

STAGES IN SETTING UP A MINI/MICRO HYDEL PROJECT

Village Electrification through Sustainable use of Renewable Energy (VE-SuRE)

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Embassy of Switzerland in India

TARA

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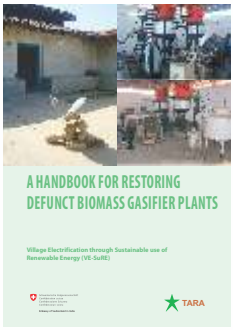

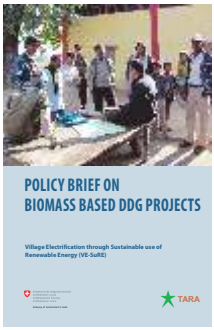

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About this document

This document provides an introduction to the various stages of planning for and setting up micro/min hydro power (MHP) plants. It is intended to give an overview of the whole process to non-expert project planners, donor agencies, or any other stakeholder involved in an MHP project. It has been designed with direct reference to the Indian context, but its approach remains valid for other countries or regions.

Introduction

Renewable energy offers three advantages: it does not lead to global warming, it is sustainable, and it can be made accessible even in very remote locations. When such remote installations are connected to the grid, not only do they contribute to the overall energy production, but they also improve the stability of the voltage at the grid end. In India, renewable energy production has grown dramatically over the last decade. The growth of renewable energy production has, however, mainly taken two forms: solar and wind. The third form: Micro and mini Hydro power (MHP), despite its significant potential[1], has lagged behind.

Due to their relatively small size, the planning, construction and operation of MHP plants are often taken up by institutions, departments or organizations that do not specialize in hydro-power. Additionally, in many cases, the setting up of MHP plants requires the involvement of local communities.

While most stakeholders understand the physical reality of an MHP plant(and its components), they do not have an overview of the whole process of planning and implementing of such projects. This lack of understanding often leads to difficulties in decision making, frustrations and unnecessary delays. This typically happens if any critical stage is missed or if the planners fail to obtain a clearance required for the project.

This document shall give a comprehensive overview of the various stages a MHP project has to go through. For each stage we shall describe briefly the different activities that are carried out and indicate the documents to be produced. We shall also mention the clearances to be applied for at that stage.

This document has been prepared in the Indian context and, before going through the various stages, we shall first enumerate the various government agencies involved in such projects and their respective roles.

Key Government Agencies

A number of government agencies have a role to play at given stages of the planning and development of a MHP plant. Table 1 presents a list of those agencies and their respective roles / functions.

Agencies	Roles
State Nodal Agency for development of MHP Such as: HIMURJA, SREDA, OREDA, KREDL, etc	• allotment of sites to Develo-pers • single window clearances • approval of Feasibility Report • signing of Implementation Agreement between the state Govt. and Developer • monitoring implementation progress of projects from allotment to the commiss-ioning stage; • facilitates grant of central financial assistance from Govt of India to the Developer
Director of Energy, State Government	• accords Techno- Economic Clearance to Detailed Project Report (DPR), forwarded to them by the State Nodal Agency
Government / local agencies Such as: Local Panchayat, Irrigation & Water supply Dept , State PWD (B&R), Pollution Control Board, Fisheries Dept, Wild Life Dept, Land Revenue Dept	• issue of various clearances or “no objection certificates” (NOC)
Ministry of Environm-ent & Forests, Govern-ment of India	• Issues Forest Clearance under Forest (Conservation) Act, 1980. The papers are submitted through the Principal Conservator of Forest (PCF) of the concerned state Government.

State Electricity Board (Distribution wing)	• finalizes the Interconnection point with the Utility grid • signs the Power Purchase Agreement (PPA)
State Electricity Regulatory Commission	• intervenes in the matter of any dispute between the developer and State Electricity Board in regard to Interconne-ction point or the power tariff in the PPA
Ministry of New & Renewable Energy (MNRE), Government of India	• sanction and release of central financial assistance in the form of capital subsidy to developers through nodal agency

Major Planning and Implementation Stages

There are five distinct stages involved in the planning and implementation of a Mini/Micro Hydel project. The five stages are: Site Identification, Feasibility Study, Preparation of the Detailed Project Report, Preparation of Tender Documents and the Award of Work, and finally, Construction and Commissioning. As is evident in the way the Stages have been named, the work of each stage comes to an end with a specific output.

