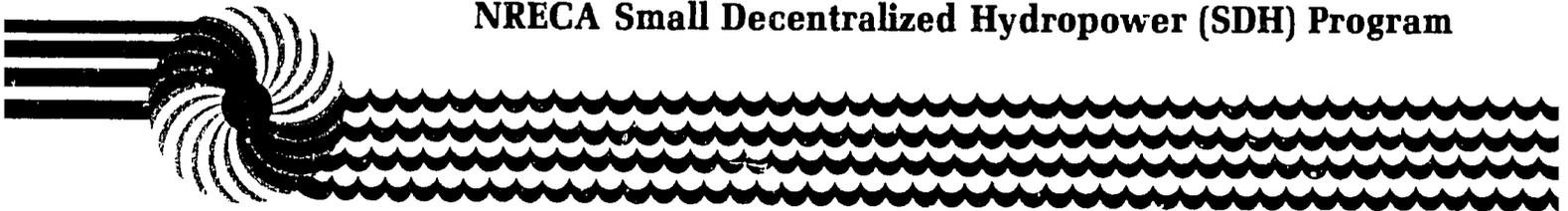


PN-AAS-765
40002

Indonesia

Recommendations for promoting small hydropower development

NRECA Small Decentralized Hydropower (SDH) Program



Indonesia: Recommendations for promoting small hydropower development

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March 1984

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

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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.

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Summary

Background

In 1982, a USAID/Washington-funded scope of assistance to the Government of Indonesia (GOI) in small hydropower, to be carried out by NRECA's SDH Program, was proposed which included:

- A field survey of five or six sites for which feasibility studies would be conducted for one or two;
- An evaluation of existing facilities for equipment R&D and recommendations for commercialization;
- The development of a training program on the most appropriate aspects of site development and management; and
- A review of existing policies, institutions, plans, and programs in order to develop an appropriate implementation plan for small hydropower and attendant policy recommendations.

This report is the result of the last of these studies--a review of the implementing institutions. In November and December 1983, NRECA provided an institutional advisor to carry out this study. The study objectives were to provide:

- A summary and status of GOI policies and programs regarding small hydropower;
- The criteria and a preliminary regional plan for field site assessments; and
- The possible implications for subsequent financing and implementation, including the roles of multilateral development banks and USAID/NRECA in training and institutional development.

National policy

The key to success in developing Indonesia's small hydro potential will be policy guidelines for implementing small hydro schemes that will be flexible and consistent with other government policies, particularly those pertaining to renewable energy resources generally.

We recommend that the GOI, through BAKOREN, continue to:

- Discourage use of diesel in areas suitable for other energy resources;
- Provide guidance for integrating small hydropower with other water resources projects;
- Promote local equipment manufacture; and
- Balance urban and rural energy development.

Implementing institutions

A range of agencies and institutions have been charged with the responsibility for developing small hydropower sites, managing them, and in some cases, selecting equipment for them. Chief among them are the Directorate General of Power (DGP) and Perusahaan Umum Listrik Negara (PLN), the state electricity corporation.

Although there are many options for institutional arrangements, NRECA believes that PLN, by virtue of its experience, facilities, and technical capabilities, is best suited

to take the lead. PLN can offer a framework for planning, implementing, and managing small hydro schemes that could attract financing. PLN cannot effectively operate all remote sites; instead remote projects are best implemented by strong local institutions.

Further resources will be required by PLN to meet the projected goal of 55 MW of additional small hydropower capacity during the next five-year plan. Emphasis should continue to be given to developing Indonesian skills for project development and management. The PLN currently has neither the mandate nor the staff necessary to undertake the planning and implementation of a major training or promotional effort in small hydropower. R&D efforts are underway to design and fabricate equipment; however, it appears that steps should be taken to begin commercialization of this equipment.

We recommend that the PLN retain the following programmatic responsibilities:

- Coordination of site inventory; assigning development responsibility; and providing training for technicians and operators;
- Site development, including prefeasibility and feasibility studies; seeking financing; promoting designs using local materials; and replacing diesel units with alternative energy resources where feasible; and
- Assisting others by developing equipment selection guidelines and safety standards; developing guidelines for local materials for equipment; conducting training for provincial staff and others; offering facilities for equipment servicing; and reviewing non-PLN specifications and designs.

Financing

A positive attitude exists throughout the development financing community regarding the usefulness of small hydropower. PLN generally attracts multilateral funding. GOI grants are provided through the Directorate General of Cooperatives (DGC) with bilateral funds spread among several agencies. There is no mechanism for private sector access to foreign currency to develop sites for reducing domestic oil consumption.

We recommend that:

- BAPENNAS develop a mechanism for private enterprises and special groups to obtain financing; and
- The central and provincial governments become equity partners for projects implemented by special groups and private enterprises.

Southern Sumatra assessment

The five provinces of southern Sumatra were designated by the GOI as the geographic region for USAID-funded assistance. Twenty-eight sites were identified, but due to inclement weather, only five sites were visited. Questionnaires circulated to the provincial governments for PLN regional staff input on each of the other 23 sites were returned incomplete and, therefore, were of limited value.

Next steps

The GOI and USAID/Jakarta must reach an agreement on NRECA's recommendations and their consistency with each agency's respective policies. After providing written comments to ST/EY for inclusion in the final report, USAID/Jakarta should request assistance for the field survey through ST/EY as outlined in Appendix D.

