Best Practice Guideline

Off-Grid Micro Hydro Power Schemes for Rural Electrification

MHPP[2]/Energising Development (EnDev) Indonesia
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

September 2011

BEST PRACTICE GUIDELINE

RURAL ELECTRIFICATION THROUGH OFF-GRID MICRO HYDRO POWER

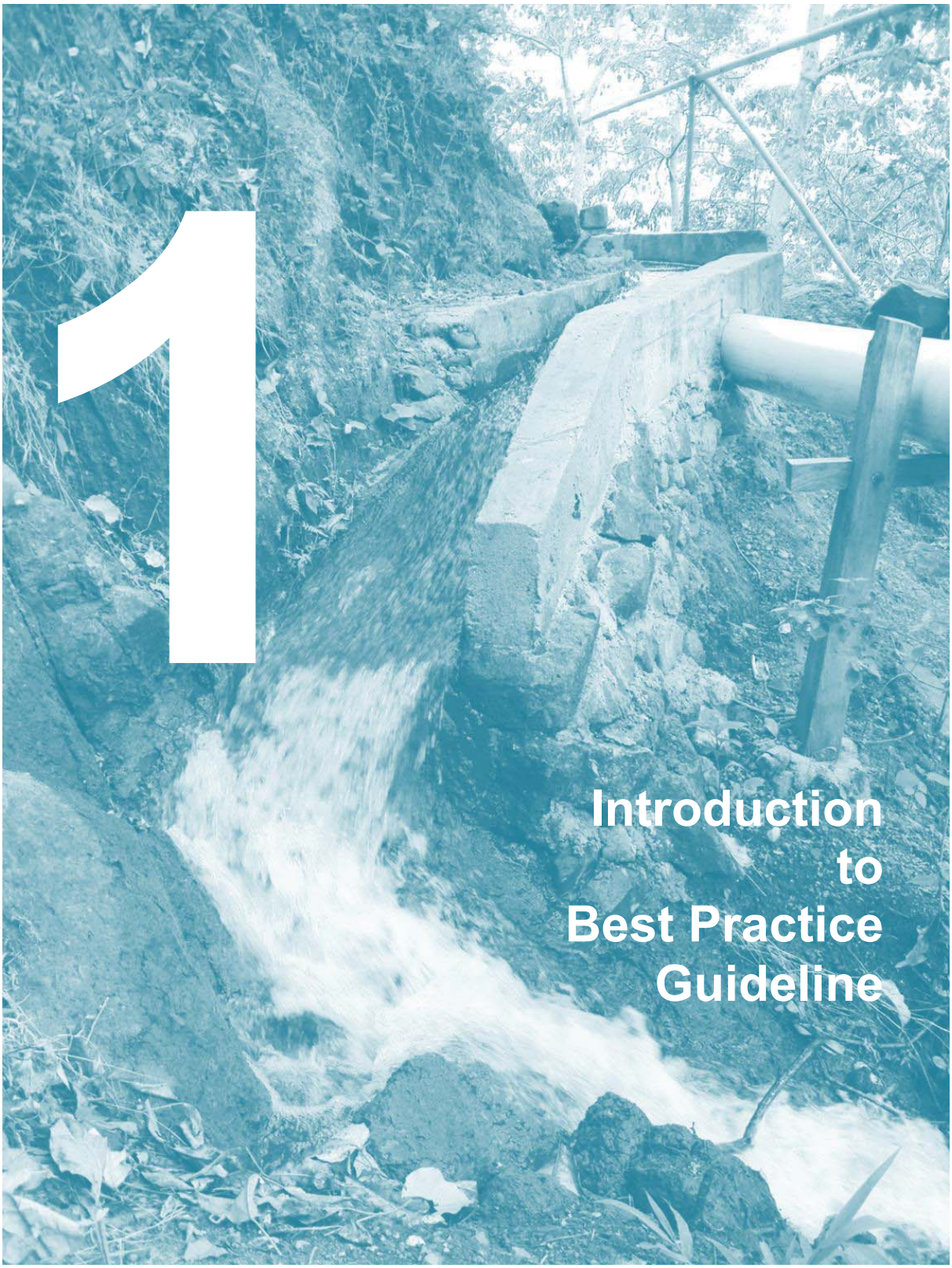
Table of Contents

List of Photos and Illustrations

Photographs in this document have been provided courtesy of the MHP-TSU, except for photos nos. (1), (2), (4), (5), (9), (16), (28), (33) and all front page and page footer photographs, which have been provided courtesy of the Consultant, 'Bush Craft'.

List of Abbreviations and Acronyms

AHB	:	Hydro Power Association Bandung
BOQ	:	Bill of Quantity
CFL	:	Energy Saving Electrical Bulb
CSO	:	Civil Society Organisation
DAK	:	Special Allocation Fund
DED	:	Detailed Engineering Design
ELC	:	Electronic Load Controller
EnDev	:	Energising Development (global energy programme)
GPS	:	Global Positioning System
Green PNPM	:	A pilot programme under PNPM Rural
GW	:	Giga Watt (1.000 MW)
kW	:	kilo Watt
kWh	:	Kilowatt hour
LED	:	Light Emitting Diode
M&E	:	Monitoring and Evaluation
MCB	:	Micro Circuit Breaker
MDG	:	Millennium Development Goals
MEMR	:	Ministry of Energy and Mineral Resources
MHP	:	Micro Hydro Power
$MHPP^2$	:	Mini Hydro Power Project for Capacity Building
MW	:	Mega Watt (1.000 kW)
NGO	:	Non-governmental Organisation
NREEC	:	New and Renewable Energy and Energy Conservation
O&M	:	Operation and Maintenance
PLN	:	National Electricity Company
PNPM	:	National Programme for Community Empowerment
QA	:	Quality Assurance
RE	:	Renewable Energy
RPJMN	:	National 5-year Development Plan
TA	:	Technical Assistance
TSU	:	Technical Support Unit



1

Introduction to Best Practice Guideline

1. Introduction to Best Practice Guideline

1.1 Background and Justification

Photo 1: Waterfall near Lake Toba, N. Sumatra

1. Indonesia has enormous untapped water resources with a high potential for rural electrification. In spite of abundant hydrological resources hydropower is only used to a small extent. The total potential capacity of hydropower resources in Indonesia is 75 GW, but in 2008 the country had only installed a total hydropower capacity of 3,504 MW, which represents a mere 4.7% of the technical potential and only 7.2% of the total Indonesian electricity generation capacity.

2. The application of MHP technology in Indonesia has been going on for more than 25 years but only a small proportion of the country's huge mini and micro-hydro power (MHP) potential has been exploited so far. Unfavourable framework conditions for stand-alone systems and on-grid schemes, lack of specialist know-how and a basic lack of awareness of the available potential have been the main reasons for the modest progress in the past. However, in remote rural areas, hydro power is now becoming increasingly competitive compared to fossil fuel-powered alternatives, due to the high energy prices (which can be three times as high as in urban centres) even with the still existing fuel subsidies by the Indonesian Government.

Photo 2: Traffic on Jl. Thamrin, Jakarta

3. Another factor contributing to an increased interest in MHP is that it is a clean, renewable, CO_2 neutral energy source that can replace or avoid the burning of fossil fuels, thereby contributing to Indonesia's climate change goals of significant reductions in CO_2 emissions in the medium term (26% before 2020). MHP plants require a constant and sufficient supply of water all year round to function properly which

can only be assured through proper management and protection of the catchment areas, thereby providing at least some protection against environmental degradation, soil erosion, and deforestation.

4. The increasing interest in MHP for rural electrification in Indonesia can be seen from the ever increasing funding channelled to the sub-sector by government, by donors, and by private sector. Several Indonesian ministries are involved in the proliferation of MHP technologies and schemes and a number of donor programmes support the implementation of on and off-grid MHP for rural electrification, including PNPM Rural and Green PNPM. In 2011 the government for the first time included rural electrification with a budget of 150 billion rupiah (approximately 17 Mio US$) in the Special Allocation Fund (DAK) and the MHP funding provided through the DAK is projected to increase gradually up to 100 Mio US$ by 2014 and each year thereafter. Other main sources of funding of MHP for rural electrification in the years to come include, *inter alia*, the PNPM (Rural and Green), the Indonesia Clean Energy Development project (USAID), and a new MHP programme funded by the Millennium Challenge Corporation.

5. It is on this background of an almost exponential increase in expected funding for MHP for rural electrification in future that this ***Best Practice Guideline for Off-grid MHP for Rural Electrification*** is put forward in the modest hope that the experience and knowledge gained through more than 20 years of German support to MHP in Indonesia can contribute to improving the economics, quality, and sustainability of new MHP programmes.

6. The Best Practice Guideline draws on and presents in short and clear bullet points the combined experience of numerous MHP specialists, both German and Indonesian, who have contributed over the last two decades to the progress and development of MHP in Indonesia, lessons and experience that have been learned through active involvement in the design, construction, operation, maintenance, and rehabilitation of a large number of MHP plants throughout the Indonesian archipelago.

Click here to see TSU and MHPP[2] Websites

7. Observations from more than 20 years of experience with MHP for rural electrification in Indonesia, most recently confirmed this year during a mid-term review of the Energising Development (EnDev) projects in Indonesia, the MHP Technical Support Unit (TSU)

and the Mini Hydro Power Project (MHPP[2]), point to clear and significant variations in quality and sustainability of existing MHP plants. Not surprisingly, there seems to be a strong correlation between the quality of an MHP plant and the level of specialised technical assistance provided during the design, construction, and operation of the plant. The more technical skills and know-how that is put into the design and construction, the better the resulting MHP.

Photo 3: Intervillage meeting (MAD II), Mamasa, W. Sulawesi

8. Observations in the field also point to close linkages between the sustainability of an MHP plant and the involvement and sense of ownership by the rural beneficiary community. In cases where the rural beneficiary community has been involved in all the steps, from the initial project idea and proposal, through the design and construction phase, and up to and including the daily operation and maintenance of the plant, the MHP scheme continues to operate for many years (unless hit by a natural disaster or other external calamity).

9. As rural communities in general are not specialists in MHP plants and their operation, the long term success of a plant to a large degree depends on how well the community is prepared and how much the capacity of the community and its members has been strengthened. When failed MHP plants or schemes are studied in more detail, the main factors are often found to be lack of community preparation and insufficient technical assistance during the design and construction, with insufficient budgets playing a critical role as well.

10. The Best Practice Guideline therefore puts focus on the observed weaknesses and provides a number of **Best Practices** that directly address the main causes of these. The Guideline mainly addresses the development of off-grid MHP schemes for rural electrification, with government funding channelled through local government, with implementation by contractors, suppliers and manufacturers, supported by consulting engineers, and with the

beneficiary community involved in all stages of the scheme development and contributing to the construction in kind.

11. Emphasis is put on community preparation and involvement; need for provision of sound technical assistance and know-how is highlighted throughout, and the importance of sound scheme economics are exemplified in Best Practices on tariff setting and productive end-use.

12. The Guideline is a first attempt to extract and condense the impressive range of practical experience and standardised approaches that exist in Indonesia at this point in time. The Guideline must be considered very much a living document, subject to improvements and adjustments as feed-back comes in from the field from the stakeholders applying the Guideline.

13. The consultant would like to thank all persons and institutions met with from government, donors, civil society and academia for their kind, invaluable and thoughtful comments and contributions to the Guideline. Particular thanks go to the team of MHP specialists in the MHP Technical Support Unit and the MHPP[2] project without whom this Guideline would not have been possible.

14. The views and opinions expressed in this document are those of the consultant and may not necessarily correspond to those of the Governments of Indonesia and Germany.

1.2 About This Guideline

1. In order to describe what this guideline is, it is probably easier to begin by describing what it is not:

2. This Guideline is **NOT** a technical guideline on micro hydro power. There is already quite a large number of very good and comprehensive technical guidelines available, both guidelines specifically prepared for Indonesia and international guidelines, available for anybody who is about to venture into the development of a single MHP plant or an entire MHP programme for rural electrification. Some of these technical guidelines are very comprehensive and aim to cover all aspects of an MHP programme while others have a more narrow and specific focus on, e.g. feasibility studies or MHP plant operation. A list of some useful

technical manuals and guidelines is presented in Appendix 10.1 of this Best Practice Guideline.

> The Guideline focuses on MHP for rural electrification because this is the best known and most widely adopted renewable energy technology in Indonesia. It should be stressed, however, that most of the processes, activities and Best Practices in this guideline can equally well be applied to other types of renewable energy, such as solar power, wind power, or biomass based energy. The Best Practices are mostly general and concerned more with processes and less with technology. Therefore, throughout the Best Practice Guideline, MHP could be seen as synonymous with Renewable Energy. This is important to bear in mind because it expands the potential use and benefit of the Guideline.

3. Also, this guideline is **NOT** a guideline for a specific group of stakeholders, such as national and local government, private companies, civil society organisations, or research and development institutions. Rather, it is hoped that all the different stakeholders may be able to benefit from using these guidelines. With increasing funding coming into the sub-sector and with government policies increasingly focusing on CO_2 neutral energy technologies, a set of Best Practice Guidelines can hopefully increase the results of future investments in MHP, economically as well as in terms of plant sustainability.

4. In terms of available future funding for MHP, the main stakeholder in MHP investments for rural electrification looks to be local governments all over Indonesia. Some of these local governments have technical agencies and staff that are already conversant with MHP technologies and have previous experience from implementation of MHP programmes and technologies while for the majority of local governments this topic will probably be new and there will be little institutional experience on how to prepare, implement, and monitor such programmes. It is therefore hoped that this Best Practice Guideline can be particularly useful to local governments and their staff.

5. The Guideline is divided into 10 sections or chapters. Section 2 provides a brief introduction to the elements that comprise an MHP scheme for rural electrification, dividing it into six (6) main components and offering a flow-chart that depicts the steps or stages in a "standard" MHP implementation programme. Sections 3 through 8 provide more detailed best practice advice on the six main MHP components, beginning with a brief introduction and description of the elements in each component and continuing with a listing of *Best Practices*.

6. The Guideline is illustrated with a number of photographs that illustrate the subjects covered in the different chapters. Within the sections there are hyperlinks to useful manuals, standard document formats, examples of protocols and log books, etc. which should enhance the usefulness of the guideline. A number of the Sections end with the presentation of a Case Study from the field which serves to illuminate further the Best Practices listed in the Section.

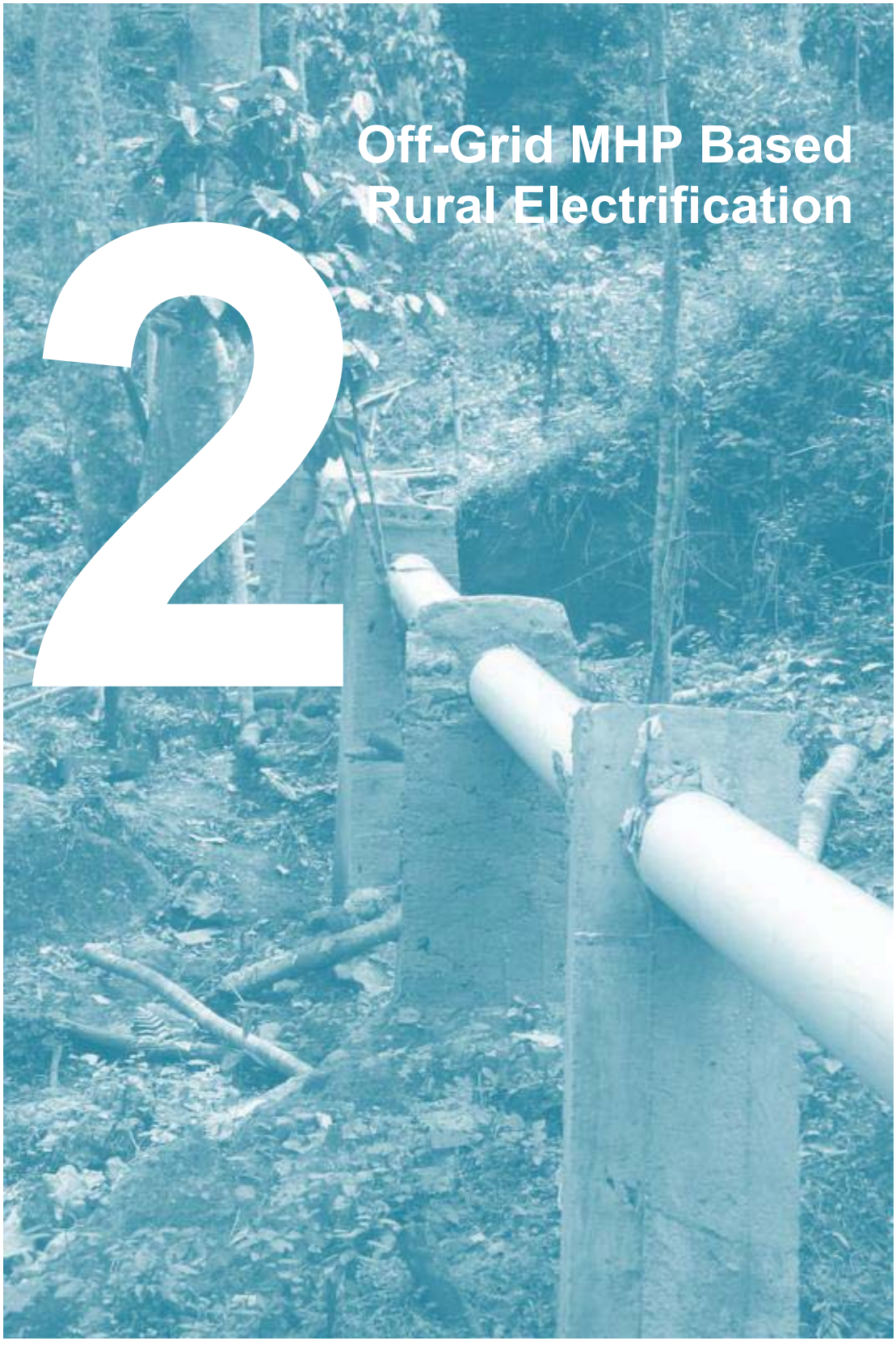
7. Section 9 discusses the institutional and organisational requirements that any sound MHP programme must meet and offers suggestions on how to arrange monitoring and evaluation, quality assurance and control, and the provision of technical assistance, at both national and local level. The section also includes some comments on the importance of quality assurance and control at all levels. Finally, Section 10 – Appendices, provides lists of and links to useful MHP manuals and guidelines and relevant websites and a listing of some training opportunities in MHP.

8. In conclusion, this Best Practice Guideline shall be seen as a supplement to existing technical, financial, and administrative guidelines and although it will be particularly useful to stakeholders that are new to MHP for rural electrification, there is plenty of sound advice and good practices for the more experienced stakeholders. The Best Practice Guideline can be read in its entirety as a simple text book or it can be used as a manual to provide insights for specific topics and processes.

9. Readers are encouraged to provide feed-back and suggestions for improvement to the Best Practice Guideline. Comments and questions can be directed to:

1. Ministry of Energy and Mineral Resources (MEMR)
   Directorate General of New and Renewable Energy and Energy Conservation
   Contact Person:

2. GIZ/MHPP2 Mini Hydro Power Project for Capacity Development
   Contact Person:



2 Off-Grid MHP Based Rural Electrification

2. Off-Grid MHP Based Rural Electrification

NB: This 'Best Practice Guideline' is also relevant to other types of renewable energy, such as solar, wind, and biomass.

This Best Practice Guideline is based on many years of experience in the field with off-grid MHP for rural electrification. This does not mean that the Guideline is only useful for this type of MHP. Apart from a few technical considerations that are specific to off-grid MHP, the Best Practices in this Guideline are generally applicable to MHP in rural areas, and most of the general recommendations and advice can equally well be applied to rural electrification programmes based on other renewable energy types, such as centralised solar power supply, biomass-based electricity generation, and wind energy conversion systems.

Irrespective of the type of renewable energy and whether or not the electricity is sold to the grid, the preconditions for an enabling environment need to be in place; the rural beneficiary community needs to be sensitised, mobilised, organised, and trained; a proposal needs to be put together and assessed; the scheme needs to be designed and built by contractors (preferably with assistance by the community); and the plant needs to be operated, maintained, and monitored by a committee selected by the community.

