NRECA'S SMALL HYDRO ACTIVITIES IN DEVELOPING COUNTRIES

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The National Rural Electric Cooperative Association (NRECA) and the United States Agency for International Development (AID) entered into a Cooperative Agreement to enhance NRECA's capabilities in small hydropower technology and to make the expertise available to developing countries. This paper will summarize NRECA's experience with small hydropower in developing countries under the Cooperative Agreement. Another paper, by Dr. Zoellner, will generalize from our specific country experience, to present an overview of small hydro potential in the third world.

NRECA INTERNATIONAL PROGRAMS

The National Rural Electric Cooperative Association is a service organization for nearly 1,000 rural electric systems serving more than 25 million consumers in the United States. In addition to the management and technical assistance it has afforded the rural electric systems in the United States, NRECA has provided assistance in 36 countries of Asia, Africa and Latin America installing nearly 1.8 million electric connections, serving 12 million consumers. More than 160 Rural Electrification Specialists have helped develop more than 196 rural electric systems overseas. In addition, they have provided specialized assistance to existing systems and have participated in the creation of several national rural electrification programs

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since 1961. During this same period, more than 360 representatives of 34 countries have received organization and management training tailored to meet their needs.

AGENCY FOR INTERNATIONAL DEVELOPMENT (A.I.D.)

A.I.D. began its energy program development effort in 1978 offering technical assistance to developing countries to contend with their energy needs. The centrally funded program has systematically evolved into a comprehensive program aimed at helping developing countries increase their energy supplies and better manage their energy resources. The programs require specialized and intensive efforts requiring AID to seek U.S. private and public sector involvement in energy assistance activities.

Training is a significant portion of their energy program. The scarcity of personnel to plan, implement and manage energy activities is recognized by AID, the World Bank and other donors as a major impediment to effectively contending with energy problems.

THE SMALL DECENTRALIZED HYDROPOWER (SDH) PROGRAM

In May of 1980, the International Programs Division of the National Rural Electric Cooperative Association (NRECA) entered into an cooperative agreement with AID to enhance NRECA's technical capabilities in the area of small (1 MW or less) decentralized hydropower and to make this expertise available to developing countries.

The SDH Program has been funded for an initial eighteen month period (May 1980 to October 1981). As the SDH base grows and study methodologies are developed and refined, it is hoped that the program may be expanded to include other funding sources.

In order to facilitate the application of SDH technology throughout the world, teams of specialists have been assembled to provide in-country consulting services in areas such as plant siting, project design, economic and technical feasibility studies, environmental/social impact analysis, and institutional development. A wide variety of informational and instructional programs have been developed by the SDH/Washington staff.

SDH PROGRAM ACTIVITIES

The main provisions of the cooperative agreement are:

1. Program Identification: identification of potential hydropower sites in developing countries, determining the role of SDH in a country's over-all energy development program, examination of technical, economic, sociological, institutional and environmental aspects of SDH projects.

2. Site Selection and Project Design: development of analyses and designs of new projects or of the SDH component of renewable energy projects including evaluation of hydrologic potential, demand forecasting, preliminary design of generation and distribution facilities, technical feasibility studies, sociological inquiries, and environmental analyses.

3. Training and Information: development of training programs, workshops, and conferences on SDH for engineers, planners, and technicians from developing countries. These activities include classroom as well as hands-on training.

4. SDH Data Base: surveying of existing SDH facilities in both developed and developing countries to provide descriptions of

system performance, economics, implementation procedures and management. The SDH staff is also identifying and evaluating equipment manufacturers; developing a "skills bank" of qualified SDH specialists and compiling a library on SDH technology.

Since May, 1980, NRECA has completed small hydro assignments in Asia, Africa and Latin America. The following is a brief summary of projects that we have undertaken.

LATIN AMERICA

Peru. In July, 1980, we 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-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 environmental specialists. Their task was to develop specific sections of the AID Project Paper and supervise the preparation of feasibility studies for two proposed mini-hydro sites being developed by ELECTROPERU, the Peruvian national electric authority. The approved Project will lend to 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

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

In November 1980, I traveled to Panama to review the design and status of two micro hydro demonstration sites and arranged for the purchase of a 10 kw and 50 kw turbine generator sets.