Introduction

Background

Indonesia has been blessed with considerable crude oil resources and oil export revenues essentially finance the bulk of the national budget. However, domestic demand for oil-based energy is increasing and production for export is decreasing. Reduced export levels, coupled with lower world crude oil prices have rapidly eroded export revenues, exerting serious financial pressures on the budget and retarding development efforts. If this trend continues, Indonesia might, according to a 1981 World Bank report, find itself short of funds essential to its further social and economic development.¹

One method of maintaining necessary oil export revenues is to restrain domestic demand of oil-based energy sources and satisfy accelerating domestic consumption requirements through the expanded development of non-oil-based energy resources. The Government of Indonesia (GOI) recognizes this problem and has enunciated a policy of replacing oil for domestic consumption with other indigenous energy sources, especially hydropower. Product pricing policy was a major constraint to achieving this policy goal and the number of isolated diesel powerplants has grown dramatically since 1981. However, adjustments to domestic fuel prices in January 1984 brought domestic oil prices in line with world prices which should now allow proper comparison of renewable energy resources with petroleum fuels.

Hydropower development

It has been estimated that the undeveloped hydropower potential in Indonesia amounts to about 31,000 MW. At the end of the second five-year plan (REPELITA II, April 1979), the total installed capacity of hydropower plants operated by Perusahaan Umum Listrik Negara (PLN), the state electricity corporation, was only 480 MW, or about 21% of its total installed capacity. Increased development of hydropower was given high priority in REPELITA III (see Table 1).

TABLE 1. Small Hydropower Development during REPELITA III (1979-84)

Types	Planned capacity (MW)	Actual capacity (MW)
Hydro (PLN)	182.9	71.6
Hydro (non-PLN)	768.0	451.0
Small hydro (PLN)	<u>5.8</u>	<u>1.8</u>
Total	956.0	524.0

¹Indonesia; Issues and Options in the Energy Sector (Report No. 3543-Ind). Report of the Joint UNDP/World Bank Energy Sector Assessment Program, November 1981.

Small hydro

Indonesia began looking at small hydropower programs in the 1960s with the idea of accelerating electrification to isolated rural areas. In 1968, two micro-hydro pilot projects were constructed. During the following REPELITA I (1969-1974), some 12 sites, with capacities between 16-200 kW, were installed, with a total capacity of 1,299 kW. During REPELITA II (1974-1979), some 22 sites were constructed, with a total capacity of 3,550 kW. In REPELITA III, another 14 small hydro plants are planned, most of which have received financing.

Most of the turbines in the small hydro plants installed after 1969 were locally made. The turbines were designed by the PLN hydropower laboratory and fabricated by two well-known workshops. PLN continues to play a major role in the design and development of locally fabricated turbines. Attempts have been made to obtain licensing agreements from foreign companies, but without success.

In 1982, a Japanese engineering firm completed a survey of potential small hydropower sites in Indonesia. The results of that survey indicated a total of 291 sites under 5 MW capacity, with a total capacity of 1,342 MW. These sites were selected based on technical requirements only (catchment area, head, type of installation, power output, etc.), with no consideration given to economic or institutional viability. Other unofficial sources indicate that about 3,100 MW could be produced by small hydropower units.

A survey of mini-hydro potential of the western half of northern Sumatra was carried out in 1981 by a New Zealand firm and Indonesian counterparts. It identified some 40 sites, each located within 4 km of existing roads and not more than 20 km from population centers requiring electricity, with a total potential of 55 MW. Of these, 16 were considered favorable for immediate development. The survey revealed that a number of these sites have similar hydrologic and topographic characteristics and could be developed using a few standardized generating sets. They could also be connected to the 20 kV distribution network being constructed as part of REPELITA III. Standardization would result in reduced cost and interconnection to the grid would enable the installed capacity to be increased beyond the firm capacity based on minimum river flows. PLN has decided to implement a pilot project developing these standardized sites in northern Sumatra and to follow this approach to develop future mini-hydro projects.

The World Bank funded this pilot project for design and construction of eight mini-hydro stations, with a total installed capacity of about 7 MW. At six locations, nine 750 kW units will be installed, and at two locations two, 200 kW units will be installed. Also under this project, PLN has appointed a consultant to prepare guidelines for the continuing investigation and development of other mini-hydro resources for the entire country and to assist in the design and construction of the mini-hydro schemes. The consultant formed a consortium with a local partner and most of the design work is being done in Indonesia under the management of and in cooperation with the PLN. To implement the project, PLN created a mini-hydro staff and recently transferred implementation responsibility to its Director for Rural Electrification. Field construction responsibilities have been assigned to PLN's northern Sumatra regional office.

Origin of study

In 1982, the GOI requested U.S. Agency for International Development (USAID) Mission in Jakarta to assist in the development of small hydropower systems (less than 5 MW) in Indonesia. In response, USAID/Jakarta agreed to an exploratory survey by Dr. David Zoellner, Manager of the Small Decentralized Hydropower (SDH) Program of

the National Rural Electric Cooperative Association (NRECA). In Dr. Zoellner's view, four types of development assistance were required:

1. Resource assessment. Five or six sites were to be selected for prefeasibility studies and then one or two for feasibility studies.
2. Technical assistance. The feasibility of using existing facilities for equipment R&D as well as manufacturing was to be evaluated and a program plan of continuing assistance was to be recommended.
3. Training. A training program was to be developed for PLN, DGC, and others on the most appropriate aspects of site development and management.
4. Strategy planning. On-going small hydro activities, agency responsibilities, existing planning and coordination structures, and broad government plans and programs were to be reviewed and a policy and implementation plan for small hydro was to be developed.

