Chapter 8
Execution, Supervision and Commissioning

8.1: Background

Traditionally, MHP projects in Nepal were implemented by three main players working together: i.e., the entrepreneur, the manufacturer, and the bank. The entrepreneur was responsible for the project management and civil works, the bank provided the necessary loan, and the manufacturer supplied and installed the equipment. This system has continued with add-on as well as stand-alone electrification plants. As plant size and sophistication have increased, it has become more difficult for entrepreneurs and manufacturers to carry out the work in the same way as with the mills.

The system that has evolved in Nepal for the implementation of turbine mills has turned out to be inadequate for implementation of electrification schemes, especially the larger ones (>25 kW). As manufacturers are not set up to provide the extensive design and supervision required for larger projects, the number of projects they are able to implement is severely limited.

Private sector MMHP plants in Pakistan are promoted mainly by the Pakistan Council of Appropriate Technology (PCAT) and the Aga Khan Rural Support Programme (AKRSP). The PCAT is a government organisation and the AKRSP is an NGO. They provide financial and technical support to communities wanting to install an MMHP plant. Technical support is provided for survey, design, and installation. Most of the equipment is manufactured locally under the supervision of the PCAT/AKRSP.

Pakistan has evolved a system in which a separate agency is responsible for survey, design, and installation. This system allows for more specialisation, which could improve the quality and volume of work.

8.2: Schedules and Methodology of Execution

8.2.1: Equipment Manufacture/Procurement

Once the detailed design of the MMHP project is completed by the consultant/ manufacturer, the equipment required must be procured. The current practice in Nepal is to buy all the equipment from the manufacturer. In the case of turbine mills, the survey, design, procurement, site supervision, and installation are carried out by the manufacturer. In some instances, the milling machinery for an MMHP plant has been purchased separately from neighbouring countries by the entrepreneur, because, as a cottage industry, the turbine mill is eligible for low customs' duties. However, this is a time and energy consuming process and entrepreneurs have generally left it to the manufacturers to supply all the hardware for the MMHP plant.

With electrification schemes, the tendency for 'one stop buying' has increased, because of the technological complexity and the need for all the components to be compatible with

each other. Only a few of the simple but bulky items (transmission wires and insulators) are sometimes purchased separately.

There are advantages to the customer in buying all the equipment from one place, as it simplifies the process and saves time and effort. However, it could increase the project cost.

8.2.2: Organisation of Recipient's Contribution

For most community-owned MMHP plants, there is some element of recipient contribution to the project. This could be in cash and/or kind. When it is contribution in kind it is in the form of local labour and materials.

When organising project construction, it is important to keep in mind the peak agricultural season when labour will be in great demand. Failure to plan for this will result in project delay.

There must also be a clear agreement among the recipients about the labour contributions; who is to provide how much and who is responsible for organising the work? The responsibility for organising the labour contribution should lie with the community and not with the manufacturer or implementing agency.

The responsibilities of the various parties involved in the MMHP project must be clearly understood by all involved, otherwise delays and increased costs will be incurred.

8.2.3: Agreements between the Parties Involved

There must be a written agreement between the different parties involved in the MMHP project before work begins. The relationships and the agreements between the different parties are given in Figure 8.1. When the manufacturer/installer takes on the role of the consultant/promoter (as with turbine mills in Nepal), the agreements will be between the manufacturer and the community/entrepreneur.

