibility studies; b. research and development assistance centering on local design and manufacture of equipment, including electronic load controllers; c. training, with respect to site development and management; and d. assistance with improving Indonesia's overall mini-hydro program planning and implementation structure.

Follow-up visits to Indonesia by the SDH Program staff and consultants were taken in 1983 to review prevailing policies and programs in small hydro development in Indonesia and prepared reports recommending measures necessary to accelerate progress in this area of the country's overall energy program. Further NRECA assistance is anticipated.

Pakistan

In August 1982, NRECA sent a three-man team, consisting of the SDH micro-hydro engineer, a socio-economic advisor, and an energy resource planner, to Pakistan to assist AID/Islamabad with the mini-hydro component of its proposed Energy Planning and Development Project. This component is to build on the experiences to date and to strengthen the institutional capability of two agencies in the North West Frontier Province to implement micro- and mini-hydro projects and to undertake adaptive research and development work on local manufacture of standardized turbines for use initially with their micro-hydro projects. A thorough and continuing evaluation of technical and socio-economic aspects of 20 prototype projects to be installed over the five-year project life was also proposed. Because of the low costs involved in the present approach, the team found a very high economic internal rate of return for the micro-hydro projects and that the use of electricity solely for kerosene substitution for lighting could cover the costs of the scheme.

Honduras

In response to a request from the AID Mission for assistance in the development of a small hydropower project, NRECA sent two engineers to Honduras for a period of two weeks in September 1982. In a report submitted to the Mission, the team made recommendations regarding the scope, cost, technical and institutional soundness of a small hydropower project in Honduras. The Mission has decided not to pursue a small hydropower project at this time.

Burundi

At the request of the AID mission in Burundi, in October 1982, NRECA sent a team consisting of a hydro engineer and an institutional/energy planner, to review the institutional, staffing and training needs for small hydropower development in that country. The team found that a number of small decentralized hydropower plants are already operational throughout the country and plans are underway to provide most of Burundi's electrical power from small hydropower plants within its borders before the end of this decade. The Ministry of Rural Development is currently engaged in an ambitious plan to install numerous plants with capacities under 250 kW. Donors seem plentiful but their program suffers from institutional, staffing, and training problems.

In its report, the team made recommendations regarding staffing and training requirements of the Ministry of Rural Development, options for making their program more self-supporting, and the mandates and roles of the two ministries currently involved in implementing small hydropower programs. To address an interest expressed by the government in applying the approach to implementing a micro-hydro program in Nepal to the situation in Burundi, the team also considered the practicality of this approach and others which have been used elsewhere in the developing world.

Lesotho

In November 1982, a two-person team was sent to Lesotho to recommend appropriate activities for developing their hydropower potential. In its report, the team established that the country has the physical features necessary for large hydro development, but that it would be very difficult to implement mini- or micro hydropower on a wide scale basis. The extreme variations in seasonal flows and low specific discharges make seasonal storage a requirement for significant amounts of dependable power. Lesotho probably has 20-40 potentially developable sites in the micro-hydro range with installed cost ranging from \$3,000 to \$6,000 per kW. Nine sites have been studied to supply regional centers with electrical loads from 100 to 700 kW, and the country has recently announced plans for a massive, \$1,250 million project to develop 190 MW of power and supply fresh water to the Republic of South Africa.

B. Site selection and project design

Morocco

In August 1980, AID/RABAT requested the immediate services of a small-scale hydro specialist to assist the Mission in reviewing the Moroccan country assessment performed by a large U.S. engineering firm. As a result, the large civil works approach was deleted from the project. This improved the economic feasibility of the hydroelectric program, AID/RABAT continued with the program. Three potential sites were identified for development and site data was collected. In November 1980, NRECA sent an engineer to Morocco to supervise a survey team which developed the site profiles and preliminary layouts.

In October 1981, NRECA sent its micro-hydro engineer and a mini-hydro specialist to work with local consulting firms and representatives of the Office National de l'Electricite and the Centre de Development des Energies Renouvelables in prospecting for sites in Ouarzazate Province and in reviewing a proposed small hydro scheme at Arhbalou-N-Kerdous to ascertain whether the proposed power plant would interfere with the existing irrigation system at the site. The team submitted a report of its findings and recommendations to the AID Mission.