NRECA, as a contribution to its Cooperative Agreement with the USAID Bureau of Science and Technology, agreed to provide the services of an institutional advisor for one month to undertake the strategic-planning exercise. After discussions with the Asia Bureau's Office of Technical Resources, the scope-of-work was modified to focus on the institutional environment for small hydropower development in southern Sumatra (see Appendix A). The expected outputs of the effort were to include:

- A summary and status of GOI policies and programs regarding small hydropower;
- The criteria and a preliminary regional plan for field site assessments; and
- The possible implications for subsequent financing and implementation, including the roles of multilateral development banks and USAID/NRECA, in training and institutional development.

The study began in early November 1983 in Washington, D.C. with a review of available documentation by the NRECA institutional advisor, Samuel Adkins. He traveled to Indonesia during the period November 10-December 14, 1983, and gathered data through a process of interviews with the GOI central government, the regional governments, and agency officials; visits to educational and small hydropower research facilities; and a field trip to the proposed project site area in southern Sumatra. A list of individuals and institutions contacted during the course of the study is provided in Appendix B. The principal findings of the study are presented in the following sections of this report.

Review of small hydropower policy and programs

National policy

The Badan Koordinasi Energy Nasional (BAKOREN), which is chaired by the Minister of Mines and Energy and includes a group of ministry-level officials involved in energy-related matters, was recently established to study the national energy picture and develop a national energy policy. BAKOREN uses the Technical Committee on Energy (PTE) to draft policy proposals and monitor their implementation. BAKOREN recognized the growing problems faced by the country in the use and development of energy resources. Its stated policy is aimed at removing subsidies for petroleum fuels and, ultimately, to replace domestic consumption of oil with other energy sources. It also has set a national small hydropower capacity goal for the next five-year plan at 55 MW.

The National Planning Secretariat (BAPENNAS) coordinates energy policy with other national sector policy and financial planning.

Conclusions

Indonesia has enacted a national policy that promotes the development of small hydropower as part of its national energy plan with defined capacity goals at the ministry level and staffing and budgets at the implementation level. It encourages the use of in-country equipment and is developing local manpower resources. The existing policy provides an adequate framework for a small hydropower program; however, it must remain flexible enough to allow the most economically appropriate local agencies to implement specific projects and, yet, must be stringent enough to meet national goals and national safety and construction standards.

It is recommended that BAKOREN continue adopting national policy to:

- Balance the development of urban, grid energy sources with the development of decentralized rural energy sources;
- Provide policy guidelines for integrating hydropower projects with other water resources, conservation, and development projects, and resolve institutional disputes between conflicting parties; and
- Promote locally fabricated equipment utilizing proven designs from the private-enterprise sector by encouraging licensing agreements with reputable manufacturers.

Implementing institutions

There are many government agencies and institutions involved in the implementation of energy projects. The relevant institutions and their respective roles are:

- Directorate General of Power (DGP) of the Ministry of Mines and Energy is responsible for coordination of electric power development in Indonesia and has considerable influence on policy.
- Perusahaan Umum Listrik Negara (PLN), the state electricity corporation, generates, transmits, and distributes electric power to the majority of consumers in the country.

- Directorate General of Cooperatives (DGC) coordinates and provides assistance to village and special cooperatives in area development. In addition, some village-level cooperatives, Koperasi Umum Desa (KUDs), are presently involved in rural electrification.
- Provincial governments have considerable authority over programs within their areas and are given wide latitude of power from the GOI. In some instances, provincial governments have implemented separate rural electrification programs.
- Provincial Economic Development Officer (BAPPEDA) coordinates and monitors all economic development in a particular province.
- Agency for Development and Application of Technology (BPPT) develops and implements appropriate technology projects, including micro-hydro.
- National Center for Research in Science and Technology (PUSPITEK) undertakes testing and demonstration of specific energy-conversion hardware, including that for solar, biogas, and photovoltaic technologies.

The Ministry of Mines and Energy is generally responsible for coordinating the development of small hydropower in Indonesia. It exercises its responsibility by delegating authority primarily to the PLN, but also to other agencies such as regional governments, the DGC, and local and private organizations. For projects not implemented by PLN, it has taken a relatively passive or reactive approach. In 1982, PLN agreed to allow other agencies to implement all small hydropower projects below 1 MW capacity. In recent discussions with NRECA's institutional advisor, PLN expressed an interest in developing sites as small as 100 kW.

In the majority of non-PLN projects, funding usually comes from GOI grants. Project preparation activities such as preliminary surveys, site assessments and selection, feasibility studies, and design work are usually completed by in-country universities or expatriate consultants. In some instances, PLN has provided assistance to these activities. These projects are administered at the local level by the village cooperatives or special groups.

Many potential sites have been identified by special groups or private enterprises, but the groups have been generally unable to obtain government assistance for the projects. More likely, the groups have been discouraged by the bureaucratic requirements for obtaining approval, import-fee waivers, etc. In some instances, the groups, on their own initiative, have constructed micro-hydro sites and then sold power to the local government offices. Because of the one-time nature for the groups' efforts and little or no support from the GOI, this required an extraordinary amount of time to understand the technology and learn the procedures for constructing such projects. It also required them to have access to foreign currency for purchasing equipment, since it is not generally known that locally fabricated equipment is available.

