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Private sector participation in decentralized hydropower programs in developing countries

A report

NRECA Small Decentralized Hydropower (SDH) Program

PNAAP 520

Seminar on private sector participation in decentralized hydropower programs in developing countries

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sponsored by:

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In cooperation with the U.S. Agency for International Development
Small Decentralized Hydropower (SDH) Program

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Small decentralized hydropower program

This publication is one of a series that fosters the effective use of small decentralized hydro-electric power systems. This series is published by the Small Decentralized Hydropower (SDH) Program, International Programs Division, National Rural Electric Cooperative Association (NRECA). NRECA operates the SDH Program under the terms of Cooperative Agreement AID/DSAN-CA-0226 with the Office of Energy, Science and Technology Bureau, U.S. Agency for International Development.

Under the agreement, begun in May 1980, NRECA provides a broad range of technical assistance to developing countries. NRECA provides assistance by:

- designing and implementing regional workshops in Africa, Asia, and Latin America
- developing and conducting in-country resource surveys and site assessments
- providing engineering, supervision, and specialized assistance
- developing specialized publications such as state-of-the-art reports, inventories of manufacturers, and assessment methodologies
- conducting special studies on issues pertaining to finance, management, evaluation, and other subjects
- providing training services in such topics as operation and maintenance, resource assessment, equipment fabrication, and institution building
- carrying out specialized services such as tours of U.S. manufacturing plants and small hydro sites and seminars on private sector involvement
- creating specialized products such as productive-use plans for energy from small decentralized hydropower.

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I. Introduction

Since its inception in May, 1980, AID's Small Decentralized Hydropower (SDH) Program has sought to provide timely and appropriate assistance to developing countries interested in pursuing small decentralized hydropower development. To serve this overall objective, AID has recognized the important potential role of the private sector, both in the U.S. and in the developing countries themselves. There remains a keen interest on the part of many of these countries to learn more about the capabilities of small hydro technology, including that which has been developed in the U.S. In order to expose developing countries to U.S. technology in this field, AID, through its SDH Program, has sponsored a number of activities and materials which reflect the state-of-the-art of small hydro technology in the U.S. Among the more prominent of these, the SDH Program has:

- conducted several regional workshops overseas where U.S. manufacturers and engineering consultants have exchanged information on equipment and services they can provide
- developed a directory of U.S. manufacturers and equipment suppliers for wide distribution throughout the world
- included a number of U.S. engineering specialists on its country survey teams in order to expose U.S. technical capabilities to developing countries.

While these efforts represent a good beginning, AID, working in cooperation with the National Rural Electric Cooperative Association, believes the time has arrived to study means of expanding the role of private sector participation in the development of small decentralized hydropower in the Third World. Further impetus for this awareness has come from the Administration's recent initiative to promote government-wide private sector participation in U.S.-supported efforts abroad.

In order to capitalize on this heightened awareness of the importance of developing new means for private sector participation in the implementation of its small hydro development assistance program, AID and NRECA sponsored a two-day seminar on private sector participation in small decentralized hydropower programs in developing countries. Representatives from the manufacturing sector, the engineering consulting industry, and private developers of small hydro were brought together with officials from various AID bureaus and offices and other U.S. agencies to discuss the salient issues pertaining to expanded private sector participation, and to formulate recommendations for courses of action AID may pursue to accelerate and facilitate the participation of U.S. firms in the development of small hydro programs in where AID small hydro projects exist or are planned. The issues considered during the seminar included:

- what is the appropriate role of the U.S. private sector in the development of small hydro in developing countries?
- what opportunities exist for indigenous private sector development of small hydropower in the developing countries?
- what are the means of creating linkages between U.S. private sector activities and indigenous private sector investment in SDH in the developing countries?
- how can U.S. equipment and consulting services gain a better competitive position in developing countries, given the apparent advantage of European, Japanese, and other suppliers?
- what specific actions are needed to improve the U.S. competitive position from a technical and a marketing point of view?
- in what ways can the U.S. foreign assistance programs, in particular the SDH Program, be modified to enhance U.S. private sector involvement?

The seminar also presented an opportunity for AID and SDH staff members to brief industry representatives on small hydro activities worldwide, and the activities of AID in the SDH field in particular. In addition to these briefings, a series of country profiles (see Appendix C) were distributed to participants as an example of informational services that could be made available to the U.S. private sector.

What follows is a brief record of the discussions which took place, and the findings and recommendations that were reached.

II. Record of proceedings

Tuesday, July 27 - Morning Session

Samuel E. Bunker, Administrator of NRECA's International Program Division (IPD), opened the seminar by welcoming the participants and by providing a brief summary of IPD's activities. Mr. Bunker highlighted the history of IPD's cooperative relationship with the U.S. Agency for International Development (USAID) over the last 20 years and the Division's scope of work in rural electrification in the developing countries.

Charles Robinson, Acting General Manager of NRECA, welcomed the participants and briefly reviewed NRECA's history and its services to its member systems.

Jack Vanderryn, Director for Energy and Natural Resources for USAID, introduced the participants to the seminar by providing an overview of AID's activities in conventional and renewable energy, forestry and other resurce programs. He expressed AID's desire to work more closely with the private sector in its development assistance programs and asked the participants to develop useful recommendations on how the SDH program can provide assistance to the private sector.

Edgar Harrell, Deputy Assistant Administrator, Bureau for Private Enterprise, USAID, provided a review of AID's activities to promote a privte sector involvement in its bilateral assistance programs. Mr. Harrell also advised participants of the activities of the Trade and Development Program, a component of IDCA, which assists private sector enterprise overseas in economic and development programs.

David Zoellner, Manager of the Small Decentralized Hydropower Program, briefed the participants on SDH's five major program activities, provided country summaries and introduced SDH staff. SDH's major activities include resource identification, site selection and project design, the development of SDH data and information base, training and workshops. SDH has provided technical assistance in these areas to over 15 countries in Asia, Africa, the Caribbean and Latin America. Other SDH activities include three regional small hydro workshops in Ecuador, Thailand and the Ivory Coast, and the publication of country assessments, methodologies and studies on key problem areas of small hydro development in developing countries. To meet the special training needs of developing countries SDH has developed a six-week intensive training program for mid-level engineers, planners and project managers on the various aspects of small hydro planning, design and implementation.

An overview of AID's conventional and renewable energy program activities was provided by William Eilers, Acting Deputy Director of AID Office of Energy. Mr. Eilers

explained the functional breakdown of AID's energy office activities by region and introduced the representatives from the four regional bureaus.

Mark Ward, Energy Advisor for AID's Africa Bureau, summarized AID's activities in the region. AID's Africa programs have adressed the continent's most pressing problems—an alternative to oil to energize its modern sector and the depletion of its traditional energy sources, mainly wood and crop fuel, for its rural sector. The Africa Bureau has emphasized programs which utilize light small-scale renewable energy applications. AID has explored the possibility of small hydro development in several African nations, but has been able to follow through only in one to date.