Thailand

In February 1981, the AID Mission in Bangkok requested NRECA technical assistance for prefeasibility investigations of 25 potential small hydro sites that had been previously identified by the Government. The 25 sites were characterized according to physical characteristics and potential demand structure. From this ranking, six sites were chosen for prefeasibility studies according to the following criteria: (a) priority of area development; (b) potential for productive uses; (c) replacement of existing diesel-generating sets; (d) lack of potential for grid connection; (e) favorable benefit to cost ratios; and, (f) potential for co-financing.

The NRECA members of the team included a small hydro engineer and an institutional advisor who manages one of NRECA's member rural electric systems. The team looked at six sites selected.

In June 1981, NRECA also provided the services of an electro-mechanical engineer whose duties included working with engineers from the National Energy Administration and helping them select appropriate equipment. A report was prepared recommending the selection of appropriate governors (mechanical or electronic) and determining the potential for their manufacture in Thailand.

Zaire

In January 1981, NRECA provided technical assistance to a group of individuals from the northwestern United States that raised money to install a small hydro unit in Nundu, Zaire for a church hospital. In addition, the staff located possible sources of additional funding for the project.

In March 1981, NRECA sent two engineers to Zaire to assist the AID mission in evaluating several proposed small hydro projects. Their assessment was aided by the SDH principal engineer who assisted in coordination and field evaluation. The engineers visited sites throughout the country, which were generally found to be feasible, and assessed the possibilities for a national small hydro program. At the end of the assignment, the team prepared a report outlining options available to AID for a small hydroelectric project. The options ranged from financial assistance at selected sites to a massive, multi-donor program involving institution building, training, and introducing productive uses of electricity.

In May 1982, NRECA sent a three-person team to Zaire to assist the AID Mission in preparing a small hydropower Project Identification Document. The team consisted of a French-speaking small hydro engineer, an economist, and a rural electrification institutional advisor. The team identified the critical issues facing the proposed project, developed program options, and made recommendations regarding the institutional structure of the program.

Rwanda

In November 1981, a two-man team, including the SDH Program's principal engineer, traveled to Rwanda to conduct a detailed study on one micro-hydro site at Kaviri Falls and an initial assessment of nine undeveloped sites, and to prepare a report of its findings and recommendations. This work was performed through the AID Mission for Rwanda's Center for Energy Research.

The team developed the preliminary engineering design for the Kaviri Falls site, but recommended that the site not be developed due to the high installation cost, and lack of defined use for the power.

The team also recommended that the Center for Energy Research initiate its hydropower program by first rehabilitating one of two observed abandoned hydroelectric sites before attempting a completely undeveloped site.

In June 1983, the SDH Program's principal engineer returned to Rwanda at the request of the AID Mission to assist in preparations to rehabilitate the site, a 100 kW plant located approximately 100 miles west of Kigali. A

report describing this project and including recommendations for its rehabilitation was sent to the AID Mission.

Dominica

In September 1981, at the request of the AID Mission in Barbados, the SDH Program's principal engineer traveled to Dominica to develop a scope of work for a small hydro team. Subsequently, a three-man team, including a small hydro engineer, a civil engineer, and an economist, was sent by NRECA in November 1981 to evaluate the potential for small hydro development in Dominica during their three-week stay in November. The team identified several possible sites and conducted on-site prefeasibility studies to assess potential for providing decentralized rural electrification and submitted a report of its findings and recommendations.

In January 1983, the SDH Program's principal engineer returned to Dominica at the request of AID/Barbados to review plans for a 20 kW micro-hydro demonstration project which was being considered for funding by the Caribbean Development Bank. At his recommendation, the project was rejected on economic and technical grounds. Alternative sites were studied, including a number of abandoned watermills as restoration projects and a 900 kW project on the Belfast River. NRECA prepared a prefeasibility report on the Belfast site and a separate report on the alternative watermill candidate sites.