Virtually all of the existing small hydropower sites in Indonesia were implemented by PLN. Other agencies active in micro- and mini-hydropower development operate with little coordination of effort or clear delegation of authority. It appears that a number of attractive sites remain undeveloped because of the uncertainty the potential owner feels concerning licensing and his right to operate a powerplant. A coherent institutional

framework for implementing and operating small hydropower plants needs to be developed. Energy planners have a number of institutional options to consider:

- PLN develops, implements, and operates all small hydropower projects. PLN has sufficient background and facilities to implement and operate all hydropower facilities in the country. Its broad resource of engineering, mechanical, and administrative talent located in all of the provinces of the country could adequately implement a small hydropower program. The ability of PLN to operate small hydropower projects under 100 kW economically is, however, questionable. The staff of highly trained employees that would require assignment to small projects could possibly raise the cost of power above village limits. PLN may not be prepared at this time to accept such small projects (below 100 kW) for operation.
- PLN develops all small hydropower projects, operates schemes greater than 1 MW and assigns units below 1 MW to provincial governments or local organizations for operation. This arrangement has considerable merit and corresponds closely to the existing agreement of assigning projects by capacity. However, large central agencies such as PLN generally cannot construct small projects (below 100 kW) as efficiently as local entities.
- PLN develops all small hydropower projects down to 100 kW that it can financially operate and promotes the development and operation of sites up to 1 MW by other local entities. This arrangement would ensure that the larger units are professionally designed and constructed, yet not require PLN to develop sites that it cannot operate financially.
- Provinces develop all projects of 1 MW and below with operations assigned to local organizations, but provincial governments would maintain coordinating authority through staff of technicians, advisors and inspectors. This type of operation would require that facilities be established at the provincial level to coordinate activities, implement contracts, and provide general supervision of projects. Although this arrangement provides good coordination and control features, it would require funding on a permanent basis. Provincial governments would probably have a difficult time obtaining funds from international sources for such a program.
- DGC develops all projects of 1 MW and below. Operation would be assigned to local KUDs with training and assistance through the Project Development Office. The DGC is presently implementing rural electrification projects at Luwu in southern Sulawesi, Lampung in southern Sumatra, and on the island of Lombok. The projects are being served from diesel generation and are coordinated through a project development office in Jakarta. There is an administrative and technical staff to assist these three cooperatives with operation and training. With facilities already established, this agency could accept the responsibility of coordinating the small hydropower program. However, there would be the need to establish good and close relations with the provincial governments for effective operations and with PLN for design and construction standards.
- Establish a new agency for development and operation of small hydropower projects. With the increased activity in small hydropower development in the next few years, an agency especially established to coordinate its development would be beneficial. Much could be accomplished in all phases of small hydropower. There would, of course, be a big expense in establishing and operating this program.

Recommendations

Of these alternatives, the third is the most attractive institutional structure for implementing small hydropower programs because, on the basis of experience, PLN is best suited to take the lead in a national small hydropower development effort by implementing sites and coordinating other activities. This option can offer a framework for project implementation, management, and operation of small hydropower schemes which, if mobilized, could attract financing from international donors. Since there are several sources of funding—multilateral, bilateral, and commercial banks; PLN general funds; GOI grants; and local distribution-system funds—the institutional framework should remain somewhat broad to embrace the specific requirements of each source.

This option also recognizes that PLN cannot effectively operate all the small hydro sites scattered throughout the country and establishes an institutional framework that gives full scope to projects which may be developed and operated more cost effectively at the provincial and local level. Provincial governments could form Divisions for Renewable Energy Projects and integrate their development resources with the PLN.

Also, village-level projects depend heavily on community participation in the construction and operation of the installations and generally are most efficiently implemented by strong local institutions. Through the proposed institutional structure, PLN would provide back-up technical and managerial expertise to the local entities.

Since PLN is a corporation and would not receive revenues for a small hydropower promotional program, it must obtain policy guidelines and a budget from the DGEF.

Programs

In the next five-year plan, the GOI has set a new small hydropower capacity goal of 55 MW. Although PLN has the manpower and skills to develop small hydropower schemes at the present rate, additional resources will be needed for this expanded program. Since small hydro development will most likely continue in the following five-year plans, Indonesians, rather than foreign consultants, are gaining the experience in the design and implementation of sites to apply to future projects. National policy should continue to promote implementation of small hydropower projects by Indonesians by providing training programs and distributing technical information. The PLN currently has neither the mandate nor the staff necessary to undertake the planning and implementation of a major training or promotional effort in small hydropower.

For such a program to be effective, a continuous supply of qualified individuals should be trained by indigenous institutions. In this regard, many officials within the small hydropower development community in Indonesia expressed an interest in guidelines and training for the undertaking of site assessment studies, the preparation of feasibility studies, and the formulation of design criteria for use by technicians in surveying potential small hydropower sites. This type of preparatory training could best be facilitated through PLN, perhaps working with a university engineering department with funding from a grant or from loan funds coming into the country for small hydro projects. Brawijaya University at Malang, East Java, is involved in rural development, has experimented with micro-hydro turbines, and has expressed a desire to become involved in small hydro training.

PUSPITEK and BPPT are also designing and fabricating small hydropower equipment. Program officials have expressed interest in obtaining assistance in refining their equipment designs. However, these efforts appear to be duplicating standard designs and

readily available equipment that could easily be manufactured in Indonesia under a licensing agreement with a reputable manufacturer. Rather than continuing to "reinvent the wheel," these efforts need to be turned over to commercial enterprises which would actively market equipment.