Photo 4: Centralised PV System, Ponelo Island, Gorontalo, Sulawesi

MHP for rural electrification is particularly suitable to poor and remote rural communities because:

- if the catchment area is intact and well maintained the source of power (the flowing water) will be sustained and no complicated logistical processes are involved in collecting and storing the power source (as can be the case with e.g. biomass-powered plants)

- MHP plants are built to last and if well maintained and cared for, should be able to function and provide electricity to the community for 20 years or more

Photo 5: Wind turbine S. Sulawesi

- the electricity generated is not intermittent (as is the case with solar power or wind power) and is not normally subject to large fluctuations (except when drought reduces the water flow significantly)

- the technology, although sophisticated, can be grasped by the community and community members can be trained to operate and maintain the MHP scheme

2.1 Main Components of a Standard Off-Grid MHP Based Rural Electrification Scheme

In order to arrange the presentation of the Best Practices in this Guideline, the MHP process has been broken down into six major components. The figure on the following page shows the components and provides a brief description of each.

This is just one of many examples of how an MHP programme can be sub-divided and the only purpose of the break-down of the MHP process into components is to make the structure of the Guideline logical and easy to use. The Guideline consists of six sections, reflecting the main components, and each section has been divided into a number of sub-chapters that cover different aspects of that particular MHP component. Each sub-chapter begins with a brief description of the topic covered. These general descriptions are marked by the icon seen on the left hand side of this paragraph.

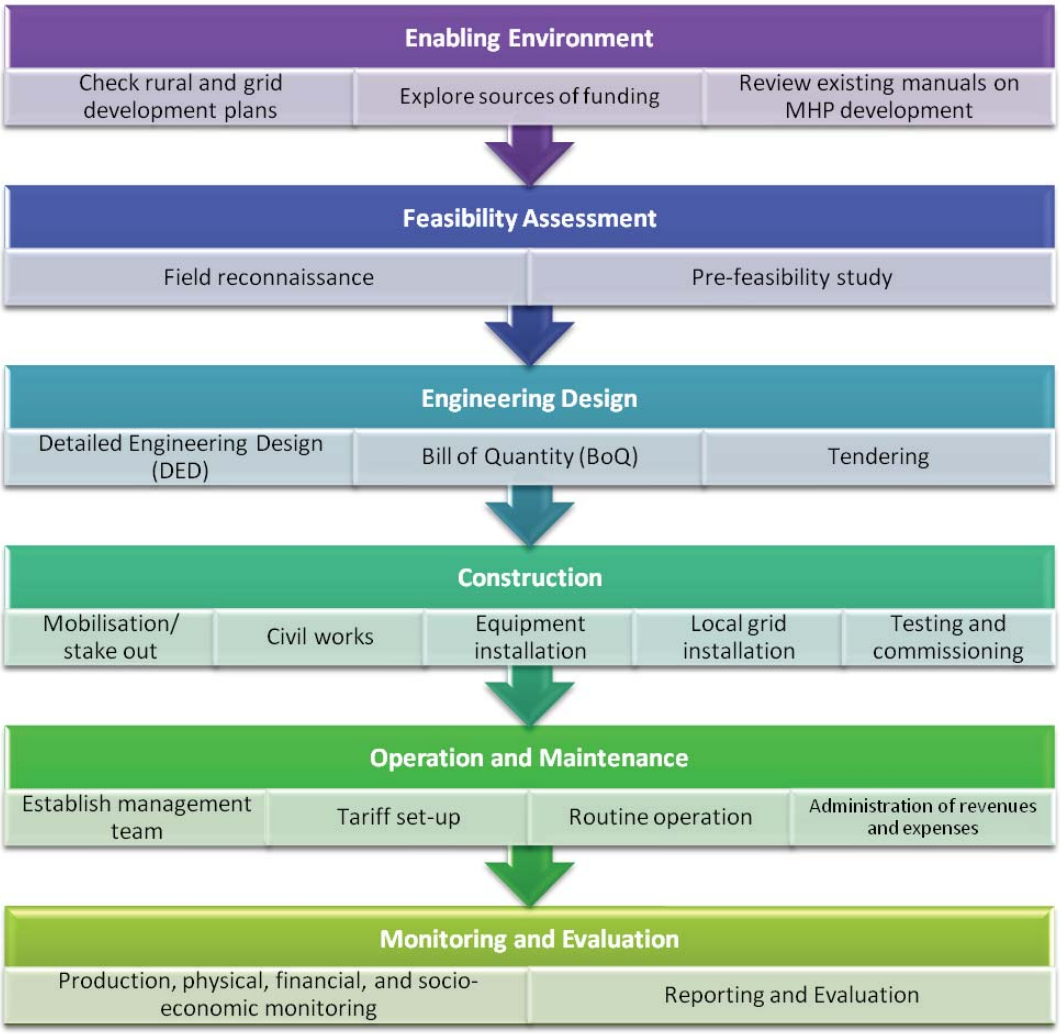
Enabling Environment	• A combination of activities that are not directly linked to an individual RE rural electrification investment programme but are setting the framework for and making such programmes feasible.
Community Preparation	• Activities and interventions that prepare the rural beneficiary community for the implementation and operation of an RE based, rural electrification programme.
Technical Project Development	• The sum of activities that characterise the development of a rural electrification scheme, from identification to the contract stage with the main contractor.
Scheme Implementation	• The physical work and other activities, from mobilisation on the ground (stake out) to commissioning of the plant.
Management, Operation & Maintenance	• Post-construction activities that aim to manage the scheme to produce sustained benefits to the rural community and opens up opportunities for generating income and improving the economics of the scheme.
Monitoring & Evaluation	• Various activities that measure and monitor the performance and impact of the scheme, in technical, physical, financial, and socio-economic terms.

Main Components of a Standard Off-Grid MHP Scheme

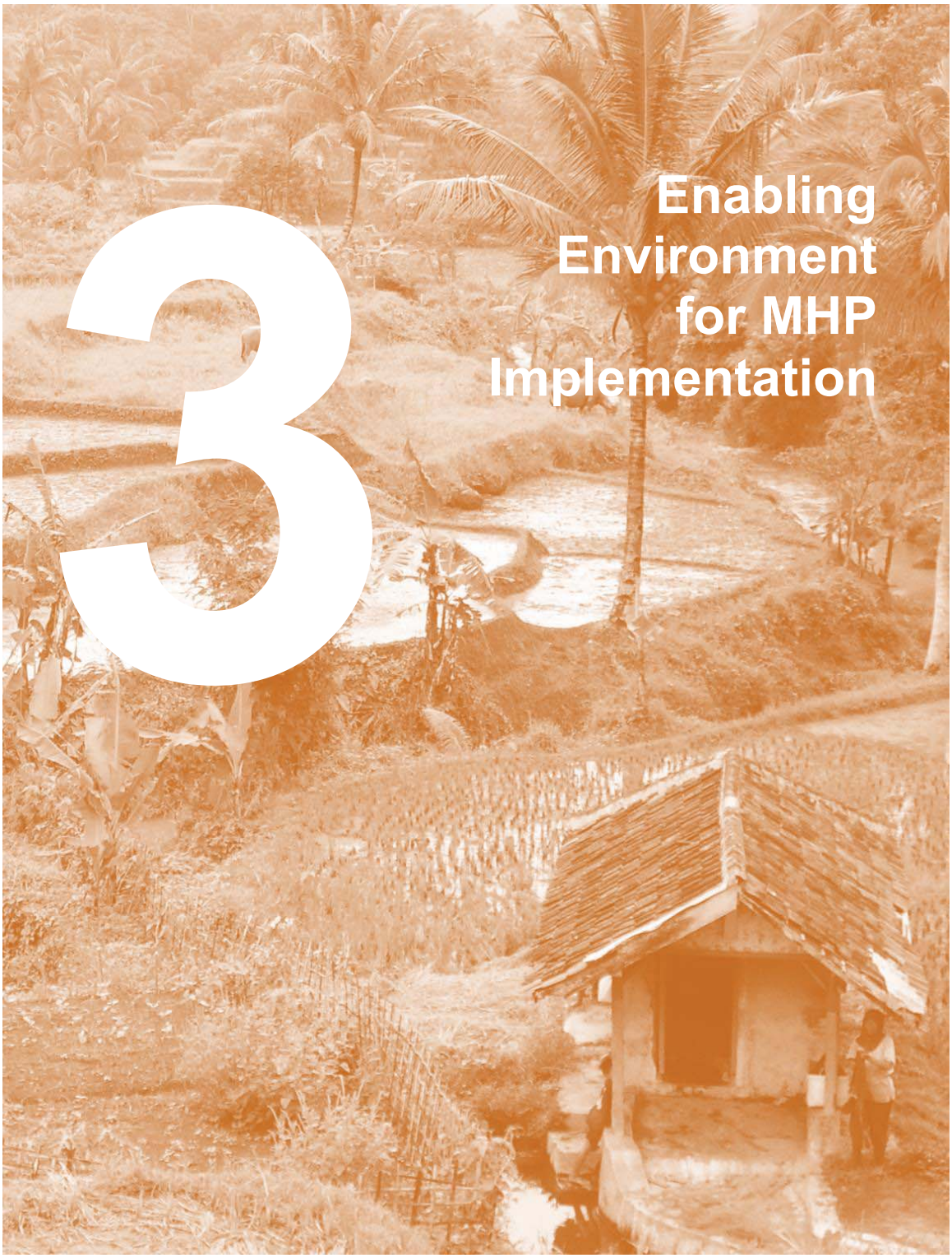
The colours of the six boxes are repeated in the six sections of the Best Practice Guideline, to make it easier for the reader to orientate him/herself when reading. Although this Best Practice Guideline predominantly deals with aspects of the MHP plant and the rural beneficiary community, a number of Best Practices and recommendations on the MHP catchment area have also been included. Where such Best Practices or recommendations are included, they are marked in the margin by the icon seen on the left hand side of this paragraph.

2.2 Flow-Chart of the Implementation Stages of an Off-Grid MHP Scheme for Rural Electrification

All MHP processes are different because they all have to be designed in accordance with the existing conditions at the site and because funding and implementation modalities differ widely from programme to programme and from region to region. It is therefore not possible to present a general flow-chart depiction of an MHP process. The below flow-chart is based on the components and stages described in this Guideline. Examples of other flow-charts valid for other situations are given in Appendix 10.5.



Flowchart of Common MHP Development



3 Enabling Environment for MHP Implementation

3. Enabling Environment for MHP Implementation

An *Enabling Environment* for off-grid MHP for rural electrification is a set of pre-conditions or circumstances that need to be in place for an MHP investment programme to be implemented successfully, with financial efficiency, and for the results to be sustainable in environmental, economical, physical, and social terms.

Some of the components of an Enabling Environment for off-grid MHP for rural electrification are: (i) policies and programmes, (ii) legal framework and subsidiary legislation, (iii) taxes, tariffs and duties, (iv) subsidies and incentives, (v) energy planning, (vi) a strong private sector, consisting of a variety of well qualified service providers, including equipment manufacturers, contractors, suppliers, consulting engineers, surveyors, community change agents, among others, (vii) favourable market conditions and instruments, (viii) vigorous and applicable research and development, (ix) supportive training and capacity building institutions, and of course (x) a hydrology that is favourable to MHP.

Best Practices

- An Enabling Environment does not grow from one day to the next. It is important to identify which areas or themes need to be addressed to improve the enabling environment, and then prepare, fund, and implement a long term strategy for improvement of the Enabling Environment.

- When addressing the Enabling Environment for off-grid MHP for rural electrification, it is useful to prioritise actions in accordance with importance (some elements of an enabling environment are vital, while others are just useful), and start by supporting the actions with the highest priority.

- The regulatory framework (including local government decrees and regulations) must be studied carefully before an MHP scheme is implemented.

- Before implementing an MHP programme, it is very useful to get an overview over the different manuals and guidelines that already exist for the sector.[1]

- Other ministries or organisations may be implementing similar programmes or may have learned valuable lessons from previously implemented programmes. Find out if other programmes are ongoing and look for synergies.

- Also, before implementing an MHP programme, it is very useful to identify the relevant local Service Providers[2] and the appropriate training institutions.[3]

3.1 Regional Energy Planning

Click here to see example of Regional Rural Electrification Master Plan

This is the planning for meeting the urban and rural energy needs at regional/local level. This includes all types of energy for all kinds of energy use. Regional Master Plans are typically consolidated into a national Master Plan. Regional energy planning is important to maximise available energy resources and to avoid duplication (e.g. different government ministries providing different renewable energy schemes to the same district/sub-district/village). Regional energy planning makes it possible to review renewable energy possibilities and make technical and economical comparison of options available. It enables government to capitalise on abundant local energy sources (e.g. wind) and to prioritise energy types.

Photo 6: North Luwu District, Sulawesi

Regional planning for off-grid MHP rural electrification is done at district and provincial level. The planning should include community

[1] See Appendix 10.1: List of MHP manuals and guidelines
[2] Sources of information can be: (1) MHP-TSU, (2) Renewable Energy Service Provider (RESP) Database, from NREEC (MEMR), and (3) Bandung Hydro Association (AHB)
[3] See list of links to useful websites in Appendix 10.2

planning through consultations and participatory planning processes.

Best Practices

- Before implementing an MHP programme, find out if regional energy plans exist and get hold of them.
- Also, before implementing an MHP programme, check on the local rural development plans.
- Integrate rural electrification planning with spatial plans (RTRW).
- Make sure that there is a high level of coordination between different rural energy and electrification programs, PLN and private power entities, and government agencies and institutions locally.
- Make an assessment of the existing and future energy demand for the area under consideration (what is the expected demographic development?).
- Find out what are the detailed development (grid expansion) plans of PLN in the medium term (up to 5 years) and whether, and when, the PLN grid will arrive at target villages. Ensure that there is a sufficiently large distance from the planned location to the next grid connection point.
- Estimate what are the "least-cost" option(s) of the different energy options available (e.g. a larger sub-district based MHP scheme that supplies 7 villages may be more cost efficient that 6-7 individual, smaller MHP schemes).

Experience shows that for sites close to the grid it is very difficult to mobilize the community for the implementation and operation of an MHP scheme. Although during initial site verification these communities all seem to be very motivated, as soon as construction starts and the first delays and set-backs happen this motivation very quickly disappears. In Green PNPM there was a case where a community paid for the grid extension because the MHP construction took too long time (which was mainly due to the community's lack of motivation in the first place).

- In the case that grid connection is a more economical option do not push for RE based rural electrification just because there is budget available.

- Make sure to have or make a very clear description of the role and responsibilities of, and agreements between, different stakeholders and the partners involved in rural electrification.

3.2 Financing and Funding Modalities

Financing and funding modalities comprise all aspects of funding and financing rural electrification by off-grid MHP, including sources and amount of funds, financing mechanisms, institutions involved, and availability of resources for technical assistance.

Government (whether national or local), when planning the implementation of off-grid MHP for rural electrification, may have access to different sources of funding, including programmes with funding (donors, e.g. PNPM Green/Rural), special funding modalities (DAK), normal ministry budgets, co-funding between national and local governments, and even loans and credits. All types of funding are accompanied by laws, regulations, and guidelines for their use, and most (though not all) are responding to a concrete demand from government. Local government may add further conditions and requirements when funding off-grid MHP for rural electrification, to improve the targeting and efficiency of the funds.

Best Practices

- Experience shows that implementation of off-grid MHP schemes for rural electrification takes a long time, often more than 1½ years from identification to handing-over. It is therefore critical that the budget is available for the entire implementation period and is not constrained to a 1-year budget cycle.

- Cost sharing between national and local government budget to ensure local ownership should be encouraged.

- Contracting (tendering for contractors) should be carried out locally, by the project owner (local government).

- Available budgets for MHP plants should be adjusted to the price of the year of construction and not only based on the results of feasibility studies conducted in previous years. Price estimates should be adjusted annually based on inflation and price information should be procured from manufacturers.

- Introduce a requirement in the funding to get commitment from the target rural community for community contribution (in kind – Swadaya) to the project.[4]

- If different sources of funding are involved in the off-grid MHP scheme for rural electrification (different government ministries or agencies; donors; NGOs; private sector), develop a clear description of the role and responsibilities of each of funding partners including their position in the funding hierarchy.

3.3 MHP Sub-sector Monitoring and Evaluation

Monitoring and evaluation (M&E) of the MHP sub-sector for purposes of the "Enabling Environment" covers both monitoring by national and by local government. In an optimal scenario, local government (e.g. Dinas) will carry out regular monitoring of existing MHP schemes, based on a standardised monitoring system with standardised approaches, routines, procedures, and forms, and computed in an MHP database. The monitoring data in a summarised form will be reported at regular intervals to the national authority.

The national government in the optimal situation maintains a national MHP registry and monitors on a regular basis, inter alia: (1) the performance of local government in implementing the MHP programme, (2) quality and performance of service providers,

[4] A contribution from the community (whether in kind or as co-financing) demonstrates community interest and priority, and changes the community from a passive "recipient" to an active "partner". *Swadaya* increases ownership.

particularly supervising (consulting) engineers, contractors, and equipment manufacturers, (3) quality, performance, condition and output by individual MHP schemes, (4) economic, social, and environmental impact of MHP schemes and programmes, and (5) state of the environment, particularly the catchment areas.

Best Practices

- Establish an M&E unit for MHP (or for Renewable Energy in general, including MHP) at national/local government level if it does not already exist.
- Build the capacity of the relevant local agency/ies to effectively and accurately monitor and evaluate the development of MHP schemes.
- Standardise the M&E system, in line with national reporting requirements and for easy exchange of data between regions.
- When possible, local government should contract a Supervising Engineer to carry out quality control of contractors and work done, on behalf of the project owner (local government).[5]

3.4 Service Provider Capacity Building

Service provider capacity building[6] comprises the training and provision of opportunities for gaining valuable experience, of different types of service providers in MHP, including surveyors, civil engineers, contractors, equipment manufacturers, community development agents, craftsmen (vocational training), suppliers, and government officials.

Photo 7: Manufacturer Training, Sumatra

Best Practices

- Capacity building is best carried out as 'Learning by doing'.

[5] See Institutional and Organisational Requirements in Chapter 9
[6] See also Appendix 10.3: Training Opportunities in MHP

- Capacity building must be hands on, target orientated, and directly related to the functions within the MHP project.
- Involve private sector people with field experience in training and capacity building (proper blend between theory and practical skills).

Click here to see List of MHP Service Providers

- Establish and maintain updated a registry of MHP service providers with information on previous MHP experience and quality of past performance and services.
- Before any capacity building is provided the service provider concerned has first to agree to take over (a minimum degree of) responsibilities for which capacity is being built.
- The capacity of the human resources of construction companies for civil works is often a limiting factor so capacity building should include training of contractor staff and labourers.

3.5 Criteria and Indicators for Target Area Selection

The definition and application of criteria and indicators for identification and selection of target areas and beneficiary groups for funding, is a way for government to ensure that policy goals and targets for the funding are met and that the defined target group is reached.

Best Practices

- The establishment of criteria for selection of off-grid MHP target areas and beneficiary groups shall be systematic and well documented.
- Possible selection criteria may include (1) present energy and electricity status, (2) distance (physical and economical) to PLN grid, (3) remoteness of target area, (4) abundance of water resources, (5) upland land-use practices (catchment management), (6) poverty criteria, (7) number of potential beneficiaries, (8) demonstrated interest from local communities, (9) commitment from local government to

provide regulatory support and human and financial resources, etc.

Some criteria are linked to the state of the environment and are particularly relevant for sustained catchment functions, e.g. (1) the level of natural resource degradation, (2) community attitudes towards natural resource conservation, (3) pressures and threats on the natural resources, and (4) existing social capital on natural resources conservation.

- It is very important that the selection criteria are strictly adhered to and are not waived e.g. for political reasons.[7]
- Monitoring and control of the site selection process should be done by a neutral consultant vested with sufficient power to veto on site selections in case of "political" decisions.

[7] This was found to be quite critical with the MHP-TSU when, for several sites, the TSU recommendation was simply overruled and sites with low potential or critical sites were implemented for "political" reasons.