Approximately 100 rural communities in Panama have expressed strong interest in having a mini hydroelectric unit installed in their area. AID is working with the Panamanians to identify the 40 most feasible sites.

Other. We have made some lesser efforts in Dominica, Ecuador and Bolivia and are beginning a large program in the Dominican Republic.

ASIA

Thailand. The AID Mission in Bangkok requested NRECA technical assistance with prefeasibility investigations of potential small hydro sites throughout Thailand. Thirty-nine sites were identified for consideration.

The NRECA team characterized the thirty nine sites according to physical characteristics and potential demand structure. From this ranking they choose six sites 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. Sites with no potential for grid connection;
E. Sites which appear to have favorable benefit to cost ratios; and
F. Potential for co-financing

NRECA also provided the services of a small hydro electro-mechanical engineer. He worked with engineers from the National Energy Authority and help them in selecting appropriate governors and determining if they could be manufactured in Thailand.

Other. Additional work is starting in Bangladesh and Indonesia. NRECA is also supplying information to Papua New Guinea, Philippines, Nepal and Burma which all have active on-going small hydro programs.

AFRICA

Togo. In April NRECA sent a 3-man team of specialists to do a major country-wide feasibility survey of small hydropower potential of Togo. The team included a hydrologist, a small-hydro/electrical engineer, and a socio-economist, identified a number of potential sites.

They found very little potential for small hydro in Togo.

Liberia. The Government of Liberia in cooperation with AID/Monrovia has requested NRECA assistance in setting up a training program for small hydro electrical maintenance staff for a small hydro project at Yandohun, Liberia. We will soon send a team of specialists to begin preparations for implementing this request.

We also proposed a rewriting of the bid specifications for Yandohun to insure that high strength materials be used and that the electrical equipment be appropriate for tropical, remote location. In addition, NRECA suggested that the Mission not proceed with their underground distribution plan as future operational and maintenance problems would likely be unmanageable.

Zaire. In March 1981, NRECA sent two engineers to Zaire to assist the AID Mission in evaluating several proposed small hydro projects. The engineers visited sites throughout the country and generally found them to be feasible, worthwhile projects. They discussed the projects with officials from the Government of Zaire to assess the possibilities of a national Small Hydro Program. At the end of the assignment, a report was left with the Mission which outlined several options open to AID for a Small Hydroelectric project. The options ranged from financial assistance at selected sites to a massive multi-donor program involving institutional building, training, and introducing productive uses of electricity.

Also, a group of individuals from Northwestern United States raised the money to install a small hydro unit in Nundu, Zaire for a church hospital. NRECA provided technical assistance to the group and located some possible sources of additional funding for the project.

Morocco. AID/RABAT requested the services of a small-scale hydro specialist to assist the Mission in reviewing the Moroccan country assessment performed by a large engineering firm.

NRECA provided a small-hydro specialist to review the large "Grand Coulee" type of civil works in the project. Smaller structures improved the economic feasibility of the hydroelectric program and were incorporated into the program. Three potential sites were identified for development and site data collected. In November, NRECA sent an engineer to Morocco to supervise a survey team which developed the site profiles and preliminary layouts.

PROBLEMS ENCOUNTERED

The problems encountered are classified as either technical, socio-economic, institutional or financial.

Technical Problems - The technical problem we faced most often is trying to size mini-hydro turbines with almost no stream flow data. The lack of records has forced us to rely heavily upon interviews with local residents and visual evidence of high water levels. Such methods are not dependable and expose the project to high risk either from inadequate flows or inadequate spillway capacity during floods. We've dealt with these problems by sizing the unit conservatively, and designing the intake structure such that if it get washed out, it can be replaced easily.

Another techical problem with every project we have worked with that has gone into the construction phase, is underestimating the time required for construction; particularly the purchase and shipping of materials. While waiting for one material, other on-site materials start disappearing and the problem compounds into major delays, cost overruns, and lots of finger-pointing.