Recommendations

The PLN should be the major coordinator of a small hydro program and should develop a plan of action to implement sites and assist entities such as private industry, plantations, KUDs, municipal governments, and others in implementing sites. Recommended activities in each of these roles for PLN are

As the coordinating body for Indonesia's small hydro program, PLN should:

- Identify those sites, from the inventory of sites, which could replace PLN, private, or other agency diesel units;
- Specify which sites it will develop (within next five-year plan) and which sites it will encourage other agencies to develop; and
- Maintain lists of qualified suppliers, engineers, and contractors with experience in small hydropower and make them available to other site developers.

PLN's site development activities should include:

- Identifying, from the inventory of sites, those sites which will replace PLN diesels, conducting prefeasibility- and feasibility-level studies, and developing a plan to replace diesel with hydro units;
- Actively seeking financing for the plan;
- Compiling standardized designs that maximize the use of local materials;
- Replacing diesel units with small hydro units; and
- Requiring an assessment of alternate energy supplies before authorizing installation of new diesels or relocating old units.

As part of its role in assisting others, PLN should:

- Develop and issue standardized guidelines for equipment to be used in Indonesia, including standard distribution voltages, generator voltages, grounding practices, and protection and safety equipment;
- Develop and issue standardized design guidelines that maximize the use of reliable, locally available materials;
- Periodically hold training seminars for individuals from provincial governments, DGC, private enterprises, and other entities, which describe site assessment techniques, suggest sources of data, explain licensing requirements, promote the use of PLN's standardized guidelines and designs, and recommend implementation procedures;

- Agree to the use of PLN facilities, on a cost-reimbursement basis, for the special repair and maintenance of non-PLN turbo-generating equipment where it is unreasonable for the owners to go elsewhere;
- Offer hydropower operator training and electrician training to non-PLN personnel on a cost-reimbursement basis; and
- Review specifications and designs of all units over 100 kW.

Financing

There is a positive attitude throughout the development financing community about the usefulness of small hydropower systems. The most probable source of funding is either multilateral banks through the PLN or GOI grants through the DGC. If DGC funds are determined to be the best source, the prefeasibility effort can be directed at locating communities with KUDs for feasibility-level studies. A mechanism is needed by which local private developers can gain access to foreign currency for sites which demonstrate a potential for reducing domestic oil consumption.

Although the purpose of promoting hydropower is to displace domestically consumed oil which can be exported for additional foreign currency, rural groups with attractive sites do not have access to foreign currency financing. A possible solution would be to allocate a significant portion of the increased foreign currency revenue gained by hydropower development to finance additional hydropower development. Thus, a self-perpetuating financial mechanism could be established that channels funds to protect the country's oil-dependent economic base.

Recommendations

Action is needed to help promote the development of non-PLN small hydropower units by village cooperatives, provincial governments, private enterprises, and special groups. In addition to the above programmatic recommendations for PLN, we recommend that:

- BAPENNAS develop a mechanism for private enterprises and special groups to obtain foreign currency financing for micro- and mini-hydro projects which displace oil fuels; the ultimate source would be from the extra foreign currency earned from increased oil revenues; and
- The central and provincial governments become equity partners in mini- and micro-hydro projects implemented by special groups and private enterprises, at least to the extent that local government agencies and projects would utilize the power; in most cases, the support should be in foreign currency.

Southern Sumatra assessment

Regional description

The GOI requested USAID to concentrate its small hydropower efforts in the southern portion of the island of Sumatra, which includes the provinces of Bengkulu, Jambi, Lampung, and South Sumatra (see Fig. 1). Except for a mountain range that extends along the southwest coastal border, this area is reasonably flat with many rivers beginning in the mountains and extending to the coastal areas. This mountain range extends to a maximum elevation of 3,159 m in this area of Sumatra with an average elevation of approximately 2,300 m along the peaks. The southwest slope of these mountains rises rather sharply from the coast over a distance of from 45-75 km. On the northeast slope, the elevation rate is less pronounced and the distance to the coast is much greater, in some instances over 200 km. The approximate annual rainfall in southern Sumatra is 2,400 mm, distributed throughout the year.

These four provinces of southern Sumatra, which comprise approximately 40% of the island's land area and about 28% of the total population, are heavily populated by transmigration people from West Java. It is estimated that there are approximately



Fig. 1. Small hydropower site assessment area.

37 people per square kilometer, which is a considerably lower density ratio than the national average of 69 per square kilometer. The per capita income in this area is reasonably high and is derived chiefly from such agricultural products as coffee, tea, and vegetables in the higher elevations and rubber, cloves, tobacco, and rice in the lower areas.

Electrical facilities in the area are not as extensive as on Java. The PLN has provided 174 MW of power, mostly in the past five years, through diesel-generation plants located in the more populated areas and two small hydropower units located in northern Bengkulu. Individuals and villages also operate a number of small, electrical-generating units in isolated areas. The range of mountains which extends along the southwest coast of Sumatra from the north to the south provides ideal resources to develop small hydropower for the many areas that are isolated from an organized, electrical distribution system.

