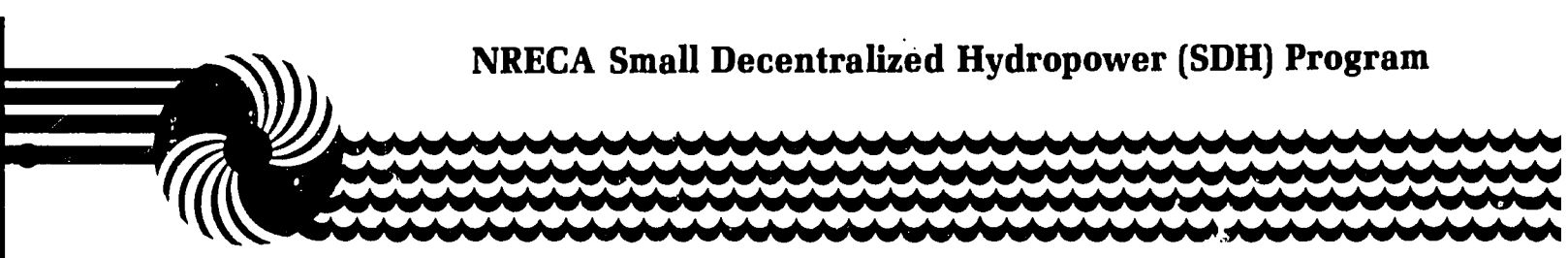
Country assessments for mini-hydropower potential

A methodology



NRECA Small Decentralized Hydropower (SDH) Program

Country assessments for mini-hydro potential: A methodology

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Small Decentralized Hydropower (SDH) Program
International Programs Division

National Rural Electric Cooperative Association
1800 Massachusetts Avenue NW, Washington, DC 20036

Small decentralized hydropower program

This publication is one of a series that fosters the effective use of small decentralized hydroelectric power systems. The 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 such technical assistance by--

- Designing and implementing regional workshops in Africa, Asia, and Latin America
- Scoping and managing in-country resource surveys and site assessments
- Providing engineering, design, supervision, and specialized assistance
- Developing specialized publications, such as state-of-the-art reports, inventories of manufacturers, and assessment methodologies
- Conducting special studies into subjects of finance, management, and evaluation
- Providing training services in such topics as operation and maintenance, resource assessment, management, and fabrication
- Carrying out specialized services, such as tours of U.S. manufacturing plants
- Creating specialized products, such as productive-use plans for energy from small decentralized hydropower.

For more information on the SDH Program, please contact:

Information Specialist
Small Decentralized Hydropower Program
International Programs Division

NRECA
1800 Massachusetts Avenue NW
Washington, DC 20036

Telephone: 202-857-9622
Telex: 64260
Cable: NATRECA

Preface

Through its Small Decentralized Hydropower (SDH) Program, the National Rural Electric Cooperative Association (NRECA), is developing a broad range of documentary materials for the use of SDH planners, managers, and consultants involved in small hydropower programs for developing nations. Several methodological guides, of which this is one, describe simple estimating and measurement techniques, rules of thumb, and common sense approaches which can be very helpful to SDH practitioners in the field, particularly in remote or rural areas where recorded data is scarce and sophisticated instrumentation not available.

These methodological guides are intended to be used by people with training and experience in water resource development and/or power generation, but perhaps with less experience in small scale projects or in developing countries. The hints and guidelines described in these documents are derived from the field experience and information abstracted from the extensive literature on small hydropower development.

Contents

Introduction

This brief methodological guide outlines the phases for carrying out an initial country survey of small hydropower potential. This guide cannot be used as a step-by-step field methodology. Such methodologies, albeit based on U. S. experience, already exist. The potential users of this methodology are engineers, energy planners, economists, and others who would either carry out such a study or would design same for someone else to carry out. Simplicity without sacrificing accuracy, quality, and overall usefulness is a key to resource assessment in developing countries.

The objective in developing small hydropower generating facilities as a source of energy is in some cases to feed additional electricity into a national grid and, in other cases, to supply a small, isolated area with a local source of power.

For programs designed to feed a national grid, the assessment of small hydropower potential follows the conventional procedures used in investigating larger sites, except that the size range of possible sites is smaller. The level of effort in collecting background information can be scaled down accordingly.

This guide, however, focuses on the assessment of small hydropower sites to serve isolated areas not supplied by a national electric grid or having a source of electricity that is too unreliable for use of electric devices and equipment. Assessment of such decentralized sites requires the same kind of physical assessments--stream flow, topography, potential energy--as larger units, but often little background information or historical data on the site is available. Moreover, issues such as ownership, management, financing, end use, economic returns, and rate structures, which are usually straightforward questions for large grid-connected installations, require different approaches for small decentralized installations.