Carolyn Coleman, Program Analyst for AID's Near East Bureau, stated that the bureau has worked in hydro development only in Morocco, a country with little hydro potential. However, she mentioned that the various missions are interested in increased hydro development activity in the Near East region, especially in the areas of training and institutional development.

In the Americas, James S. Hester, Chief Environment Officer for the Latin American and Caribbean Bureau stated that AID's most active hydro programs are in Peru and the Dominican Republic. AID has placed several million dollars in project and institutional development in these two countries.

Robert Ichord, Senior Energy Advisor for the Asian Bureau, briefly outlined AID's current program activities in Thailand and stated that follow-up is anticipated in Indonesia, Pakistan and possibly Bangladesh, although rivers in Bangladesh are of very low head.

Jack Fritz of the Board on Science and Technology for International Development (BOSTID) of the National Academy of Sciences described BOSTID's activities in evaluating renewable energy technologies for use overseas. Mr. Fritz, who formerly served in AID's Energy Office, briefly highlighted the beginnings of the SDH Program and its objectives, and suggested that greater effort be directed toward staffing AID programs and Mission offices with fewer "development generalists" and more technically competent specialists who can develop genuine counterpart working relationships with local technicians. He also suggested that greater attention be given to research and development of small hydropower technology that is technically and economically appropriate to developing country requirements. For example, he noted that most small hydro activity in the U.S. is centered around low-head applications and the regulatory and licensing requirements associated with the development of these projects. He questioned whether this emphasis is relevant to developing countries.

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Tuesday, July 27 - Afternoon Session

The afternoon session included two panel discussions focusing on private sector perspectives from U.S. hydro manufacturers, and U.S. engineering consultants and developers, respectively.

Panel of U.S. Manufacturers

William Eilers, Office of Energy USAID (Moderator)
William H. Delp, Independent Power Developers
John R. Brown, James Leffle & Company
Mike Johnson, Little Spokane Hydroelectric
Gary Kitching, Small Hydro Electric Systems and Equipment
Daniel New, Canyon Industries
Duane Sachs, Generators Unlimited
Robert Hayden, Renewable Energy Institute

The manufacturers addressed questions involving technology transfer, training, research areas, information exchange, marketing and finance. A general consensus was formed on the need for standardization of small hydro machinery and the industry. The lack of performance standards and the inability of the U.S. firms to compete with standardized European and Japanese equipment has made U.S. manufacturers less competitive in developing countries. The need for infrastructure, service industries and the level of specification complexity were seen as considerations in technology transfer. The shortage of foreign reserves in developing countries, and the lack of creative financing for U.S. small hydro equipment sales and guarantee mechanisms were seen as obstacles to effective U.S. private sector participation. Demonstration sites and site visits in the U.S. were held as viable marketing and training tools. Regional or country demonstration sites were suggested as well as centrally located U.S. site with a cross section of U.S. equipment for display and training purposes. It was noted that provisions must be made to select the trainees who are sent to the U.S. who are capable of transferring the knowledge gained from site visits and training programs to others.

Suggestions made for encouraging U.S. manufacturers to become more involved in small hydro technology transfer to developing countries included:

Financing

- making funds available for prefeasibility and feasibility studies and let the private sector bid for these funds and projects competitively.
- targeting AID funding more directly at U.S. manufacturers and suppliers as a general policy.

- providing financial assistance, including guarantees, to U.S. manufacturers to make them more competitive with their OECD and Asian counterparts
- initiating discussions between industry and the Trade and Development Program, Exim Bank and other U.S. institutions designed to promote U.S. goods and services abroad with the goal of modifying their lending and funding criteria to include smaller projects.

Marketing

- increasing U.S. hydro industry exposure through demonstration projects, through greater person to person contact, and trade missions overseas
- developing a coherent national trade policy on an industry-by-industry basis.

AID's Role

- developing its philosophy of technology transfer to add credibility to its program
- putting more emphasis behind programs that serve both the concerns of manufacturers and AID development objectives (one panelist felt that current AID projects do little to generate immediate sales which is an important factor in getting the private sector involved)
- distributing information on available U.S. equipment and advising U.S. manufacturers of market opportunities and conditions
- developing a procedure by which manufacturers can remain in closer contact with AID
- enlisting manufacturers' assistance in training programs.

Panel of U.S. Engineering Consultants and Small Hydro Developers

Bard Jackson, NRECA (Moderator)
Richard Hesse, American Consulting Engineers Council
G. J. Pete Smith, Energenics Systems, Inc.
Peter McGrath, American Hydro Power Co.
Walter Lawrence, Consultant

The problems perceived by this panel were similar to the conclusions of the panel of manufacturers. Risks in doing business in developing countries are heightened by the lack of pertinent information, problems of cash flow and infrastructural inadequacies, and the inability of U.S. firms to participate in attractive and creative financial packages to compete with other industrialized countries.

The role of the small hydro developer was seen as identifying sites, acquiring equipment, subcontracting firms and developing financial packages. Developers could make equity investments and funnel monies from the U.S. private sector to projects overseas. Also the developer could assist in translating projects into models for a

country or region. However, for the developer, institutional factors were seen as the critical consideration in investing in developing countries. AID and NRECA could assist them by:

- screening projects in terms of institutional capabilities, and providing training and other institutional and administrative assistance
- providing information on other constraints, such as availability of materials and costs.

It was also recommended that NRECA and AID utilize the multidisciplinary capacity of the large engineering firms. It was pointed out by representatives of two large engineering firms that they could make equity investments, especially when there is the possibility of larger hydro projects. The American Consulting Engineers Council could identify capable firms for projects and help to establish important data banks.

To overcome the cash flow constraint in developing countries and assure the U.S. private sector of payment for their services, AID could:

- maintain a "hedging" fund in U.S. currency
- negotiate contracts with developing country governments and then subcontract to the U.S. private sector
- investigate tax credits for overseas investment in renewable energy projects and co-financing through OPIC
- investigate the possibility of bartering for services (e.g. Brazil developing hydro sites in exchange for oil from Angola).

However, in addition to implementing these recommendations, a coherent rational export policy that integrates trade activities under one umbrella was seen as paramount. Also, it was felt that any discussion on the private sector involvement in AID's hydro program required high level policy discussions and decisions at AID.

Wednesday, July 28 - Morning Session

Peter A. McGrath, President of American Hydro Power Company outlined perceived barriers to U.S. private sector involvement and the possible role for AID in reducing the risks involved. Mr. McGrath described the problems as being a lack of pertinent information involving market sales and power demand, the structure of utility ownership, potential sites, site characteristics, and local costs, regulatory and financial uncertainties; and currency rate fluctuations and the general political and economic instability of developing countries. AID could minimize these risks by supplying

pertinent information and technical data through seminars between utility officials, government power officials, site owners and developers. It was suggested that AID, acting as liaison between the U.S. developer and the utility, could negotiate contracts and then subcontract to the developer.