Selection criteria

The following criteria were developed by NRECA's institutional advisor for use in a brief survey and identification of potential project sites in southern Sumatra:

- **Number of households in the general area adjacent to the proposed project site.** From a financial point of view, a project's viability depends on its ability to provide operating costs and repay funding within a reasonable time period. Sufficient households should exist or transmigration statistics should indicate placement of a minimum number of families to satisfy funding agreements.
- **Banking activity in general area.** The degree of banking activity is a good indicator of the economic climate. Banking activities usually stem from commercial activities such as stores, small shops, and industry and also suggest that local people have reasonably good incomes.
- **Industrial and/or commercial activity.** Those rural areas of Sumatra with such industry as ratan factories, tobacco-processing facilities, rubber-processing centers, and sugar mills usually develop a healthy economic climate, typically characterized by above-average wages. Such an economic climate generally provides a good indication of the affordability of electric service in a region. A positive industrial climate also provides a source of management and technical skills which can be easily transferred to small hydropower projects. Industrial installations can also be considered as potential customers with the added possibility of joint operation of the electrical facilities.
- **Existing, active projects.** The success of small hydropower projects, as with other rural electrification projects, will depend on a positive attitude among the area officials and general population toward economic development. Existing activities are an indication that the area has a positive attitude and will support new projects.
- **Economic level.** An area's economic level provides an indication of its basic financial status. This rating takes into consideration such factors as average income of the population, commercial activity, consumer products purchased, number of vehicles, etc. The economic level of the area is of value in determining the affordability of electric service.
- **Productive-use prospects.** Small electrical systems are difficult to manage financially on household lighting loads only. In such cases as this, service is usually

provided during nighttime hours only. For a system to maintain electrical stability, a mix of customers requiring demand for household lighting at night and daytime demand from shops, small businesses, or possibly light industry is needed. The implementation of electric systems will, in most cases, generate productive uses if appropriate programs are initiated. The general attitude of the community toward progressive development will provide key indicators of the likely productive use of new energy supplies.

- Existing electrical facilities. Many communities in Indonesia have developed a community electrical system either with help from the regional government or from local or individual sources. Usually these small systems are served by diesel generation. Their existence suggests a desire and willingness to operate and maintain a feasible small hydropower project. The chances are good that a community with existing electrical facilities would support a hydro project.
- Institutional resources. The operation of small hydropower facilities and their distribution systems requires management and technical skills. The availability of these skills in the area provides a good climate for project development and a good indication of a relatively high degree of educational, technical, and industrial experience. Areas without such experience will likely need manpower training before the initiation of a project.
- Various sources of income. Communities which are generally most able to support cooperative or government-operated projects, such as small hydropower projects, receive income from a variety of sources—shopkeepers, farmers, government workers, professional people, day laborers, etc. This diversity of income provides a good economic climate and suggests a progressive attitude toward a higher quality of life.

Site assessment

Because of excessive rains, difficult road conditions, and the remoteness of many potential sites, NRECA's institutional advisor was only able to visit five of the many possible sites for small hydropower development. These site visits were supplemented by economic and institutional data obtained from PLN and BAPPEDA, discussions with provincial officials, and a review of topographical statistics. Although the site identification process was clearly constrained by the lack of hard data, sufficient information on water supplies, population magnitude, and household size was available from the sources cited above to permit the targeting of 28 potentially viable small hydro project areas. Questionnaires designed to obtain more economic and institutional data were later circulated to appropriate officials in each target area (see Appendix C). The 28 potential sites are listed in Table 2. The information received from the survey is incomplete and, in many cases, the sites for which information was received are not located in the same general area as the proposed candidate sites. The resource assessment team will need to collect and analyze additional information on those sites for which information was incomplete and obtain information as requested originally on those for which none was supplied before selecting candidate sites for prefeasibility studies.

Next steps

It is important that each designated party in Table 3 carry out its responsibilities in the review and discussion of this report, so that the next phase of assistance, the field

TABLE 2. Candidate Hydropower Sites

Desa	Kecamatan	Kabupaten
<u>Bengkulu</u>		
Muaraaman	Lehong Utara	Rejang Lebong
Duku	Curup	"
Suban Air Panas	Curup	"
Tadak Gedung	Kepahing	"
Jutik	Kepahing	"
Kampung Bogor	Kepahing	"
Samelako	Lebong Selatan	"
Bintuan	Kaur Selatan	Bengkulu Selatan
Lubuk Kebur	Seluma	"
<u>Jambi</u>		
Keliling	Danaukerinci	Kerinci
<u>Lampung</u>		
Kedamain	Kota Agung	Lampung Selatan
Kesugihan	Kaliando	"
Talangpandang	Talang Padang	"
Rantaute miang	Blambangan Umpu	Lampung Utara
Dwi Kora	Sumberjaya	"
Sumber Agung	Pesisir Tengah	"
Poncowati	Terbanggi Besar	"
<u>Palembang (South Sumatra)</u>		
Lubuk Buntak	Pagar Alam	Lahat
Tebing (Ranten)	Tebingtinggi	"
Lawang Agung	Jerai	"
Bandar	Pagar Alam	"
Pandang Kendidai	"	"
Seleman	"	"
Geramat	Kota Agung	"
Banding Agung	Muara Dua	Ogan Komering Hulu
Martapura	Martapura	Martapura
Muaradua	Muaradua	Ogan Komering Hulu
Tanjung Kaning	Pangadonan	"