There are two basic approaches to the development of national small decentralized programs. One approach might be called "learn by doing." A country selects a site and installs a demonstration unit and, as the demonstration progresses, the country learns the problems, costs, and benefits of small hydropower. If the demonstration is successful, it can persuade the rest of the country and lending institutions that the experiment should be replicated as further need and resources are identified.

The other approach is to conduct an assessment of the small hydropower potential in the country (or in a region of the country). Such a country assessment can reveal--

The number of potential sites in the country or region

The typical size and characteristics of small installations in that region

The contribution they might make to the overall economic and social development of the country, and

An appropriate level of effort, funding, and structure for a national or regional program.

To conduct a country assessment, a team is assembled to collect data and visit potential sites. It consists of a team leader and technical specialists. The exact makeup of the team depends on the host country's characteristics and the nature of the request from the host country or sponsoring organization. Team composition may range from one small hydro engineer and one economist or hydrologist to a group with engineers, social scientists, rural development specialists, institutional analysts, and so on.

The team must have a clear statement of the objectives of the small hydropower development program that is planned or desired. If the objective is to displace the use of oil for generation in isolated areas, for example, the team will locate areas of diesel generation and then look for possible sites near those installations. If the objective is to provide electricity in nonelectrified areas, the team will locate areas in want of electricity and look for possible sites in those areas.

In either case, begin by defining the need for power and consider small hydropower as one alternative for meeting that need. Procedures that first identify potential hydropower sites and then search for a use for the power generally are not as succesful.

A country survey usually has four phases:

Preparation

Formulation of basic criteria for selecting or rejecting sites

Gathering and correlating data, and election of sites, and

General evaluation and developing recommendations for a national program.

Phase I

Preparation

The team leader should visit the host country or region about a month before the team's scheduled arrival. He or she arranges or coordinates the team's logistic support to make sure that they will be able to obtain the data, maps, working space, and transportation needed for site visits. The leader makes the necessary arrangements and obtains commitments from local sources for logistic support.

If possible, the team should work with a corresponding group from the local area. This will give the team better insight into the area's special characteristics and problems and give the local participants an opportunity to learn how to do hydropower assessments.

Phase II

Developing criteria fro site selection

Begin the assessment by trying to find out how small hydropower can fit into the country's future energy picture. This will depend on the area's existing energy use and future alternatives available to the communities. Information needed to make this determination includes—

Existing and projected power sources and energy costs

Existing electrical transmission and distribution grids and the cost of expanding them

Existing natural energy resources, and

The energy use profile for the target communities.

Much of this information should be available from government agencies and public or private institutions, from literature on the host country, or from other sources such as World Bank or UN surveys.

Basic site criteria

Analyze this information, survey the general hydrology and topology, hold discussions with government officials, and, finally, propose a set of criteria for selecting candidate sites. These criteria may, and generally will, include--

A minimum local population to be served, or load forecast. This may be a village or population center that has enough schools, medical facilities, small commercial enterprises, residential household, etc., to productively use the benefits of electricity.

Availability of electric power. This criterion could rule out some areas for consideration depending on the energy source for the existing transmission grid and the distance of the candidate load center from the grid. For example, a country in which the national grid is powered primarily by hydropower may choose to extend the grid to load centers within 10 kilometers of a high-voltage line, and no additional sites may be needed.

Minimum potential power. This criterion would eliminate sites where water resources exist but where, due to seasonal flow fluctuations, the power potential is too low or too unreliable to be considered for a national program.

Minimum head available. This criterion would eliminate potential sites that have sufficient water resources but would be too costly to develop because of the low head available.

Exclusion areas. Some areas may be ruled out due to overriding political, environmental, economic, or physical conditions.

Such criteria usually apply to the whole country, but some regions in the country may have unique characteristics. In this case, special selection criteria may be needed.

Phase III

Candidate site selection

After the basic criteria for candidate sites have been established, begin to identify actual sites for possible development. Gather demographic data to locate suitable population centers, gather hydrologic data to locate favorable river and stream areas, and compare the two lists to identify candidate hydroelectric sites.

Demographic analysis. After the population criterion has been defined, identify centers that fit it. The data for this analysis is usually available from the central government or other development agencies. If it is not available, the demographic determination will have to be based on indicators of population that are available, such as the number of schools or hectares under cultivation. There may be other factors such as medical clinics, food coops, etc., which would indicate active, supportive communities.