Theodore W. Schlie of the Office of Competitive Assessment, U.S. Department of Commerce, briefed the participants on its efforts to guide U.S. regulatory and policy actions for making U.S. industry more competitive through the Competitive Assessment Program. Micro as well as macro impacts of federal actions on specific sectors of U.S. industry have been assessed with the objective of developing policies that made U.S. industries more competitive abroad.

Edmund K. Leo, Chief of the New and Renewable Energy Section of the U.N. Department of Technical Cooperation for Development gave a brief summary of its hydro program's scope of work and its objective. The objective of the U.N program is to identify and evaluate potential sites for electricity generation and distribution to small isolated rural areas in the third world. Eventually assessments will be made in a total of 42 countries. The program, initiated in November 1980, is currently in its second phase. To date, surveys have been conducted in over 12 countries. Several sites with exploitable potential have been idetified, and recommendations have been made for follow up. The third phase of the program, scheduled for May 1983, may include hydropower assessments in 10 countries in Africa, three in Asia, and two in Latin America.

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III. Findings and recommendations

During the afternoon session on Wednesday, July 28, the participants divided into three workshop discussion groups to formulate recommendations to AID on the best means of expanding private sector participation in the development of small hydro systems in the developing countries. One group consisted of U.S. manufacturers, another of U.S. engineering consultants and firms, and the third of U.S. private developers of decentralized hydropower projects. A listing of the participants in each of the groups appears in Appendix B. Spokesmen for each of the groups then reported in a plenary session on the findings and recommendations of their respective groups.

Findings

In general, the groups reported that opportunities do exist for U.S. firms to become more directly involved in AID's small hydro activities. These included:

- direct participation in the activities of AID's Small Decentralized Hydropower Program;
- opportunities for co-venturing relationships between U.S. firms, AID and other agents of U.S. development assistance programs, and the developing countries; and
- training programs

The specific findings of the three groups were most striking in their similarity and the confluency of views supporting the group recommendations. Each group saw a need for improving informational support from AID to U.S. firms on its activities and findings in the field related to small hydropower development. Each saw a need to expand AID's role in marketing U.S. small hydro technology and expertise. Each saw a role of U.S. firms in providing training assistance to developing countries. And, among other findings, each group saw a need to strengthen the coordination of U.S.-supported programs and activities.

Recommendations

1. Broadening of U.S. Private Sector Participation. The groups uniformly recommended that AID expand the use of U.S. private firms in carrying out its development assistance objectives for decentralized hydropower in the developing countries. It was recommended that this be accomplished in the following ways:

a. increase the utilization of representatives from the private sector in its field survey and project identification activities;

b. increase the utilization of representatives from the private sector as resource

persons at workshops and other information-exchange and training sessions;

c. develop roles for private firms in AID's small hydro training programs, including a specific recommendations for an "internship" program for developing country nationals to spend periods of time with manufacturing and private developer firms to gain on-the-job training and experience; and

d. prepare a concept paper on the feasibility of participation of U.S. firms in joint-ventures with developing countries for local manufacture of equipment and for engineering and development of decentralized hydro systems. Such a concept paper should include the formulation of criteria for identifying joint-venture opportunities, a general model for executing joint-venture projects, and an overall strategy for implementing a joint-venture program between U.S. firms, AID and other agents of U.S. development assistance programs, and appropriate groups within the developing countries.

2. Informational Support Activities. A second area universally addressed by the groups in their recommendations was the provision of timely and accurate information on LDC projects, conditions, and needs relating to small hydro development in the developing countries. These included:

a. expanding current information and data collection to include accurate and up-to-date information on hydrologic and hydraulic data on regions and sites with small hydro development potential, utility systems and rates, political conditions and institutional arrangements including key contacts in relevant organizations and ministries, and overall and site-specific economic development priorities and needs; and

b. providing such data on a regular and timely basis to U.S. firms, including copies of reports and studies conducted under AID auspices.

3. Marketing of U.S. Technology. All three groups recommended taking steps to improve AID's efforts to market U.S. small hydro equipment and expertise. These included:

a. efforts to heighten the awareness in developing countries of the benefits of small hydro systems;

b. increasing the exposure of U.S. technology and equipment to developing countries by expanding opportunities for representatives of U.S. firms to travel to developing countries;

c. expanding current literature prepared under AID's auspices which gives information and specifications on U.S. equipment and technical capabilities, including the development of a directory of U.S. private developer firms;

d. inviting representatives of U.S. firms to participate in workshops and other information-exchange sessions, including possible funding assistance for such participation;

e. scheduling tours of U.S. manufacturing firms and sites developed by private firms in the U.S. for key developing countries nationals;

f. funding demonstration projects exhibiting U.S. equipment and expertise, including projects in the developing countries which demonstrate the success of private development approaches for small hydro system implementation and management; and

g. developing a "match-making" role within AID's small hydro program to bring U.S. firms together with appropriate groups in the developing countries for joint-ventures or other public or privately supported cooperative ventures.

4. Project Development and Implementation. Several recommendations were made regarding AID's approach to executing projects. These included:

a. strengthening generally the technical quality of AID's small hydro programs and projects;

b. ensuring that project designs are carefully drawn to the proper specifications according to the project's requirements so that the resulting systems perform well technically and economically—it was recommended that individuals familiar with the equipment and materials to be used should participate in the design and specifications stage for this reason;

c. developing industry-wide standards to ensure that U.S. suppliers can provide uniformly high-quality, low-cost, and technologically appropriate equipment;

d. make absolutely certain that U.S.-supported projects using U.S. equipment, particularly in the early stages of a country program, perform according to expectations and are not "flops";

e. emphasizing a "total system" approach to project development so that the necessary support/service industries are present in the country to keep small hydro projects functional; and

f. recognizing the importance of waterpower projects as multi-use investments which have implications for other uses of water and environmental standards.

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5. Improving the Coordination of U.S. Programs and Industry. Recognizing that U.S. development assistance, and small hydro assistance in particular, is supported by numerous agencies in the U.S. government and within AID itself, the groups recommended a number of steps to improve the coordination of effort within the government and between the government and industry, including:

a. coordinating AID's diverse activities in small hydro development, particularly in the area of training;

b. improving the communication between AID Mission personnel involved in small hydro projects and Commercial Officers in the U.S. Embassies to enable the latter to provide more timely information on investment or sales opportunities to U.S. firms;

c. improving the strategic operation of various development assistance bureaus within AID in closer cooperation with other U.S.-supported agencies, particularly financial institutions, to assist in the on-going development of small hydro programs after AID support for such programs lapses; and

d. generally strengthening the liaison between government and industry in the development of U.S.-supported small hydro projects in the developing countries.

Appendix A

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Appendix B

Workshop Discussion Groups

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Appendix C

COUNTRY MINI-HYDROPOWER PROFILES

It is estimated that some two-thirds of the world's hydropower potential exists in the developing countries of Latin America, Africa, Asia and the Pacific Islands. Of the world total, about 29% is found in Latin America, 16% in Africa, and 30% in the Asia/South Pacific region. In terms of small hydropower, very little of this potential has been developed.