Liberia

At the request of AID's Africa Bureau, a two-man NRECA team, in February, 1982, visited an on-going AID/Peace Corps-sponsored project for a 35 kW micro-hydro scheme in Yandohun, Northern Liberia, to evaluate progress on construction of the site and to advise the resident Peace Corps volunteer and the AID Mission on means of bringing the project to successful completion. A final report of the team's findings and recommendations was submitted to the AID Mission.

Country assistance anticipated

New assistance or follow-up assistance in resource identification, site selection and project design is anticipated in the following countries:

ASEAN (training)	Indonesia
Costa Rica	Nepal
Dominica	Niger River Basin
Ecuador	Togo
Guinea	Zimbabwe

II. Development of data and information base

A. Equipment manufacturers

NRECA has developed an inventory of U.S. manufacturers of small hydroelectric equipment, and, in most cases, has visited the manufacturers. NRECA has classified the manufacturers' products for

appropriate applications and continually revises the file of U.S. manufacturers and products, reflecting market changes.

The second edition of the Directory of Sources of Small Hydroelectric Turbines and Packages contains descriptions of U.S. and developing country firms which satisfy U.S. source requirements and their equipment lines as well as an introductory chapter on packaged units. A third edition is under preparation.

To provide greater access to U.S. turbine manufacturers and small hydro package suppliers, NRECA has developed a tour of manufacturing plants and small hydro sites for visiting engineers from developing countries interested in looking at U.S. equipment in the shop and operating in the field. In May 1982, NRECA initiated this special program with a three-week cross-country tour for two Panamanian engineers interested in receiving equipment bids for four mini-hydro projects being developed with AID assistance.

B. State-of-the-art technology

NRECA engineers have visited numerous small-scale hydro projects in developing countries to study various approaches that have been undertaken using conventional as well as unconventional technologies. NRECA has gathered photographic documentation of small hydropower sites in five Asian countries (Indonesia, Nepal, Pakistan, Papua New Guinea, and Thailand) in the form of nearly 1,000 slides to document their social, economic, and technical characteristics. This documentation 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 expose other developing countries to methods that have proven successful in typical rural settings in the developing world.

The first two studies, "Pakistan: Village-Implemented Micro-Hydropower Schemes," and "Nepal: Private Sector Approach to Implementing Micro-hydropower Schemes," have been completed, which discuss unusually low-cost (\$350-700/installed kW) approaches being used to install hydropower plants up to 50 kW in remote mountainous regions of those two countries.

C. Assessment guidelines

NRECA has developed guidelines for the following field assessment tasks:

1. Country Assessment of Mini-Hydropower Potential—
for assessing a country's physical characteristics, in determining the need and feasibility of a national mini-hydro program
2. Prefeasibility Studies of Candidate Mini-Hydro Sites—
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

3. Hydrological Estimates for Small Hydroelectric Projects-- for estimating stream-flow duration and peak flows in regions here very little data is available
4. Environmental Assessments of Small Hydropower Projects-- for assessing environmental impacts of a prospective mini-hydro project.

D. Special studies

NRECA has undertaken three special studies designed to focus on key problem areas in the implementation of SDH programs and projects in developing countries on--

1. management--analyses of issues of centralized versus decentralized control, including successes and shortfalls
2. site evaluation--development of criteria from which to build a methodology for evaluating small-scale energy systems
3. economic planning--comprehensive planning guide consisting of economic feasibility methodology, end-use planning guide, costing methodologies, and financial analysis approaches including a directory of private and public financial sources and their lending criteria (under development).

III. Training program

Decentralized hydropower can be an attractive, cost-effective option, as a substitute for or as a supplement to, expensive diesel electric power generation, and national programs have sprung up all over the developing world. 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. However, many of the international training programs 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 SDH Program has developed a training proposal to provide training to developing country nationals both overseas and in the U.S. Capacities of systems considered 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, hydrologic analysis, civil works design, socio-economic issues, management approaches, etc. It is designed to provide the SDH Program maximum flexibility in course content, timing, and location in responding 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/project to view the program as an entity and not as disjointed units.