TABLE 3 Next Steps

	Task	Responsibility			
		Administrative	Substantive	USAID/Washington	USAID/Jakarta NRECA GOI
1.	Deliver report to USAID and GOI				X
2.	Deliver report (w/USAID concurrence) to reps. at WB and ADB for review and comment				X
3.	Review report and provide comments to NRECA			R. Ichord, Asia/TR A. Jacobs, ST/EY	
4.	Review report and provide comments to USAID/Jakarta				A. Munandar, DGP D. Hamid, DGP Suryono, PLN I. Subroto, PLN J. Rumondor, PLN R. Pasaribu, PLN L. Sen, Min. of Fin.
5.	Discuss appropriateness of recommendations with GOI			W. Fuller D. O'Reardon J. Baird D. Tinsler	A. Munandar, DGP Suryono, PLN J. Rumondor, PLN R. Pasaribu, PLN
6.	Determine relevance of recommendations to GOI needs, on-going, planned USAID projects, and GOI assistance policy			W. Fuller D. O'Reardon	
7.	Forward GOI and AID/Jakarta comments to USAID/W and NRECA				X
8.	Incorporate comments in report (attn. given to recommendations, technical accuracy, and work for field survey) for final draft				X
9.	If concur with report recommendations, send request to USAID/W for further assistance				X
10.	Discuss request with USAID/W and obtain concurrence				X
11.	Review and select candidates for field team and submit to USAID for approval				X
12.	Bring team to WDC for substantive briefing at NRECA to review in-house materials and to discuss survey w/USAID and WB reps.				X
13.	Send team to Indonesia				X

survey, may be undertaken in a timely fashion. Appendix D outlines a preliminary scope of the planned field survey.

Of the responsibilities outlined in Table 3, it is particularly important that:

- USAID/Jakarta ensure that this report is distributed to key GOI personnel; determine the consistency of report recommendations with overall USAID policy; discuss recommendations with GOI personnel; and forward comments to USAID/Washington.
- GOI consider the appropriateness of report recommendations to GOI needs and, if in agreement, provide commitment to assisting NRECA and USAID/Jakarta in implementing the next phases.

The NRECA SDH Program staff feel that the planned assistance for Indonesia meets the following stated SDH Program Objectives:

- Energy planning. Specific projects will more clearly identify areas of conflict between local communities and the national power authority, which perhaps will allow for better policy recommendations. Site-specific data gathered will be used to refine the national small hydro capacity goals set forth in the next five-year plan.
- Technical assistance. Identifying appropriate sites for small hydro development will be an obvious prerequisite to obtaining project financing.
- Institution building and training. This undertaking will allow consulting engineers to work closely with PLN counterparts giving the consultants an opportunity to assess the in-country skills and future training requirements.
- Information networking and financing. The technical and financial assumptions used in the prefeasibility and feasibility studies will be in accordance with major funding institutional requirements and geared to attract funding for the next five-year plan.
- Private-sector participation. The assessment team may locate a site which would be attractive for private-sector development and could then propose policy and institutional arrangements to encourage private development of small hydropower.

Appendix A. Scope-of-work

The scope-of-work for Samuel Adkins, as agreed to with USAID/Jakarta, is contained in the cable, STATE 302284:

1. ST/EY proposes to begin scope-of-work for subject assistance as developed by Zoellner (NRECA) and sent to Mission (Bosken) August 9, 1983. Ichord is in agreement with following strategy.
2. In this first step (Project Four in scope) of the small hydro planning and site assessment, it is proposed to look at the institutional and economic environment. The rationale for this phase is that full consideration should be given to institutional arrangements and economic viability before selecting sites for their technical merit in an attempt to avoid past problems in implementation and operation.
3. The GOI has expressed several times that they would like USAID-funded assistance in small hydropower to focus on S. Sumatra. Therefore, the focus of the institutionally oriented first step will be on this geographic region. Alternative region could be Java depending upon opportunities stemming from new watershed approach.
4. The expected outputs of the first phase:
 - Summary and status of GOI policies and programs;
 - Criteria and a preliminary regional plan for field assessment; and
 - Possible implications for subsequent financing and implementation, including roles of multilateral development banks and USAID/NRECA, in training and institutional development.
5. To initiate this phase, ST/EY proposes Mr. Sam Adkins to carry out the above approach and develop the elements of the first phase, from meetings with USAID, PLN, BPPT, and other relevant officials. A visit to the region will also be included. Prior to proposed dates, Mr. Adkins will review existing material and prepare a discussion document. Discussions will attempt to reach concurrence on financing, implementation, and operating responsibilities for various types of installations in accordance with long-range national development goals. A draft report will be prepared before departure from Jakarta, and a final report within eight weeks of his return to Washington.
6. As a reminder, ST/EY has proposed to fund all phases of this assistance from the Small Decentralized Hydropower Program. Funds for Mr. Adkins are provided by NRECA as an in-kind contribution to the Cooperative Agreement.
7. Mr. Adkins has over twenty years of rural electrification experience and spent four and a half years in Indonesia as a rural electrification advisor to PLN. Mr. Adkins has completed the review of background mini-hydro material and is ready to travel to Indonesia to begin in-country discussions immediately.
8. Request Mission concurrence with proposed plan of action by October 31. ST/EY will then send Mr. Adkins' ETA.