In order to provide summary information on a number of countries that are pursuing small hydro development, brief country profiles on twenty selected developing countries are attached. These contain certain vital statistics, key contacts and references pertaining to small hydro activities, and a short descriptive commentary on each country's small hydro potential and efforts currently underway to develop it. The information presented here is representative of the kind of data the SDH Program staff collects from various sources on both small and large hydropower development, and updates on a regular basis for general distribution. An asterisk(*) appears after countries where USAID has a presence.

COUNTRY: Bangladesh*

Population: 88.9 million

Per capita GNP: $90

Total power sector installed capacity: 833 MW

Total hydro capacity: 110 MW

a) grid-connected: 80 MW b) auto-generated: 30 MW

Average national kWh rate: 2.9

Estimated hydropower potential: 1,307 MW

Comments: Blessed with ample water supply and a monsoon climate, Bangladesh shows considerable promise for development of small hydropower despite the absence of significant heads throughout most of the country. The majority of this potential lies on existing or planned irrigation barrages and canals. An NRECA team reviewed a number of these sites in 1981. In the Chittagong Hill Tracts, Sylhet, Mymensingh and Tanralpur Districts, the team identified eight feasible sites totalling about 1 MW of capacity. In the Rangpur-Dinajpur Districts, considerably greater potential exists (about 12 MW), including 400 kW of capacity at five barrages and up to 11 MW at the Teesta Barrage Project currently under construction. The Water Development Board (WDB), which controls this project, is reported to be resisting efforts to include power generation as part of this project, and is speeding up construction to discourage this option. Other agencies responsible for small hydropower development are the Power Development Board (PDB), and the Rural Electrification Board (REB), a more recently formed organization. All three are under the direction of the Ministry of Power, Water Resources and Flood Control.

Key references:

NRECA (1981). "Bangladesh: An Assessment of Small Hydropower Potential."

WDB (1981). "Prospect of Low Head Hydropower Generation in the Irrigation Canals, Teesta Barrage Project."

Mahmood, S.T.S. (1982). "Prospect of Small Scale Hydro Power Development in Bangladesh." Proceedings of a Workshop on Small Hydropower for Asian Rurual Development, NRECA.

Key contacts:

Aminul Islam, Chief Planning Engineer, WDB.

Masud Hassan Jamali, Chief Staff Officer, PDB.

L. K. Siddiqui, State Minister, Ministry of Power, Water Resources and Flood Control.

Susan Downs, USAID/Dacca.

COUNTRY: Dominica*

Population: 0.1 million

Per capita GNP: $400

Total power sector installed capacity: 6.6 MW

Total hydro capacity: 2.8 MW

a) grid-connected: 2.8 MW b) auto-generated: 0

Average national kWh rate: N/A

Estimated hydropower potential: N/A

Comments: Run-of-river small hydro systems comprise 43% of the existing generating capacity Dominica. Diesel power is used mainly to supplement hydro generation during seasons of low flows and peak demands. The East Coast of the island, unserved by the grid, has been viewed as ideally suited for small hydro development due to the cost of extending the grid to the area. NRECA has assessed six sites on the East Coast (Nyson, Savane, Malabuka, O'Hara, Demitre, Layou) and determined that SDH is technically feasible, but economic and institutional problems pose serious problems. The team suggested that the financial viability of SDH at Malabuka and Nyson could be enhanced by combining SDH with the reconstruction of two village water supply systems at Bagetelle and Petite Savane. Because the potential hydropower capacity of 400 kW at Layou River far exceeds the power needs of the surrounding community, the team recommended that the site be developed only if generated power could be delivered to the grid. The team also identified six rivers suitable for gauging which will serve to enhance the Dominican meteorological and hydrological data collection and analysis capabilities. Other East Coast sites have been evaluated by the Canadian International Development Agency (CIDA) and Appropriate Technology International (ATI). The Organization of American States is also planning to fund a small hydro development program.

Key references:

NRECA (1981). "Dominica: An Assessment of Small Hydroelectric Potential."

UNIDO (1980). "Mini-hydro Electric Generation in Jamaica and Other Countries of the Caricom Region." ID/WG.329/14.

OAS (1982). "Report of the First Workshop on Multinational Mini-Hydro Power Generation Project." Ocho Rios, Jamaica.

Key contacts:

Justinian Coipel, Ministry of Communications, Works and Tourism, Ros[illegible]

Alex Sunderman, USAID/Barbados.

COUNTRY: Dominican Republic*

Population: 5.3 million

Per capita GNP: $990

Total power sector installed capacity: 987 MW

Total hydro capacity: 159 MW

a) grid-connected: 159 MW b) auto-generated: 0

Average national kWh rate: 5.2

Estimated hydropower potential: N/A

Comments: The development of small-scale hydropower is extremely attractive for the Dominican Republic. There is an abundance of water resources and existing small hydro experience within the country. The GODR policy is to increase investment in hydroelectric facilities to both displace the existing use of fossil fuels and to develop new decentralized hydro sites in areas now without electrification. A preliminary study has identified over 40 sites and there is potential for many more. In the near future AID will be funding 2 demonstration projects. The World Bank is considering a $50 million loan package for the construction of a 25 MW hydro facility at Rio Blanco and possible future funding of hydroelectric dams on the Upper Yague el Norte and Bao River basins. The Inter-American Development Bank (IDB) has loaned $64 million for development of a hydroelectric plant with an 18 MW capacity and is considering a possible $30 million loan for mini-hydro development in FY 1983.

Key references:

NRECA (1981). "The Viability of an AID Financed Small Hydro Program in the Dominican Republic."

NRECA (1981). "Site Selection Methodology for Small Hydroelectric Power Plants."

USAID (1981). "Energy Conservation and Resource Development: Dominican Republic." Project Identification Document (PID).

Key contacts:

Daniel Bolden T., Director de Planificacion, Corporacion Dominicana de Electricidad.

Allen Merrill, USAID/Santo Domingo.

COUNTRY: Ecuador*

Population: 8.1 million

Per capita GNP: $1050

Total power sector installed capacity: 857 MW

Total hydro capacity: 214 MW

a) grid-connected: 204 MW b) auto-generated: 10 MW

Average national kWh rate: 4.4

Estimated hydropower potential: 22,000 MW

Comments: To date, Ecuador has developed only 1% of its theoretical hydro potential. The Government has initiated an ambitious hydro development program with the objective of relegating thermal and other generation to only a supplemental role. The World Bank recently funded a country-wide assessment of hydropower potential conducted by the National Reinvestment Fund of Ecuador (FNR). Decentralized micro hydro generation is the main focus of the government's rural electrification program because geographic disparity in the mountains, foothills and plains precludes integration of rural areas into the national grid. The National Electrification Authority (INECEL) has established a micro hydro office within its rural electrification and planning division and is undertaking to develop or restore over 70 micro hydro stations in the 50 to 100 kW range. The micro hydro group of the National Energy Institute (INE) is studying and evaluating the components of the many non-operating small hydro units of 500 kW - 5000 kW that have existed since the 1900s. INE has also established a national technological development center to develop local expertise for small hydro design, development, manufacture, research, and training.