Stage 1 : Site Identification or Allotment

There are four activities undertaken during this stage: Desk Study, Site Visit, Topographical Survey and River discharge Measurement and Estimation.

1.1. Desk Study

This first-level study[2] is conducted, off-site, with the help of a Survey of India topographical map of the area and other available data[3]. This study not only helps to identify the site, but also to estimate its hydro power potential. The latter estimate is based on data available on water availability, head, geological features, access, power evacuation[4] facilities, land and water use, etc.

1.2. Site Visit

The site visit serves to physically verify the results of the desk study. The site visit involves site measurements and refined calculations of elevations[5] and discharges to study possible alternative alignments and accurately establish the location of project components and the plant installed capacity.

1.3. Topographical Survey

The Topographical survey of the project area is preferably done on a scale of 1: 500 with 2 m contour intervals. This survey covers the general layout, diversion structure, water conductor system, penstock, powerhouse, tail race, switch yard and showing land use, land-slides, loose rock slopes, historical flood levels etc. During the survey permanent survey benchmarks are constructed, on the ground, for reference. An assessment of availability of construction materials is also doneat the same time.

1.4. River Discharge Measurements and Estimations

This is done by establishing a discharge measuring station at a suitable site. This measuring station is used to measure the discharges for at leasttwoleanseasons.Measurements are conducted by the technical team.

Collection of all other data is done by accessing existing records[6].

Stage 1 results in a Pre-Feasibility Report (PFR) that is ready to be submitted to the State Nodal Agency for appraisal and approval.

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[1] particularly in the Himalayan Belt and in the Western Ghats

[2] The term “first level” means a rough study of the site and its potential done without even going on the site. It is called first level as more detailed studies are conducted later. These studies include that of topographical features as well as for the hydro potential estimation.

[3] The term 'available data' means all data and information that can be obtained from maps, from government records, from satellite imaging, or any other sources. Example of such data are data on river discharge, geological features, proximity of villages, towns, access roads, high voltage lines, electrical sub-station, etc.

[4] 'Power evacuation' is a standard term in electrical engineering to describe the electrical sub-stations and transmission lines that will allow the transport (evacuation) of the energy produced from the generating station to the consumers.

[5] The term 'elevation' means the exact altitude in meters above sea level. During the on-site visit, it is possible to make much more accurate measurements of the elevation of the various points of interest in the landscape as compared to the data available from the topographical maps. This is important as difference in elevation between intake and power house, called the hydraulic head, is a key parameter for estimating the hydro-electric potential of a given site

[6]Other data includes rainfall, snowfall and Temperature data collected from the Indian Meteorological Department (IMD)

Stage 2 : Feasibility study

There are three components of the Feasibility study: Preliminary Design, Hydropower study and Financial Analysis.

2.1. Preliminary Designs

The work of making preliminary designs includes three tasks: designing the civil structures, working out the details of the Electro mechanical equipment and transmission line, and based on these two, preparing the initial estimate of Project Costs. The details of the tasks are as follows:

- Design of Civil Structures: this involves developing the Hydraulic designs for the dimensioning[1] of various project components and drawings.
- Electro-mechanical Equipment (E & M) and Transmission line: This involves the formulation of basic parameters of electro-mechanical works in terms of type, number, capacity of turbines, generators, transformers, powerhouse and sub-station equipment and power evacuation and inter - connection system. This task includes conducting Cost enquiries from the manufacturers.
- First Order Estimation of Project Cost: This is done based on the design of civil structures and E & M enquiries.

2.2. Hydropower Study

This involves the calculation of annual energy generation. This calculation is based on prescribed [CEA Guidelines(2)] values of available discharge in a 75% dependable year[3].

2.3. Financial Analysis

Financial Analysis is done by calculating the most commonly used financial indicators, viz., NPV (Net Present Value) and IRR (Internal Rate of Return).