IV. Workshops

NRECA has conducted a series of workshops on small hydro development in Latin America, Asia, and West Africa. A fourth workshop is to be held in East Africa in June, 1983.

A. Latin America and the Caribbean

NRECA conducted its first international workshop August 19-21, 1980. Held at the Hotel Inter-Continental Quito in Quito, Ecuador, the workshop attracted 118 attendees from 13 Latin American countries and the U.S.

NRECA, in cooperation with USAID, jointly sponsored the workshop with the Instituto Nacional de Energia (INE) and the Instituto Ecuatoriano de Electrificación (INECEL). NRECA developed the technical program, which included recruiting, coordinating, reimbursing AID-sponsored attendees, and preparing printed materials for the workshop.

Nineteen technical papers were presented dealing with various aspects of small hydroelectric development including site selection, environmental effects, design, operation, and economic feasibility. Speakers from Ecuador, the U.S., Peru, England, and France participated in the program.

Complete proceedings of the workshop, prepared by the SDH Program staff, are available in Spanish and English on a limited basis.

B. Asia and the South Pacific

NRECA held its second workshop in Bangkok, Thailand, June 8-12, 1981. NRECA, in cooperation with USAID, cosponsored the workshop with the Asian Institute of Technology (AIT) and the National Economic and Social Development Board of Thailand (NESDB). More than 100 attendees from 15 Asian and South Pacific nations heard technical presentations and panel discussions and participated in small discussion groups on subjects ranging from hydrologic methodologies to economic and financial issues pertaining to the development of small-scale, rural hydroelectric projects.

Proceedings of the workshop, prepared jointly by AIT and NRECA, are available.

C. Africa

The third and fourth regional workshops were held in Abidjan, Ivory Coast, March 1-5, 1983 and in Mbabane, Swaziland, June 20-24, 1983.

The Abidjan workshop was attended by representatives from 22 nations of the Central and West African regions. Cosponsored by NRECA, AID, the Union of Producers, Conveyors, and Distributors of Electrical Energy in Africa (UPDEA), and the African Development Bank (ADB), the workshop featured 15 major paper presentations by several SDH staff members and other speakers from Pakistan, Colombia, Ecuador, New Zealand, Germany, Malaysia, Great Britain, the United States and a number of African countries, on a wide range of technical and non-technical subjects in small hydro development. A field case study of a site in nearby Aboisso that is

under consideration by the Government of Ivory Coast for development was conducted. The participants were given four design options for schemes with capacities ranging from several hundred kW to 14 MW and divided into four working groups to study the relative technical and economic merits of each approach. At the workshop conclusion, representatives from each group presented their findings in a plenary session to review the issues that had been raised during the week's presentations in the practical context of a simulated project design.

Proceedings of the workshop, prepared by NRECA, are currently available in English. A French version of the proceedings will be available in November, 1983.

The Mbabane workshop was attended by representatives of 13 East and Southern African nations. Cosponsors of the workshop were NRECA, USAID, the Swaziland Electricity Board, and the Ministry of Works, Power, and Communications of Swaziland.

The week's activities centered around three main training objectives: (1) to provide an introduction to the fundamental concepts of small hydro (including micro-hydro) assessment and development; (2) to establish a set of basic skills required in conducting preliminary feasibility and design studies of projects; and (3) to offer an opportunity to see first-hand what small hydro projects look like and how they operate.

The first objective was addressed through a series of formal plenary session lectures on technical, economic, management, and financing issues. In meeting the second objective, participants were presented with detailed maps and supporting data of an actual site in Swaziland and asked to propose designs for a micro project (70 kW) and a small project (1-5 MW), given certain energy-use circumstances for each case. Field visits were also scheduled to a nearby hydro site where participants could experiment with different methods to make head and flow measurements. The field trips also included visits to several operating small hydro plants, which satisfied the third workshop objective.