Key references:

Golarza, Leoncio (1980). "Micro Hydro Powerplant Program in Ecuador." Proceedings of a Workshop on Small Hydroelectric Powerplants, NRECA.

Moran, Eduardo (1982). "Micro-Hydroelectric Generation Program of Ecuador." Proceedings of a Workshop on Small Scale Hydropower in Africa, NRECA.

Key contacts:

Dr. Carlos Quevedo, Director National Energy Institute (INE), Quito, Ecuador.

Leoncio Galarza, Director of Planning Ecuadorian Institute of Electrification (INECEL), Quito, Ecuador.

Leo Garza, USAID/Quito.

COUNTRY: Ghana*

Population: 11.3 million

Per capita GNP: $400

Total power sector installed capacity: 898 MW

Total hydro capacity:

a) grid-connected: 790 MW b) auto-generated: 0

Average national kWh rate: 0.8

Estimated hydropower potential: 1,615 MW

Comments: Ghana exhibits few characteristics conducive to the development of decentralized hydropower status. The climate is generally dry, since rainfall is concentrated in one or two brief wet seasons, and most rivers and streams have very gradual gradients. In a study of western Ghana in 1981, an NRECA team identified only two potential hydro sites, both requiring extensive civil works due to extremely low heads and intermittent flows. The team learned that the Government may be interested in developing three sites on the Tano, Ankohia and Pra Rivers in the western region totalling, 72 MW of capacity. The team recommended that further study be concentrated in other regions of Ghana, including two sites in the Volta Region (Wli Falls, Hohee, and Amedzafe Falls, Amedzofe), one in the Eastern Region (Boli falls, Koferidan), and one in the Brong-Alafo Region (Fullers Fall, Kintampo).

Key references:

NRECA (1981). "Analysis of Rural Electrification in Ghana with Special Emphasis on Western Regions and Mini-Hydro."

Key contacts:

Robert Ankrah, Volta River Authority.

C. W. Adam, Electricity Corp. of Ghana.

Clarence Kooi, Energy Advisor, USAID REDSO/W.A., Abidjan, Ivory Coast.

COUNTRY: Indonesia*

Population: 142.9 million

Per capita GNP: $370

Total power sector installed capacity: 4,143 MW

Total hydro capacity: 350 MW

a) grid-connected: N/A

b) auto-generated: N/A

Average national kWh rate: 6.2

Estimated hydropower potential: 31,000 MW

Comments: Indonesia has a substantial potential for hydropower development. Government estimates total 31,000 MW; 5,580 MW for Kalimantan, 4,650 MW for Sulawesi, 3,720 MW for Sumatra, 2,480 for Java, and 14,570 MW for Irizu Jaya (inhabited by only 1% of the population). Hydroprojects planned for completion by 1989 include: four projects on Java totaling 1,583 MW, 6 projects on Sumatra totaling 308 MW, 2 projects on Kalimantan totaling 72 MW, 5 projects on Sulawesi totaling 236.5 MW and on Irian Jaya, 1 project for 13 MW. The Japanese are conducting a two-year national inventory of sites with potential greater than 5 MW. Bilateral assistance with small hydro sites is being provided by the UK, France, New Zealand. The World Bank and Asian Development Bank are both interested in funding sites in Indonesia. The Ministry of Mines and Energy (MME) coordinates all energy sector activities and the Directorate General of Power is responsible for promotion and supervision of the power industry. Perosahaau Umum Listrik Negarz (PLN) is the public utility.

Key references:

World Bank (1981). "Indonesia: Issues and Options in the Energy Sector."

Key contacts:

Dr. Samaun Samadikun, Director General of Power, MME.

Professor Suryono, Senior Advisor, PLN.

Mr. Robert Davis, Chief, Power, Transportation and Engineering, USAID/Jakarta.

COUNTRY: Jamaica*

Population: 44.2 million

Per capita GNP: $1,260

Total power sector installed capacity: 249 MW

Total hydro capacity: 15.6 MW

a) grid-connected: 15.6 MW b) auto-generated: under 1 MW

Average national kWh rate: 8.4

Estimated hydropower potential: N/A

Comments: Over the next five years the Government plans to develop 22 MW of hydropower generating capacity. The present installed hydro capacity is 15.6 MW, generated for the most part by three small hydro stations built 20 years ago. Recently, the Government received a $31 million loan from West Germany to finance construction of six hydroelectric powerplants with a total generating capacity of 18.6 MW. The Jamaica Public Service has received permission to develop three other stations in the one megawatt range. The Scientific Research Council has developed a 10 kW station, using community water supply and a reverse pump turbine. The Council also is investigating the feasibility of electricity generation from gravity-fed pipes on existing water and irrigation systems. In 1976, a hydropower survey by Motor Columbus Consulting Engineers identified five sites in the Blue Mountain Region and in the middle and western regions of the island with a combined hydropower generating capacity of 20 MW. The site potentials range from 1.4 to 7 MW. The Government plans to develop autogenerating schemes or mini grids for isolated farming communities; however, plans include integration of small schemes into the national grid. The Renewable Energy Development Division has initiated a program to solve the technical problems associated with grid-connected small hydro on the island. Other small hydro activities will be undertaken by a Renewable Energy Development Station, to be financed through a bilateral agreement with Sweden, and a demonstration site to be developed under funding from the Organization of American States.

Key references:

UN (1982). "Environmental Profile of Jamaica." Man and the Biosphere Secretariat.

UNIDO (1980). "Mini Hydro Generation in Jamaica and Other Countries of the Caricom Region."

Key contacts:

Dennis Minott, Regional Coordinator, Caribbean Alternative Energy Programme, Scientific Research Council.

Ainsworth Lawson, Ministry of Mining and Energy.

COUNTRY: Morocco*

Population: 19.5 million

Per capita GNP: $740

Total power sector installed capacity: 1,166 MW

Total hydro capacity: 465 MW

a) grid-connected: 449 MW b) auto-generated: 16 MW

Average national kWh rate: 4.7

Estimated hydropower potential: 975 MW

Comments: As part of its renewable energy development project in Morocco, USAID is collaborating with the Ministry of Energy and Mines in developing the capacity of the Center for Renewable Energy-Development (CDER). As part of this effort, USAID is funding the costs for the turbogenerating equipment for several small decentralized hydropower projects being developed in the High Atlas mountains in the central part of the country. These range from about 100-500 kW capacity each. The Office Nationale de l'Electricite' (ONE) has been given the responsibility for the installation and management of these schemes. A number of other plants are being considered for future development by the Government of Morocco as part of a larger project.