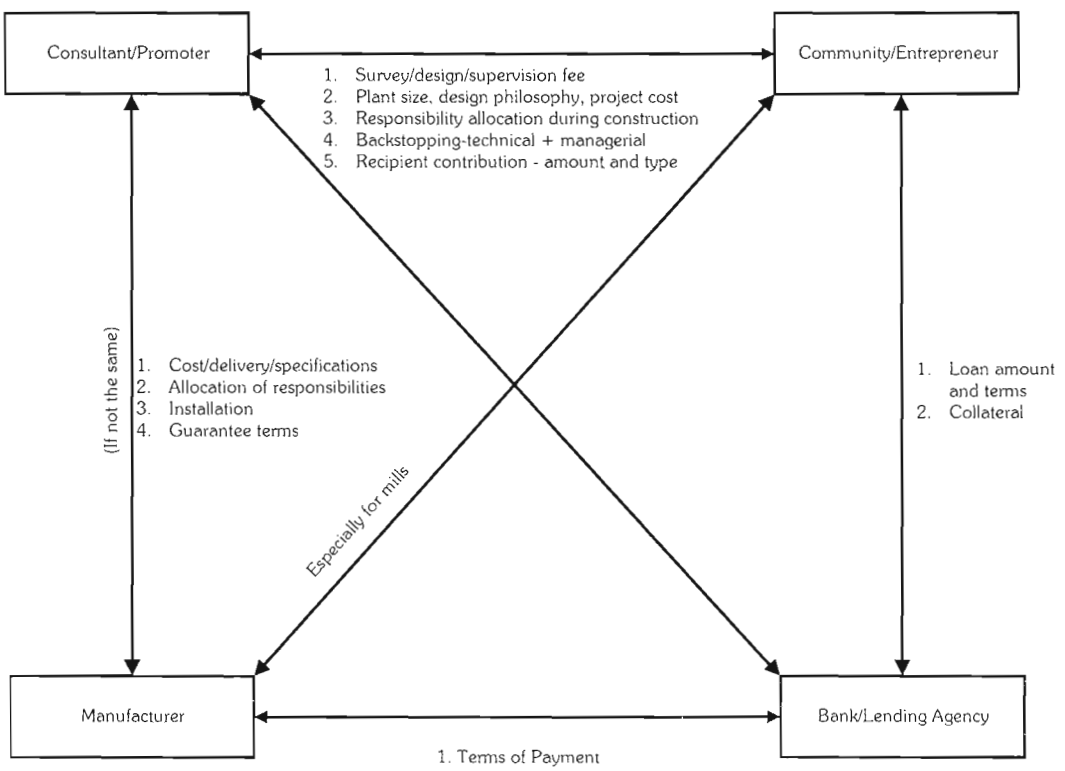

Figure 8.1 Agreements between Various Parties Involved in Building an MMHP Plant

8.3: Site Construction, Management and Supervision

Different countries in the region have evolved different systems for supervision and management. In Pakistan, the implementing institution supervises the work and manages the project. In Nepal, this is carried out by the entrepreneur and the manufacturer. For peltrics, the entrepreneur does all the site work and management himself; for turbine mills, some of the work, such as foundations and forebay tanks, is supervised by the manufacturer and the rest by the entrepreneur; for bigger electrical schemes, the electrical portion is supervised by the manufacturer as well.

8.3.1: Civil Works and Powerhouse

Supervision of the civil works and powerhouse is best carried out by a qualified supervisor on the site, especially if the work involves a fair amount of cement and concrete work. In cases in which the canal required for the MMHP plant is similar to the ones that are already being constructed for irrigation, this work can be left to the local people.

8.3.2: Inspection and Testing

The equipment made and supplied by the manufacturer must be inspected and tested before it leaves for the site. This should be undertaken by the manufacturer and supervised by the entrepreneur or his consultant. The following tests/inspections are recommended.

Penstock	– Pressure test of up to at least 1.5 times the design pressure; painting, other corrosion protection adequately carried out. Numbering markings carried out, as required.
Turbine	– Unobstructed movement of the runner, guide vanes. Balancing of the runner. Painting, corrosion protection.
Other mechanical parts	– Construction integrity, corrosion protection
Generator, control equipment	– These must be shop assembled and run to see if the control system works as designed.
PTCs, MCBs, current cut-outs	– These must all be tested to see that they function properly before despatch.

8.3.3: Transmission and Distribution System

This area requires careful supervision, especially in terms of safety.

Poles	– Buried to appropriate depth. If wooden poles are used, it must be ensured that they are of the right species and size for the purpose. Painting, treatment carried out appropriately .
Transmission wire	– Properly strung out. Connection to insulators sound.
Lightning arrestors	– Connected properly, earthing completed.
Distribution	– Proper connection between service wire and transmission cable. Properly connected cut-out devices. Wiring up to standard. Earthing carried out properly.

8.3.4: Transport

The transport of equipment and materials must be organised so that it arrives at the site not long before it is required. There, it must be stored properly so that it is not damaged or stolen. Components and parts, such as controllers, generators, turbine shafts, and electric meters, which might easily be damaged, must be protected or packed well enough to prevent damage.

Transport of materials for an MMHP plant in remote areas could involve the following modes of transport.

- By road vehicles
- Carried by porters or animals
- By air

When the equipment has to be carried by porters or pack animals, it is important to design the packing properly so that it is easily carried. If costs permit, it is worthwhile considering transporting bulky but sensitive equipment, such as generators, by air.

Involvement of the recipient (individual or community) is an important aspect of project implementation. Portering the equipment to the site from the roadhead is usually the responsibility of the recipients. However, they might need advice and supervision for this.

8.3.5: Equipment Installation

Different systems have been developed in different countries of the region for equipment installation. In Nepal, this is normally carried out by the manufacturer. In Pakistan, another implementing agency handles installation.