Stage 2 results in a Feasibility Report (FR) that establishes the financial viability of the project in all respects. The feasability report is submitted to the various departments from whom clearances are sought[4]. The acquisition of project land is also initiated at this stage.

[1]Dimensioning is the process of calculating the size and form of various components of the system from engineering perspective.The components to be dimensioned include the weir, desilting structures, canal, forebay, penstock, tailrace, etc.

[2]Please refer to the Guidelines issued by CEA for Small Hydro Power Development

[3]The "available discharge in 75% dependable year" is the discharge that is expected to be exceeded in 75% of the years.This will directly translate into energy production and therefore financial returns.

[4]Clearances may include:

- Forest Clearance, where forest land is involved.
- Wildlife Clearance

Stage 3 : Preparation of Detailed Project Report (DPR)

There are seven activities undertaken at this stage: conducting detailed hydrological studies, conducting a detailed topographical survey, condu cting a power potential and optimization study, an analysis of the rates for principle civil items, the cost estimates, treating the environment and getting environmental clearance, and finally, making the drawings required for the Detailed Project Report.

3.1. Detailed Hydrological Studies

There are five sub-activities that comprise detailed hydrological studies:

- Discharge and silt measurements.
- Determination of 75 % dependable year and its discharges.
- Flow duration curve.
- Water requirement for irrigation and other riparian rights.
- Calculation of design flood and flood during construction period.

3.2. Detailed Topographical Surveys & Investigations.

There are three sub-activities that comprise this activity:

- Confirmatory detailed topographical surveys of project components preferably on a scale of 1:100 and contour intervals of 1m.
- Geological investigations about soil and rock types, slope stability and future surface movements (loose rock, slopes, mud flows, rock falls snow storms and flood behaviour)
- Construction material surveys and testing.

3.3. Power Potential & Optimization Studies for installed capacity.

- State Pollution Control Boards' Clearance
- Gram Panchayat Clearance
- Water Supply & Irrigation Department Clearance
- Public Works Department Clearance
- Fisheries Department
- Land Revenue Department

[1]All civil structures have to be designed to withstand flood events. This is usually done by designing them for the worst case flood expected to happen at about 100 years intervals (referred to a “100

years return period"). In very practical terms, this means that the final civil structures must be designed such that, in case of flood, the excess water should be able flow over the retaining structure (dam or weir) or get discharged by the side of the canal. All this should happen either without damaging the structure itself or increasing the risk of collateral damages down stream.

During the construction period too there is a risk of flood events. In this case too we must avoid possible damages to the structures and collateral damages downstream. This is done taking into account the risk of floods when planning the construction. Here we normally consider flood events of lesser magnitude, typically with a 30 years return period.

In this sub-activity, Studies for power output and optimization for various installed capacities are carried out. Based on these studies the power output and energy generation corresponding to the adopted installed capacity for 75% dependable year are calculated.

3.4. Analysis of Rates for Principal Items of Civil Works and Construction Machinery

This involves working out the Project specific analysis of rates of construction materials, labour, construction plant and machinery in order to determine the unitrates for principal items of civil works.

3.5. Cost estimates and Financial Evaluation.

The cost estimates covering civil works, electro- mechanical works, transmission and interconnection bay works are prepared as per CEA guidelines and incorporated in the DPR.

The complete proposal of financing is prepared with details of funding, phasing of expenditure, loan repayment schedule, interest, depreciation, O&M expenses, gross and net annual generation, and cost per unit. Financial indicators, like NPV and IRR, are used to determine the financial viability of the scheme.

3.6. Environment and Ecology.

The environmental aspects such as, catchment area treatment, consent of the State Pollution Control Board to establish and operate the unit under the Water (Prevention and control of pollution) Act and Air

(Prevention and control of pollution) Act on account of the project implementation are included.

3.7. Drawings.

The drawings required for the DPR are prepared. They generally comprise location and vicinity maps, general lay-out plan, longitudinal section of the scheme, detailed drawings of civil engineering componentsand single line diagram of sub-station.