Key references:

USAID (1981). "Morocco Renewable Energy Development Project."

INCOMAG (1981). "Selected Sites for Hydroelectric Plants in the Province of Ovarzazate."

Key contacts:

Abdellatif el Ghorfi, ONE.

Gary Brecker, USAID/Rabat.

COUNTRY: Pakistan*

Population: 79.7 million

Per capita GNP: $260

Total power sector installed capacity: 3,678 MW

Total hydro capacity: 1,665 MW

a) grid connected: 1,567 MW b) auto-generated: 95 MW

Average national kWh rate: 3.5

Estimated hydropower potential: 20,000 MW

Comments: Before the creation of the Water & Power Development Authority (WAPDA) in 1958, the Government of Pakistan had already installed several small hydropower units in the megawatt range along irrigation drops in their extensive irrigation network. Later because of the wide scope of their mandate, which includes the generation, transmission, and distribution of power, WAPDA has found it difficult to devote much time to small hydropower. The northern regions of the country are mountainous with innumerable isolated villages and it was for this area that the Government of Pakistan bought 100 "standardized" 50 kW and 100 kW units. To date only about a dozen sites are operational. High costs and difficulties of management have prevented progress in this area. The Appropriate Technology Development Organization (ATDO) has undertaken to develop village-implemented projects at the low end (5-15 kW) locally manufactured turbines, simple system designs, and community assistance. About fifty plants, at various stages between planning and operation, have been implemented, at an installed cost of about $500/kW. USAID is currently in the project paper stage for a $20 million energy program of which $2 million has been allocated to assist with the development of a small hydropower program in the North West Frontier Province.

Key references:

NRECA (1981). "Pakistan-Villager-Implemented Micro-Hydropower Schemes: A Case Study."

Key contacts:

Waseem Khan, WAPDA.

Mohammed Abdullah, ATDO.

Charles Moseley, USAID/Islamabad.

COUNTRY: Panama*

Population: 1.8 million

Per capita GNP: $1,400

Total power sector installed capacity: 516 MW

Total hydro capacity: 166 MW

a) grid-connected: 166 MW

b) auto-generated: under 1 MW

Average national kWh rate: 7.5

Estimated hydropower potential: 2,400 MW

Comments: There is considerable potential for the development of hydropower of all scales in Panama. Many sites have already been identified, ranging from 1.5 MW to 264 MW. The Institute of Hydraulic Resources and Electrification (IRHE) has developed a program for microhydro power development designed to provide electric service to communities remote from the existing and planned grid. Under USAID funding, two demonstration sites were completed in 1981 (10 kW and 50 kW), and bids are being taken for four more sites under 100 kW. Forty additional sites are expected to be developed under this program, with medium-high heads and under 200 kW of capacity. It is expected that equipment for at least the next four sites will be purchased in the U.S. The Government is also interested in developing in-country capability to manufacture equipment.

Key references:

World Bank (1980). "Panama: Energy Sector Memorandum," L. A. and the Caribbean Regional Projects Department.

UNIDO (1974). "Panama's Mini Hydro Electric Plants Programme."

USAID (1979). "Panama Project Paper: Alternative Energy Sources," AID Project Number 525-0207.

Key contacts:

Jorge Cedeno, Manager of Technical Studies, Inst. Hydroelectric Resources, IRHE.

Julio Villafanae, USAID/Panama City.

COUNTRY: People's Republic of China

Population: 964.5 Million

Per capita GNP: $260

Total power sector installed capacity:

Total hydro capacity: 20,320 MW

a) grid-connected: N/A

b) auto-generated: N/A

Average national kWh rate: 5-6

Estimated hydropower potential: N/A

Comments: It is reported that there are as many as 92,000 decentralized hydropower stations of 12 MW or less in China, contributing about 6,680 MW of installed capacity. Current plans call for increasing this by 1.5 million kW each year during the current decade and by 2.0 million kW during the next decade. China estimates that it has 378,500 MW of exploitable hydropower capacity remaining to be developed, with two-thirds of that centered in the Southwest region of the country. Equipment used is almost exclusively Chinese-made; over 100 plants throughout the country proudce a million kW of small hydro machinery annually, including 83 different turbine designs capable of operating at heads of 2.5 to 400 meters. Little is known in the West about the quality of Chinese hydraulic and electric equipment, although it is reported that low efficiency and power factors which characterize the lower range of the system contribute to excessively low capacity utilization rates. China is said to be interested in improving various aspects of its electric power systems, including transmission facilities, load management systems (including communications facilities), and relay protection equipment.

Key references:

Taylor, R. (1982). Rural Energy Development in China, Resources for the Future, Washington, D.C.

UNIDO (1980). "Small Hydropower in China." PRC Ministry of Water Conservancy. ID/WG. 329/23.

Cheng Xeumin (1982). "China's Small Hydropower Development." Proceedings of a Workshop on Small Hydropower for Asian Rural Development, NRECA, Washington, D.C.

Key contacts:

Robert Taylor, World Bank Consultant.

Cheng Xeumin, Ministry of Power.

COUNTRY: Peru*

Population: 17.1 million

Per capita GNP: $730

Total power sector installed capacity: 2,200 MW

Total hydro capacity: 1,415 MW

a) grid-connected: 1,010 MW b) auto-generated: 405 MW.

Average national kWh rate: 2.8

Estimated hydropower potential: 58,346 MW

Comments: The UN has identified 1,000 potential hydro sites with heads of 100-300 meters and flows of 200-500 liters/second in the 50-1000 kW range. In 1980 the Ministry of Energy and Mines established a plan for small hydro development to replace existing small thermoelectric units and to provide power to the many remote areas still without electrification. An analysis of small hydropower potential indicates that a major part of the sierra and the high jungle population centers can be supplied through hydropower generation. The plan anticipates the implementation of 50 projects of small plants during 1980-85. USAID has has committed $10 million to develop 28 small-scale installations in the 100-1000 kW range by 1985. These activities are concentrated in the departments of San Martin, Cajamarca and Junin to complement other AID projects for health and regional development. West Germany has provided DM 5.0 million for hydro development in Peru.

Key references:

Puccinelli, H. E. "Planning of Small Electric Systems and Mini Hydropower Plants." Electric Peru.

UNIDO. "Small Hydropower in Peru." (Prepared by E. M. Indacochea, ITINTEC).

Key contacts:

Juan Mata la Cruz, Jefe OPTA, Electro Peru.

Douglas A. Chiriboga, USAID/Lima.