Installation Procedure

- Ensure that all the necessary materials, tools, and personnel are available.
- Mark out the position of the various equipment according to the design.
- Concrete in the parts that are to be embedded
- Wire up electrical connections and other work that does not require the concrete to have set.
- Install the machinery on the foundation when the concrete has set

8.4: Commissioning and Testing

The commissioning and testing procedures for an MMHP plant are an important part of the implementation process. They provide a system for checking that all the components of the MMHP plant function as designed and as specified by the supplier. The commissioning and testing procedures also provide a record of the operational status of the plant at start-up, and this is useful for future reference.

The commissioning and testing procedures, the methods for working out whether the equipment meets the performance standards stipulated in the contract, and the action to be taken in the case of under-performance must be agreed upon beforehand. In the case of under-performance, the penalties to be paid, the remedial work to be carried out, and so on must also be agreed upon at the time the contract is signed, otherwise it could lead to unnecessary disputes.

8.4.1: Commissioning Procedures

The commissioning procedure can begin after all the work has been completed and checked. The commissioning report must have a list of all the items to be checked or tested. Alongside the items, their condition, whether this condition is satisfactory, or whether it needs to be rectified must be mentioned. Likewise the test results and the data obtained (e.g., efficiency) must be noted, along with the conclusion concerning whether or not this meets the specifications.

Items to be included in the list are as follow.

Civil – Intake, canal, desilting/flushing system, overflow, gates/stoplogs, trash rack, penstock supports/anchors

Mechanical – Turbine, baseframe, penstock, valves, governor/controller

Electrical – Generator, load controller, control and protection panel, ballast load

Distribution – Poles, wire/insulator, lightning arrestors, service connections, cut-outs.

8.4.2: Commissioning Tests

The machines should first be checked with no load. The speed is increased at 10 per cent intervals until the rated speed is reached. At every stage, it is checked for unusual sounds, vibrations, and behaviour.

Starting at the rated speed and no load, the load on the machines is increased in steps of 10 per cent until full load is reached. At every load interval, the system is allowed to reach a steady state and readings are taken.

Readings to be taken, at different outputs

Flow (if possible), turbine speed, bearing temperature, alternator temperature at different points, governor oil temperature, alternator voltage and current on all phases, exciter voltage and current, power factor, voltage drop across transmission line.

Efficiency tests are quite difficult to carry out on small plants and peltrics. However, electrical power is measured to ensure that the specified output is achieved. For larger plants and where the dry season flow is critical, efficiency tests are more appropriate.

Tests to be carried out

Over-voltage, over-current, over-speed, vibration, efficiency, governor/controller response, generator insulation test, transmission line 'megger test'.

8.4.3: Rectifying Problems

During the commissioning tests, it is possible that there will be problems with the functioning of the plant for various reasons. The nature of the problem must be determined during commissioning as one of the following.

- **Serious :** stop work until the problem is rectified
- **Ordinary :** commissioning work can continue and the problem be rectified later at a more convenient time.

- **Minor :** can be rectified immediately or not significant enough to stop commissioning.

If there is a major rectification to be carried out, the responsibility for the work, its completion, and commissioning date must be agreed upon between the concerned parties.

8.4.4: Certification

In Nepal, the procedures and methods for carrying out the commissioning and testing are not well developed. In the case of mill turbines, the general practice is for the manufacturer to operate the turbine and the mill machinery for a day and then hand it over to the client. The client then signs a statement saying that the turbine and mill machinery are performing satisfactorily. The manufacturer then presents this statement as proof to the bank that the work has been completed and requests the remaining payments. In electrification projects, the requirement is that the manufacturer demonstrates that the design power output has been achieved.

In larger electrification projects, such as those in Siklis or Salleri, the commissioning procedures are more elaborate and involve measurement of turbine efficiency, operation of the control and protection system, and so on. This is largely because these projects are backed by institutions that have the technical expertise and resources to demand and get such tests done.

A system of testing and certification that is acceptable to all sides is needed. This would establish performance standards and make it possible to compare the relative performances of different manufacturers, which in turn would be an incentive to the manufacturers to continue to improve their products.

The main parties affected are the manufacturers, the lending institutions, the consultants/promoters, and the recipient communities/entrepreneurs. A new organisation, or an existing one, which is independent of the affected parties and has the technical capability to carry out the work, is a desirable institutional need. Such a separate body will need to be financed; and, ideally, the various parties involved will pay for its services.

8.4.5: Training

Training is an important but often neglected aspect of MMHP. In Nepal, most of the training given to MMHP plant owners/operators is 'on-the-job' training. In turbine mills, the installer demonstrates to the owner how the turbine and milling machinery works once the installation is complete. Similarly, for electrification schemes, the manufacturer demonstrates how the plant operates and points out the safety aspects in running the plant before handing over to the customer. The areas in which training is required are discussed in more detail in Chapter 13.