4

Community Preparation

4. Community Preparation

Off-grid (stand-alone) MHP schemes in rural areas are usually owned and operated by the rural community that benefit from the electricity. *Community preparation* refers to the combination of activities that aim to prepare the rural community for MHP ownership and for proper utilisation and management of the plant.

Photo 8: Community Meeting in Mamasa District, W. Sulawesi

The key word in community preparation is "ownership". Communities must feel a strong ownership to the MHP scheme and this ownership is best ensured when communities are well prepared, properly organised, well informed, and participate and are involved in the entire MHP process, from the idea is conceived until the MHP plant is operating and electricity is generated and utilised. There is unfortunately a tendency for rural people to see an MHP scheme as a "project" and therefore they automatically assume that their participation should be paid for.

Best Practices

- Involve the rural target community as much as possible in the overall MHP process and build up the commitment to the MHP scheme.
- Use participatory approaches that are inclusive and equitable when working with the rural communities.
- Make sure that women are represented and involved in the MHP process in a culturally acceptable way.

- Try to apply safeguard measures and approaches to avoid the risks of “Elite Capture”.
- Use rural development agents from civil society (CSOs) with local knowledge, skills and presence, in the preparation of the rural communities.

4.1 Awareness Raising / Sensitization

Awareness raising and sensitization is the provision, in a proper manner, of information and knowledge to the potential rural target community, about the MHP project opportunity, limitations, expected benefits, and the tasks and obligations of the community.

Photo 9: Green PNPM Village Information Board

Awareness raising and sensitization also include all efforts towards the building of community awareness on the efficient use of energy, including the use of renewable energy and awareness of the importance of and potential for, productive use of energy to improve economic results and sustainability of the MHP plant.

Best Practices

- Present the messages in a variety of ways to increase community understanding and ownership.
- Bring intended beneficiaries to visit other communities that are already operating their own MHP schemes.
- Use villagers from nearby villages with successfully operating MHP schemes as extension agents.

- Employ appropriate rural development institutions/CSOs to carry out awareness raising and sensitization.

- Awareness raising and sensitization must also include aspects of catchment management and conservation as well as foreseen and planned productive end-uses for income generation.

4.2 Community Organisation

Community Organisation refers to an existing community organisation or the establishment of a community organisation that legally and functionally can be used as the basis for the MHP scheme. The existence of a legally approved community organisation is a pre-condition for handing over MHP plant ownership from government to the beneficiary community.

Best Practices

- Make sure that the community complies with the legal requirements for transfer of ownership of the MHP at the end of the construction period.

Photo 10: Rice farmers in Sulawesi

- Focus on small groups (rather than large groups), made up of individuals with a good standing, well respected, and with a good reputation in the village.

- Have (social) issues cleared before a fixed date. In case issues remain unresolved, move the potential site to next year's budget or eliminate it completely.

- Keep the community organisation simple and functional (smaller rather than bigger).

Click here to see Community Organisation Structure Example

- Try to make sure that there is equal representation by men and women in the different community groups.
- The selection process for members to a group should be democratic and should be supervised to avoid elite capture.
- Provide the villages with an organisational framework that improves transparency and accountability.
- Encourage the community to establish a group that represents the community during the MHP construction.
- Encourage that the community selects candidates for MHP operation and management (these people will form the basis for subsequent training and capacity building).
- Candidates for MHP operation and maintenance should be selected among villagers who already have experience and technical knowledge e.g. pump mechanics, bicycle repair men, agricultural equipment repair men and handymen in general.
- Often it is an advantage if the MHP plant management is formally institutionalised, e.g. as a cooperative or in the form of a rural electricity management agency.
- Support the establishment of a natural resources conservation group (*Kelompok Pelestari SDA)* at village level, to safeguard the environment and manage the MHP micro catchment.

4.3 Capacity Building / Training

Capacity building/training[8] refers to the preparation of involved stakeholders through training and practical experience in order for them to be able to successfully fulfil their roles in the MHP scheme (individual villagers, village government, and local government staff).

Photo 11: The capacity of the community is vital to success

[8] See also Appendix 10.3: Training Opportunities in MHP

For the later Operation & Maintenance, a formal classroom training followed by on-site-training should be done. Informal on-site refresher training of operators is highly recommended as people tend to forget, after a period, the subjects and skills they were taught initially and many develop bad habits e.g. cutting corners in daily maintenance.

Best Practices

- The intensity of community capacity building largely depends on the implementation approach of the MHP schemes. Significantly more technical and managerial capacity building is required if schemes are built by communities instead of by contractors.
- Whenever possible, utilise locally based capacity building organisations, institutions, and CSOs.
- Train communities in productive end-use, including a number of relevant income generating activities that can be powered by the MHP plant.
- Identify and utilise in capacity building activities "community champions" – successful and highly motivated villagers that have experience from other community based MHP schemes in the region.
- Be clear and agree about expectations/role/responsibilities of the participants before any capacity building is provided.
- Provide on-site training and use training materials that have been specifically adapted to the local situation.
- Train and organise community members in participatory monitoring of the MHP construction process.
- To safeguard the MHP catchment, train community members in participatory mapping of micro-catchment boundary; tree seedling production, sustainable land management, and agroforestry practices.

4.4 Community Proposal

Community Proposal comprises the development, by the community, of a proposal for an off-grid MHP for electricity, typically submitted to local government. The preparation shall normally be done in an inclusive and participatory manner that ensures that the proposal is representative of the wishes of a majority of the rural beneficiary community. Community proposals are typically sketchy, with little technical content, and with only an approximation of the funding and other resources required.

Best Practices

- Since rural communities in general do not have the capacity to formulate MHP proposals, they should be supported during the whole proposal preparation process by a qualified facilitator from the relevant program or government institution or by a local CSO with MHP experience and knowledge.
- The language of the proposal should be simple, clear, and easy to understand, also for non-technicians.

Click here to see the *TSU knock-out and ranking tool*

- Clear knock-out/eligibility criteria have to be defined by the MHP investment program and clearly communicated to the communities to avoid the preparation (and even verification on site) of proposals which do not meet such minimum criteria.
- A community proposal should be considered as the community's Expression of Interest to participate in a government funded MHP programme. It must clearly identify and quantify the future beneficiaries.
- Treat information and data from the villagers as preliminary and make sure to verify such information in the project development phase (as early as possible).

Click here to see the TSU Form A (Community Proposal)

- Develop and disseminate a standard proposal format (with instructions and possibly training on how to fill it in) for reporting project specific minimum data and information of

critical relevance to the MHP project to local government, and sufficient to form a basis for evaluation.

- The community proposal should clearly indicate (and if possible estimate the value of) the contributions that the community is prepared to bring to the MHP process (labour, local materials, land, funds, etc.).

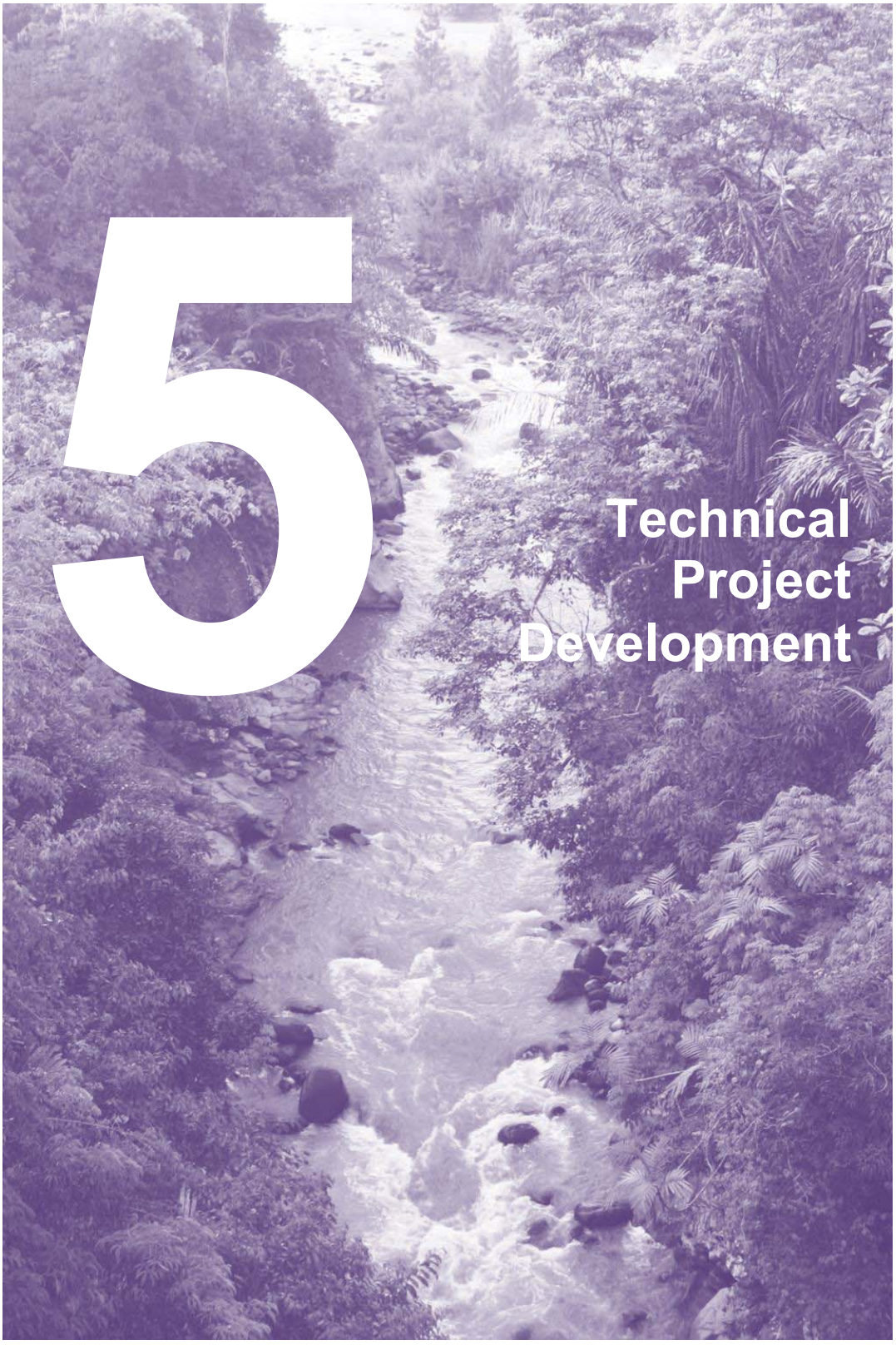
Photo 12: Beneficiary communities may contribute in kind to MHP schemes

- The community proposal should include information about the catchment area for the MHP scheme and suggestions for how this area should be managed and protected. An assessment of the costs of catchment area rehabilitation is very useful.

- Try to negotiate and enter into a formal agreement with the community whereby the community undertakes to manage and protect the catchment area (in particular existing natural vegetation, trees and forest in return for receiving the benefits of the MHP scheme in the form of electricity for lighting and productive uses.

4.5 Case Study

Examples available from Green PNPM



5

Technical Project Development

5. Technical Project Development

Technical project development comprises the MHP development activities from initial project identification through to detailed designs and procurement.

The project developer has to consider early on (before tendering) what type of contract he will aim for in the construction of the MHP plant. The basic considerations are:

- Who should carry out the work (one general contractor or a number of specialised contractors)?
- In the case of several contractors, who will coordinate between them?
- Will the beneficiary community contribute to the construction process (local materials and labour) and, if so, how will this be arranged and under what conditions?

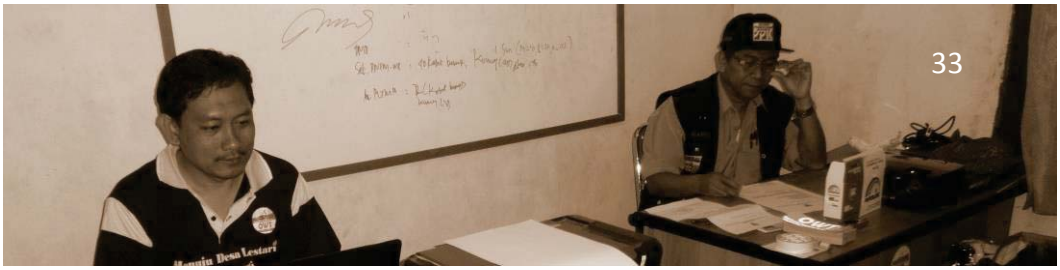
What type of contract will the construction of the MHP be based on (will the project developer hire in all the works and materials and act as the main contractor; will the contract be a unit price contract (fixed prices per unit of materials and work); or will it be a lump sum contract, i.e. fixed price for the total implementation of the scheme)?

Best Practices

- Off-grid MHP schemes for electrification of rural communities should always be designed as run-of-the-river plants because storage plants are normally not economically feasible under such conditions and may cause serious environmental impacts.

- The outcome of technical project development determines the quality and sustainability of the completed plant. The time required for technical project development should not be underestimated and sufficient budget should be made available to contract experienced professionals for this task.

- Supervisory and advisory technical capacity, independent of suppliers and contractors, should be available to the project



developer (local government) essentially from project start, either as own staff or contracted (owner's engineer[9]).

5.1 Project Identification

Project identification comprises an initial screening at desk level of MHP potential in the region concerned, with particular reference to village proposals received, followed by field reconnaissance (also called site verification) visits to sites that look suitable. The more precise and standardised the proposal form is, the easier the field reconnaissance becomes.

Best Practices

Click here to see List of relevant information sources

- During the desk study phase (desk screening), make sure to exploit all available sources of information, such as maps, hydrological data, demographic data, energy master plans, maps of land use, ownership, and legal status, etc.
- Field reconnaissance must preferably be carried out in the dry season and definitely never during the height of the wet season, because it is the minimum flow of water during the dry season that determines the potential capacity of the MHP plant.
- The field reconnaissance team must have the required technical qualifications and experience to survey a site and assess its potential; and must be equipped with adequate surveying equipment (such as easy flow, hypsometer, pressure gauge, GPS).

Photo 13: Flow measurement, W. Sulawesi

[9] The consulting engineer represents the client or the particular MHP programme during project development and implementation, making sure that the interests of the project owner or MHP programme are safeguarded.

Photo 14: Surveying, Bantimurung, Sulawesi

- The field reconnaissance team should overall be neutral and should not have a vested interest in the implementation of a specific project site.
- To make sure that MHP is the most suitable option for the rural electrification in a particular village or area, assess and compare costs of alternative energy supply options (least-cost option), including PLN grid extension, grid densification, and renewable energy sources other than MHP.
- Be careful not to create unrealistic expectations within the rural communities by maintaining a low profile during field reconnaissance visits.

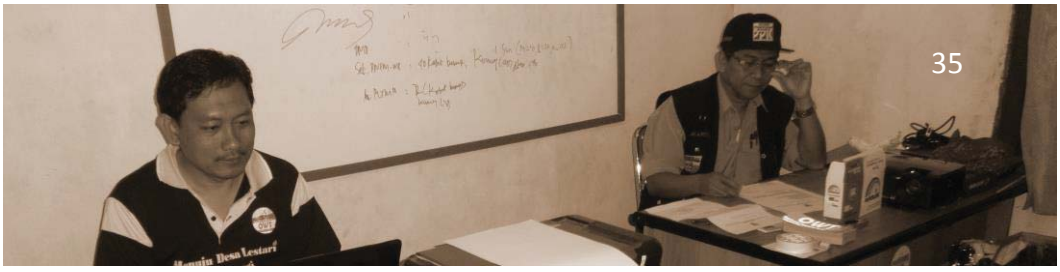
5.2 Project Feasibility

Project feasibility studies for small off-grid MHP schemes analyses in detail the technical, economical, social, and environmental feasibility of the proposed project, including major risks and assumptions. The result of the feasibility study forms the basis for subsequent project budget and procurement.

Best Practices

- Flow measurements as the basis for feasibility studies must always be carried out during the dry season and preferably over a period of time (installation of stream flow measuring devices as early as possible in the feasibility phase).

Photo 15: Flow measurement, Lembung, Sulawesi



- Always commission contractors for the feasibility study that have a proven track record in MHP or irrigation work.

Click here to see TSU Form B & C

- It is very useful to develop standard formats for feasibility studies and thus make the process of feasibility studies much more efficient and transparent.
- The feasibility study should include: (i) Options for future productive end-uses; and (ii) Village ability and willingness to pay tariffs.

Click here to see a sample of TOR for Contractors

- Make sure that the Terms of Reference for the contractor to the feasibility study are clear on scope of work and expected deliverables (a *Table of Contents* for the feasibility study report should be included in the Terms of Reference).
- Clear deadlines must be established for implementation of the feasibility study, with a time frame planned well in advance.
- Photographs of the site support the design process and are also proof that the contractor actually visited the site during the feasibility study.
- In general, make sure that there are clear agreements between all partners about division of responsibilities and about who has authority to decide/approve/reject what (technical, social etc.).
- Establish a regular meeting schedule for monitoring of progress in the feasibility study phase.

5.3 Engineering (DED, BOQ & Tender Documents)

The *Engineering* takes as point of departure the results of the feasibility study and comprises the preparation of detailed engineering design, site drawings, bill of quantity and the tender documents for the procurement process. Engineering is crucial to the success of the MHP scheme. If the design is weak or deficient, the MHP plant will not provide the designed and measured capacity.

Best Practices

- Make sure to commission experienced contractors (consulting engineers) who have a proven track record in MHP or irrigation work, for the Engineering phase.
- Terms of reference, work plans, and conditions must be tailored to the unique conditions of each site.
- Make sure that all project stakeholders understand their roles and responsibilities in the engineering phase, and plan the engineering time frame and deadlines well in advance.

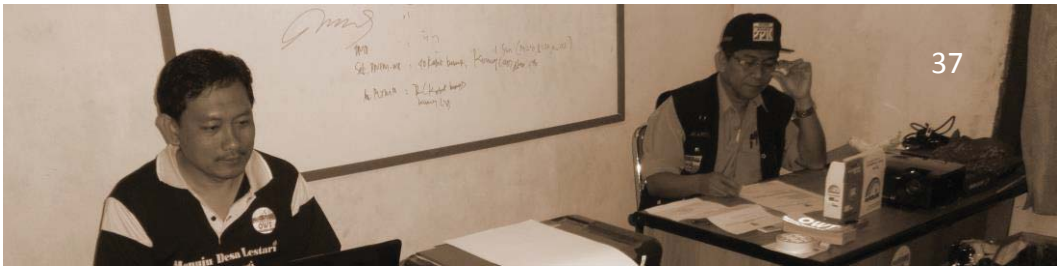
Click here to see *TSU Standard Drawings and BOQ Tools*

- MHPs have to be individually designed to fit the specific site conditions. To a certain extent standard design tools and drawings can be used, but there is always a large design component which is specific to each site.

Click here to see examples of DED and BOQ

- Establish a clear time line with milestones for the conclusion of main tasks (DED and BoQ) and get agreement from all project partners on this time line.
- The supply of proper tools and equipment for MHP routine maintenance works must be included in the procurement packages.
- Use proven engineering approaches and technologies in design and selection of equipment (technology that is known to work under similar conditions in Indonesia).
- For typical conditions in Indonesia the cross-flow turbine has proven to be the best choice for off-grid, run-of-the-river MHP plants.
- For MHP plants in the range of 5 – 50 kW it is highly recommended to install Electronic Load Controllers (ELC).

Photo 16: Cross-flow turbine and generator, Bandung, W. Java



Click here to see Standard Technical Specifications for Tenders

Click here to see *TSU Tender Documents*

- The format of technical drawings, BOQ, calculations and particular technical specifications should be standardized.
- Tender documents should be standardised. This is easily done except for technical specifications for works which are specific to a certain site.
- Do not as a general rule experiment with new and unproven technology because it increases the risks of village livelihoods being negatively impacted.
- Construction always involves a certain degree of uncertainty, for instance concerning the geological conditions of a site, and this uncertainty has to be reflected in the design and cost estimates by adding contingency budgets in percentages of the work budget lines.
- Remember to allocate sufficient budgets for community preparation and for capacity building and training.
- If the MHP scheme is planned to support productive end-use, the preparation for these should form part of the engineering. In such cases, use three phases because electrical appliances will not work on a single phase.