COUNTRY: Philippines*

Population: 46.7 million

Per capita GNP: $600

Total power sector installed capacity: 3,765 MW

Total hydro capacity: 1,346 MW

a) grid-connected: 746 MW b) auto-generated: 600 MW

Average national kWh rate: 2.3

Estimated hydropower potential: 7,504 MW

Comments: Some 4,000 potential minihydro sites have been identified in the Philippines capable of supplying up to 5,000 MW of capacity. Of these, preliminary data have been collected for about 1,200 sites. Present plans call for developing 239 sites by 1987 with a total capacity of 305 MW. One-third of these have been selected. Civil works costs, estimated to average $1,000/kW, will be funded by the Government. A target average cost for equipment, which for the most part will initially be imported, is $750/kW. About 60% of the required financing for equipment has already been committed, including $104 million from a number of donor countries, France ($20 million), W. Germany ($2 million), Japan ($20 million), Norway ($2 million), UK ($30 million), and the PRC ($30 million). These funds are being used to purchase equipment from the respective donor countries. An additional $2-3 million has been secured from the Asian Development Bank to be used to test the comparative value of equipment from other sources. The Government expects local manufacturing capability to be sufficient in the near future to enable the majority of equipment to be supplied from local firms midway through the program.

Key references:

UNIDO (1980). "Mini-hydro Application in the Philippines." National Rural Electrification Administration. ID/WG.329/2.

Santos, Z (1982). "The Philippine Mini-hydro Program." National Electrification Administration.

Santos, Z. (1982) "The Mini-hydropower program of the Philippines." Proceedings of a Workshop on Small Hydropower for Asian Rural Development, NRECA.

Key contacts:

Zenaida Santos, NEA.

Frank Denton, NEA.

COUNTRY: Rwanda*

Population: 4.9 million

Per capita GNP: $200

Total power sector installed capacity: 38 MW

Total hydro capacity: 35 MW

a) grid-connected: 34.7 MW b) auto-generated: under 1 MW

Average national kWh rate: N/A

Estimated hydropower potential: N/A

Comments: Hydroelectric power is the primary source of energy for Rwanda's industries, administrative sector, and a small part of the urban sector. Production is expanding at an average 10%-13%/year. Demand will be 115 GWh by 1986. Future hydro sites for development include Ruziai II - 140 to 200 GWh (to be shared with Zaire), Gisenyi II - 15 GWh and Rusomo - 100 MW (to be shared with Tanzania). Small hydropower potential is considerable, concentrated mainly in the West and Sothwest portion of the country. In previous reports by UN (1980) and W. Germany (1967), 4 sites ranging from 1.0 MW to 2.5 MW have been identified. Many waterfalls on small streams offer possibilities for medium - and high-head (5-200+ meters) power plants with capacities of 10 kW to 250 kW. Very preliminary cost estimates for sites visited by the NRECA team varied from $1000 to $6,000/kW. Many abandoned sites with potential for rehabilitation could cost, depending on the condition, as little as $200/kW. In 1981 a Swiss study examined small hydro schemes in some detail. Donors for existing hydro systems have been: F.E.D., BADEA and Swiss, German and Belgian aid. Interested donors include BAD and French aid. Relevant Government agencies: Ministry of Natural Resources - planning, development, funds acquisition responsibilities; ELECTROGAZ - management and maintenance responsibilities. The Government strongly supports exploitation of hydropower and recently is interested in developing small hydro plants for local power requirements. Planned large-scale industrial development at Lak Kivu could mean the development of substantial hydropower resources to satisfy the increased requirements. There is currently one OPIC project for tea production and marketing.

Key references:

USAID (1981). "Draft Environmental Profile on Rwanda," Office of Forestry, Environment and Natural Resources, RSSA SA/TOA 1-77.

USAID (1981). "Energy in Rwanda - A Synopsis".

NRECA (1982). "Small Decentralized Hydropower in Rwanda."

Key contacts:

Alphonse Nkubana, Chef de Division Eau et Energie, Ministry of Natural Resources, Kigali.

Wes Fisher, USAID, REDSO/E.A., Nairobi, Kenya.

Norm Olson, USAID/Kigali.

COUNTRY: Sierra Leone*

Population: 3.4 million

Per capita GNP: $250

Total power sector installed capacity: 20 MW

Total hydro capacity: 2.5 MW

a) grid-connected: 2.5 MW b) auto-generated: 0

Average national kWh rate: 7.0 (Freetown) 10.0 (rural)

Estimated hydropower potential: 3,000 MW

Comments: Current plans include partial development of a scheme at Bumbunz for 60 MW by 1986, which, fully developed, will produce 305 MW. Another large scheme of 120 MW is being investigated on the Mano River. The government is interested in developing small hydro sites and previous studies by the UNDP (via Motor Columbus) and the Chinese indicate a good potential. The Sierra Leone Electricity Corporation is responsible for power generation and supply. The Ministry for Energy and Power is responsible for planning and development of power. Both are very interested in mini-hydropower. The Chinese and the Canadians are developing two small sites.

Key references:

UNIDO (1978). "Establishing a Programme of Micro Hydro Electric Power Development for Rural Electrification in Sierra Leone."

UN (1981). "Summary of the National Report Submitted by Sierra Leone." Conference on New and Renewable Sources of Energy.

NRECA (1982). "Report to USAID/Freetown on Mini-Hydropower in Sierra Leone."

Key contacts:

Mr. Kabia, Chief Engineer, Ministry of Energy and Power.

Alex Dickie, AID Affairs Officer, USAID/Freetown.

Clarence Kooi, Energy Advisor, USAID REDSO/W.A., Abidjan, Ivory Coast.

COUNTRY: Sudan*

Population: 16.4 million

Per capita GNP: $370

Total power sector installed capacity: 260 MW

Total hydro capacity: 118 MW

a) grid-connected: N/A b) auto-generated: N/A

Average national kWh rate: 7.2

Estimated hydropower potential: 16,000 MW

Comments: Several recent surveys of small hydro potential have been carried out in the Sudan. Most have focused on retrofitting existing dams or irrigation barrages in southern Sudan and on mainstream Nile and secondary rivers in the south. Although in every case detailed feasibility studies will be required, the sites and possible potential are: Jebel Aulia - 2 to 10 MW, Sennar (irrig. barrage) - 2 to 10 MW, Sabaloka - 10 MW, Rumela - 20 MW (planned), Fola Rapids - 10 to 400 MW (depending on scheme), Kinyeti - 1 to 5 MW. Future plans for large hydro development include additions to existing systems - 120 MW to Roseires; 30 MW to Sennar. Long range (turn of century or later) possibilities include Merowe - 600 MW and Shiri Is. - 450 MW. Problems constraining the development of small hydropower: (a) with the exception of portions of the south and west, elevations in Sudan are low and rainfall is minimal, (b) high silt load in many streams, (c) irrigation takes precedent over all water uses, (d) evaporative and absorptive losses in impoundments are a serious problem, (e) flows in many streams are seasonal, with low or no flow at least two months of the year, and (f) reduced power output due to head loss in flooding during high flows. The Public Electricity and Water Corporation (PEWC) has been recently reorganized into the National Electricity Corp. (NEC) and the Greater Khartoum Water Authority.

Key references:

NRECA (1982). "Sudan: An Assessment of Decentralized Hydropower Potential."

Key contacts:

Eng. Ibrahim Ali, Chief Hydro Engineer. (Power III, IV) PEWC.