Stage 3 results in a Detailed Project Report (DPR) which is submitted to:

- the Director of Energy for Techno-economic Clearance.
- the Electricity Board for Interconnection to GRID
- the Financial Institutions or Funding Agencies

At this stage we must reach the Financial Closure[1].

[1]Financial closure has been defined by RBI as *"a legally binding commitment of equity holders and debt financiers to provide or mobilise funding for the project. Such funding must account for a significant part of the project cost which should not be less than 90 per cent of the total project cost securing the construction of the facility"*

Stage 4 : Preparation of Tender Documents and Award of Work

There are three major activities in this stage: preparation of the Tender documents, floating of tenders, and award of contracts based on the evaluation of bids. This stage comes to an a end with the awarding of contracts and the signing of agreements.

4.1. Preparation of Tender Documents

This activity involves preparation of Tender documents for civil, electro-mechanical and transmission lines. Care needs to be taken that these tender documents have sufficient technical specifications and drawings

4.2. Floating tenders / receiving bids

In this activity Tender documents are floated, and widely publicized in the press. Subsequently, the received offers are reviewed using standard criteria.

4.3. Bids evaluation and contract preparation

In this final activity of Stage 4, contracts are awarded as per the reviews conduct; and agreements are signed. Simultaneously, the preparationof detailed construction drawings is commenced

Stage 4 results in the completion of formal “Contract Agreements”

Stage 5 : Construction and Commissioning

In this final stage, three major activities are taken up: construction of the civil structures, the installation of E&M equipment and the construction of transmission lines; and the Testing and Commissioning of the plant. This stageconcludes with the successful commissioning of the project.

5.1. Construction of Civil Structures

In this the Civil Structures are constructed as per the given design. Interestingly, the detailed designing design activities continue parallely even as the construction progresses

5.2. Installation of E&M equipment and construction of transmission lines

In this the Electro-mechanical equipments in the powerhouse and switch yard are, commissioned and tested as per construction schedule

Simultaneously, the Transmission lines and interconnection bay are also erected and commissioned

5.3. Testing and Commissioning

In this, the final activity of the final stage, Pre-commissioning, and Commissioning tests are conducted on the plant as per standard International Codes and Practices: these are done in order to establish guaranteed parameters.

Subsequently, Acceptance tests to are performed, any time during the warranty period, as per specified standards and practices, to affirm the same guaranteed parameters.

Stage 5 results in declaration of successful commissioning of the project as per contract agreement.

Stage 1	Stage 2	Stage 3
Site Identification or allotment	Feasibility study	Preparation of Detailed Project Report (DPR)
1.1 Desk Study • Hydrology assessment • Plant capacity calculation • Load assessment	2.1 Preliminary design and drawings • Design of civil structures • E-M equipment enquiries • Estimation of costs	3.1 Detailed hydrological studies (flow duration) • Silt and sedimentation studies
1.2 Site Visit • Physical verification • Selection of sites for civil structures • Study of variants	2.2 Hydro-power study Annual energy	3.3. Power Potential & Optimization Studies 3.4. Analysis of Rates 3.5. Cost estimates and Financial Evaluation
1.3 Topographical survey	2.3 Financial analysis {NPV and IRR}	3.7. Environmental & Ecology.
1.4 River Discharge Measurements		3.8. Drawings.
Pre-feasibility Report • Submission to State Nodal Agency	Feasibility Report • Application for clearances • Land acquisition	Detailed Project Report • Techno-economical clearance • Financial institutions • Interconnection to GRID • Financial closure

Stage 4

Preparation of Tender Documents and Award of Work

4.1 Preparation of tender documents

- Civil work
- Electro-mechanical eqp
- Transmission lines and interconnection bay
- Preparation of detailed engineering drawings

4.3 Bids evaluation and contract preparation

Contracts

Stage 5

Construction and commissioning

5.1 Construction of civil structures

- Preparation of construction drawings

5.2 Installation of E&M equipment and construction of transmission lines and interconnection bay

5.3 Testing and commissioning

- Commissioning tests
- Acceptance tests

Test Reports

Notes

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