5.4 Tender Process

When the detailed designs, BOQ, and tender documents are ready, a tender will either be announced publicly or directly to pre-selected companies on a short list (call for proposals). The tender process describes the activities, assessments and decisions carried out in order to select suppliers for materials and equipment and contractors for parts or all of the works. The works can be carried out by one contractor and be all-inclusive (turn-key) or they can be divided into parts (civil works, electro-mechanical works) and contracted out separately.

Prior to the tender process it is a good idea to introduce a pre-qualification of manufacturers of EM equipment. Such a pre-qualification should result in a short list of eligible manufacturers generally experienced and qualified enough to carry out the required works. Workshop visits or visits to previously implemented sites by the manufacturers may be required at that stage by the tender evaluation agent. This may seem to be quite a large effort in the beginning, but as soon as a short list is established, it will save a lot of time and trouble during the tender process.

The challenge during the tender process is that without a pre-qualification, a number of inexperienced and not qualified companies will tender and will stand a good chance of winning the contract by offering dumping prices. Depending on who is in the tender evaluation committee, there can be vested interests by committee members to award a contract to a certain contractor even though he may not be qualified at all. A pre-qualification at least ensures that only qualified companies are allowed to tender.

Best Practices

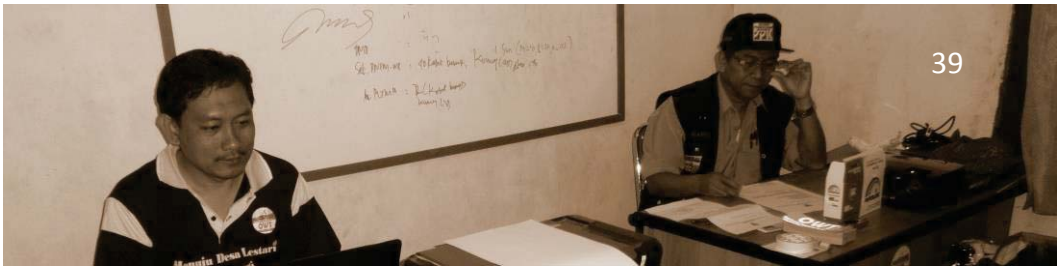
- The impact of the tendering on the success of the implementation cannot be underestimated and all care has to be taken that the tender process is indeed fair and transparent and results in the selection of the best qualified contractor.

- A quality-cost based selection should be applied where possible. In other words, the decisive factor in selecting a proposal should be a careful consideration of quality and price, and not just price. This is another reason why it is important only to use manufacturers/contractors that already have experience in MHP.

- Make a pre-selection of suppliers and contractors who will be invited to submit proposals, based on their track record in the field and their references from previous works.

- The rules and procedures laid out in the tender dossier must be followed by all parties; both Client and bidders.

- The specifications for the goods and services to be tendered for should be very precise. Warranty and maintenance should form part of the tender.



- The evaluation of the proposals should be public and the members of the tender evaluation committee should be impartial and not have any vested interests whatsoever in the outcome of the tender process.

Photo 17: Tender, South Orobua, South Sulawesi

- The participation of representatives from the beneficiary rural community in the tender evaluation committee improves transparency and agreement with the result.

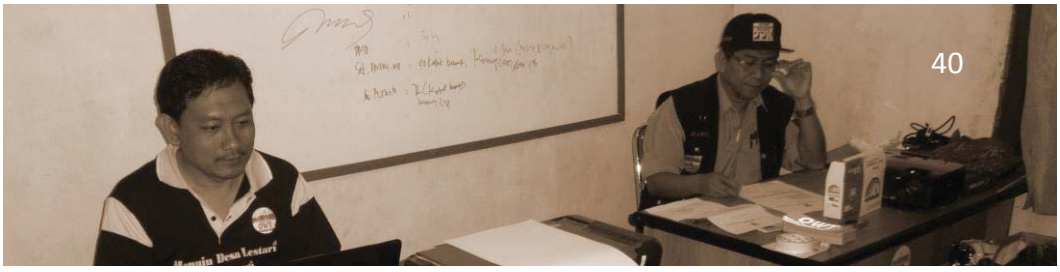
- In case the project developer has contracted an "owner's engineer", he/she should form part of the tender evaluation committee, with specific responsibility for evaluation of the technical quality of the proposals.

- Clear and unambiguous tender evaluation criteria must be developed and communicated clearly and early to potential bidders. Evaluation criteria must be specified both for the technical proposal and for the financial proposal, and the tender documents must clearly show how much weight the technical and financial proposal will be given in the evaluation.

- The tender winner should be selected, based on the best outcome of the proposal evaluation, both regarding technical quality and financial bid. Tenders should not be evaluated on price alone.

5.5 Contracting

Contracting begins when the tender evaluation committee has selected the best proposal(s) and invites the company/ies for detailed contract negotiations, and ends when a final contract is signed by the two parties.



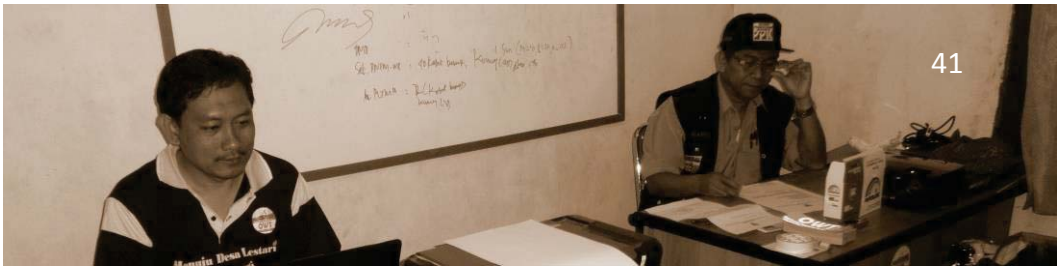
The construction of an MHP plant is typically divided into separate works with a contract for each part of the work, e.g. a civil contractor for the civil works, a supplier for the electro-mechanical equipment, and possibly a separate supplier for the distribution network.

Best Practices

- The tender winner should be invited by the project developer for contract negotiations, particularly regarding the technical specifications of the plant.
- It is important that a fair and transparent contract document is prepared. A short and concise contract document provides less room for misunderstandings and interpretations.
- Prior to the award, the complete contract document should be presented to the contractor and the various clauses should be explained.

Most of the trouble during implementation between the parties arises out of misunderstandings and misinterpretations of certain contract clauses. It should therefore be in the interest of the employer to explain the contract in detail to the contractor, and to make a fair and "neutral" contract.

- The contract must stipulate clear procedures to follow in case of a need for design changes during the construction phase, and all changes must be approved in writing by the project developer or his representative (owner's engineer) before any action is taken on the ground.
- The contract must include clear instructions to the contractor for provision of a safe work environment, including safety instructions to workers and safety equipment (safety shoes, helmet, goggles, etc.).
- Particularly for very remote sites, consider including maintenance contracts for a certain period beyond the manufacturer's guarantee and contractor's warranty period.

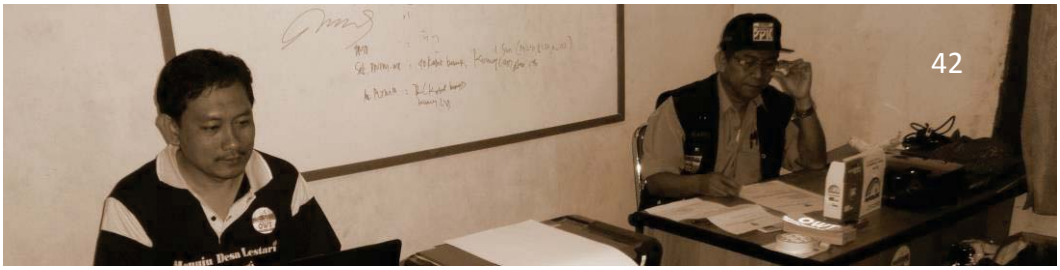


- The contract should make very clear the contractors obligation regarding the efficiency of the completed MHP plant. The responsibility for plant testing should form part of the contract.
- The employer should introduce a system of delay damages and bonuses for fast completion. Usually a bonus works much better as a motivator to expedite completion than a penalty.
- It is advisable to identify milestones in the contract and to divide the total contract sum into tranches that are only released when milestones are reached.
- A clear procedure for contract termination should be defined for the case that the contractor fails to perform.

Although contract termination should always be the very last resort after all other measures are exhausted, a clear procedure should be in place for that case to prevent unnecessary further delays until termination and award of new contract (defining exactly after how many days of a contractor's or employer's default, a contract may be terminated, etc).

5.6 Case Study

Description



6

Scheme Implementation

6. Scheme Implementation

Scheme Implementation is the actual physical construction of the MHP plant and the testing and formal hand-over of the plant from the main contractor to the rural community. The main components of *Scheme Implementation* are (1) civil works; (2) installation of turbine and electro-mechanical equipment; (3) installation and connection of local grid; and (4) commissioning of the final plant.

The components can themselves be broken down into a series of activities and events that begins with the staking out of the main plant structures on the ground, followed by the construction of intake, water canal, forebay, penstock, and power house; and the installation of turbine, generator, control system and local grid; and concluded by a testing of the civil works and commissioning and formal handing-over of the MHP plant by the contractor to the plant owner (local government/rural community).

Best Practices

- Establish a time schedule and adhere to it during scheme implementation to maintain control of the project.
- When variations in the set time schedule occur, the schedule must be updated and possible conflict areas and starting times for subsequent tasks must be revised accordingly (monitoring of the critical path to constructions).
- MHP schemes involve dangerous work in often difficult terrain and under difficult conditions. Therefore, make sure that the agreements on safety laid down in the contract(s) are strictly adhered to by the contractor(s) and work force during plant construction.

6.1 Mobilisation / Stake-Out

Mobilisation describes the process whereby the contractor(s) brings his equipment, materials and labour to the site prior to the start of the works.

Stake out refers to the marking on the ground of the components of the MHP plant prior to construction. Corners are typically marked with stakes and the outline of the structures with string or wooden boards.

Photo 18: Stake out, Tanjung Sari, Bengkulu, Sumatra

If planning and implementation of an MHP scheme are not done by the same entity, the stake out forms a crucial part of the hand-over of the project from the design to the implementation phase.

Best Practices

- All important stakeholders should be involved in the scheme stake out (project owner, design engineers, contractors, and local community) because this is the process whereby the theoretical design is translated into reality on the ground.
- Expect and allow for minor changes and adjustments to scheme design during stake out, if dictated or made necessary by the conditions on the ground.

6.2 Civil Works

Civil works comprise the construction of the civil hydraulic structures of an MHP scheme, including diversion structure and intake, channel, forebay, penstock, power house, and tailrace. It typically involves significant earth works and construction of reinforced concrete structures plus a suitable building to house the turbine, generator, and control panels, etc. (power house).

Best Practices

Photo 19: Civil construction, West Sulawesi

- The most critical aspect of the civil works is usually reinforced concrete works. Due to their complicated nature, such works should be limited as much as possible in the design.
- Reinforced concrete should only be cast after the supervisor (owner's engineer) has approved the reinforcement and is present on site during the casting.
- Concrete works done without supervision and approval should be removed at the contractor's cost.
- Make sure to adhere to general techniques and approaches applied in construction projects while always considering the specific requirements for hydraulic structures (e.g. water proofing and stability of foundations).
- When the local community is contributing with labour and local materials to the civil works, it is critical to ensure that the agreed time schedule is adhered to, since communities have other, more pressing priorities over the year, e.g. agricultural activities and cultural ceremonies. Community contribution must therefore be agreed before planning starts.
- Avoid degradation of the natural landscape during the civil works and prevent exploitation and destruction of natural resources (stone quarrying, tree cutting).

Click here to see the TSU Civil Construction Manual

Community contributions (swadaya) to an MHP scheme in general increase the community's feeling of ownership towards the completed plant which improves plant sustainability but it also increases the risk of delays in the construction phase and of sub-standard work.

6.3 Installation of Turbine and Electromechanical Equipment

Installation of turbine and electro-mechanical equipment is the placing, alignment and connection of turbine, generator and control system in the power house, as well as the preparation for testing.

Best Practices

- Installation of turbine and electro-mechanical equipment should be included in the contract with the supplier of the equipment.
- Installation of turbine and electro-mechanical equipment must be carried out by experienced professionals.
- The installation works have to be supervised by an experienced supervisor/ facilitator.

Photo 20: Turbine installation

- All components (turbine, generator and control system) should be delivered and installed by the same contractor, to reduce the need for complex coordination between various suppliers and the risk of incompatibility between components.

6.4 Installation of Local Grid

The installation of the local grid provides the electrical connections between the MHP power house and individual consumers (houses). It does not normally include the house connections and internal wiring within the houses. The local grid is often carried out as a mixture of community contribution (preparation and erection of poles) and contracted work.

Best Practices

- The household connections should be done (or at least approved) by a qualified electrical technician.
- In case no qualified person is available in the village, the household connections should be covered in the project budget and installed by the electrical contractor.

> Household connections and internal house wiring usually pose a challenge to the communities since the MHP projects typically only provide the connection up to the house.

- Electrical safety must be considered carefully when installing the local grid. Poles must be made of materials that are resistant to rapid decay and should be erected vertically and secured by support wires whenever the cable changes direction.
- Household connections should be equipped with an MCB (micro circuit breaker) to avoid overload on the grid.
- Make sure that the beneficiary village implement energy efficiency measures such as energy saving electrical bulbs (CFL) or LED lamps, because energy saving will mean that more consumers can benefit and will be an advantage when eventually the community is connected to the PLN grid.
- At the same time, the community must be taught how to safely recycle CFL lamps.

6.5 Testing

The logical sequence for testing is in the direction of the flow of water/electricity, starting at the intake and ending at the house

Testing describes an assessment of the function of the civil works and installed electro-mechanical equipment under simulated operational conditions. It is normally carried out separately for individual MHP components, e.g. testing of the channel, testing of the penstock, etc. The electromechanical equipment including

the turbine is tested on dummy load (simulating the future consumption by the consumers by using the electricity to e.g. heat water in large water heaters).

In cases where more than one contractor is involved, the testing will proceed step-wise, beginning with civil works and ending with electromechanical equipment and distribution grid, and needs to be closely coordinated between the suppliers and contractors.

Photo 21: Testing of civil works, Sulawesi

Best Practices

- Each part of the works should be tested by the respective contractor under supervision by the site supervisor/facilitator. For example, civil works (canal, intake, penstock, etc) should be tested by the civil works contractor.
- Whenever possible, backfilling of civil hydraulic structures and pipes should be done only after testing for leakages.
- Responsibilities for any repairs or replacements following testing shall remain with the contractor/supplier.
- The testing is carried out by the contractor/supplier and must be supervised by the owner's engineer or by a contracted third party.
- Extreme care must be taken during testing because components may fail (walls may collapse and the penstock may rupture during pressure testing, resulting in flooding of certain areas.

- As a general rule, members of the public should not be present during testing, and staff of the contractor must be informed and possibly withdrawn from certain areas before the testing.

6.6 Commissioning

Upon successful testing, commissioning describes the formal process of taking the MHP plant into operation, closely supervised and documented by the major stakeholders. It also marks the formal handover of the completed works by the contractor to the project owner.

Photo 22: Inspection, Mesakada, West Sulawesi

Ownership of an MHP plant is usually transferred from the developer/programme to the local community after commissioning and from that point in time the project owner is the community.

Best Practices

- The MHP plant shall only be commissioned after all components of the works have been tested successfully.
- Plant commissioning must be done under the presence of the electro-mechanical contractor and conducted by a representative engineer from the MHP programme (or owner's engineer as the case may be).
- During commissioning, the plant shall be run at full design capacity for several hours.

Click here to see Commissioning Form (TSU Form D)

- A standard procedure and format for testing and commissioning should be developed and used.
- Similar to the case for the testing, members of the public and contractor staff should not be present during commissioning.

6.7 Supervision

Photo 23: Supervision of turbine

Supervision comprises a range of supervisory activities to be carried out during the construction of the MHP plant to ensure that the work is carried out according to agreed standards and specifications and that the final plant is of the desired quality. The compliance with safety measures and safeguards also forms part of the supervision.

Supervision is the responsibility of the project owner, usually represented through the owner's engineer, who in most cases maintains an on-site supervisor.

In the Green PNPM, supervision is carried out by consultants/ facilitators hired by government through a consulting company, and the MHP-TSU safeguards the owner's interests and the quality in all aspects of MHP development and construction through targeted technical assistance, advice and capacity building inputs.

Best Practices

- A regular (daily, or minimum twice a week) visit by a representative of the owner's engineer to supervise the construction works is crucial to ensure that quality standards are adhered to.

- During critical construction stages (e.g. concreting of turbine foundation), continuous supervision is mandatory.
- The supervisor should have a civil engineering background ideally with experience in MHP or hydraulic (irrigation/water supply) construction and needs to have a willingness to spend extended periods of time in the field.

Click here to see TSU Monthly Status Report

- Standard procedures, formats and schedules should be defined for reporting requirements from contractor/community and from supervisor.

Click here to see TSU Construction Log Book

- A daily site diary/logbook has to be kept by the contractor's site foreman, showing the daily activities and events, and the materials delivered and used.
- Monthly progress reports summarizing the daily logs should be used to present the site progress to the project owner/programme.

Photo 24: Electro-mechanical installation, Tabang, Sulawesi

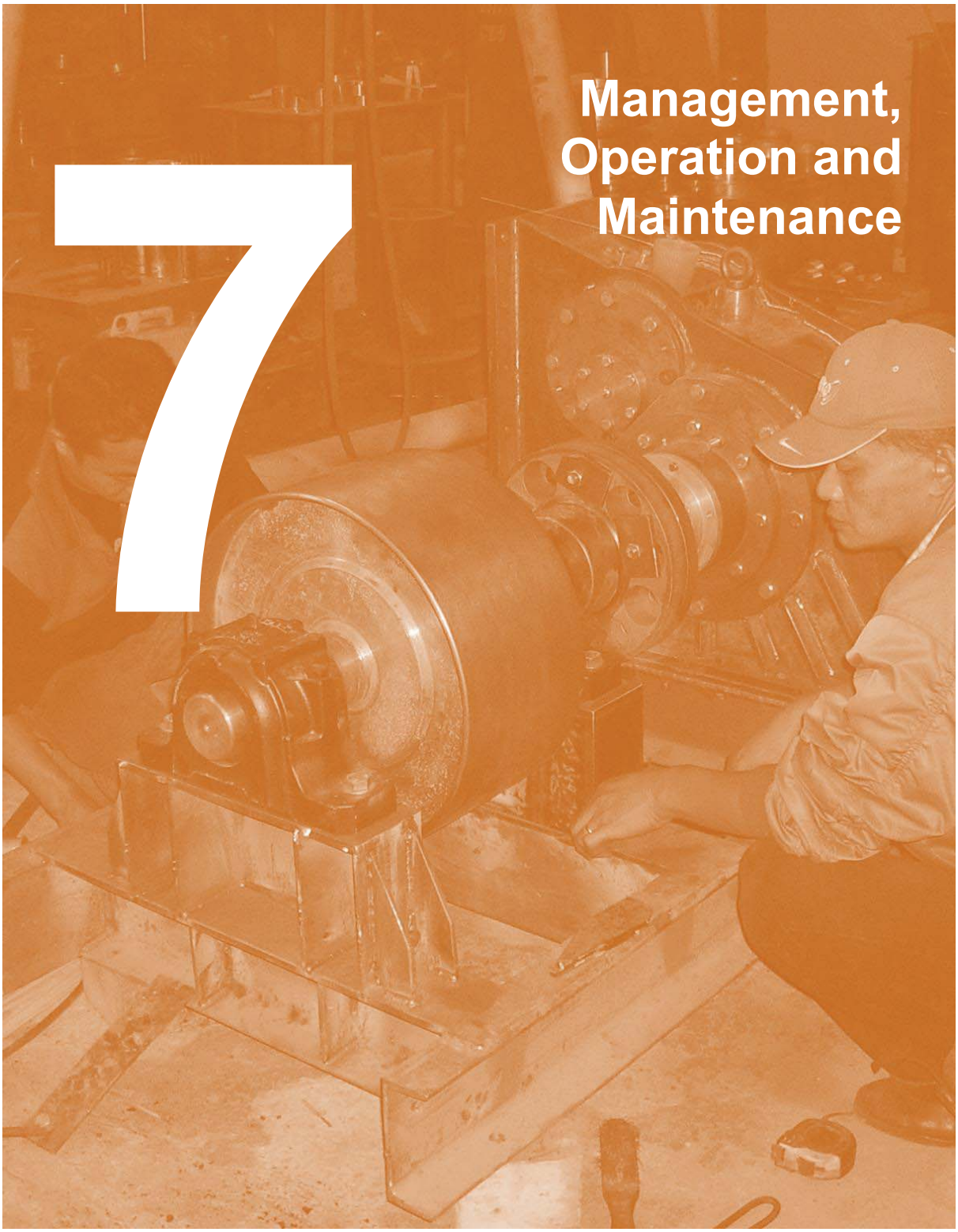
- In-situ changes to design should only be done with the approval by the owner's engineer/project owner, and if he is not suitably qualified, by the designer and by no means by the contractor or other stakeholders.
- Design changes have to be documented in the daily log as well as in the monthly report. Standard procedures for such changes have to be defined.