Appendix B. Individuals and institutions contacted

Information in this report was obtained through meetings and/or conferences with the following individuals:

Ir. Almizan Abdullah	Head, Electrical Engineering Department Brawijaya University Malang, East Java
Ir. Sjoufjan Awal	Chief, Project Development Office, Department of Cooperatives
Mr. James Baird	Rural Electrification Project Officer, USAID/Jakarta
Mr. William P. Fuller	Mission Director, USAID/Jakarta
Ir. Djurzan Hamid	Director for Power Resources, Director General of Electric Power
Ir. Budiono Mismail	Technical Faculty, Brawijaya University Malang, East Java
Prof. A. Aris Munander	Director General, Office of Energy, Ministry of Mines and Energy
Mr. Darwin Nasution	Director for Planning and Program Development, Department of Transportation
Mr. Desmond O'Reardon	Chief, Power, Transportation and Engineering, USAID/Jakarta
Ir. Richard Pasaribu	Chief, Technical and Survey Branch, Perusahaan Umum Lистраik Negara
Ir. John Rumondor	Deputy Director for Rural Electrification, Perusahaan Umum Listrik Negara
Dr. Lalit K. Sen	Consultant, Department of Finance
Mr. Ray Shoff	Team Leader, NRECA/Jakarta
Ir. Ibnu Subroto	Chief, Electric Power Research Center, Power Research, Perusahaan Umum Listrik Negara
Ir. Suhardono	Dean, Faculty of Engineering, Brawijaya University
Prof. Suryono	Advisor to Perusahaan Umum Listrik Negara
Mr. Doug Tinsler	Chief, Rural Development, USAID/Jakarta

A field trip to the four provinces for an on-site view of selected project locations was arranged by Ir. Hamid. Ir. Pasaribu coordinated the trip and accompanied the survey group as an advisor during the period December 6-12.

Appendix C. Questionnaire

Survey Form

Small Hydropower Site Assessment

Date _____ Area _____ Desa _____

Kecamatan _____ Kabupaten _____

1. What is the population of the general area (number of households)? _____ Is this a transmigration area? _____
2. What is the general economic rating the area? _____
3. Is there industrial and/or commercial activity in the area? _____
4. What is the chief source of household income? _____
5. Do banking facilities exist in the area _____
6. Are there electrical facilities? _____
7. Are there new projects in the area (i.e. roads, irrigation, etc.)? _____
8. Are there community-operated projects in the area? _____
9. Can the people afford electricity? _____ How much can they afford to pay per month? Rp. _____
10. Are there institutional resources in the area? _____

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Appendix D. Preliminary field survey plan

Purpose

The purpose of this prefeasibility effort is to test the viability of several candidate sites using generalized regional cost and benefit guidelines to identify one or two sites for a more detailed feasibility study.

Terms of reference

ST/EY will send a three-person team to Indonesia to conduct prefeasibility studies for approximately six sites. The team's activities, which will require a total of approximately 18 days in Washington and 26 days in Jakarta, will include:

- 3 days in Washington, D.C. to review the project status, collect data, and meet, brief, and coordinate with AID and World Bank officials.
- 7 days in Jakarta to work with PLN counterparts to prepare for field effort by:
 - Collecting hydrologic data, maps, previous reports, and cost data;
 - Reviewing site-selection criteria and survey forms and locating missing data;
 - Selecting about six sites for prefeasibility analysis and from 28 original sites and making logistical arrangements.
- 15 days in southern Sumatra working with PLN to conduct prefeasibility studies including:
 - Laying out hydropower scheme;
 - Costing of scheme;
 - Calculating potential power and energy production;
 - Analyzing potential benefits;
 - Assessing potential impacts on local social, environmental, and economic conditions; and
 - Developing framework for implementation and management consistent with report recommendations.
- 4 days in Jakarta to assemble field data, prepare preliminary report, and present findings during one-day seminar for PLN management and AID. Recommendations for continuing with a feasibility-level study on one or two sites will be made along with recommendations for an appropriate scope-of-work. The scope-of-work will reflect the team's recommendations for detailed site field work required for a feasibility determination. For example, the team may identify the need for a stream-gauging program, soil investigation, surveying crew, etc. Each of these investigations will require locating skilled manpower and a funding source.
- 15 man-days in Washington for the team leader to finalize the prefeasibility reports and brief AID/Washington and World Bank. Final reports with recommendations for appropriate follow-on activities will be delivered to AID/Jakarta and PLN within eight weeks after the team's departure.

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Expertise required

The SDH Program, through its Cooperative Agreement with S&T/EY, will provide the following expertise:

- **Economist.** The team economist will have developing country experience in conducting energy system studies. He/she will be familiar with electrical power system capacity-addition issues and experienced in performing analysis based on lowest-cost alternatives and the net benefit to the local economy. He/she will be knowledgeable in shadow pricing and tariff structures and will be able to prepare a financial plan based on an assumed debt-service schedule and revenue projections. To the extent possible, he/she should be prepared to analyse potential for productive use of energy and suggest institutional arrangements for local development and operation.
- **Hydropower engineer.** The team engineer will have developing country experience in the layout and cost estimating of small hydropower schemes. He/she will be familiar with general costs curves for conducting prefeasibility-level analyses and with more detailed unit costs for conducting feasibility-level analyses. He/she will be knowledgeable in cost-containment features important to small hydro projects and versed in their operation and maintenance requirements. He/she will have a general knowledge of soils and foundations so that additional site investigations can be recommended as needed.
- **Hydrologist.** The team hydrologist will have experience in preparing flow duration curves for sites where little data exist. He/she will be familiar with various methods for synthesizing hydrologic data and will be able to select and implement the appropriate method for southern Sumatra. He/she will be knowledgeable about hydrologic data collection networks and will be able to recommend optimal gauge types and location.