On the final day, representatives from each of four working groups presented their respective design proposals in a plenary session. Each group was then required to defend its proposal and to suggest modifications to other groups' designs. The workshop was marked by a high degree of active participation and a spirited exchange of views.

The proceedings, Small Hydropower in Africa, will be published by NRECA in December, 1983. The proceedings will include plenary lectures, case studies, country small hydro profiles that were presented by each African delegation in attendance, a detailed description of the workshop exercises, and a complete record of plenary discussions.

D. Financial issues

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.

E. Private sector participation issues

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.

V. Other activities

A. Invited conference participation

In September 1980, the SDH program manager was invited by the Organization of American States (OAS) to participate on a rural energy panel at the Inter-American Symposium on the Development of Alternative Energy Sources held in Sao Paulo, Brazil.

Two members of the SDH staff were invited by the UN to present papers at the UNITAR Conference on Small Energy Resources in Los Angeles, California, September, 1981. The papers outlined small hydropower potential in developing countries and the SDH Program's efforts to assist these countries in tapping this resource.

In December 1981, the SDH Program's micro-hydro engineer traveled to Nairobi, Kenya at the request of USAID to present an overview on small hydropower with slides at a USAID-sponsored workshop. The workshop was designed for those USAID individuals in African AID Mission countries involved with energy programs.

In June 1982, the SDH Program's micro-hydro engineer was invited by the Organization of American States (OAS) to participate in the Regional Mini-Hydro Workshop, making an oral presentation on appropriate designs and approaches to small hydropower development and participating in a panel discussion on low-cost approaches to equipment design. This workshop, held in Jamaica, is the first of four workshops to be held in the Caribbean area in the OAS biennium 1982-83. The objective of these workshops is to increase capabilities of the participating countries in all stages of mini-hydro development.

In November 1982, a member of the SDH staff presented a paper on "End Use of Small Scale Energy Systems in Rural Areas" at the First U.S.-China Conference on Energy, Resources, and Environment held in Beijing, the People's Republic of China. This paper was also presented at a workshop on the Productive Uses of Rural Electricity of Bangladesh in Dhaka, November 1982.

SDH Program staff members participate regularly as resource people for the Training in Alternative Energy Technologies (TAET) program at the University of Florida in Gainesville. At the request of the TAET program,

which is funded by AID to provide short-courses instruction to AID host-country participants on a variety of energy issues and technologies, SDH Program staff have offered one-day sessions on hydrologic assessment, project design, and equipment selection for small hydro projects.

In December 1983 the SDH Program Manager attended an international conference on Alternative Sources for the Generation of Electricity in Caracas, Venezuela, at the request of the U.S. Embassy, where he presented a paper on small hydropower development in the U.S. and considerations for rural energy based on NRECA experience in the small hydro on developing countries.

B. Miscellaneous

At the request of the Institute of Hydraulic Resources and Electrification (IRHE) in Panama, NRECA's International Programs Division sent the SDH Program's mini-hydro development specialist and a senior power use specialist to develop a promotional program in conjunction with Panama's Five Year Rural Electrification Plan. The two-man team developed guidelines for a complete promotional program based on NRECA experiences in the U.S., Bangladesh, Bolivia, and other developing countries.

In March 1983, the SDH Program's Principal Engineer traveled to Malaysia at the request of the World Bank and the Government of Malaysia to review progress on a major small hydropower program being undertaken with World Bank financing and to recommend measures which could reduce construction costs of projects. A report was provided by NRECA to the Malaysian government outlining a number of recommendations on the areas of civil works design and equipment selection.

The SDH staff also acts as a resource for NRECA's member rural electric systems in the field of small hydropower development. The staff has provided technical advice to member systems on the installation of mini-hydroelectric plants.

VI. Publications

A. Publications completed

Copies of the following SDH Program publications can be obtained by contacting the SDH Program. To receive a publication for which there is a charge, please send a check, payable to NRECA, to the Training and Information Specialist, NRECA/IPD, 1800 Massachusetts Avenue N.W., Washington, D.C. 20036. Add 35% to the listed price for mailing costs in the U.S. and Canada, 80% for Latin America and Europe, or 100% for Africa and Asia. These publications are available at no charge to AID Missions and developing country governments.