6.8 Case Study

Description

7

Management, Operation and Maintenance



7. Management, Operation and Maintenance

Management, operation and maintenance comprise the activities, resources, and systems that are required to ensure the sustained function and benefits of the MHP scheme. It includes (1) the establishment and function of an MHP management team, typically consisting of a general scheme manager, an accountant, and one or two plant operators; (2) the routine operation of the MHP plant and its different components; (3) the management and protection of the micro catchment area for sustained water flow; (4) the handling and administration of plant revenue (tariffs); and (5) the continuous maintenance of all parts and structures of the MHP scheme.

Best Practices

- To ensure the sustainability of the MHP scheme it is recommended to provide long term support (> 3 years) from local government to the beneficiary village(s), which should include refresher training and overall monitoring of the MHP scheme, including tariffs, management committee performance, plant operator performance, and productive end-use beneficiaries.

Photo 25: Community training, Orobua Selatan, West Sulawesi

7.1 Tariff Setting and Administration

Tariff administration consists of (1) tariff calculation for sustainable MHP operation and (2) regular tariff revision. Tariff calculation is the calculation of the price(s) that electricity consumers must pay to the MHP management unit to sustain the MHP operation. This includes ensuring that sufficient funds are available for payment of operators and other personnel related expenses in connection with the

operation of the MHP, for periodic maintenance and repair work, and for larger rehabilitation expenses as a result of major breakdowns or natural disasters.

Best Practices

Click here to see examples of Tariff Calculation

- The tariff as a minimum must reflect the true costs of operating and maintaining the MHP scheme, with savings for periodic major overhauls included.
- Tariff decisions above the minimum tariff required to sustain the MHP operation may be left for community decision.
- The community should be properly sensitised on the importance of paying sufficient tariffs.
- The tariffs may be graduated according to different household income levels (social tariff for disadvantaged households; otherwise based on consumption).
- Use an incremental tariff system – low consumption pays lower tariffs – higher consumption pays higher tariffs.
- The tariff system can be based on actual metered consumption or on the number and type of electrical appliances (lights, TV, etc.) connected per household.
- The base calculations for tariff definition must be repeated annually to take into account price increases, and tariffs must be adjusted / increased accordingly.
- Government can assist villages by compiling and disseminating information on a regular basis on different tariff systems and rates that are being applied successfully by off-grid MHP rural beneficiary communities.

7.2 Productive End-Use

Productive end-use can be described as: 'Small scale income generating or cost-avoiding activities (by households or small companies) that are powered by MHP electricity that is not required

for other community purposes, e.g. agricultural processing, cottage industry, carpentry, refrigeration, etc.'

Photo 26: Productive end-use (carpentry)

Best Practices

Click here to see a List of Productive End-use Examples

- Productive end-use under the right circumstances can significantly increase revenue generated, thereby improving the economic sustainability of an MHP scheme.
- Try to integrate productive end-use equipment in the initial design because it is much easier than adding it on later.
- The addition of a productive end-use facility to an MHP plant needs to be engineered which requires skills and knowledge so outside assistance is required.
- Productive end-use will not happen on its own. It needs to be promoted and supported by outside agents such as local government, CSOs, or universities.
- For MHP plants below 10 kW whenever possible, use direct drive (mechanical drive directly from the turbine axel) because it is more efficient and technically less complex than using electricity.
- Direct drive productive end-use requires good and easy access to the power house area as produce (e.g. rice for milling) will have to be transported to the site and back after processing.

Photo 27: Direct-drive, productive end-use

- Prioritise existing small scale village industries in productive end-use rather than creating new ones because existing village industries have been tested and are typically the result of a succession of trial and error.

7.3 Capacity Building/Training

Capacity building for management, operation and maintenance comprises the formal and on-the-job training of members of the rural community who have been assigned responsibility for operating the MHP scheme. Training is required in overall management aspects (administration, finance, handling of tariffs), in plant operation, and in routine plant maintenance and smaller repairs.

Photo 28: Electro-mechanical training, Mesakada, West Sulawesi

Training will also be required in practical aspects of micro catchment management, such as nursery production, tree planting and erosion control.

Photo 29: Tree seedlings in local nursery

Best Practices

- The main focus of capacity building should be on practical, hands-on, on-the-job training of villagers.

- Capacity building measures must also include aspects of catchment management and protection (proper land uses) to ensure a continued and sustained water flow.

- During training, emphasize the critical points to achieve successful plant management, especially proper tariff and financial management.

- Training in MHP operation and management is best done as formal classroom training followed by on-site training.

- Several, smaller training interventions repeated over time are much better than a once-off large training course at the start of MHP operations because some training requires that participants have gained a measure of practical experience before being trained.

- Whenever possible, send appointed staff for training in outside villages that operate successful MHP schemes (peer learning).

- Where appropriate and possible, include the relevant local government staff in the capacity building measures because it increases government understanding and improves government monitoring and supervision.

- In case of capacity building to be provided by equipment manufacturers and contractors, make sure that they have the necessary experience (documentable) to do this.

Photo 30: Training of community members

- During the first months of plant operation, it is important with a frequent follow-up by outside specialists (whether facilitators, local government staff, or consulting engineers) until the community O&M organisation is well established and functioning.

- It is important to repeat the on-site Operation and Maintenance trainings after several months of MHP operation because people are in a better position to learn and understand once they have some practical experience.

7.4 Management of Facility

Management of an MHP plant comprises scheme administration (e.g. reporting, liaison with local authorities, record keeping and ledgers, etc.), village policies and regulations, and personnel (plant employees) and financial management (tariff collection, accounting).

Photo 31: Collecting household data for management purposes

Management and protection of the micro catchment area, although very important to the sustainability of the MHP plant, falls outside the responsibility of the MHP management committee, and must be considered a village responsibility. The MHP catchment area should be mapped using participatory mapping practices.

Best Practices

- The management committee should strictly enforce regulations, in particular those related to payment of tariffs. Sanctions should be applied where necessary to create and maintain economic discipline and awareness among consumers. The financial viability of the MHP plants depends on the correct and timely payment of tariffs.

- Practical measures for protection and proper management of the micro catchment area for the MHP scheme can be formalised in a set of village regulations (PERDES). When two or more villages are benefitting from the MHP, clear inter-village regulations for catchment protection need to be agreed.

- The village must establish a bank account especially for the MHP plant to facilitate transparent financial administration, control and savings.
- The MHP management team should establish a point of payment where consumers come to pay their monthly tariffs, instead of the management team having to collect tariffs from individual households.
- Avoid too frequent changes of personnel within the MHP management unit by recruiting unit members from village residents of a good standing.
- Involve women in financial management, particularly the handling of accounts and petty cash.
- Formalise procedures for improving transparency and accountability of MHP plant management, e.g. by regular village MHP meetings with financial and management reporting.

Click here to see Template for Financial Management of an MHP

7.5 Operation of Facility

Photo 32: Operation of Mesakada MHP, Mamas a, W. Sulawesi

Operation of the MHP facility comprises all the routine tasks that are involved in starting, running, and stopping the plant on a daily basis, and the maintenance of the operator's logbook. The operation of the plant is the responsibility of the MHP operator(s), supervised by the MHP management committee.

Best Practices

- The MHP operator(s) should be involved in the installation and commissioning of the plant equipment and receive practical, on-the-job training, usually be the equipment supplier.

Click here to see Template for Operator's Logbook

- MHP operation should ideally be based on an Operator's Manual which specifies daily and monthly routine tasks and special measures after heavy rains.

Photo 33: MHP Operator Training

- Safety rules must be displayed at the power house and operator compliance with safety measures must be strictly enforced.

- During periods with low power output (e.g. during the dry season) it is preferable to use orderly load shedding routines rather than overloading the system from consumption in excess of supply.

Photo 34: Selection of 'mother' trees for seed production

- Routine operations must include the MHP catchment, such as development of nursery for micro-catchment rehabilitation, conservation of indigenous tree species, catchment rehabilitation through planting campaigns, and protection of indigenous forest.

7.6 Maintenance of Facility

Maintenance of the MHP facility comprises the regular and periodic measures which are required to keep the scheme in a safe and functional condition. It includes civil structures, electro-mechanical equipment, and electrical distribution network and ranges from daily maintenance by the operator to occasional specialised maintenance and repair work by a service provider.

Best Practices

- Preventive maintenance is much better and less costly than repair work which calls for simple and clear maintenance schedules for the operators to follow.
- When a problem occurs, repairs must be attended to immediately and professionally and not be left to deteriorate further.

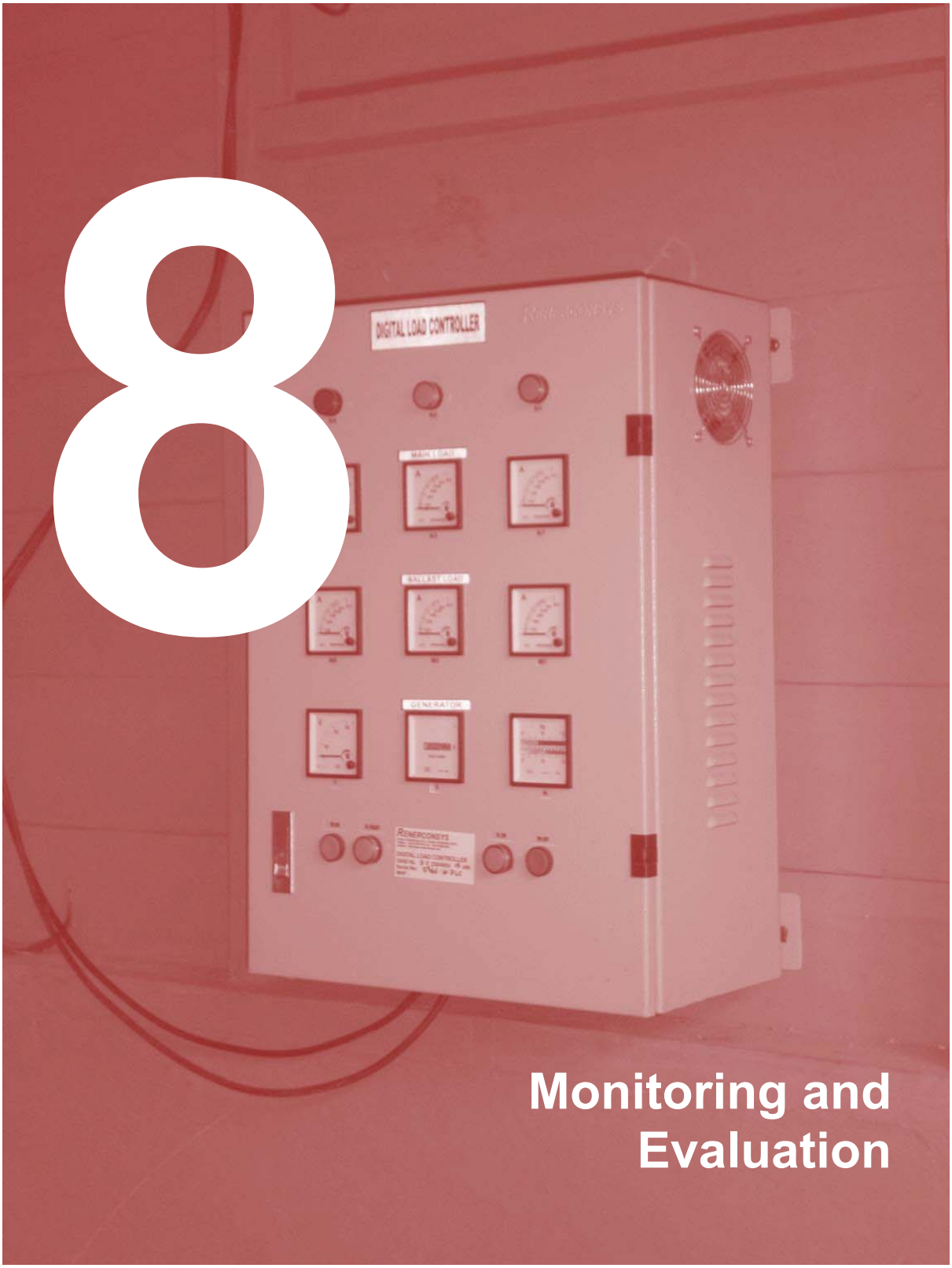
Photo 35: Turbine maintenance

- The supply of equipment must include a set of appropriate tools for service and maintenance.
- Proper access to key features (intake, channel, forebay, power house), of the plant must be maintained at all times.
- MHP maintenance shall be based on a maintenance schedule, displayed at the power house, which specifies periodic routine maintenance tasks.

Click here to see an example of a Maintenance Schedule

7.7 Case Study

Description



8

Monitoring and Evaluation

8. Monitoring and Evaluation

Monitoring in the context of an MHP scheme for rural electrification combines the monitoring (physical, financial, social, and environmental) carried out by government authorities at national and local level, with the monitoring at the local level carried out by the MHP plant owners and operators. For the latter, it is difficult to draw the line between routine operation and maintenance and monitoring of the MHP plant.

The objectives, frequency, intensity, and reporting of the monitoring by government and by MHP plant owners/operators may be quite different and undertaken for quite different purposes but overall, monitoring of MHP schemes whether by government or by MHP plant owners/operators has to do with quality control and control of the sustainability of the plant. The results are being used differently as well, with monitoring results by MHP plant owners/operators being used to determine the physical condition, the quality and quantity of the electricity produced, the economical status and the financial result, and socioeconomic impact of the MHP plant – and the need for repair and re-investment; while government mostly uses the results for planning purposes and for feed back into local or national reports and plans.

> Monitoring attempts to measure and document changes, progress, results and outcome compared to a base situation. If the starting point is not known it will be impossible to measure progress. All too often, projects and programmes ignore to establish a proper baseline description and later face difficulties when attempting to measure and quantify progress.

Evaluations of MHP schemes are typically carried out by government to determine whether government investments are cost-efficient and effective; whether socio-economic benefits are being produced as predicted; whether environmental impacts are acceptable; and in order to ascertain the status of rural electrification, for planning and

investment purposes. Occasionally, evaluations are carried out by private sector operators (manufacturers, suppliers) to control the quality of own works and to determine the potential market for rehabilitation and repair.

Best Practices

- It is important to link a national or regional monitoring system for MHP to overall development goals (both national and global, e.g. RPJMN, MDG)

Click here to see an example of a Baseline Report

- A good description of the baseline situation, including definition of relevant indicators, before starting the MHP programme is crucial.

- It is advisable to establish a common, unified monitoring system for monitoring of MHP for rural electrification by government, with common indicators, methodology, baseline approaches, data formats, and reporting format. A common system will facilitate not only monitoring in the field but also subsequent analysis and use of monitoring data.

- As monitoring and evaluations require special skills and experience, it is useful to establish separate units within government (local/national) to handle these tasks.

- All kinds of monitoring and evaluation should be realised in a participatory way in order to make the MHP owners/ operators/users benefit from the monitoring process and its results; positive results help to motivate and negative results should be used to remediate deficiencies.

Photo 36: Management of monitoring

- Monitoring and evaluation need clear indicators (what should be measured?)

- Clear distinctions have to be made between the different types of monitoring. Don't mix up the monitoring of the physical conditions of a plant (proper operation and management) with the monitoring of socio-economic impacts.

- "Monitoring should be fair" meaning that only outputs and outcomes, which were defined during project planning should be measured; don't formulate expectations by hindsight.

8.1 Production Monitoring / Metering

Production monitoring/metering comprises the continuous measurement and recording at the power house of power generated by the plant and distributed for consumption. Metering may also in some cases include the metering of electricity consumption by individual consumers (private/commercial), depending on the way the tariff system has been devised.

Best Practices

- Install a reliable analogue kWh meter both for electricity production and consumption. Such meters are good indicators for how long and if the plant has been running.

- For a better understanding of consumption and for checking on MHP performance an MHP scheme could be equipped with a proper data locker that reports on a regular basis to the responsible government unit or project developer. This is a good way to monitor long term performance of the MHP plant and to identify potential problems.

- Train an operator to be responsible for monitoring (in order to have the plant monitored on a daily basis).

- Carry out regular monitoring, preferably on a daily basis.

- Maintain a logbook with data on the operation of the plant.

- Record important technical data such as: electricity produced (kWh), electricity used (kWh), voltage (V), current (A), frequency (Hz), and operational time (hours).

8.2 Physical Monitoring

Physical Monitoring of an off-grid MHP plant comprises the regular monitoring and control by the MHP management group of the condition of the different elements of the plant, including the civil structures, the turbine and electro-mechanical equipment, the local grid, and (in some cases) productive end-use structures and facilities. This part of physical monitoring closely resembles the daily recordings of the plant operator.

Physical monitoring also includes the continuous monitoring of water flow and quality, the general condition of the catchment area for the MHP plant, and the implementation by the community of catchment management and conservation activities for sustained water flow.

Best Practices

- Physical monitoring of the plant itself must be carried out regularly by the MHP management group and must be documented in reports to the community.

- Government (national/local) should carry out routine physical monitoring of MHP plants to provide statistics on generation capacity and electricity coverage and usage, and to draw information and lessons for the planning and implementation of rural energy programmes in other areas.

- Physical monitoring should include a stock taking (inventory) of all the elements of the MHP plant, with observations on condition and possible needs for repair/replacement.

- Do not simply register the physical condition but try to analyse reasons for problems / causal relationships because this is the only way to learn lessons; mostly the results of physical and financial monitoring can only be understood together.

- Physical monitoring of the MHP catchment should be carried out at regular intervals (semi-annually, annually) and should take note of land-use changes incl. deforestation, soil erosion problems, and the construction of roads and other rural infrastructure. It should also include monitoring of tree seedling survival, stream hydrology monitoring, and land-cover/use changes.

- Action plans for rehabilitation and improvement of the catchment should form part of the village development plans.

8.3 Financial Monitoring

Financial Monitoring in this context shall mean the routine monitoring of plant operational costs and tariff revenue by the plant owner/operator (and reported to the rural community); and the monitoring by government of the costs linked to the initial plant investment and subsequent government support, e.g. in the form of major repair and spare parts, and re-training of operators and other MHP management staff, as well as possible financial support to link up with the PLN grid.

Government may also decide to launch specific studies that look into the economic and financial viability of individual MHP plants and the rural electrification scheme as a whole, and to obtain base data for feasibility studies of new or larger schemes or for schemes in other regions of the country.

Best Practices

- Financial monitoring must be included in the MHP monitoring scheme by government and by the MHP management group.

- Financial monitoring by the MHP management group must include cash-flow projections, including predictions of points in time when major payments will be required (e.g. replacement of parts of the electromechanical equipment).

- Make sure that the financial monitoring system captures the necessary data for tariff adjustments/increases over time.

- Government's financial monitoring of MHP for rural electrification should be based on a number of criteria and the definition and measurement of indicators for each of these. This will make economic and financial analyses easier and financial reporting more uniform.