Hydrologic analysis. The effort required to conduct the hydrologic analysis depends heavily on what data and maps are available. The two main data bases needed for the hydrologic assessment are those for rainfall and river discharge. Become familiar with the typical patterns of river flow in the streams. Unfortunately, this generally requires data gathered over a long period of time. But draw together the best information available on rainfall, distribution, runoff coefficients, guaged river flows, and topography. Because of cost, assume that any reservoirs or impoundments would be small, utilizing only "run-of-river" streamflows. Also, unless there is information to the contrary, assume that the water quality is suitable for hydropower development (that is, free of heavy silt loads).

From this data, correlate suitable population centers with suitable hydrologic sites to compile a list of initial candidate sites. Review the list of initial candidate sites to develop a profile of a typical candidate site, and from the profile, prepare preliminary cost estimates.

On-site inspections

At this point, it is necessary to make on-site visits. This allows you to--

Check the accuracy of the maps, data, and assumptions used.

Assess the potential environmental impacts.

Assess potential social impacts.

Assess local communication facilities and access.

Assess the geology of the sites.

It may not be necessary to visit all candidate sites, if one site is representative of several. After the site visits, refine the selection criteria and the list of candidate sites. Then estimate the average size of small hydro installations and develop generalizations about the cost, impacts, and benefits of an average installation.

At this point the team may stop. Or, it can continue with further evaluations, depending on the needs of the host country and/or the sponsoring program.

Phase IV

Evaluations and program recommendations (optional)

Using the list of candidate sites and their typical characteristics, tentatively—

Evaluate the potential impact of the hydro program on the national, or regional energy use.

Evaluate the potential impact of the program on individuals and groups within the country.

Evaluate the impact on national economic development.

Develop a financial plan for funding a small hydropower program.

Develop an institutional plan for managing and operating a small hydropower program, and

Develop an implementation plan for integrating financial, technical, and management components of the program.

Energy-use profile

There is a relationship between energy consumption and socioeconomic development. Knowing this, social analysts can anticipate how a given population may benefit from hydropower. The installation of small hydropower units could have significant local impacts on--

Population growth rates

Rural outmigration

Family incomes and family expenses

The role of women

Local infrastructure

The use of time

Health and education.

Observe the local community, and describe it in terms of these characteristics and how they might change. Note the infrastructure development programs that may be necessary to realize the potential benefits of hydropower.

Economic development

Estimate the cost of a hydro program and weigh it against the projected economic benefits. These benefits would likely come from--

Savings from substitution for other energy forms

Productive use of electricity

Secondary economic benefits from social improvements such as better health, education, etc.

Development of small and cottage industries.

These benefits will take time to develop and be realized. It is necessary, therefore, to have a financial plan that allows the economic development to take place while paying back any borrowed funds.

Financial plan

Propose a financial plan to the host country for borrowing funds for the program. The plan must take into account--

The ability of the local community to pay for electric service

The support which the national government will lend to the program

The ability of the host government to raise capital.

You may want to suggest the appropriate amount of funding that should come from--

Loans from developed countries

Grants from developed countries

Commitments from the national and local governments

Loans from development banks

Loans from private institutions.

The plan might also suggest appropriate tariff structures, operating revenues, and equity levels, and briefly discuss the financial linkages with other development programs.

Institutional plan

Survey the existing local and national infrastructures and

recommend a management structure for operating and maintaining the hydroelectric systems. Your recommendations should consider--

Centralized vs. decentralized management

Personnel requirements

Salaries to attract and hold trained personnel

Use of consultants and technical assistance

Special problems the management will have to face

Local and national responsibilities.

Implementation plan

Develop an implementation plan that coordinates the financial plan with the manpower requirements and construction schedule.

The level of effort required to do a country assessment varies considerably from country to country. The following table shows the approximate level of effort required per ten candidate sites. This would be a minimum effort; a country that has one hundred candidate sites will require approximately ten times as much effort. Teams should be big enough to complete an assessment in 4 to 12 weeks. The report can be completed after the team has returned to their base of operations and appropriate sponsoring organizations have had the opportunity to comment on the draft report.

Phase	Effort/10 sites
II	10-20 person days
III	30-60
IV (optional)	10-20

NRECA has conducted a number of small hydropower country surveys; summaries of some of these, with USAID concurrence, are available and will be helpful in illustrating the outcome of the approach described above. Ask for--

Bangladesh: An assessment of small hydroelectric potential

Dominica: An assessment of small hydropower potential

Zaire: A proposed small hydropower and rural electrification project

See also NRECA's other methodological guides, such as--

Hydrologic estimates for small hydroelectric projects

Prefeasibility studies of candidate mini-hydro sites: A methodology

Environmental methodologies for small hydropower projects