Small Decentralized Hydropower (SDH) Program—brochure describing the SDH Program history and activities; also available in Spanish and French (no charge).

Small Hydroelectric Powerplants: An Information Exchange on Problems, Methodologies, and Development—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 Electrificación; available in English and Spanish. Printed editions no longer available; photocopies available for \$12.50/copy.

Country Assessments of Mini-Hydropower Potential: A Methodology—from a country's physical characteristics, conclusions can be drawn on the need and feasibility of a national mini-hydro program; also available in Spanish and French (\$1.50/copy).

Prefeasibility Studies of Candidate Mini-Hydro Sites: A Methodology—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 French (\$2.75/copy).

Hydrologic Estimates for Small Hydroelectric Projects—for estimating stream-flow duration and peak flows in regions where very little data is available (\$2.75/copy).

Environmental Methodologies for Small Hydropower Projects—for assessing environmental impacts of a prospective mini-hydro project (\$3.50/copy).

Directory of Sources of Small Hydroelectric Turbines and Packages—descriptions of U.S. and developing country manufacturers and their equipment lines as well as information on packaged units; second edition now available; also to be available shortly in French (\$3.50/copy).

"Thinking Small: When the Oil Crunch Hit, Pakistan Turned to Small Hydropower," Agenda, January-February, 1982 issue (no charge).

"Rural Power Schemes in Pakistan," International Water Power and Dam Construction, November, 1981 issue—article summarizing the work of the Appropriate Technology Development Organization in implementing micro-hydropower schemes in Pakistan (no charge).

"Pakistan: Villager-Implemented Micro-Hydropower Schemes, A Case Study"—discusses the unusually low-cost approach used to install hydropower plants in remote regions in northern Pakistan (\$3.00/copy).

"Use of Alternative Energy Technologies by U.S. Rural Electric Systems," ELECTRORURAL, November, 1981 issue; article outlines efforts of U.S. rural electric systems in renewable

energy technologies (wind, solar, hydroelectric, biomass, peat, and geothermal) (no charge).

Small Hydro Potential in Developing Countries—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 (no charge).

NRECA's Small Hydro Activities in Developing Countries—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 (no charge).

Centralized vs. Decentralized Management of Small Hydropower—analysis of issues of centralized versus decentralized management approaches (\$2.00/copy).

Evaluating Electrification Experience: A Guide to the Social Evaluation of Small Hydroelectric Units in Lesser Developed Countries—development of criteria from which to build a methodology for evaluating small-scale energy systems (\$6.50/copy).

"Private Sector Participation in Decentralized Hydropower Programs in Developing Countries"—report of a seminar held July 1982 in Washington, D.C. (\$2.00/copy).

"End-Use of Small-Scale Energy Systems in Rural Areas"—paper to be 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 (no charge).

"Nepal: Private Sector Approach to Implementing Micro-Hydropower Schemes, A Case Study"—discusses unique approach using local resources to implement small hydro systems (\$3.00/copy).

Catalogue of Rural Electric Utility and Small Hydropower Training Programs—lists 78 training courses offered by NRECA in the U.S. and abroad in the areas of rural electric utility management, accounting, engineering, construction, operations and maintenance, and small hydropower assessment, design, construction and management (no charge).

Small Decentralized Hydropower for Asian Rural Development—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) (\$12.50/copy).

Small-Scale Hydropower in Africa—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 (\$12.50/copy).

Micro-centrales Hydrauliques en Afrique - proceedings of a workshop held in Abidjan, Ivory Coast March 1-5, 1982 (French Edition) (\$12.50/copy).

B. Publications underway

Small Hydropower in Africa - proceedings of a workshop held June 20-24, 1983 in Mbabane, Swaziland.

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

"The Contribution of Legislative Initiatives such as PURPA Towards Involving the Private Sector in the Development of Small Hydroelectric Powerplants in Developing Countries"—analyzes effects of PURPA on the private sector's involvement in developing small hydropower plants in developing countries.

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