8.4 Socio-economic Monitoring

Socio-economic monitoring is the monitoring of the results, impacts, and consequences of the electricity provided by the MHP plant, both for household use and for productive use. It includes, among others, the cost and use of electricity per household; number and type of electrical appliances; household consumption patterns and changes

> Socio-economic monitoring is particularly interesting to government (local/national) because it enables it to assess the outcome and longer term impacts of development interventions and public investments and to compare these with national and global development goals.

over time; tariff calculation and possible social tariffs; behavioural changes as a result of electrification; consumption and costs in relation to household income; categories and economical results of productive end-uses; participation of the community in plant management, operation and maintenance and transparency of reporting; the commitment of the community to micro catchment management and conservation, as well as numerous other socio-economic factors of relevance to the community itself, to local and national government, to potential donors, and to civil society organisations involved in rural community development.

Also developments which can not directly be attributed to the electrification but which might have consequences for the MHP scheme should be monitored and documented.

Best Practices

- The monitoring system must be set up in a way that allows for comparisons (rural communities with/without MHP scheme) of indicators and results.

Click here to see an example of an Impact Study

- For "impact monitoring" a participatory approach is the most appropriate way to get satisfactory results; i.e. villagers formulate their expectations (in a moderated process additional input can stimulate ideas e.g. towards productive use of electricity); this approach makes it easier to monitor whether expectations have been fulfilled.

- Technical restrictions have to be understood and taken into consideration for the impact monitoring; e.g. if during daytime the water flow is needed for irrigation, use of electricity won't be possible during that time; if the MHP system is not equipped with a proper control system productive use of electricity might be limited etc.

- Surveyed households should benefit from the results; discuss the outcome of the monitoring in the village, ask for additional feedback (did we understand correctly that…); don't leave the village behind by drawing your "personal" conclusions.

8.5 Reporting

Reporting is the verbal or written documentation and conveyance of the results of routine and specific monitoring and of special studies and evaluations. At the community level, data and information is compiled on a daily or weekly basis by the MHP management group and reported to the entire community, either verbally in community meetings or through written progress reports to the relevant community authorities. Other information, for instance on households and population, is compiled by village government structures, through routine monitoring.

Government, on the other hand, compiles and reports on the results of supervision and monitoring by local government officials, e.g. from the technical services agencies, on a regular basis, more frequently during the implementation phase of an MHP scheme, and less frequently once an MHP scheme has begun routine operation.

Best Practices

- Reporting at the rural community level is best done in public community meetings, as verbal reports by the MHP management committee, supported by accounts, bank statements, MHP log book, and other relevant documents, and summarised for the entire village on a public information board.

- Physical and financial reports by the MHP management group should be open to inspection by community members, upon request.

> Rural community members are not generally used to reading technical and financial reports and all reporting at the community level should therefore be kept simple. Copy the information onto large posters and public announcement boards at a place in the community which is accessible by all community members. Focus on the essential facts and figures.

8.6 Evaluations

Evaluations in connection with an off-grid MHP scheme for rural electrification will typically be carried out by authorities and other entities which are not part of the beneficiary rural community with the aim to assess and document the results, outcomes and/or impacts of the scheme(s). Evaluations can be carried out ex-ante (before); ex-post (after), and as progress and mid-term evaluations and are obviously most useful if the project or scheme has a well

described baseline situation (what was the situation in the rural community before the advent of electricity from the MHP scheme) and clearly defined indicators with set targets, against which progress can be measured.

The results of evaluations are used to improve programmes under implementation as well as to provide feed-back for planning of future schemes and rural electrification programmes in general.

Best Practices

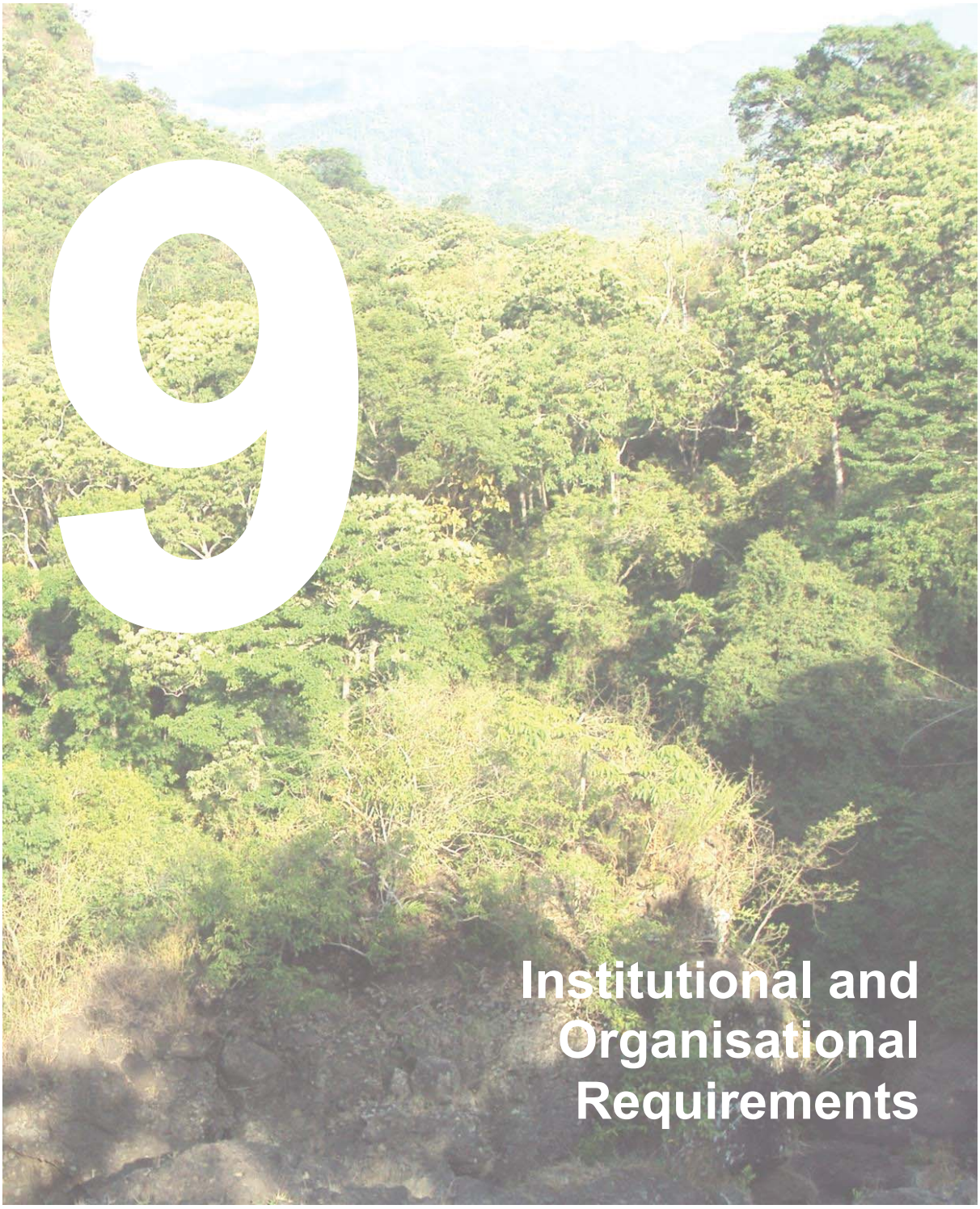
- The foundation for any evaluation is the description of the baseline situation, with definition of clear and measurable indicators. If there is no knowledge about the starting point, it will be exceedingly difficult to measure progress and achievement of objectives and outcomes.
- Government should always carry out evaluations of past and ongoing MHP programmes for rural electrification, and feed the results into improving the planning and implementation of future investment programmes.

Click here to see List of MHP Key Performance Indicators

- It will be very useful to define standard criteria, indicators and formats for evaluations of 'off-grid MHP for rural electrification' programmes as data otherwise may not be comparable across regions and for different approaches.
- Define specific indicators to measure the state of the environment and particularly the integrity and condition of the MHP catchment area. Indicators may include: (1) total forest area, (2) total area under cultivation, (3) area with terracing, (4) total road surface, (5) area occupied by settlements (villages and hamlets), (6) percentage (or area) of indigenous forest cover, and (7) percentage (or area) with tree crops.

8.7 Case Study

Description



9

Institutional and Organisational Requirements

9. Institutional and Organisational Requirements

9.1 Sustainability of MHP Schemes

Experience from the field has demonstrated the importance of **quality** to improve sustainability of the MHP scheme. Quality is best assured through sufficient construction budgets and technical assistance and support during planning, construction, and operation by MHP service providers.

Another, equally important, contributor to increased sustainability is the plant **economics**, i.e. the extent to which the generation of income from electricity tariffs and from productive end-use can match the costs of operating and maintaining the plant and the need for repairs and re-investment (depreciation). Finally, plant management by the rural community and the community's feeling of ownership to the plant are two important factors for achieving sustainable MHP schemes.

Experience from the Green PNPM indicates that in order to improve the sustainability, appropriate technical assistance must be provided to the community, including:

- Sensitization and awareness raising;
- Community organisation and establishment of MHP management committee;
- Capacity building in practical aspects of MHP operation and maintenance (bookkeeping, financial management, tariff calculation and updating, maintenance routines, simple repairs);
- Capacity building and technical assistance to productive end-use;
- Capacity building in catchment management and protection.

The community's sense of ownership to the MHP plant is best ensured by involving the community in all stages of the MHP implementation, by giving them opportunity to influence the scheme design and development, and by strengthening their capacity through repeated trainings in the different aspects needed

for MHP management and operation. Ownership is also enhanced by the community's in-kind contributions.

From the project developer's point of view (e.g. local government) independent advice and quality control by consulting engineers, contracted as owner's engineer and not involved in the construction of the MHP scheme should be available, including:

- Control of site verification (field reconnaissance)
- Support to pre-feasibility and feasibility study
- Engineering
- Preparation of tender documents
- Support to and supervision of tender process
- Supervision of construction
- Supervision of plant testing
- Supervision of plant commissioning

Support by highly qualified MHP service providers can best be assured through a continuous programme of capacity building and strengthening of such service providers, aiming in particular at turbine manufacturers, suppliers, and contractors. Since capacity is best built through practical work in the field, the provision of opportunities for MHP service providers, i.e. the number of MHP project opportunities and the available MHP funding, is critical to strengthening of these private sector operators.

9.2 Monitoring and Evaluation at National Level

At the national level, the MEMR as the ministry formally charged with responsibility for rural electrification based on renewable energy, will need to monitor, evaluate and provide general oversight and support to MHP programmes for rural communities. The relevant tasks and responsibilities may include (the list is not exhaustive):

- M&E of DAK funded MHP by local governments
- M&E of donor funded MHP programmes
- M&E of MHP programmes funded by private sector
- Coordination of MHP programmes in Indonesia
- National inventory and database of MHP schemes
- National database on MHP service providers

- Provision of a "Clearing House" for MHP for rural electrification
- Support to stakeholder capacity building, including technical staff within local governments and MHP service providers
- Promotion of R&D within MHP and facilitation of linkages between R&D institutions and the MHP sub-sector
- Dissemination of information, lessons learned, and best practices
- Preparation of a regulatory framework for MHP development
- Development of guidelines and standards for the industry

With the exponentially increasing funding for MHP schemes for rural electrification, the MEMR could benefit from the establishment of a special MHP Unit for M&E and general support to the industry. The same of course applies to local governments who will be faced with a substantial increase in MHP based rural electrification programmes, with its concurrent monitoring, supervision, administration, and reporting requirements.

9.3 Quality Assurance and Control

Another, equally important challenge is Quality Assurance and Control. Experience shows that good and consistent quality in all the implementation stages of an MHP scheme is paramount to the sustainability of the plant. Quality assurance and control cannot be done centrally; it must logically be carried out at the local level, at the sites of future MHP programmes. The concept of an ***Owner's Engineer***, a private company of consulting engineers that acts on behalf of the project developer i.e. the local government; who has no vested interests in the MHP programme; and who is only acting in an advisory capacity and not in any way economically involved in the implementation of MHP schemes, is highly recommended.

Owner's Engineer

In the ideal scenario, there is a sufficient number of capable, independent, and highly professional consulting engineers available throughout Indonesia, who can be hired by MHP project developers such as local government to safeguard the interests of the project developer during all stages of the MHP scheme implementation, to provide technical assistance to the different stakeholders, and to control and ensure the quality of work by suppliers, manufacturers,

PNPM Facilitators

general contractors and the rural community itself. It is not an impossible vision. In many places, independent consulting engineers are already available and the PNPM Rural/Green Programmes are training large numbers of technical facilitators who may form the basis for many new consulting engineer companies. What is required, however, is a change of current government regulations and current implementation practices.

Accreditation and Certification

In order to ensure consistency and quality in the technical assistance and work by the consulting engineers in MHP, there is a need to constantly capacitate, upgrade, and eventually certify these. Consulting engineers must be certified by the government's National Body for Professional Certification (BNSP) but this certification only certifies that the consulting engineer is in compliance with and conforms to an established set of criteria. It does not certify based on quality of work, services and human resources.

There is therefore a need to establish an accredited MHP organisation at national level, a national MHP certification scheme for consulting engineers must be devised and set in motion, and consulting engineers with MHP knowledge and experience must be technically certified. Rather than constructing an elaborate and theoretical certification scheme for consulting engineers in MHP, it would be advisable initially at least to base technical certification on proven conduct and results by the consulting engineer in past MHP schemes.

9.3 Organisational Implications

To constantly improve the quality and economics of MHP schemes for rural electrification (and hence their sustainability) the following institutional arrangements are recommended:

National Level

MHP Unit

A special government MHP Unit within the MEMR (under the DGNREEC) with the tasks and responsibilities mentioned above in chapter 9.2. Alternatively, this unit could be a Renewable Energy Unit, with the inclusion of a special MHP Task Team.

National MHP Body

An independent body for promotion of MHP for rural electrification formally accredited and approved to technically certify consulting

engineers in MHP. This body which could be an industry association, a public institution, or an independent foundation, will be tasked with technical certification of consulting engineers in MHP, quality assurance of MHP schemes, technical assistance to MHP stakeholders, capacity building of turbine manufacturers and MHP suppliers and contractors, and possibly the establishment of an *MHP Clearing House*.

MHP Teams

Local Level

Special MHP Teams within Local Government (e.g Dinas Energi), responsible for MHP planning in the region, coordination between stakeholders, mobilisation of regional and local research and development in MHP, supervision of operating plants, tendering for MHP contractors, contracting of consulting engineers, CSOs and contractors, monitoring and evaluation of plants and beneficiary communities (e.g. development effects of the MHP schemes; socio-economic changes; productive end-use and effects on household income, etc.).

Owner's Engineer

A number of technically certified Consulting Engineers in MHP, who may be used as Owner's Engineer by project developers and who can provide technical assistance to MHP implementation, supervision, and quality control of works and contractors as well as training of MHP operators.

The vision for the future could look like this:

1. Qualified and professional MHP contractors with significant field experience available in all major regions of Indonesia;

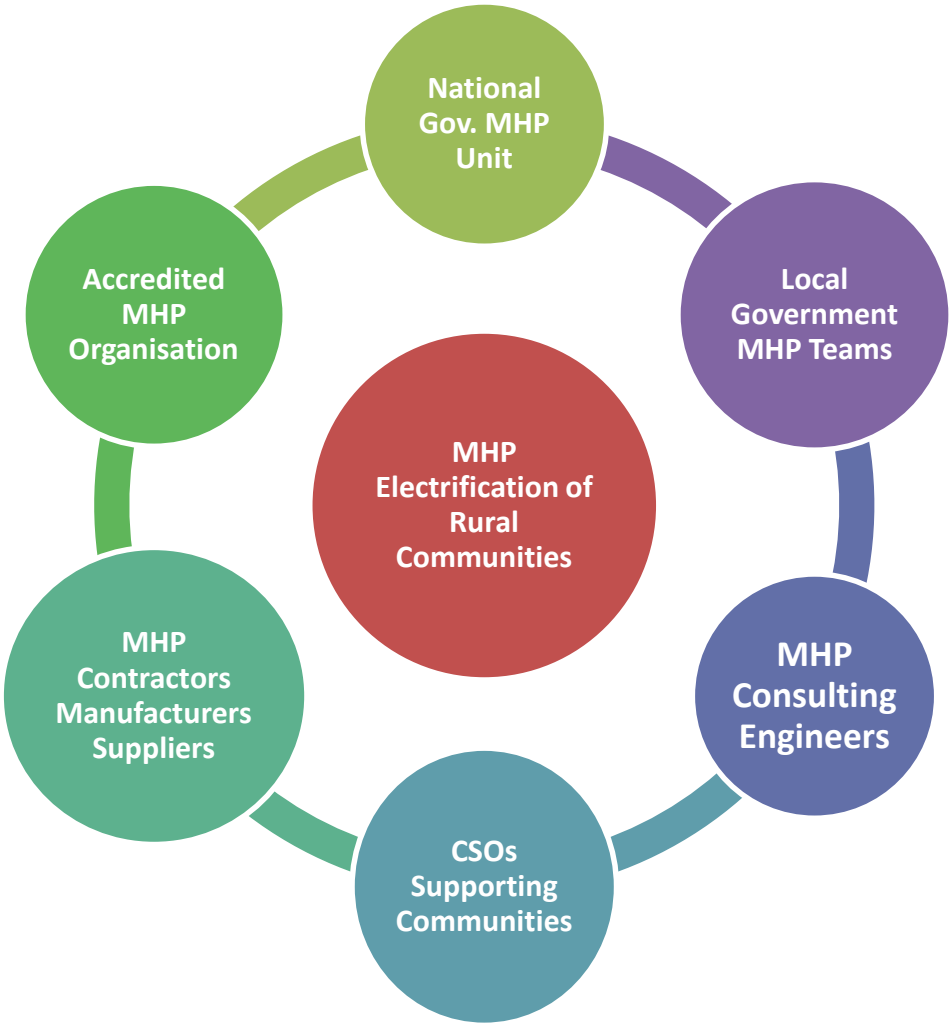
2. Highly skilled and experienced manufacturers and suppliers available in several clusters throughout the Indonesian archipelago;

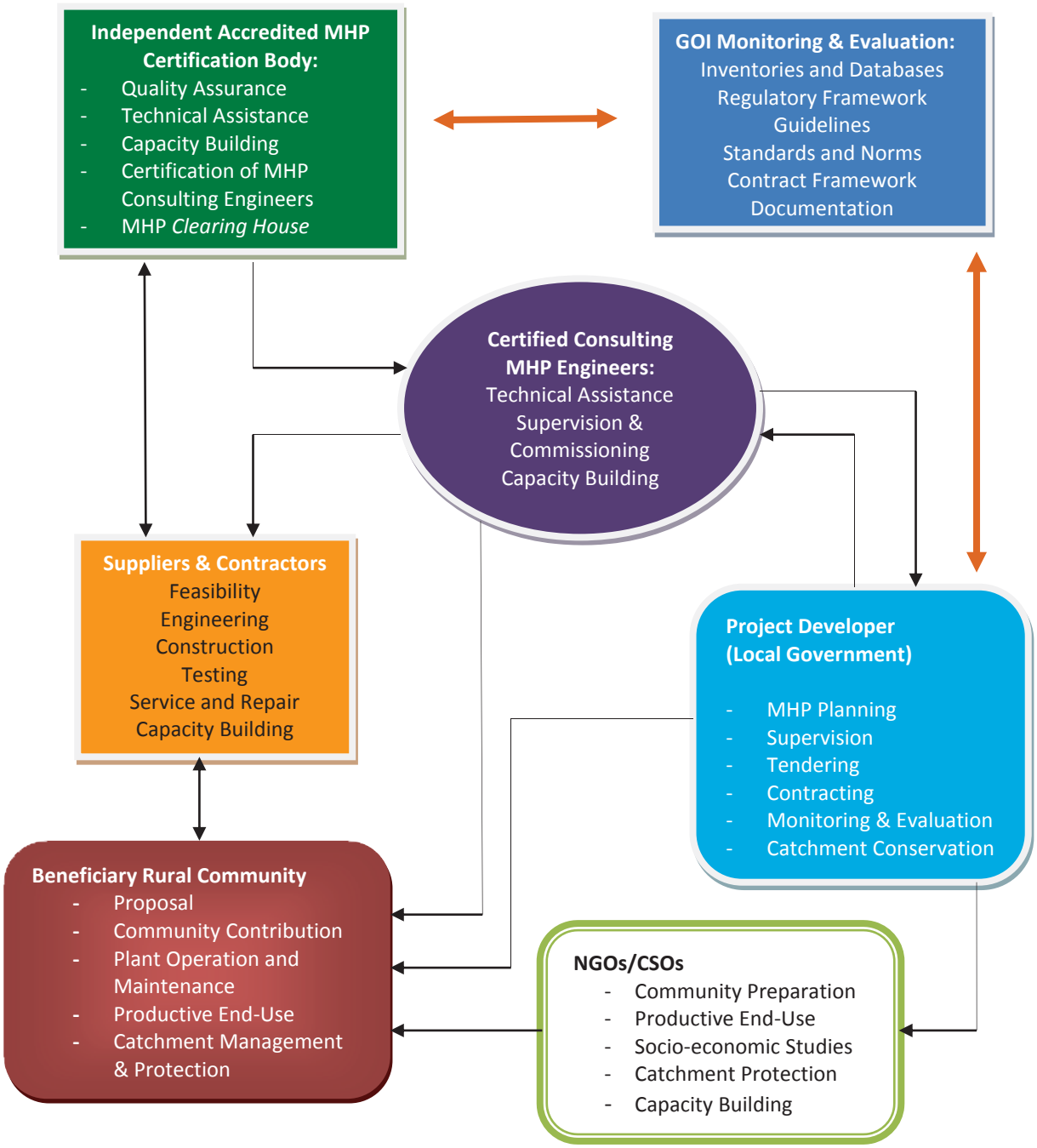
3. Consulting engineers operating at the local (provincial or district) level, offering assistance to MHP project developers (local government; national programmes, private developers);