NRECA has been asked to review projects that had started with a poor design. These units were under 50 kW making it difficult to justify consultants to review the design. The high engineering cost per kW for mini-hydro is a major roadblock, and the reason most large engineering firms don't know mini hydro technology. A good mini-hydro handbook does not exist that shows the non-specialist good designs and explain why they must be followed. We're starting to put one together.

Socio-Economic Problems - The basic economic problem we run up against is that the local rural people generally can't afford the cost of electric service. This means someone has to subsidize projects that have a rural electrification component. Unless rural people have the credit to purhcase electrical equipment, the output power usually will not be put to uses where a direct economic return can be seen. A project that just supports residential and street lighting will have a hard time gaining financial independence.

We have run across an interesting problem in developing countries that have their own oil or gas resources. They held their internal energy prices so low, that small hydro couldn't compete with the diesel-generator or gas-turbine alternatives. The alternatives must use the opportunity cost of selling the oil, or natural gas to make small hydro option attractive.

The major social problem we have encountered is that electrification is only one part of a development package, and many other parts are needed before and after electrification in order for development to progress. Many parts of Africa are socially not ready for electrification, even though enormous potential for small and mini hydro projects exist.

Institutional Problems - Our Institutional involvement with mini-hydro programs has been primarily in the initial organization phase of projects. We are just beginning to get into the actual operation and maintenance phases.

The problem we've encountered is in selecting the appropriate institutions to carry out a national mini-hydro power program. In some instances more

than one agency wanted the mini-hydro program, and in others, no one wanted it. Most countries have the equivalent to a Department of Energy, a national utility, a rural development agency, and an "Appropriate Technology" type of organization; all which might be implementing agencies. Our Management Study is a tool for Institutional Advisors that we send to do institutional planning. The Study has looked at numerous SDH installations and has attempted to typify successful programs, and management structures, as a function of the country characteristics. The Advisor will be able to survey local characteristic, find the recommended management structure, and look for the institution that best fits.

Usually, the national utility is the only agency set up to operate and maintain the units. However, in one instance, they were not interested in managing units under 100 kW. One solution was to create a new department within the utility for small decentralized energy systems. In another instance, the utility had such a bad track record of poor management that donors wanted to avoid loans with the national utility all together.

Financial Problems - Obtaining financing is one of the biggest problems facing developing countries with small decentralized hydro potential.

Due to the economic problems of rural electrification, some sort of central government support usually is necessary. Then the government generally looks to development banks or institutions for funding. Development banks generally don't look at projects under $5 million so potential mini-hydro sites must be grouped into a loan package through the central government. This means the institutional problems discussed earlier must be resolved before funding takes place.

Lending institutions have had many years of experience in funding large hydro sites and have developed their set of requirements for feasibility studies. The same concerns exist with small hydro installations, but it is not reasonable to demand the same degree of studies and field investigations. On mini-hydro sized sites, the cost of doing the feasibility studies, as they are now done, can kill a project.

Small communities that don't want the central government controls that come with central government funding, generally don't know where to turn for financing. In our Financial Study we list possible sources and their loaning criteria.

One financing problem faced in most countries where AID works is coordinating a substantial small hydro program between several different donor institutions.

As an example, we don't know what the UNDP is doing in small hydro, and I don't think they know all that we're doing. Each donor agencies wants to fund the most feasible sites - rather than sharing the risk with a mix of less feasible sites. Each donor also has strings attached to loans which often contradict a good program. As an example, donors will require purchasing equipment from the donor country, when the mini hydro program is trying to standardize their installations with equipment from another source. Coordination among the donors and the development banks needs to be formalized.

CONCLUSION

We have attempted to learn not only from the problems we have encountered, but from those encountered by organizations installating and operating SDH units. We have conducted several case studies of successful and un-

successful installations worldwide and can draw upon those studies when designing future programs. The problem encountered and lessons learned from our case studies could be the subject of another paper.

There are hundreds of locally controlled, decentralized auto-generating systems currently in operation worldwide. The exact number is unknown and documentation on most of these units is nonexistent. Many small hydro units have been in operation for decades with apparently excellent results. We hope our program will expand the number of these systems and make a significant impact on the fuel usage profile of numerous developing countries.