Eng. Kamal Ali, Dir. General, Nile Water Affairs and Dams, Min. of Agriculture and Irrigation.

H. E. Shareff El-Touhami, Minister, Ministry of Mines and Energy.

Lynn Sheldon, USAID/Khartoum.

COUNTRY: Thailand*

Population: 45.5 million

Per capita GNP: $590

Total power sector installed capacity: 3,971 MW

Total hydro capacity: 910 MW

a) grid-connected: 910 MW b) auto-generated: under 1 MW

Average national kWh rate: 2.7

Estimated hydropower potential: 6,242 MW

Comments: As part of the Fifth National Economic and Social Development Plan (1982-86), twenty-five hydropower projects in the 50 kW to 6 MW range are to be developed. Heads generally range from 30-100 meters. An initial study of the project costs for these sites varies from about $2,000/kW for schemes in the 1.5-6 MW range to about $4,000/kW in the 200 kW-1 MW range. The National Energy Administration (NEA) has estimated a dry season potential in the mountainous regions along the western frontier and in the northwestern and southeastern regions of about 1100 MW. USAID has offered to assist the development of 12 micro- and mini-hydro projects. In the micro-hydro range, the NEA is interested in cutting costs through local manufacture of some of the equipment. Several schemes using locally fabricated crossflow turbines are already operational and, at the request of NEA, NRECA has undertaken a study of potential for local manufacture of various governing devices. Though the Electricity Generating Authority of Thailand (EGAT), the Provincial Electricity Authority (PEA), and the National Energy Administration (NEA) are all involved in some aspect of generation, transmission, and distribution of electricity in Thailand, the NEA has been authorized by the government to plan and develop small hydropower resources.

Key references:

Mohar Songh Mongo (1982). "Planning of Mini-Micro Hydropower Projects in Thailand." Proceedings of a Workshop on Small Hydropower for Asian Rural Development, NRECA.

Key contacts:

Prepath Premanni, NEA.

Chulapangs Chullakosa, PEA.

Srid Aphaiphuminart, EGAT.

Mintana Silawatshananai, USAIA/Bangkok.

COUNTRY: Togo*

Population: 2.4 million

Per capita GNP: $350

Total power sector installed capacity: 2.8 MW

Total hydro capacity: 2 MW

a) grid-connected: 0 b) auto-generated: 2 MW

Average national kWh rate: 6-7

Estimated hydropower potential: 480 MW

Comments: Similiar to other countries in Sehelian climate zone of West Africa, Togo is characterized by low and variable flows and overwhelmingly flat terrains. The majority of the country power supply (93%) comes from the Akosombo Dam in neighboring Ghana. The balance is supplied by diesel-run generators owned and operated by the national power company, La Companie Energie Electrique du Togo (CEET). The World Bank will finance Togo's first hydroelectric project in the Mono River, in the southern part of the country; no other hydro development is currently planned. In 1981 NRECA sent a team to study Togo's small hydro potential. Of ten sites the team reviewed, two appear to have reasonable potential: Tomegbe (4 x 2,000 kW) and Wonougba (160 kW). Both sites are close to the proposed national gird and were recommended for more detailed analysis.

Key references:

NRECA (1981). "Togo Small Decentralized Hydropower Study."

Key contacts:

Clarence Kooi, USAID, REDSO/W.A., Abidjan, Ivory Coast.

Laurent Cyrille Faboury, General Director, CEB.

Agbeviade K. Galley, Director of Commercial Affairs, CEET.

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COUNTRY: Tunisia*

Population: 6.2 million

Per capita GNP: $1,120

Total power sector installed capacity: 660 MW

Total hydro capacity: 29 MW

a) grid-connected: 29 MW b) auto-generated: 0

Average national kWh rate: 6.4

Estimated hydropower potential: N/A

Comments: Due to its predominantly arid climate, hydropower makes only a minor contribution to the country's energy resources. Current installed capacity includes a 13 MW plant at Nebeur and a 3 MW plant at El Arrousia. A 25 MW site at Sidi Salem is under development. Both USAID and the Government of Tunisia are interested in assessing the potential for further development of small scale hydro resources, particularly in the northern region of the country. An NRECA team visited Tunisia in 1981 to explore plans for further study. The team recommended prefeasibility studies be conducted on a number of sites in the region north of the Dorsal. The greatest potential was identified to be on existing small dams currently used for irrigation and/or water supply. The team also discovered potential for additional development of seasonal flow capacity in the extreme northwest region. The team specifically recommended the formulation of a methodology for retrofitting "head breakers" on irrigation conduits for low-head development of hydropower. The team also recognized that potential exists for local fabrication of turbine machinery, given substantial expertise with the manufacture and use of waterwheels; and, given the relatively high proportion of private ownership of capital to GNP (30%), for private development of small hydro resources for sale to the national grid.

Key references:

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Key contacts:

Richard Stevenson, Science and Technology Advisor, USAID/Tunis.

Ali Ben Ahmed, Director, Energy Task Force, Ministry of National Economy (MNE).

Hedi Messolli, Chef de la Division Hydraulique, Societe Tunisienne de l'Electricite et du Gaz.

COUNTRY: Zaire*

Population: 27.5 million (1979)

Per capita GNP: $260

Total power sector installed capacity: mostly hydro

Total hydro capacity: 1,428 MW

a) grid-connected: 1,428 MW b) auto-generated: under 1 MW

Average national kWh rate:

Estimated hydropower potential: 132,000 MW

Comments: It is estimated that Zaire has about 13% of the total world hydroelectric potential. The number of feasible sites for small hydropower development probably exceeds 1000; however, only recently has the Government given a high priority to small hydro. USAID had received, as of July 1981, 13 requests for grant assistance to develop small hydro sites. As a result of preliminary NRECA work, USAID is considering investing around $10 million in 2 programs of small hydro development. Government energy organizations: Department of Energy - planning, policy, project approval authority; Societe' Nationale Electrique (SNEL) - implementation responsibilities, electric supply to urban areas and Inga Shaba; PLAN - coordinates project currency and donor activities; Special Presidential Study Group (SPE) - compiled a list of small hydro sites. Other organizations: Constructeurs Inga Shaba (CIS) - a consortium to construct Inga Shaba, (Morrion Knudson is a key element in constructing the I.S. transmission line); International Engineering Company (subsidiary of M.K.) has prepared a preliminary investigation of hydro sites in Zaire; U.S. Bureau of Reclamation - monitoring the I.S. project for SNEL.

Key references:

NRECA (1981). "Small Hydropower and Rural Electrification Project for Zaire."

Key contacts:

Mutzuda Ngoy Myauz - Directeur Equipment, SNEL.

Matzuda Fundani, Chef de Division Electromecanique, SNEL.

James L. Ferry - Directeur General, Resident, CIS.

Seka Buhoro - Secretary of State, Department of Energy.

Mulamba Wa Kabasele, USAID/Kinshasa.