4. Civil society organisations, with a broad experience in renewable energy and expertise in community approaches, providing support, advice and guidance to beneficiary rural communities;

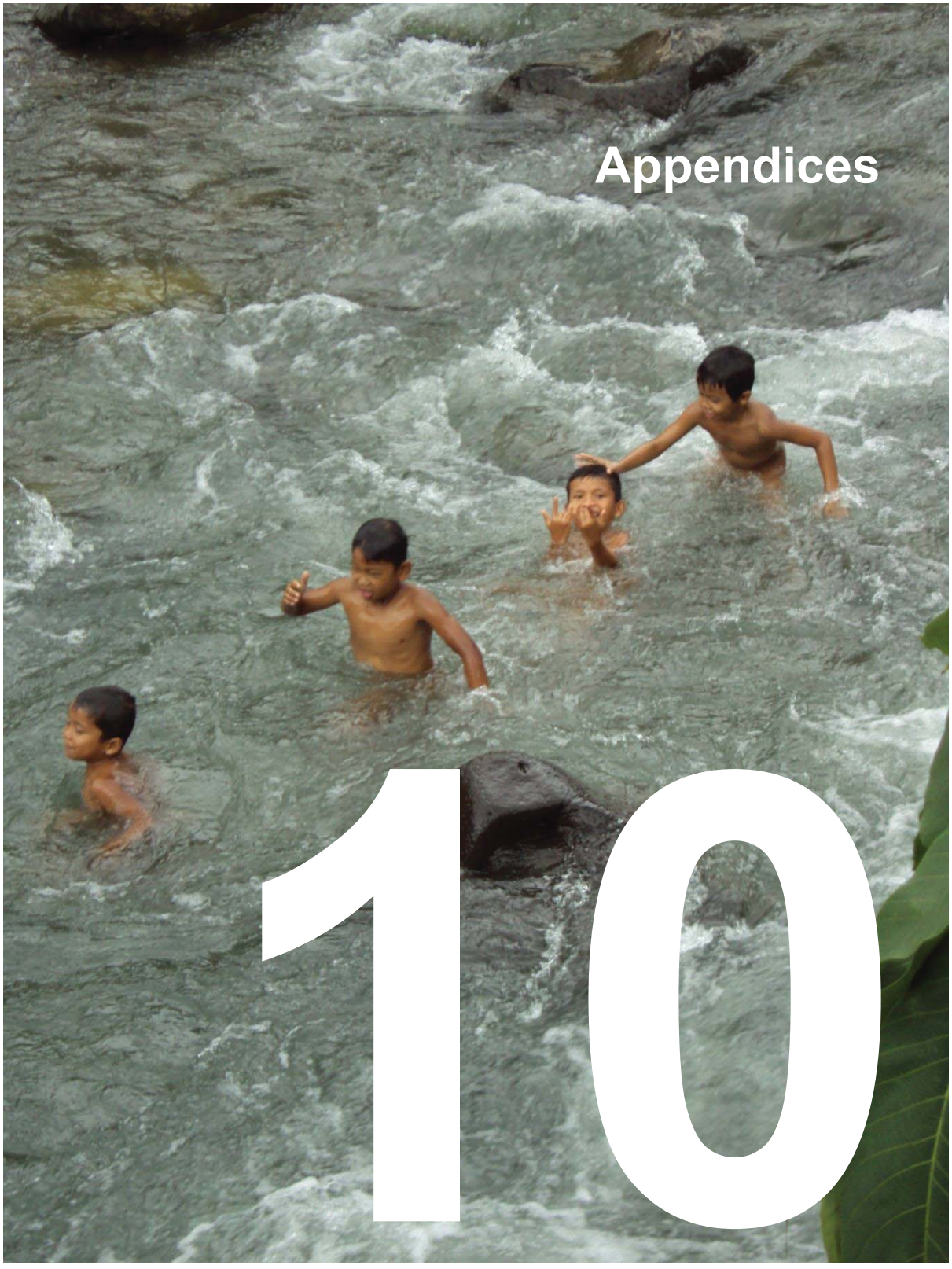
5. Local government MHP Teams (technical teams at district level) supporting off-grid MHP development for rural electrification, including implementation of MHP investment programmes, electrification planning, tendering and contracting, oversight and supervision, monitoring and evaluation, promotion of local MHP research and development, and improvement of the enabling environment for MHP.

Stakeholder Map: Off-Grid MHP for Rural Electrification





Recommended Institutional Arrangement for MHP Development



Appendices

10

10. APPENDICES

10.1 LIST OF MHP MANUALS AND GUIDELINES

No	Title	Publisher (Support)	Year	Content
1	A Practical Guide to Assessment and Implementation of Small Hydropower	Hydro Tasmania Consulting	--	
2	Panduan Spesifikasi Teknis PLTMH (untuk proyek PNPM-LMP)	PNPM Mandiri	--	▪ Electrical mechanical equipments ▪ Transmission & distribution network and home installation
3	Micro-Hydro Power Sourcebook: A Practical Guide to Design and Implementation in Developing Countries	NRECA International Foundation	1986	
4	Micro-Hydro Power: A Guide for Development Workers	The Stockholm Environment Institute et al.	1991	
5	Harnessing Water Power on a Small Scale: Village Electrification	SKAT, Swiss Centre for Developing Cooperation	1992	
6	Layman's Handbook on How to Develop a Small Hydro Site	European Small Hydropower Association	1998	
7	Mini-Grid Design Manual	Joint UNDP/World Bank ESMAP	1999	Energy Sector Management Assistance Programme (ESMAP)

APPENDIX 10.1

No	Title	Publisher (Support)	Year	Content
8	Best Practices for Sustainable Development of Micro Hydro Power in Developing Countries	Joint UNDP/World Bank ESMAP	2000	▪ The cost and financial profitability ▪ Meeting Needs and the Circumstances of Affordability (including subsidies and grants) ▪ Intermediation in Practice ▪ Best Practices: lesson Learned ▪ Selection of case studies in: Sri Lanka, Nepal, Peru, Zimbabwe and Mozambique
9	Manual on Rural Energy Supply with Utilization of RE in Rural Areas in Indonesia	IBEKA (JICA, MEMR)	2003	The contents are divided into 4 different stages (project initiation, development, implementation, and operation stage) and 5 different stakeholders (Govt of Indonesia, provincial govt, district govt, community, consultant/NGO)
10	Guidelines for Rural Energy Supplies with Utilization of Renewable Energy in Rural Areas of Indonesia	JICA (MEMR)	2003	
11	Manual for Micro-Hydro Power Development	JICA (MEMR)	2003	
12	Langkah Pembangunan Pembangkit Listrik Tenaga Mikro Hidro (PLTMH)	MHPP-GTZ (YBUL, FF)	2005	▪ What is PLTMH ▪ Why PLTMH ▪ PLTMH Management ▪ Technical Management of PLTMH ▪ PLTMH Development ▪ PSK Tersebar (Scattered Small Scale Power Generation) ▪ List of organisations active in PLTMH
13	**Buku Utama**: Pedoman Studi Kelayakan PLTMH	IMIDAP (UNDP, MEMR)	2008	MHP Feasibility Study Guideline
14	**Buku 1**: Pedoman Studi Potensi (Pra Studi Kelayakan)	IMIDAP (UNDP, MEMR)	2009	Pre-feasibility Study Guideline
15	**Buku 2B**: Pedoman Studi Kelayakan Sipil	IMIDAP (UNDP, MEMR)	2009	Civil Feasibility Study Guideline

APPENDIX 10.1

No	Title	Publisher (Support)	Year	Content
16	**Buku 2C**: Pedoman Studi Kelayakan Mekanikal Elektrikal	IMIDAP (UNDP, MEMR)	2009	Electrical-mechanical Feasibility Study Guideline
17	**Buku 2D**: Pedoman Studi Kelayakan Ekonomi/Finansial	IMIDAP (UNDP, MEMR)	2009	Economic/Financial Feasibility Study Guideline
18	**Buku 2E**: Pedoman Studi Kelayakan Sosial Budaya	IMIDAP (UNDP, MEMR)	2009	Socio-cultural Feasibility Study Guideline
19	Good and Bad of Mini Hydro Power	MHPP-GTZ (ACE, IMIDAP, UNDP, GEF)	2009	Compilation of know-how and experiences in applying MHP (potential identification, civil construction, mechanical electrical equipments, transmission & distribution network, management & operational
20	Manuals and Guidelines for Micro-hydropower Development in Rural Electrification	JICA	2009	MHP-1 Manual for Design, Implementation, and Management for Micro-hydropower MHP-2 Guideline for Selection of Potential Sites and Rehabilitation Sites of Micro-hydropower MHP-3 Project Evaluation Guideline for Micro-hydropower Development MHP-4 Micro-hydropower Plant Site Completion Test Manual MHP-5 Micro-hydropower Operator Training Manual MHP-6 Training Manual for Micro-hydropower Technology
21	**Buku 2A**: Pedoman Studi Kelayakan Hidrologi	IMIDAP (UNDP, MEMR)	2010	Hydrology Feasibility Study Guideline
22	**Buku 2F**: Pedoman Studi Kelayakan Lingkungan	IMIDAP (UNDP, MEMR)	2010	Environment Feasibility Study Guideline
23	**Buku 2G**: Pedoman Studi Komprehensif Berkelanjutan	IMIDAP (UNDP, MEMR)	2010	Sustainability Comprehensive Study Guideline
24	**Buku 3**: Pedoman Penyusunan Laporan Studi Kelayakan Teknis	IMIDAP (UNDP, MEMR)	2010	Technical Feasibility Study Reporting Guideline
25	Manual Pengelolaan Pengembangan Pembangkit Listrik Tenaga Mikrohidro (PLTMH) untuk Program Listrik Perdesaan	MEMR	2010	▪ Sustainability of MHP (technical, economic, and social aspects) ▪ Approach on Development of MHP ▪ Pre-feasibility Study of MHP Construction ▪ Technical Design and Construction of MHP

APPENDIX 10.1

No	Title	Publisher (Support)	Year	Content
				▪ Preparation on Development and Management of MHP ▪ Operational and Maintenance of MHP ▪ Implementation of MHP Management
26	Panduan Singkat: Mengenal lingkungan PLTMH	PT Entec Indonesia	2010	Very brief description on how to develop an MHP (from what is PLTMH to how to calculate water flow)
27	Manual Pelatihan Teknologi Energi Terbarukan yang Tepat untuk Aplikasi di Masyarakat Perdesaan	DANIDA (PNPM Mandiri)	2011	Training Manual for the proper RE technology application for rural communities Module 1 – Introduction of RE Module 2 – Solar Energy Module 3 – Wind Energy Module 4 – Biomass Energy Module 5 – Micro-hydro Energy
28	Petunjuk Teknis Penggunaan Dana Alokasi Khusus bidang Listrik Perdesaan Tahun Anggaran 2011	MEMR	2011	Minister of Energy and Mineral Resources Decree No. 08 Year 2011 (on Technical Guideline for the Implementation of Special Allocation Fund in Rural Electrification Sector)
29	Panduan Singkat Pengembangan Pembangkit Listrik Tenaga Mikrohidro (PLTMH)	GIZ	2011	The Indonesian version of Micro Hydro Power Scout Guide which was published by GTZ Ethiopia in 2009
30	Pembangunan PLTMH - Panduan Teknis Untuk FT, TPK dan Pekerja Konstruksi PLTMH	MHP-TSU (PNPM Mandiri)	--	A construction guideline

10.2 LINKS TO USEFUL WEBSITES

Institution/Administrator/ Description	Website
Micro Hydro Power Scheme and Technology	
General knowledge	http://id.wikipedia.org/wiki/Mikrohidro
Source for small hydroelectric, renewable hydropower information	http://smallhydro.com/
News and knowledge on hydropower sector	http://www.hydroworld.com/index.html
Home Power (editorial venue for homeowners, business owners, and renewable energy professional)	http://homepower.com/home/
Hydropower technology provider	http://www.micro-hydro-power.com/
Hydropower website by Wim Jonker Klunn	http://www.microhydropower.net/index.php
Electronic Load Control for Micro hydro system	http://ludens.cl/Electron/picelc/picelc.html
Governmental Organizations	
Official website of Ministry of Energy and Mineral Resources (MEMR)	http://www.esdm.go.id/index.html
Official website of Directorate General of Electricity, MEMR	http://www.djlpe.esdm.go.id/index.php
Official website of Directorate General of New Renewable Energy and Energy Conservation, MEMR	http://www.ebtke.esdm.go.id/
Official website of Directorate General of Research Centre for Electricity, New Renewable Energy, and Energy Conservation, MEMR	http://www.p3tkebt.esdm.go.id
Clearinghouse Energi Terbarukan & Konservasi Energi	http://www.energiterbarukan.net
Non Governmental Organization	
GIZ MHPP[2]	http://mhpp2.or.id/
GIZ MHP-TSU (Technical Support Unit)	http://tsu.or.id/cms/
PT Entec	http://www.entec.ch/entecweb/
CASINDO (p/o Energy Research Centre of the Netherlands)	http://www.casindo.info/
IBEKA (Yayasan Institut Bisnis dan Ekonomi Kerakyatan)	http://ibeka.netsains.com/

APPENDIX 10.2

Institution/Administrator/ Description	Website
Yayasan Mandiri	http://www.yayasanmandiri.com/default.asp
Yayasan Bina Usaha Lingkungan	http://ybul.or.id/
Wahana Pengembangan Usaha	http://www.wpu.co.id/
Masyarakat Energi Terbarukan	http://www.meti.or.id/
Masyarakat Ketenagalistrikan Indonesia	http://www.mki-online.org/
REFF-Burn – Indonesia's Clean Energy Initiative	http://reffburn.org/
Planet Hijau	http://www.planethijau.com
Daftar perusahaan PLTMH	http://www.docstoc.com/docs/13528698/Daftar-perusahaan-pltmh
International Network on Small Hydropower	http://www.inshp.org/main.asp
European Small Hydropower Association	http://www.esha.be/
UNIDO Regional Centre for Small Hydropower	http://unidorc.org/
B2B Renewable Energies	http://www.renewablesb2b.com/ahk_indonesia/en/portal
Nepal Micro Hydro Power Development	http://www.microhydro.org.np/index.html
GVEP (The Global Village Energy Partnership)	http://www.gvepinternational.org/en
Practical Action	http://practicalaction.org/

10.3 OVERVIEW OF MHP TRAINING PROVIDERS

No.	Institution	Address	Type of Training	Type of Institution
	Ibeka (Yayasan Institut Bisnis dan Ekonomi Kerakyatan/People Centered Economic and Business Institute)	Bandung PO Box 8439 Lembang Bandung Jawa Barat, Indonesia Ph : 62-260-471897, 471827 Fax: 62-260-471326 Jakarta Jl. Madrasah II No. 28, RT 04/RW 02, Kelurahan Sukabumi Utara Kebun Jeruk, Jakarta Barat 11540, Ph/Fax:62-21-5492087, E-mail:tri.mumpuni@gmail.com	Operator and Management Team of MHP Facility	NGO
	Asosiasi Hidro Bandung (Small Hydro Power Association)	Jalan Sabang No. 25 Bandung 40114 Ph: 62-22-4240310 Fax: 62-22-4261477 E-mail: hidrobandung@yahoo.com	Oparator and Management Team of MHP Facility	NGO
	HYCOM (Asean Hydropower Competence Centre)	Jl. Pasantren km 2 Cibabat Kota Cimahi 40513 E-mail office@hycom.info Website www.hycom.info	Customized MHP training programs, focusing on technical aspects of MHP	
	Yayasan Ragom	Jl. Nusantara Gang Nusantara V/42 Labuhan Ratu, Kedaton Bandar Lampung 35142 Ph: 0721 788 489 E-mail: h3rm1nyudi@yahoo.com (Hermin Yudi Puja Bhakti)	MHP Management Team	NGO

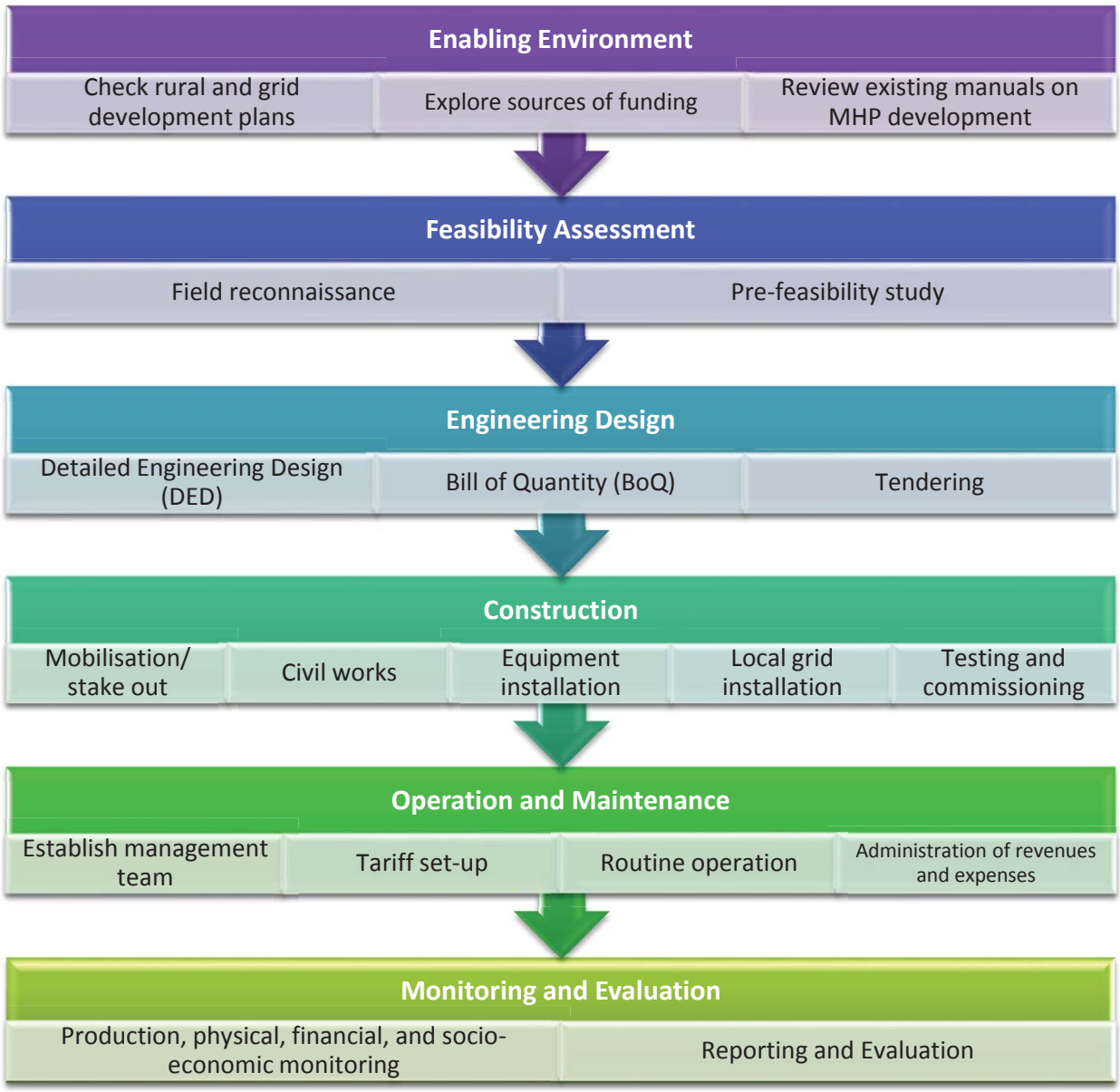
APPENDIX 10.3

No.	Institution	Address	Type of Training	Type of Institution
	YKSSI (Yayasan Keluarga Sehat Sejahtera Indonesia)	Jalan TGH.Bangkol no.17 Karang Anyar, Pagesangan Mataram 83125 Nusa Tenggara Barat Ph: 0370-634576 Fax: 0370-634576	MHP Management Team	
	Electricity, New and Reneable Energy Training Centre of MOEMR (Pendidikan dan Pelatihan Ketenagalistrikan, Energi Baru, Terbarukan dan Konservasi Energi)	Jl. Jend. Gatot Subroto Ka. 49 Jakarta Selatan 12950 Ph: 021-5254508 Fax: 021-5255863 E-mail: info@diklat.esdm.go.id Website: http://www.diklat.esdm.go.id	MHP Competency Training for Goverment Officials	Government Body
	BLKI (Balai Latihan Kerja Industri) – Industrial Career Training Centre	Jl. Taman Makam Pahlawan No. 4 Makassar, Sulawesi Selatan Indonesia 90231 Ph: (0411) 442322	Customized MHP training programs, focusing on technical aspects of MHP	College

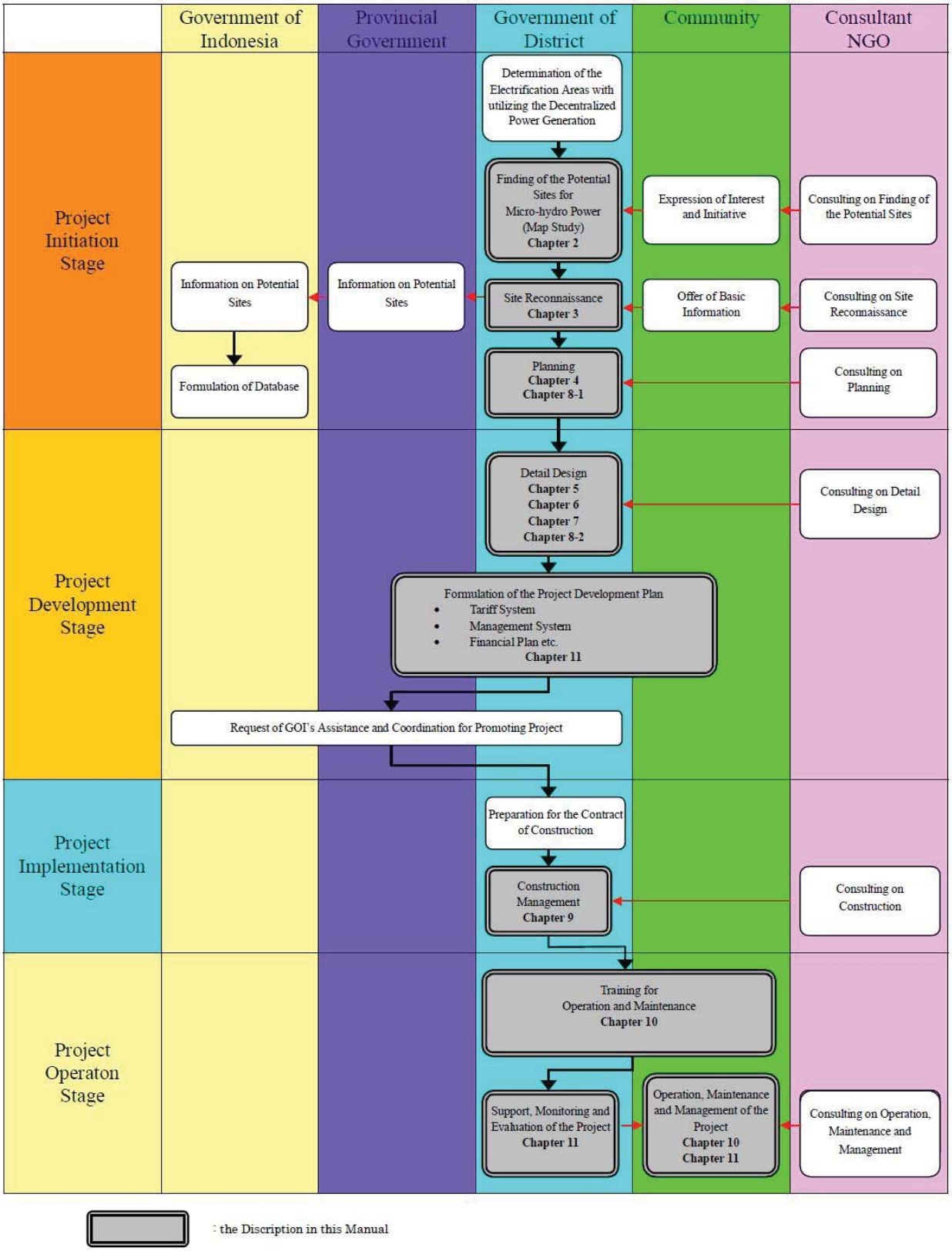
10.4 LIST OF EXAMPLES AND FORMATS HYPERLINKED IN THE GUIDELINE

#	Reference	Hyperlinked in Guideline
1	TSU and MHPP2 Websites	Section 1, page 3
2	Example of Regional Rural Electrification Master Plan	Section 3, page 17
3	List of MHP Service Providers	Section 3, page 22
4	Community Organisation Structure example	Section 4, page 27
5	TSU Knock-out and Ranking Tool	Section 4, page 30
6	TSU "Form A" – Community Proposal	Section 4, page 30
7	List of Information Sources for Desk Screening	Section 5, page 34
8	TSU "Form B" (Socio-Economic Data) + "C" (Site Data)	Section 5, page 36
9	Example of TOR for MHP Contractors	Section 5, page 36
10	TSU Standard Drawings and BOQ Tools	Section 5, page 37
11	Examples of DED and BOQ	Section 5, page 37
12	Standard Technical Specifications for Tenders	Section 5, page 38
13	Example of Tender Documents (PNPM Green)	Section 5, page 38
14	TSU Civil Construction Manual	Section 6, page 46
15	TSU Form D – Commissioning Data	Section 6, page 51
16	TSU Monthly Status Report	Section 6, page 52
17	TSU Construction Log Book	Section 6, page 52
18	Examples of Tariff Calculations	Section 7, page 55
19	List of Productive End-Use Examples	Section 7, page 56
20	Template for Financial Management of the MHP	Section 7, page 60
21	Template for Operator Logbook	Section 7, page 61
22	Example of an MHP Maintenance Schedule	Section 7, page 62
23	Example of an MHP Baseline Report	Section 8, page 65
24	Example of an MHP Impact Study	Section 8, page 70
25	List of MHP Key Performance Indicators	Section 8, page 72

10.5 EXAMPLES OF MHP DEVELOPMENT FLOWCHARTS

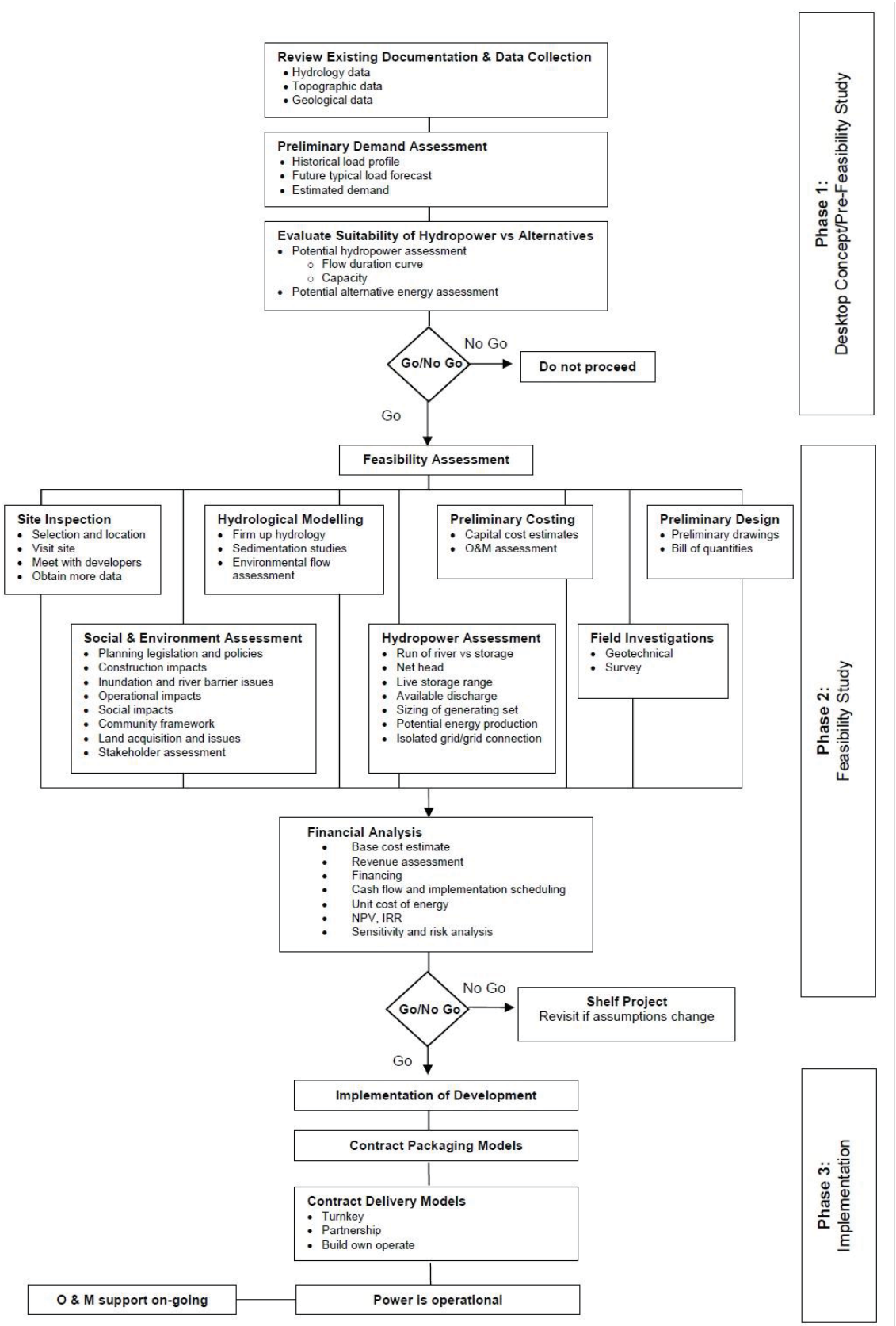


Flowchart of Common MHP Development



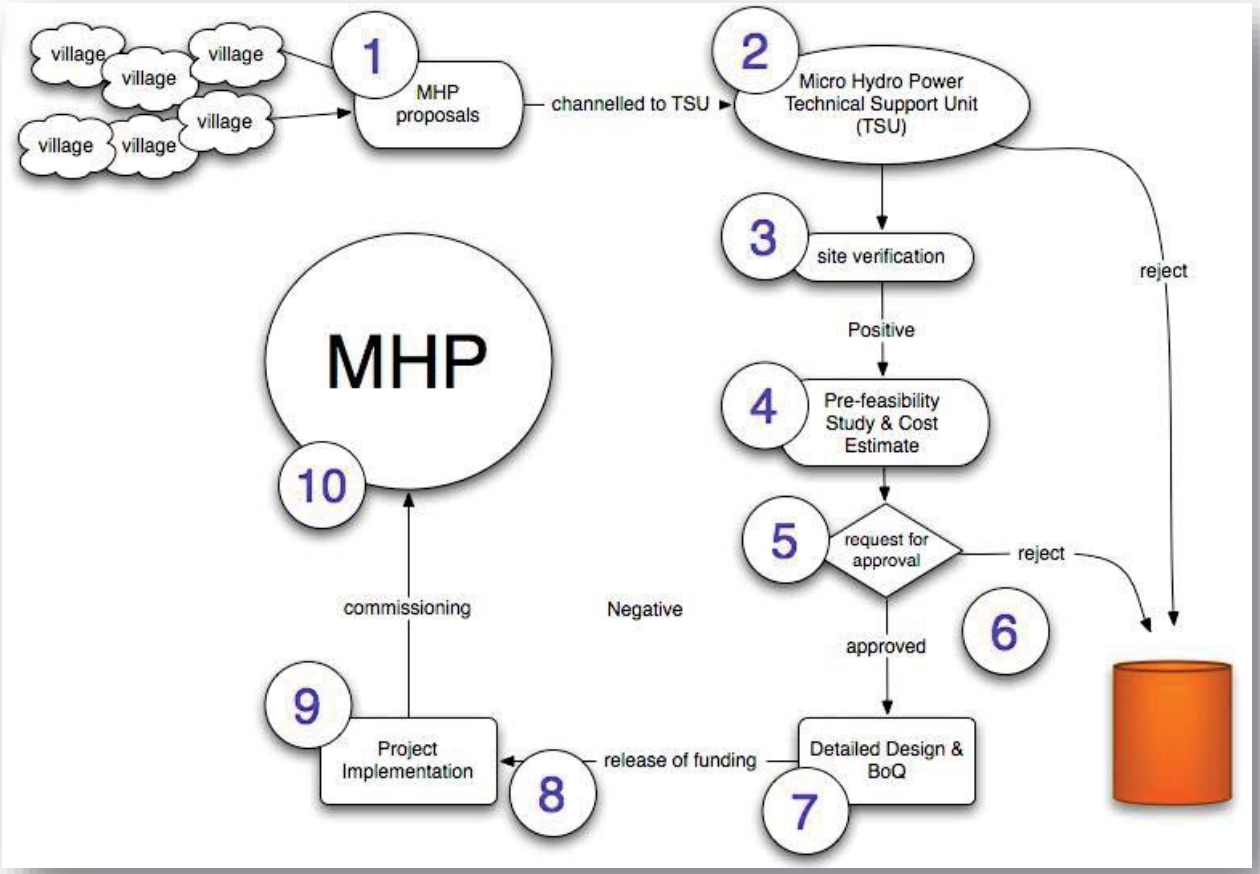
Flowchart of Micro-hydro Power Development

Source: Manual on Rural Energy Supply with Utilization of RE in Rural Areas in Indonesia (IBEKA, 2008)



Investigation to Implementation Activities

Source: A Practical Guide to Assessment and Implementation of Small Hydropower (Tasmania Hydro Consulting)



Flowchart on MHP Development

Source: MHP-TSU

Diagram Tahapan Pengembangan PLTMH

Source: Wahana Pengembangan Usaha (WPU), http://wpu.co.id/

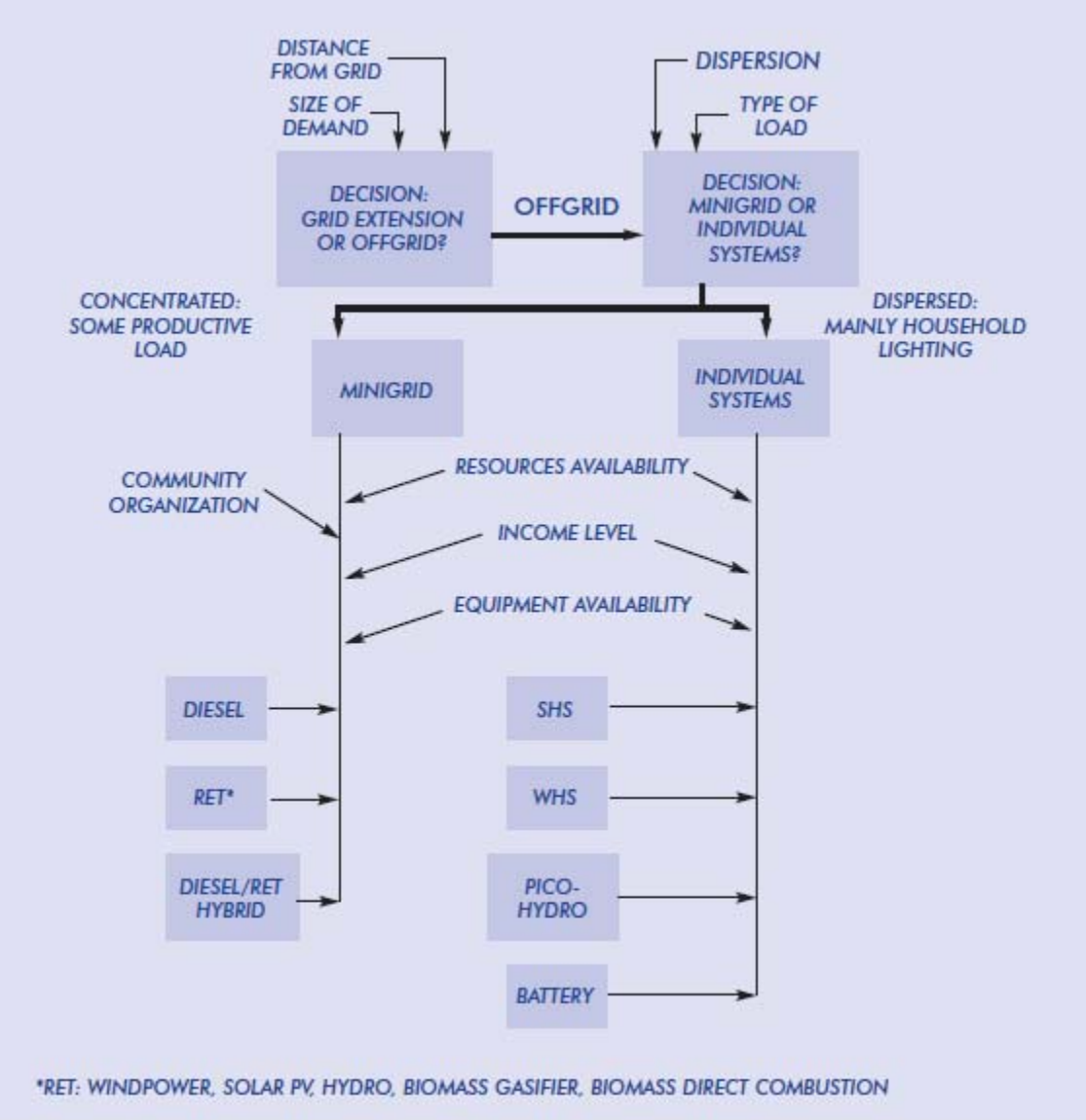


Diagram Tahapan Pengembangan PLTMH
Source: Wahana Pengembangan Usaha (WPU), http://wpu.co.id/

EnDev Indonesia is a proud project under

Renewable Energy Programme Indonesia/ASEAN

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Energising Development (EnDev) Indonesia
Jl. Tebet Barat VIII No. 52
Jakarta 12810, Indonesia
T +62 21 830 9438
F +62 21 830 9032
I www.giz.de; www.endev-indonesia.org

Funded by

BMZ Federal Ministry for Economic Cooperation and Development

Ministry of Foreign Affairs of the Netherlands

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS