GOOD & BAD
of
Mini Hydro Power








Volume 2

- Transmission & Distribution
- House Installation
- Management & Administration
- Utilization of Energy

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of
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with the resources of Entec AG

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Edited by

Roman Ritter
GTZ

ASEAN-German Mini Hydro Project (AGMHP)

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Foreword

The urgent call for reducing the carbon footprint of our economies combined with the world's ever growing demand for scaling-up access to energy is a priority challenge on the global agenda which defines the role for renewables.

Renewable energies offer climate-friendly, low risk technology options for decentralized power generation. In remote areas, utilizing local renewables to support the development of poor rural communities is often more economically viable than transporting diesel fuel or expanding the national electricity grid over long distances. In locations where however the network infrastructure is already in place, harnessing natural resources for feeding power into the central grid also offers an important source of local income that contributes to macroeconomic stability by gaining independence from price-volatile fossil fuels.

In the light of this, the Association of South East Asian Nations (ASEAN) is emphasizing the need to strengthen the development of renewable energies. Promoting mutual cooperation for the transfer of knowledge and skills in order to narrow development gaps among the ASEAN countries, to empower the region's peoples, and ultimately to alleviate poverty is seen as the way forward.

With this publication, *'GOOD & BAD of Mini Hydro Power',* the ASEAN Centre for Energy (ACE) aims to provide valuable lessons from experiences gained in one member country for the dissemination of good practices throughout the whole region. This is intended to support the capacity development of ASEAN's human resources in the sustainable planning, design, implementation, management, operation and maintenance of mini hydro power (MHP).

The two underlying principles of this book are: "a picture is worth a thousand words" and "the only real mistake is the one from which we learn nothing". Thus – along the sequence 'from water to wire' – contrasting pictures of good & bad examples are provided to illustrate what actually defines the difference. Each picture is complemented by short explanations so that the book can serve as a technical training manual that offers direct and easy-to-understand guidance.

Although MHP is a relatively mature and cost-competitive energy technology, a lot of mistakes are still being made which lead to increased maintenance cost, reduced power output, shortened service life or even physical danger. The good news is that in many cases it is only small changes which need to be made – doing things the right way often requires no more funds than doing them the wrong way. However, what is definitely required is a proper awareness and expertise among hydro practitioners and their principals for whom, quite literally, "knowledge is power".

Nguyen Manh Hung
ACE, Executive Director

Roman Ritter
GTZ, Principal Advisor AGMHP

Acknowledgements

This book draws on countless photographs and experiences which have been collected in practically applying international MHP know-how for the successful improvement of mini hydro power implementation in Indonesia.

Therefore special thanks go to the Indonesian *Directorate General for Electricity and Energy Utilization (DGEEU)* and its Mini Hydro Power Project (MHPP) which has been jointly implemented for more than 10 years by *DGEEU* and *GTZ*, the German Technical Cooperation – *Deutsche Gesellschaft für Technische Zusammenarbeit.*

Big thanks also go to the team of authors who made great efforts in bringing together Entec's expertise in MHP development with the didactical concept of using contrasting pictures which require only short explanations to point out the decisive difference.

Last but certainly not least, the *ASEAN Centre for Energy (ACE)* is highly grateful to the German *Federal Ministry for Economic Cooperation and Development (BMZ)* for its continuous support of the ASEAN-German Mini Hydro Project (AGMHP) which provided the necessary resources for compiling this publication.

Nguyen Manh Hung
ACE, Executive Director

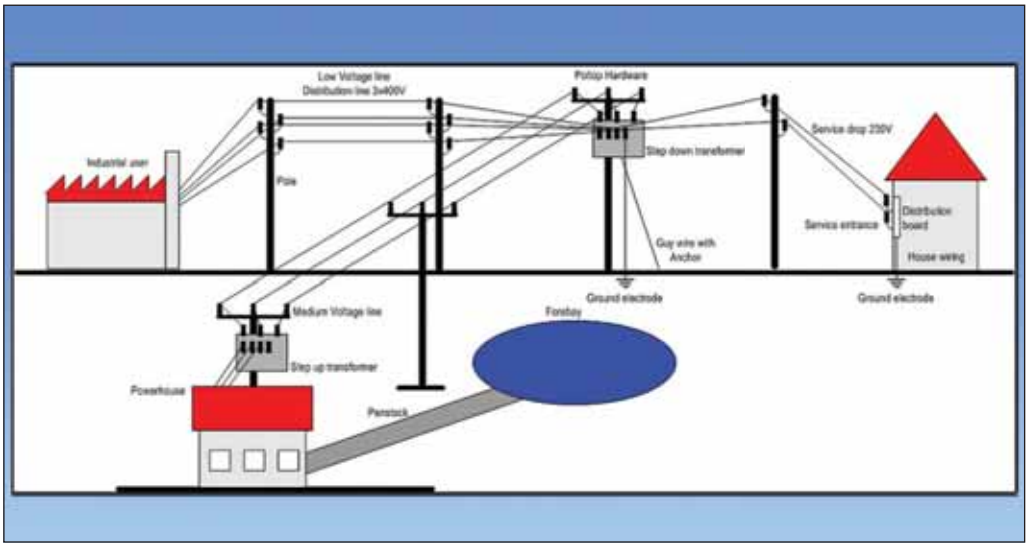







4. Transmission & Distribution

4.1 GENERAL BASICS



Small island grid

This graph depicts major elements of a small island grid which are the transmission line, the transformers and the distribution line.
At the powerhouse, the low voltage from the generator is transformed via a step up transformer to high voltage in order to reduce losses when transmitting the electricity over longer distances. In small island grids with relatively short distances, stepping up to medium voltage is often sufficient for the transmission.
The transmission line usually ends at a central point in the village. There, the voltage is transformed via a step down transformer to low voltage again and the distribution line will make the connection to houses and small industrial facilities.

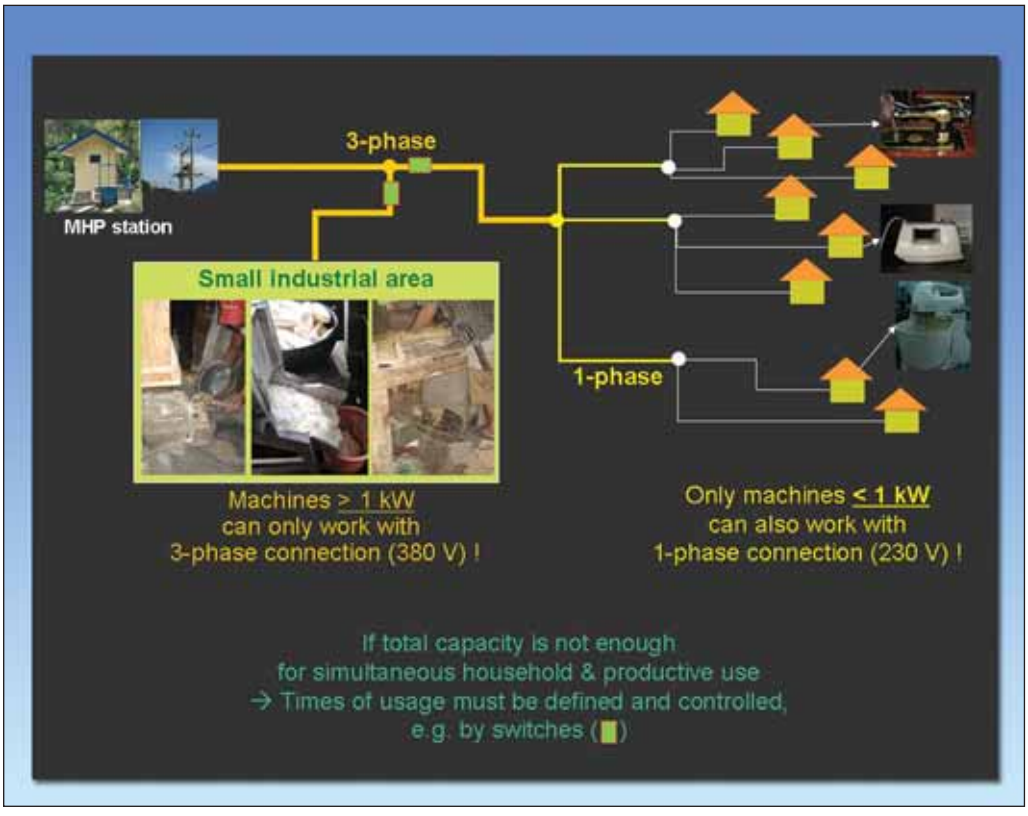
4.1.1 Basics for Grid Planning, Design & Layout

For a proper technical layout of a transmission and distribution system, a lot of expertise and experience is required. Since such work can only be done by well trained, authorized professionals, no more than just a few selected issues are listed here:

- Start the grid layout from the power house to the customers and try to service all potential consumers
- Distance from power house to grid, and from grid to consumers shall be as short as possible → less length of cables reduces the losses and the cost of the system
- Define the location of poles carefully → look for a dry location, easy terrain and enough ground clearance of cable
- Sufficient ground clearance determines the maximum distance between two poles. It should be not longer than 30 – 50 m

- Minimum ground clearance should follow local regulations; for low voltage lines it should be at least:
  - 4.5 meters for off road installations
  - 5 meters alongside of road installations
  - 5.5 meters crossing roads installations
- For medium voltage lines, ground clearance has to be even higher. Check local regulations
- Define appropriate type, diameter and lengths of cables needed as well as number, type and material of poles, including all accessories and pole top hardware

4.1.2 Implications of Productive End Use on Network Design

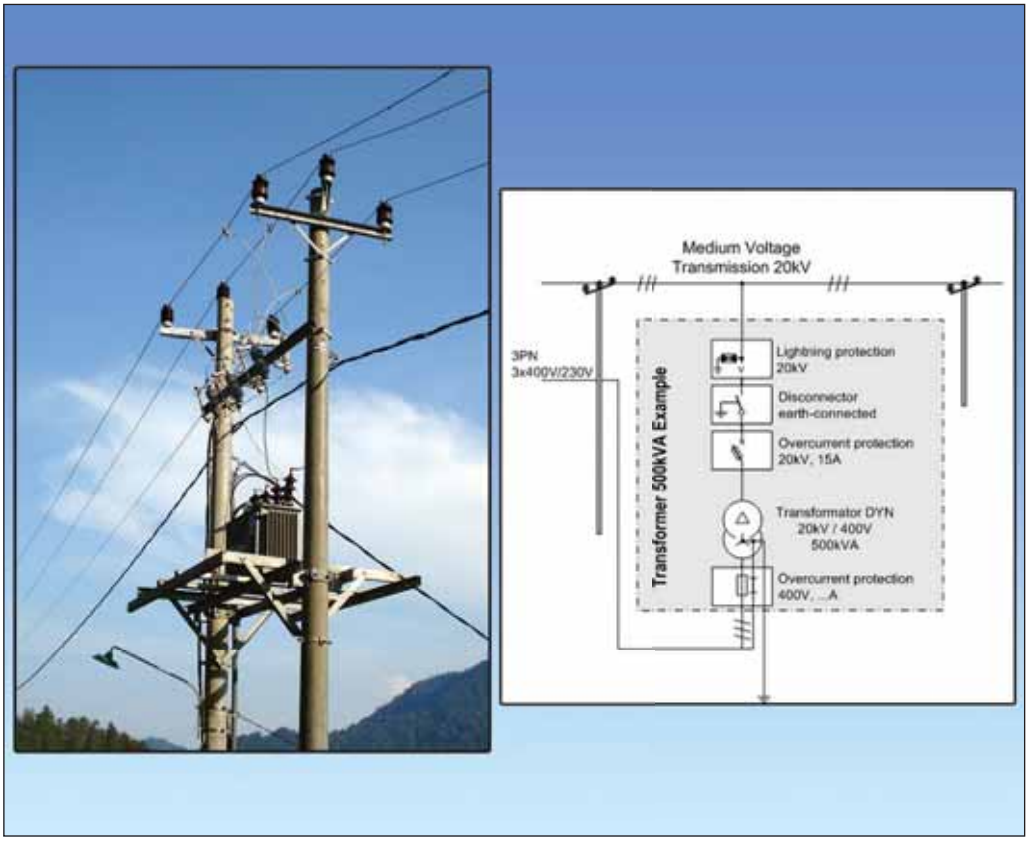


If electricity is only used for lighting, TVs and other small domestic appliances, the distribution can be designed as a low-cost 1-phase system.

However, in order to allow its users to fully benefit from MHP, also productive end use of electricity – often requiring 3-phase connections – should be enabled. How this can be done without providing every single household with an expensive 3-phase connection is exemplary shown in the above graphic.

4.2 MAJOR COMPONENTS

4.2.1 Transformer Station



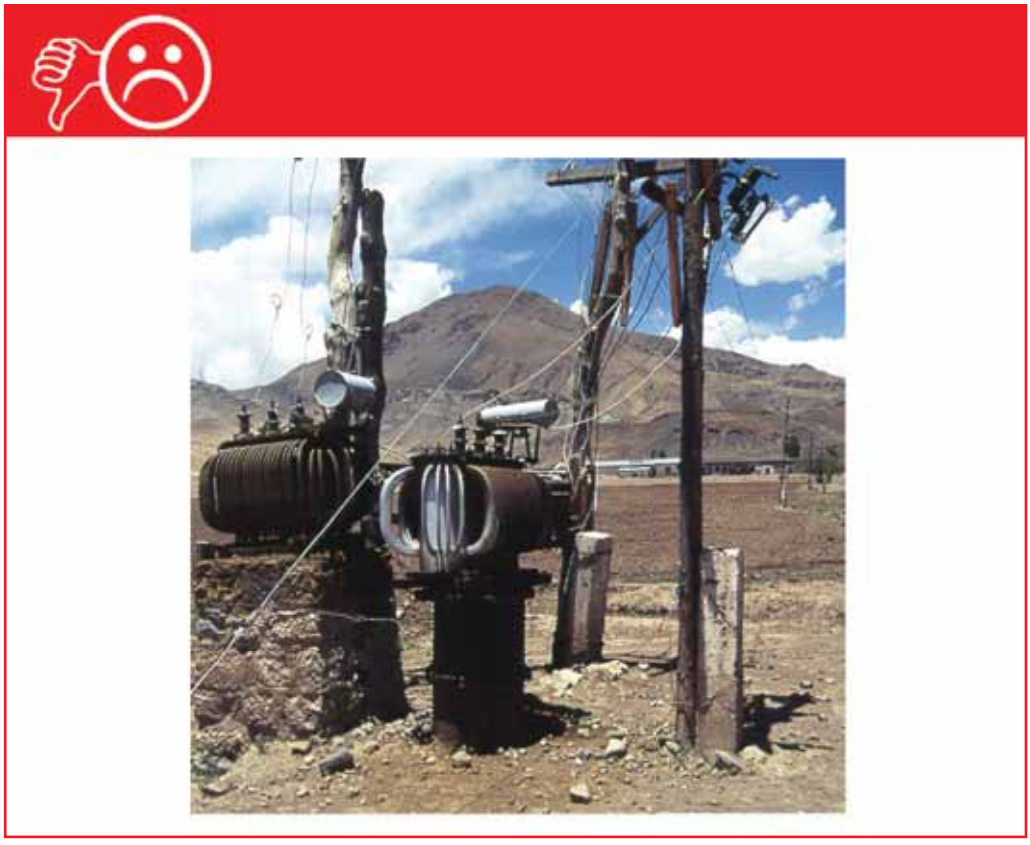
Main elements & design principles of a transformer station:

- Medium voltage line on the top for longer transmission lines & small currents (line length longer than 1-3 km)
- Protection elements (lightning protection, disconnector, overcurrent protection) depending local regulations
- Concrete poles with pole top hardware (insulators)
- Transformer on elevated platform = safety for the public
- Low voltage distribution line below medium voltage line for shorter transmission lines & higher currents (line length less than 1-3 km)

Good example of a transformer station

Why is this a good example?

- Transformer is out of reach of humans and animals
- It is mounted high enough so that nobody can reach it accidentally – minimum ground clearance should be according to local regulations
- Transformer is fixed on a steel frame, held by two concrete poles
- Cables are well arranged for an easy understanding of the system



Bad example of a transformer station

Why is this a bad example?

- Transformers are not out of reach of humans and animals, humans can be injured accidentally
- Risk of injury and death is high
- Sabotage is easy possible

How can I improve it?

- Transformers must be out of reach:
  - either set the transformers at least 4 meters above ground or
  - protect the area with a strong, grounded fence
- Each transformer has to be grounded
- Cabling has to be clear, well arranged and installed with a minimum ground clearance of 4.5 m for low voltage lines and even more for medium voltage lines.

Good example of a transformer station

Why is this a good example?

- Suitable fence protects transformer against unauthorized access
- Transformer on the ground makes maintenance easier
- The fence prevents access by unauthorized person or animals
- The height of the fence should be at least 2 m
- A gravel pad keeps the surface and the equipment dry

4.2.2 Distribution Poles and Lines

Bad example of distribution pole & lines

Why is this a bad example?

- The distribution pole looks unsafe, poorly built and not supported
- The line is not free, plants are very close to the wires
- The minimum distance above ground-level is not kept, so it's a very dangerous situation
- The transformer is also at ground level; blank wires can harm people and animals

How can I improve it?

- Approach and improve such dangerous installations only with well trained authorized professionals

Good example of distribution pole & lines

Why is this a good example?

- The pole is perfectly vertical and stabilized by guy wires
- All cables are properly fastened to the pole top hardware
- The power line looks healthy, well built and well supported
- The line is installed free, there are no house part, tree or plants near the wire
- The distance above ground-level is ok. If somebody passes the line, there is no risk to touch the dangerous blank wires
- The line is built with concrete poles, making the line more durable and more robust
- Service drops to the panel are in ducts and fastened to the pole
- Panel is out of reach of unauthorized persons

4.2.3 Wiring connections

Bad wiring connection

Why is this a bad example?

- Knots and tapes are unsuitable for wiring connections
- Approved connection clamp is missing

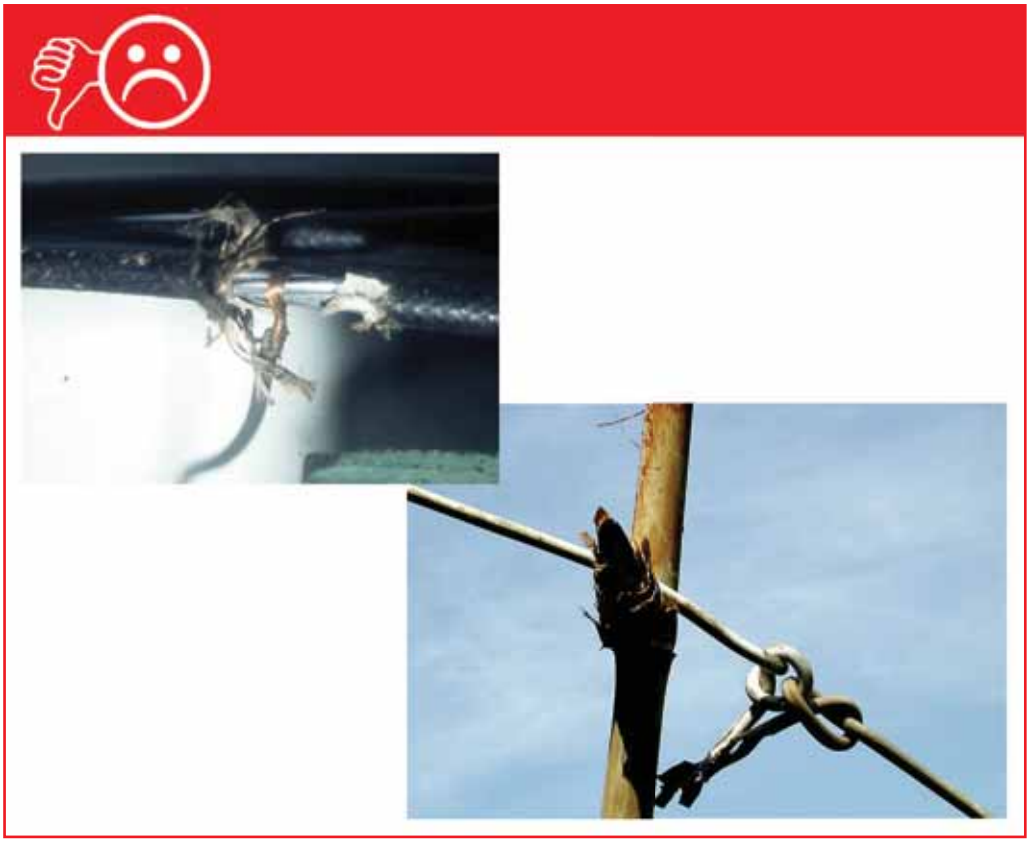
Note:

EACH UNPROPER CONNECTION IS PRONE TO BREAK → CABLES WILL FALL TO THE GROUND CAUSING DANGER TO LIFE AND PROPERTY!

Good wiring connection

Why is this a good example?

- These clamps consists of two parts which are tightened after inserting the cable
- These clamps can withstand the tension of the cables between two poles
- Use only approved clamping devices to avoid breakdowns during operation



Bad wiring connection

Why are these bad examples?

- Connection is made with the cable itself, approved connection clamp is missing
- Careless done wiring connection, without clamp and without connection box
- Blank wire, without insulation is a high risk to get injured by electrical accident

How can I improve it?

- Such works have to be done by professionals only
- Use ONLY approved parts and accessories for cable connections
- Make all connections very carefully and use a connection box with clamps inside

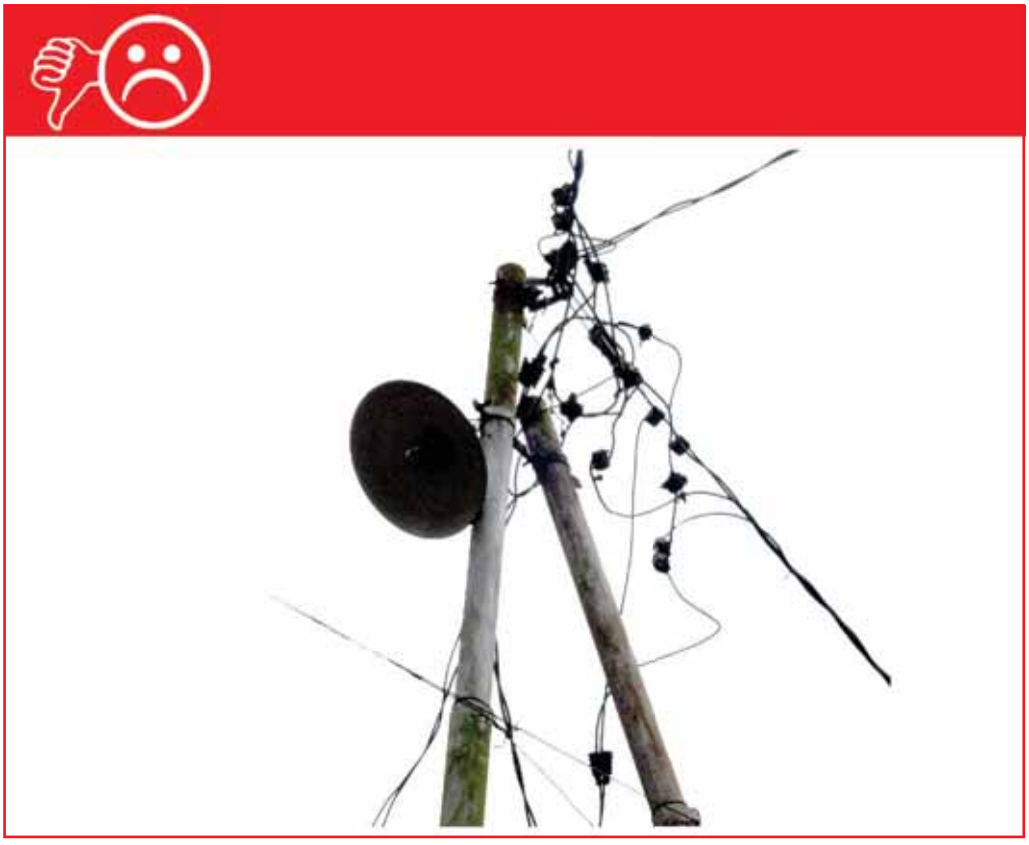
Note:

IMPROPER CABLE CONNECTIONS ARE A HAZARD FOR THE SYSTEM AND COULD CAUSE ACCIDENTS OR FIRES!

Good wiring connections

Why are these good examples?

- Well designed and built service pole, concrete type set in a solid concrete foundation
- Cables are well arranged and fixed to the pole
- Panel with fuses well built and safe
- Guy wires absorb the forces caused to the pole by the cables



Bad example of a wiring connection

Why is this a bad example?

- The various connections are unsystematically arranged and confusing everybody who needs to locate a possible failure
- The cables hang around without being fixed

How can I improve it?

- Cabling works have to be carried out by professionals only
- Wiring connections have to be done well, for example by using a connection panel with terminals inside

Good example of a wiring connection

Why is this a good example?

- The cable under tension is held by the clamp
- The clamp is fixed to the pole
- The cable is around the pole without tension

Note:

ALWAYS LEAVE A CERTAIN LENGTH OF CABLE WITHOUT TENSION BETWEEN THE CLAMPS!

Bad example of a street light wiring

Why is this a bad example?

- The cable is under tension
- The socket is fixed with the power cable itself

How can I improve it?

- Fix the socket to the pole and install the cable without tension

Good examples of street light installation

Why is this a good example?

- Power cables are free of any tension
- Bulb sockets are not hanging at the power cables but they are fastened to the lampshades
- The lampshades are fixed to the poles
- The electrical connections are protected by the improvised lampshades
- Energy saving light bulbs are used

4.2.4 Maintenance

What needs to be done for the pole maintenance?

- Switch off power first
- Check stability of pole before you go to the top
- Check guy wires as well

When stability and guy wires are ok, then you can go to the top, if necessary in order to:

- Check cable connection and cable tension (overhead clearance)
- Check pole top hardware
- Clean insulators from dirt

Note:

CHECK WOODEN POLES MORE OFTEN – PARTICULARLY IF THEY START ROTTING!

Good selection of tools

Why is this a good example?

- Tools for good electrical workmanship for transmission and distribution lines as well as for house installations
- For well done electrical work, the need of good tools is essential
- The shown tools are necessary, because of different shapes and sizes.

Note:

FOR EACH SHAPE AND SIZE, USE THE SPECIFIC TOOL!
KEEP TOOLS CLEAN AND TAKE CARE OF THEM!






5. House Installation

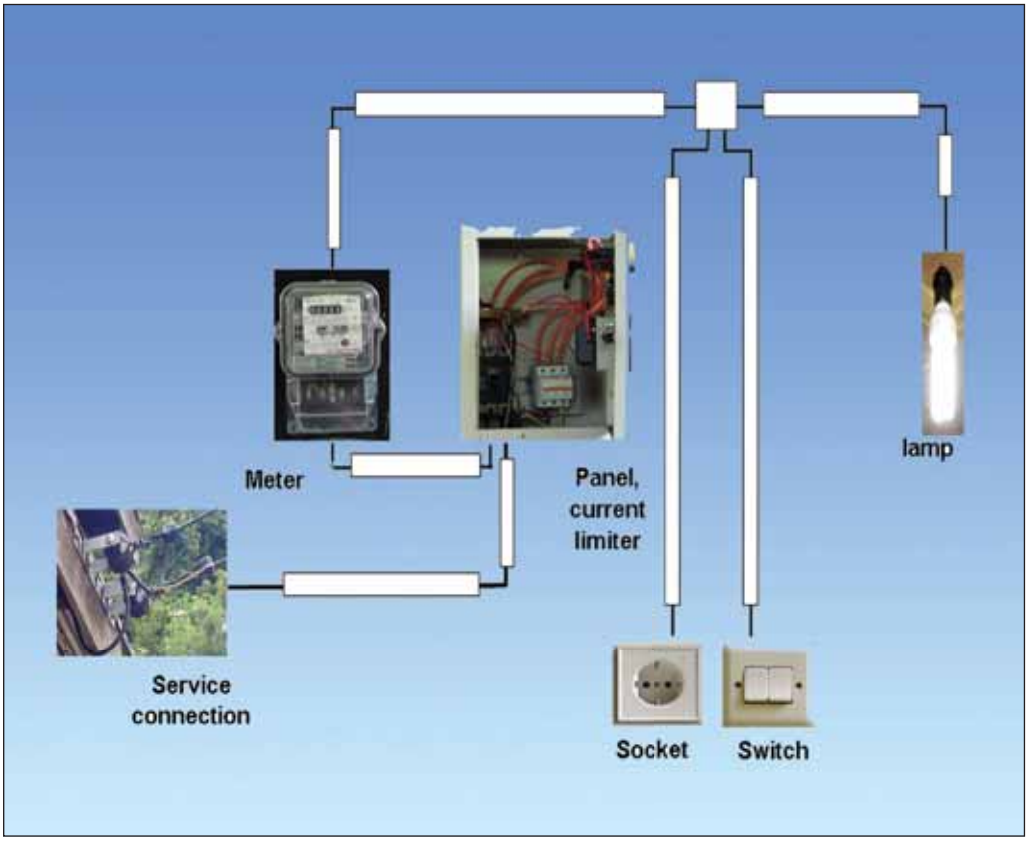
5.1 GENERAL

Electricity – when not handled with proper care – is very dangerous for people and their property

Note:

IN ORDER TO PREVENT DANGEROUS SITUATIONS, HOUSE INSTALLATIONS HAVE TO BE DONE ACCORDING TO THE LOCAL REGULATIONS AND BY EDUCATED AND CERTIFIED PROFESSIONALS ONLY!

5.2 MAJOR ELEMENTS



This graph depicts major elements of the house installation (however, ground electrode as part of the earthing system is not shown here) which are illustrated in more detail in this chapter.

5.2.1 Service Connection

Service connection - bad

Why is this a bad example?

- There is no distance between the cable and the roof; the insulation will eventually be damaged by the roof
- This can create short circuits and fire

Note:

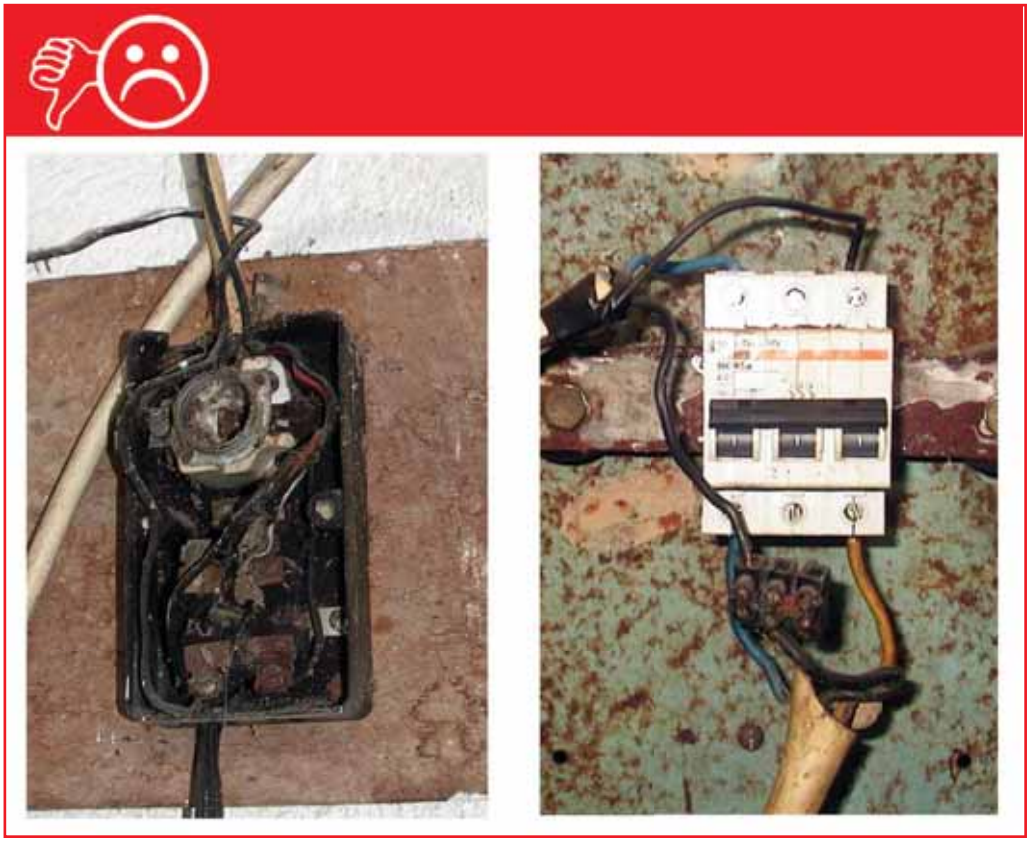
THIS KIND OF WIRING IS VERY DANGEROUS – ESPECIALLY FOR A WOODEN HOUSE!

Service connection - good

Why is this a good example?

- The service drop from the distribution system is under tension
- It is installed high enough to be out of reach
- The cable between connection and meter is without tension
- Meter is well protected under the roof against rain and moisture
- Cable fixed with clamps to the underside of a roof beam

5.2.2 Current Limiting Device



Current limiting device - bad

Why are these bad examples?

- Current limiting device is burned because of missing fuse; fuse was bypassed
- Bypassing a fuse is the worst you can do, directly attacking life and property
- Never install limiting devices like this
- Never bypass limiting devices

Current limiting device - good

Why are these good examples?

- The fuses are fixed properly
- Incoming and outgoing lines are well separated
- There is no bypass visible

5.2.3 Metering

Metering - bad

Why is this a bad example?

- Wiring should always be straight and well protected
- Loose or hanging wires may cause connection losses and damage insulations

How can I improve it?

- Fix the connection of the service drop to the house in order to remove the tension on the service cables
- Wiring should be done by the shortest and clearest way possible – straight and protected within cable ducts

Metering - good

Why is this a good example?

- The meters are fixed in a proper cabinet and well protected against rain and moisture
- The cables come all from the bottom, no loose or hanging wires

Metering - bad

Why is this a bad example?

- Meters are costly and need to be protected in order to keep functioning
- Birds faeces touching electrical wires can damage the insulation and create a short circuit

Note:

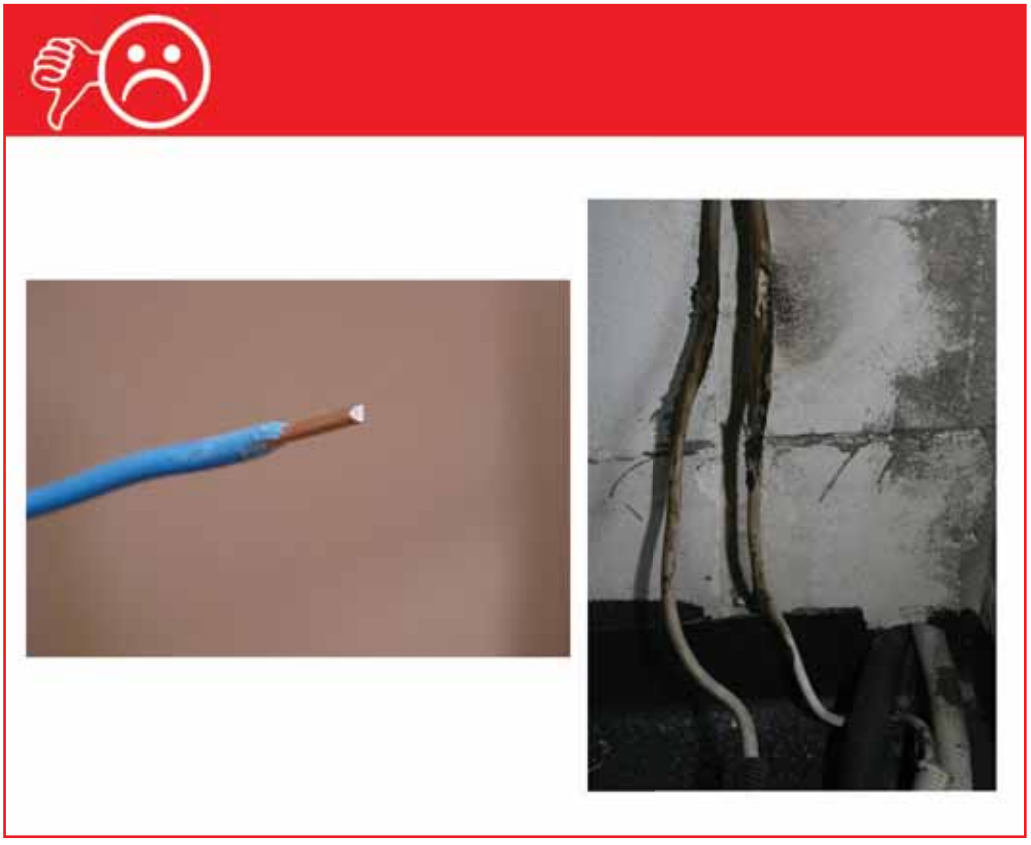
NEVER ALLOW DUST OR MOISTURE TO SPREAD NEAR ELECTRICAL INSTALLATIONS!

Metering - good

Why is this a good example?

- Wiring is clearly arranged. It would be even better to put the wires inside a cable duct
- The meters are sealed
- The current limiting devices are inside a panel

5.2.4 House Wiring and Fittings



Bad components

Why are these components bad for house installations?

- Wires have only one single layer of insulation. When this insulation is damaged, the danger of an accident is immediately given
- It is international standard to use wires only within closed electrical cabinets / panels or if they are fixed 100% within protection pipes or ducts
- All cables are specified for usage only up to a certain maximum current. Apparently the cables in the right picture were selected wrongly and used for a much higher current, with a very high danger of cable fire

Note:

NEVER USE WIRES!

Good components

Why are these components good for house installations?

- Cables have double insulation, with separately insulated wires inside
- Depending on the required current of your equipment, use always the appropriate cable with the correct diameter
- Contact a professional to check local regulations on the required minimum diameters for different electrical installations

Note:

ONLY USE CABLES OF THE RIGHT DIAMETER!

House wiring and fittings - bad

Why is this a bad example?

- This is a very dangerous situation and the installation was made by a layman without any knowledge of electricity
- Wires are used instead of double insulated cables
- Only a question of time until somebody becomes injured and/or a cable fire starts

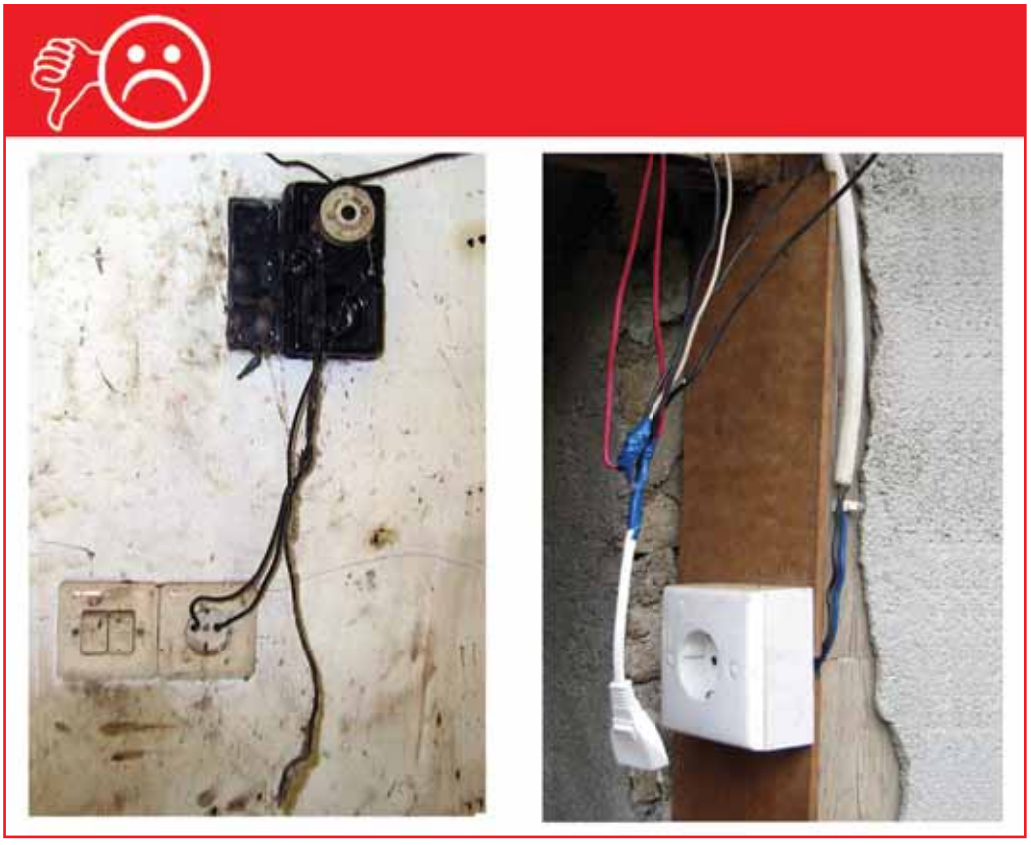
How can I improve the situation?

- Contact a professional, who knows how to do electrical installations according to safety-requirements

House wiring and fittings - good

Why is this a good example?

- Service board with switches and current limiting devices
- The incoming and outgoing cables are well fixed on the wall
- Proper installation on a service-board
- Flashlight in case of a black out



Sockets, plugs and switches - bad

Why is this a bad example?

- These are very dangerous examples on how electricity should never be handled; it can harm humans, destroy the connected electrical appliances and cause fire
- Wires are used instead of cables; not being laid in a pipe/duct
- To turn electricity on/off, a socket is used instead of a switch

How can I improve it?

- Contact a professional who knows how to do electrical installations
- Raise households' awareness for the danger of electricity
- Familiarize households with good practice examples
- Perform regular household inspections (e.g. when collecting the electricity tariff) and disconnect houses in which safety rules are not followed

Sockets, plugs and switches - good

Why are these good examples?

- The power supply cables are installed within ducts to prevent damages or faults
- Socket and switches are of approved type
- The sockets are grounded (i.e. have earthing) which makes the use of appliances safer
- A correct type of plug is used to take the electricity from the socket
- Installations were made by a professional

Lamp installations - bad

Why is this a bad example?

- Lamps are hanging directly on electrical wires, putting tension on the connection
- Socket is fixed on wood directly without heat protection
- Wood was heated up already

How can I improve the situation?

- Screw sockets and other electrical components correctly to the wall or to the ceiling
- Use only sockets which can be fastened with bolts or screws
- Never keep wires under tension
- Never leave bare wires without insulation

Lamp installation - good

Why is this a good example?

- Lamp-socket is fixed to the beam (be sure there is no wood directly under the socket)
- There is no tension on the cable
- A cable (not wires !) is used and properly fixed





6. Management & Administration

6.1 COMMUNITY PARTICIPATION AND MOBILISATION

Participation of the community is a crucial factor for success

Key aspects for community participation:

- The Community has to be involved from the very beginning of a project, starting from the first site visit; in an ideal case: community itself took the initiative and proposed the construction of a MHP scheme
- Organize regular meetings between community and consultant during the planning stage, and between community, consultant and contractor during construction stage in weekly intervals, to inform and coordinate all activities and to give the parties the chance to discuss potential conflicts (compensation for damages to property, etc); make sure that women get the chance to actively participate in, and contribute to the discussions
- Keep all involved stakeholders (contractor, government officers, etc) informed and up to date with latest developments and plans → make sure that community and villagers do not receive different information from different sources
- Make clear which party is expected to contribute what (financial and technical inputs for project, village contribution, etc)

Village meeting where MHP issues are discussed

- Make clear that villagers' contribution to construction work, either in cash or labor is a condition to implement the project. Villagers' contribution significantly boosts their feeling of ownership of the plant. However, make sure that contribution is reasonable and within their ability (e.g. labor contribution by the community during harvest periods will be very limited)
- Transfer information on technical, institutional, and environmental issues: necessity of management and operation of MHP system, protection of river catchment, solving of water usage conflicts, etc.
- Don't raise wrong expectations in the community about the MHP project (e.g. community has to understand and be aware of power supply limits during the dry season) → transparency
- When presenting the project always consider and explicitly mention related costs not covered by the project (e.g. metering system per household, workshop equipment for productive use of energy, household cabling) → people must always be aware of all costs related to the project

Involvement of Women

- Women are very often more trustworthy and experienced in managing the household finances and thus more qualified as book keepers of the MHP finances during the operation stage
- Usually women tend to have a deeper understanding of the importance of the implementation and sustainable operation of the MHP and the resulting improvement to their and their children's' livelihood. Women therefore usually have a much greater interest to see the project implemented and well maintained, making them the priority group to address for community mobilization
- Project agents are in the position to stress the presence of women during all meetings, even if it is not common in the culture and tradition → The MHP project is an "innovation" and thus can be introduced in an "innovative" way
- Encourage women to express their opinion and suggestions regarding the MHP system, as well as the productive use of energy

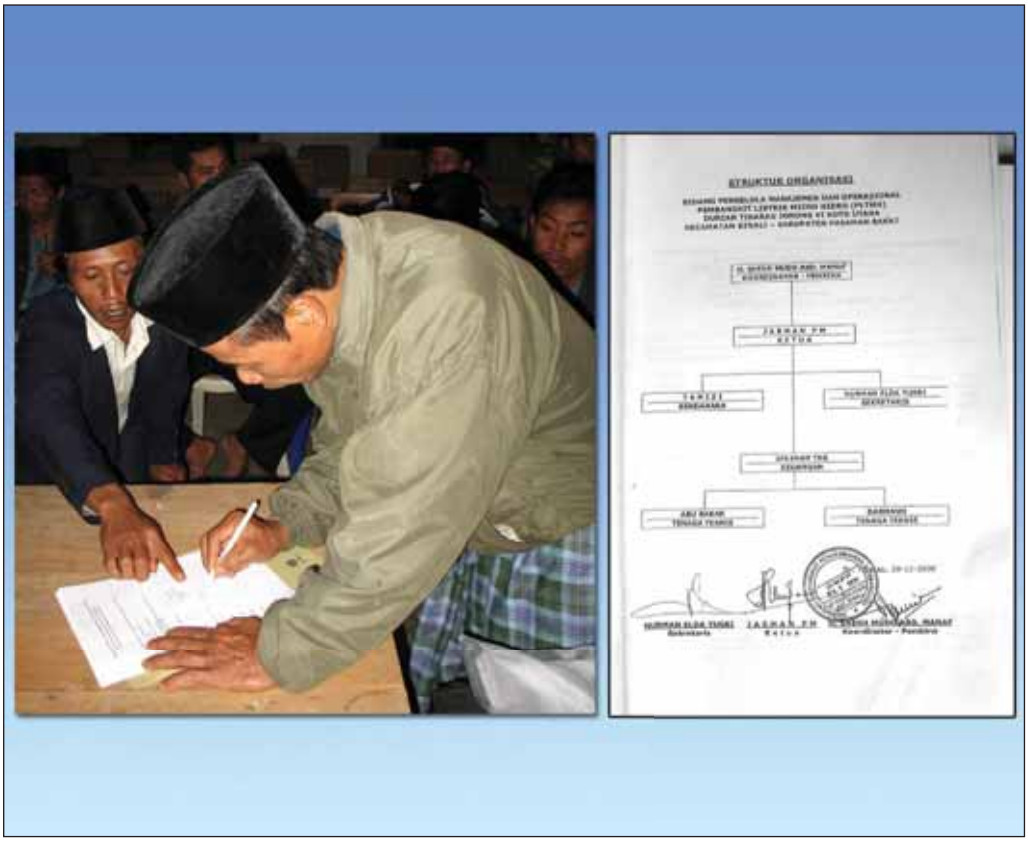
Key Questions in Community Mobilisation and Participation

- What is important for whom and when? Consider if for certain issues separate meetings with men and women are useful (also depending on total number of people and available facilities)
- How much time is needed for which kind of meeting? Take your time for community meetings! MHP might be a very new concept for the community, resulting in lengthy discussions
- Which decisions have to be taken at what stage of the project? Mention important deadlines (planned project schedule, start of operation, opening of bank account, etc.). Establish a plan of action for the activities required from the community (legal registration process, definition of land use rights, compensation, labor input)
- Which language is spoken in the village and what is the level of education? → select staff and media accordingly
- Use videos, pictures etc to make people easily understand! If Power Point presentations are used, present short and concise text only, with many photos
- Limit presentations to the essential and leave enough time for discussions, questions, input from villagers

Key Issues of Community Mobilization

- Planning & construction of MHP system and definition of duties of community during these stages
- Identification of management and operation staff. Management staff should be appointed at an early stage of the project to coordinate with the contractors and for organizing community contribution. Operation staff should participate in the installation of the electromechanical equipment.
- Identification of training measures for operation and management staff
- Activities regarding productive use of electricity (awareness creation workshop, capacity building measures)
- Definition of expected contribution from community (contribution in cash or labor, set up of an institution, selection of staff, opening and managing of a bank account for operation and maintenance, tariff and sanction system, develop productive use…)
- Clarification of land/water use rights
- Compensation of land owners (e.g. damages to property)
- Clarification of water usage to avoid later conflicts between water use for power production and irrigation or water supply

6.2 INSTITUTIONAL SETUP



Key issues of institutional setup:

- When a community-based organization is needed to take over ownership of the system and thus also responsibility for its operation, preferably an already existing organization should be used (e.g. cooperative managing the irrigation system in the village). If no such organization exists, identify a suitable institutional and organizational setup for the MHP project under consideration of the local conditions
- Within the organization individual staff must be assigned for specific tasks of operation and management (OM). A typical staffing looks like this:
  - o 2 operators (mandatory)
  - o 1 book keeper (mandatory)
  - o 1 head of management (optional)
  - o 1 secretary (optional)
- Identify suitable OM staff (see below)
- Clarify legal and regulatory issues regarding a formal registration of the community as owner, operator and beneficiary of the project
- For each staff position a detailed task description should be written up and made accessible for the customers

- Salaries for each position must be agreed accordingly
- Depending on the size of the system, staff may have to be employed part-time or full time
- Operators should earn more since their tasks are heavy, and also more difficult and time-consuming
- If salaries are set too low, they do not attract and/or motivate the people with required skills to do a good job
- But if salaries are too high, they are difficult to be covered by tariff payments
- Salary has to be competitive to avoid migration of trained staff
- The community must agree on a reasonable tariff system covering all expected costs
- The community must agree on a sanction system in case of late or non-payment of tariffs
- Define and collect an initial fee from all customers to cover the first salary payments and as a sign of commitment from the community

Selection of Staff for Management & Operation

- Selection of qualified staff is crucial for a sustainable operation of the plant!
- Staff should be selected under consideration of the following:
  - o Technical skills and education,
  - o Know-how on book keeping, etc.
  - o Relevant, long and varied experience in the field
  - o Tendency to stay in the village over the long term.
  - o Don't choose candidates who plan to move away in the future (e.g. unmarried young men are more likely to move away)
  - o Involve women as much as possible

Note:

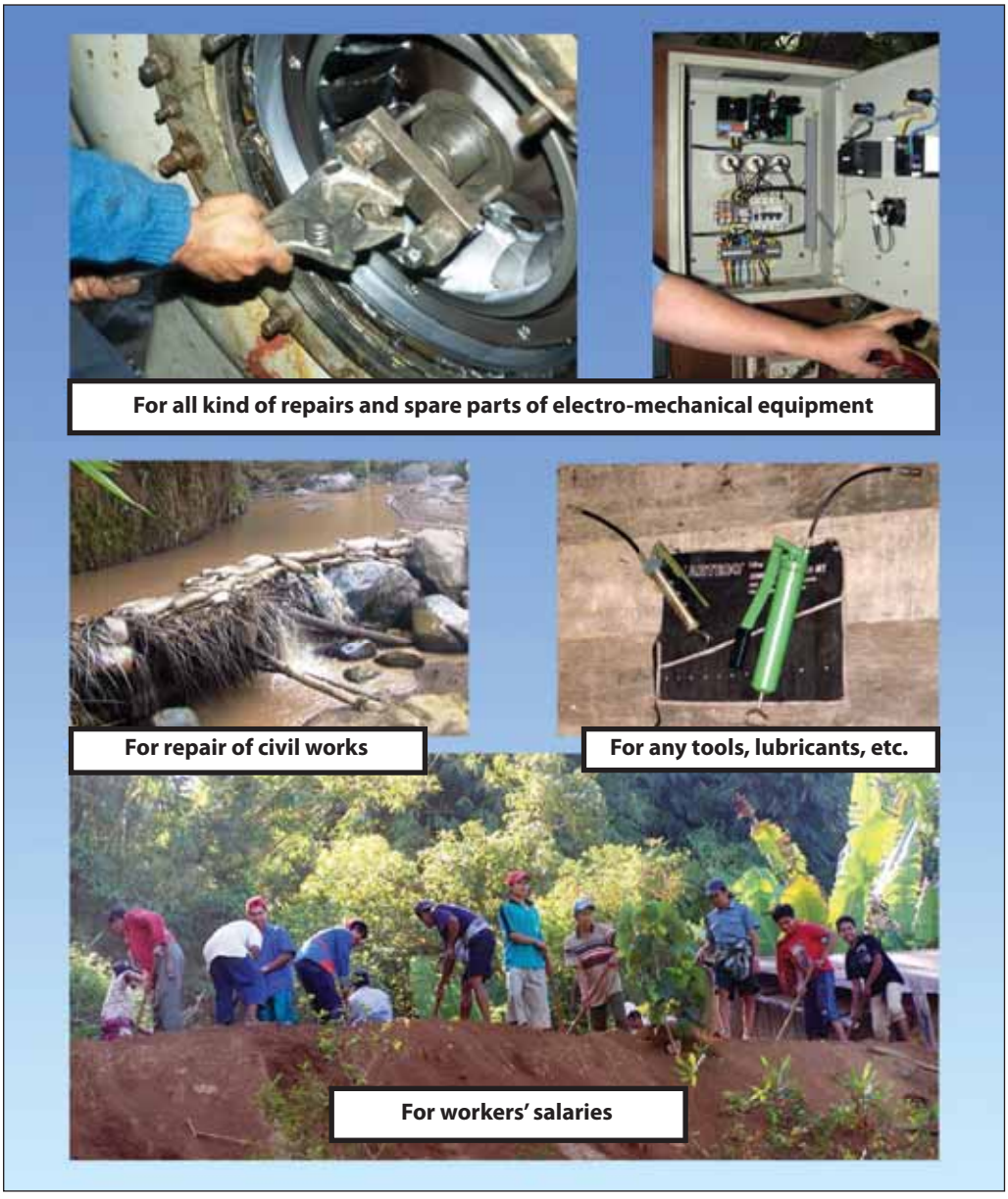
CHOOSE TRUSTWORTHY PEOPLE!

6.3 CAPACITY BUILDING AND TRAINING

Aspects for efficient capacity building and training:

- Conduct training and capacity building measures separate from village meetings in small groups in an interactive and participatory way
- In case of several villages in one area, get operators, book keepers and secretaries together for a common training workshop
- For training in small groups as well as workshop training use demonstration material / visual aids, like log-books, book-keeping folders, etc
- If possible invite an operator / secretary from an existing MHP system or organize a visit to an MHP system in operation, with some village representatives (preferably the selected OM staff) → this would facilitate a direct exchange
- Award certificates to those attended a training successfully in order to raise their social standing and thereby the qualified influence on the MHP

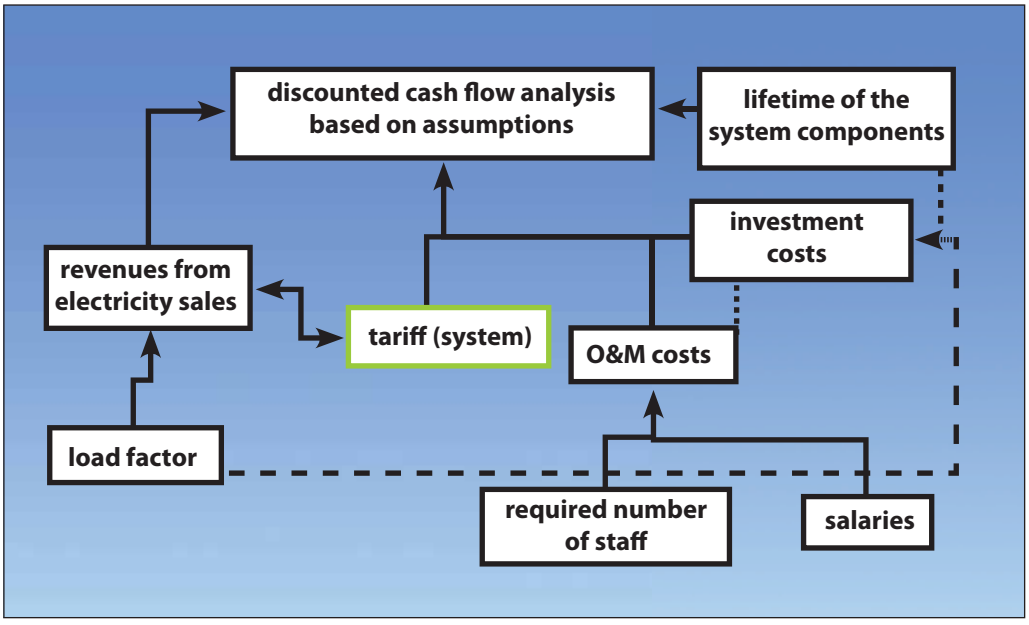
6.4 TARIFF POLICY



Only the fuel is for free – everything else costs a lot
to operate a MHP in good condition

THAT'S WHY SUFFICIENT & REGULAR TARIFF REVENUES ARE NEEDED!

Elements to be considered for Tariff Calculation:



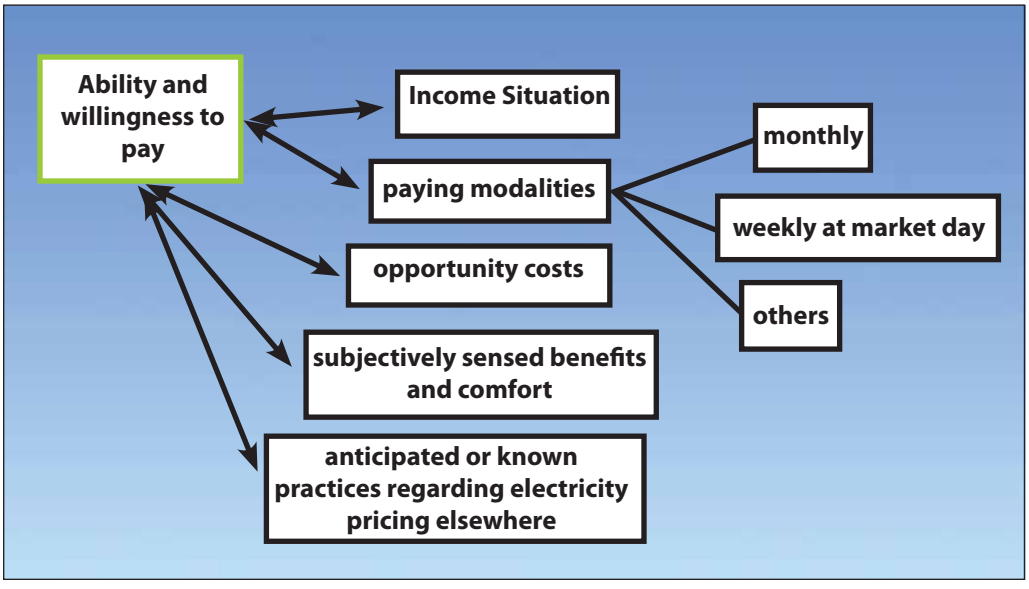
- The tariff needs to be based on the cost recovery principle (long-term unit costs) to ensure the MHP's viability and should reflect the customers' energy usage (to be charged lump sum per appliance or per kWh in case of electricity meters)
- Poor village communities often can not afford to pay the MHP's initial investment by themselves and therefore depend on subsidies. In these cases, the investment should never be covered fully by the subsidy but still require contributions from the villagers (in cash or in kind) to increase their sense of ownership
- Paying subsidies to cover the operating costs is absolutely counter-productive and should never be an option! It would make the MHP's operation too much dependent on factors beyond the village's influence and reduce the sense of ownership and appreciation for electricity
- Income generation through productive use of energy improves consumers' ability to pay; often higher tariffs con be paid for productive end uses
- The tariff system should also fix regular tariff increases (e.g. yearly) in order to compensate for price increases of spare parts, etc due to inflation
- Fix penalty fees for late payment, electricity pilferage etc
- The tariff needs to be fixed based on a proper cash flow calculation. With a laptop and a high-beamer, the process of assessing and agreeing on an appropriate tariff can effectively be facilitated by changing various input figures in a spreadsheet in order to immediately see and discuss the consequences in front of a village meeting

- To fix an appropriate tariff, all expected future expenditures must be considered:

	% of revenues to be assigned
Salaries for all staff (operators, book keeper, etc.)	About 30-40%
Expenditures for daily routine O&M (tools, small spare parts, lubricant, stationary for book keeping, etc.)	About 5-10%
Savings for serious repairs and purchse of bigger spare parts → as reserve into bank account!	About 5-10% About 50-60%

Ability and willingness to pay

Tariff should be in line with the consumers' ability and willingness to pay. The ability and willingness to pay is thereby influenced by:



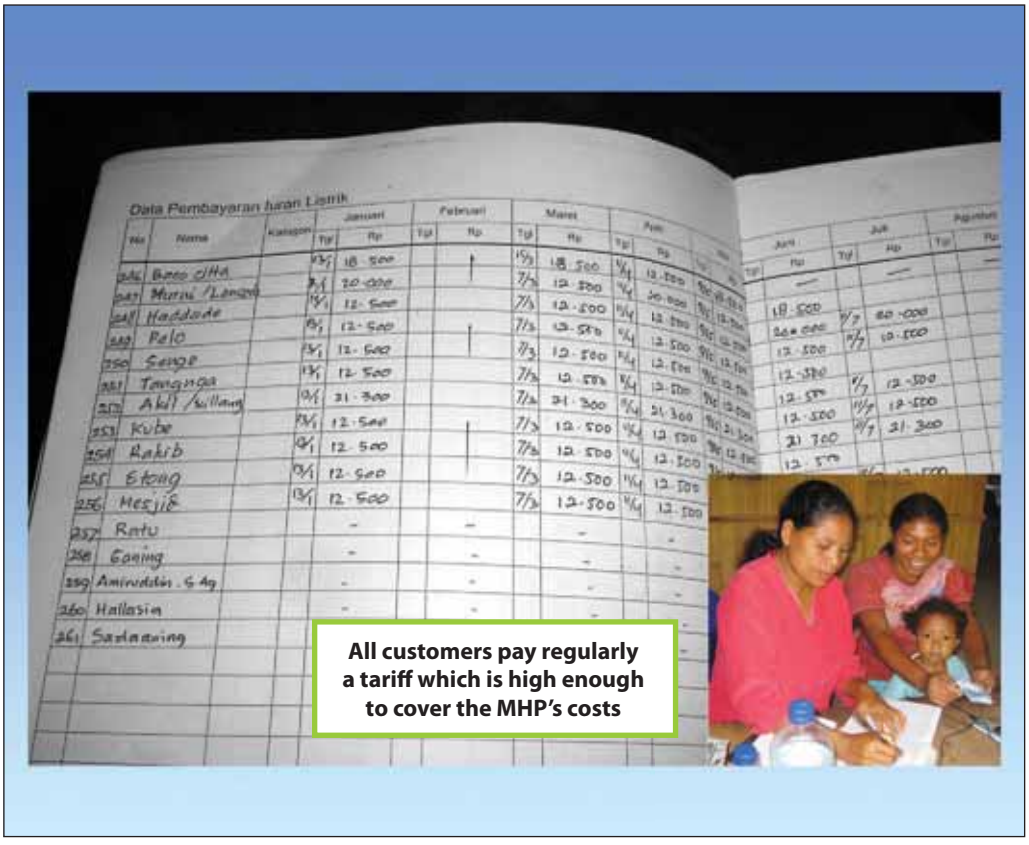
Note:

TO ASSESS AFFORDABILITY COMPARE THE TARIFF WITH OTHER EXPENDITURES OF THE HOUSEHOLDS (E.G. KEROSENE FOR LAMPS, CIGARETTS, ETC)!

WOMEN SHOULD BE THE PRIORITY GROUP TO DISCUSS EXPENDITURES. THEY OFTEN HAVE A BETTER UNDERSTANDING & AWARENESS OF THE ACTUAL LIVING COSTS!

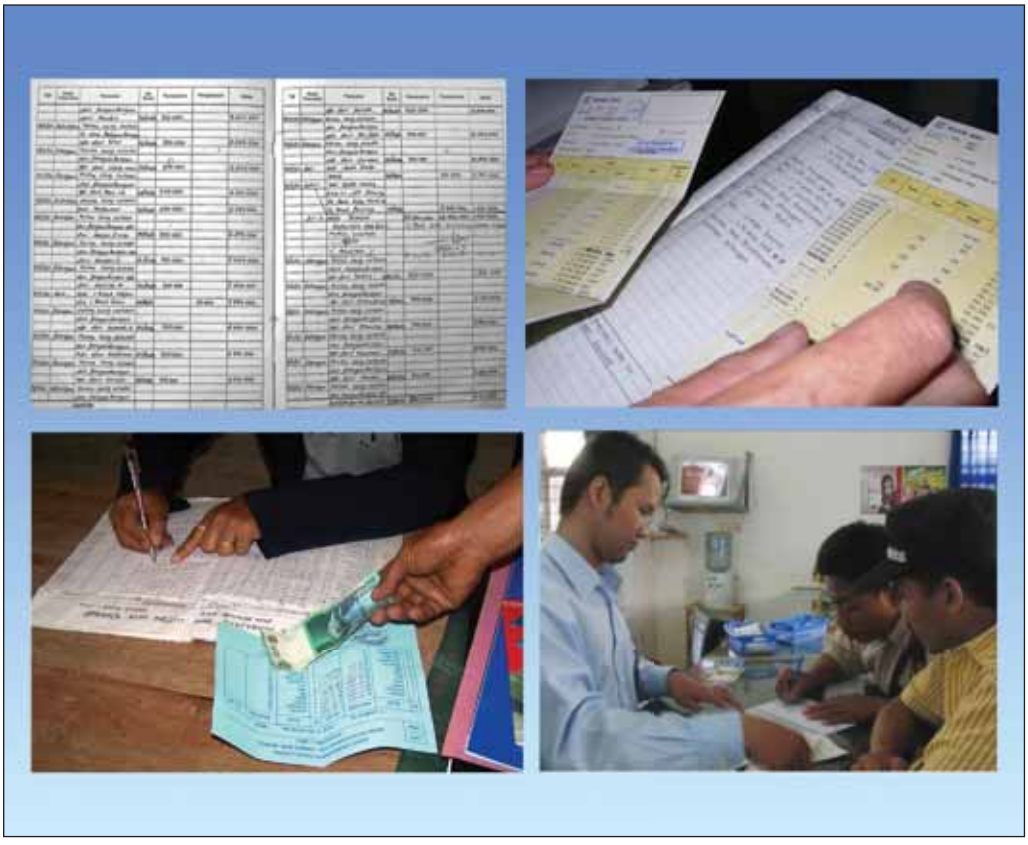
REGARDING THE WILLINGNESS TO PAY IT MIGHT BE NECESSARY TO CLARIFY THAT "CHEAP ELECTRICITY MEANS NO ELECTRICTY"!

Metering and Tariff Collection Options:



- Standard kWh meter (fair and transparent, but relatively high costs for the hardware and the meter reading)
- Digital kWh meter (allows time and amount related tariffs, but high costs and technically complex reading/billing)
- Pre-paid systems (fair and transparent, no meter reading, but high costs and less forgery proof)
- Current limiter (to limit peak demand, no meter reading, very cheap, but danger of fraud and theft and time of usage not considered)
- Flat rate (no hardware cost, but needs a lot of social control to prevent waste of electricity, risk of higher peaks because of no load control)

6.5 FINANCIAL MANAGEMENT



How to manage finances?

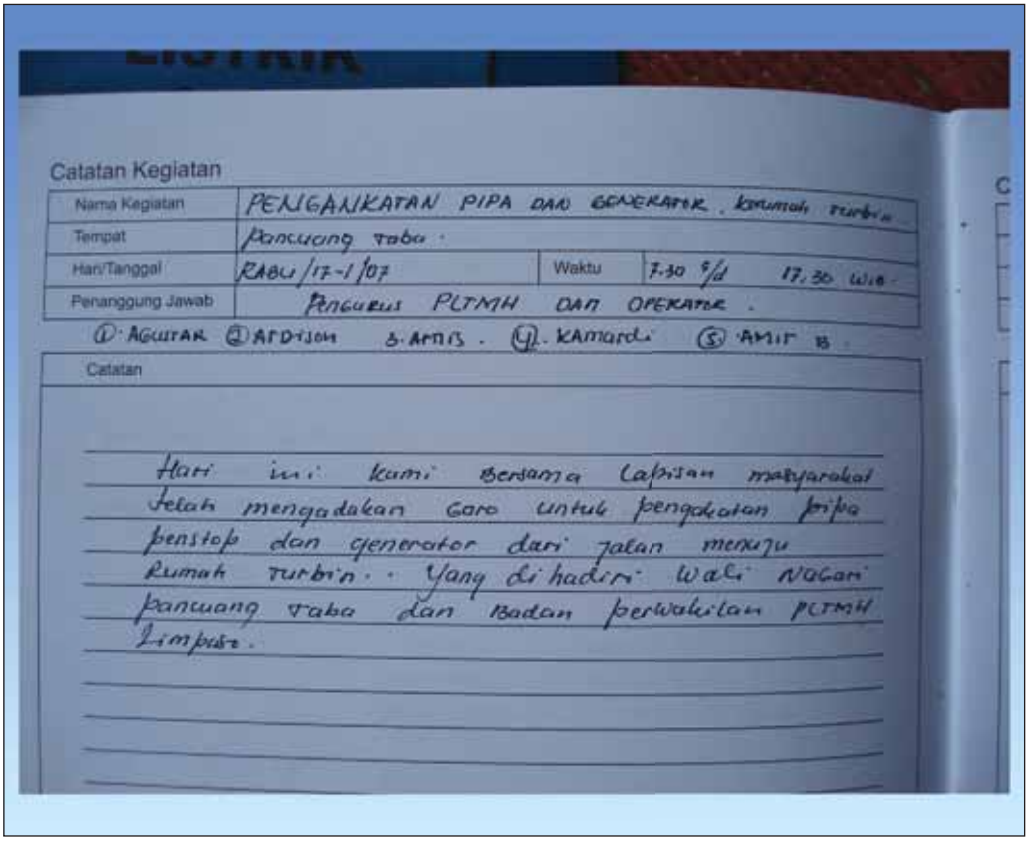
- All payments must be recorded in a book and on customers' cards, and must be signed by the customer and the bookkeeper to verify the payment
- Every financial transaction must be recorded in a cash book
- Get receipts for revenues and expenditures, number them and keep them in a folder
- Open a bank account (in the name of the organization) for which 2 persons (for mutual control) must countersign for any withdrawal of money
- Deposit revenues as often as possible (e.g. monthly) into the account
- Check the balance of funds (also in the bank account)
- Transparency is of crucial importance to keep peoples' confidence and support and to solve problems which might arise – the book keeper / treasurer must be a very trustworthy person

Note:

FINANCIAL TRANSACTIONS MUST BE TRANSPARENT!

KEEP ALL INCOME IN A BANK ACCOUNT!

6.6 MONITORING AND DOCUMENTATION



Catatan Kegiatan

Nama Kegiatan	PENGANGKATAN PIPA DAN GENERATOR . kerumah turbin
Tempat	Pancuang Taba .
Hari/Tanggal	RABU / 17-1-07
Waktu	7.30 s/d 17.30 WIB
Penanggung Jawab	Pengurus PLTMH DAN OPERATOR .

① AGUSTAR ② ARDISON 3. AMIS . ④. KAMARDI ⑤ AMIR B .

Catatan

Hari ini kami bersama Lapisan masyarakat telah mengadakan Garo untuk pengakatan pipa penstop dan generator dari jalan menuju Rumah turbin . Yang di hadiri Wali Nagari pancuang taba dan Badan perwakilan PLTMH Limpisa .

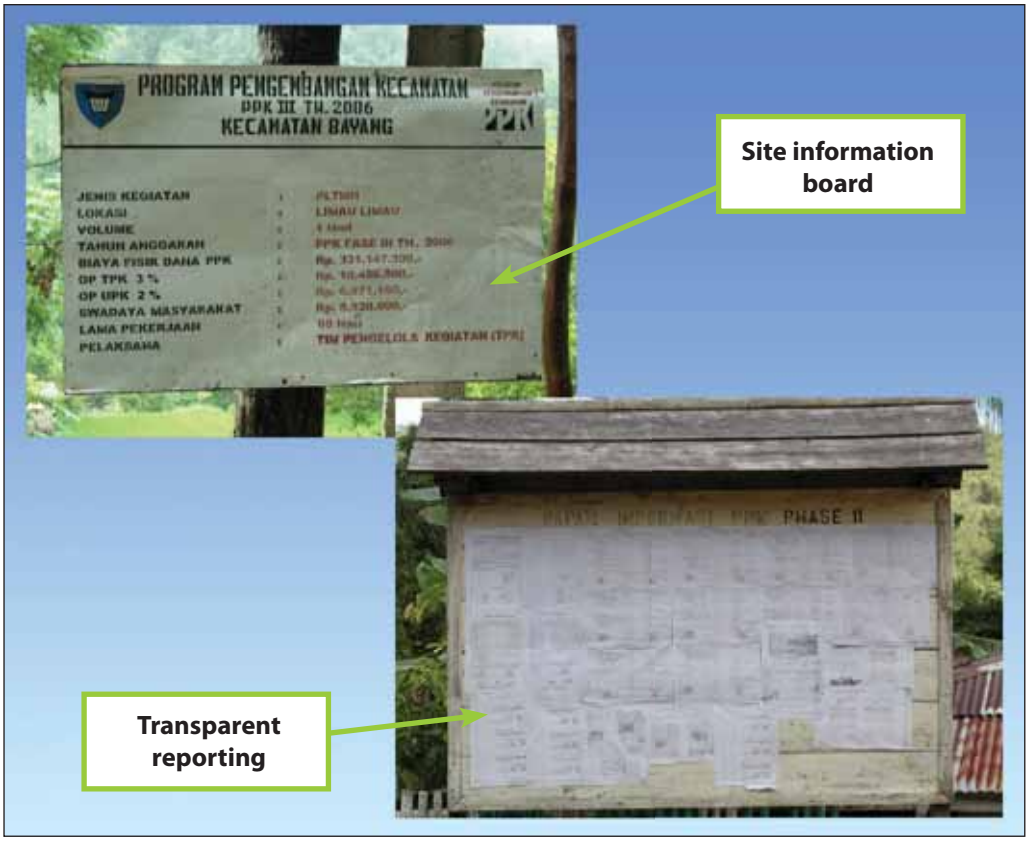
All important activities, meetings etc are noted in the log book

What should be monitored & documented and why?

- A thorough record of routine O&M and also of any unusual events occurring in the system will facilitate troubleshooting, e.g. when experts from outside the village are consulted for help
- All civil and electro-mechanical parts of an MHP system must be inspected periodically → important results of these monitoring activities must be recorded in a log book
- Protocols of community meetings in connection with the MHP system should be recorded in the log book, including any important decisions, agreements and conclusions
- Important actions and occurrences with regard to finances, book keeping and administration should also be recorded in the log book

Note:

PROPER MONITORING AND GOOD RECORDS MAKE OPERATION AND MAINTENANCE WORKS EASIER AND ENHANCES CUSTOMER'S TRUST!



Public information on boards at the MHP and in the village

Publishing information about the MHP

- All consumers must be kept informed of activities of management and operations staff, any difficulties encountered, planning for the future, etc, either through meetings and/or reporting on information boards
- The better people are informed, the better their understanding and acceptance, and the higher their motivation to regularly pay electricity bills (they have a right to know what their money is used for)
- Transparency increases acceptance and satisfaction of consumers
- Publish protocols of community meetings on the MHP system, reports from the operator and the bookkeeper, the balance of funds (income and expenditures), and the balance of the bank account, status of tariff payments, etc
- Transparent reporting of financial matters helps to establish and maintain good governance and prevent corruption






7. Utilization of Energy

Always choose energy efficient appliances!

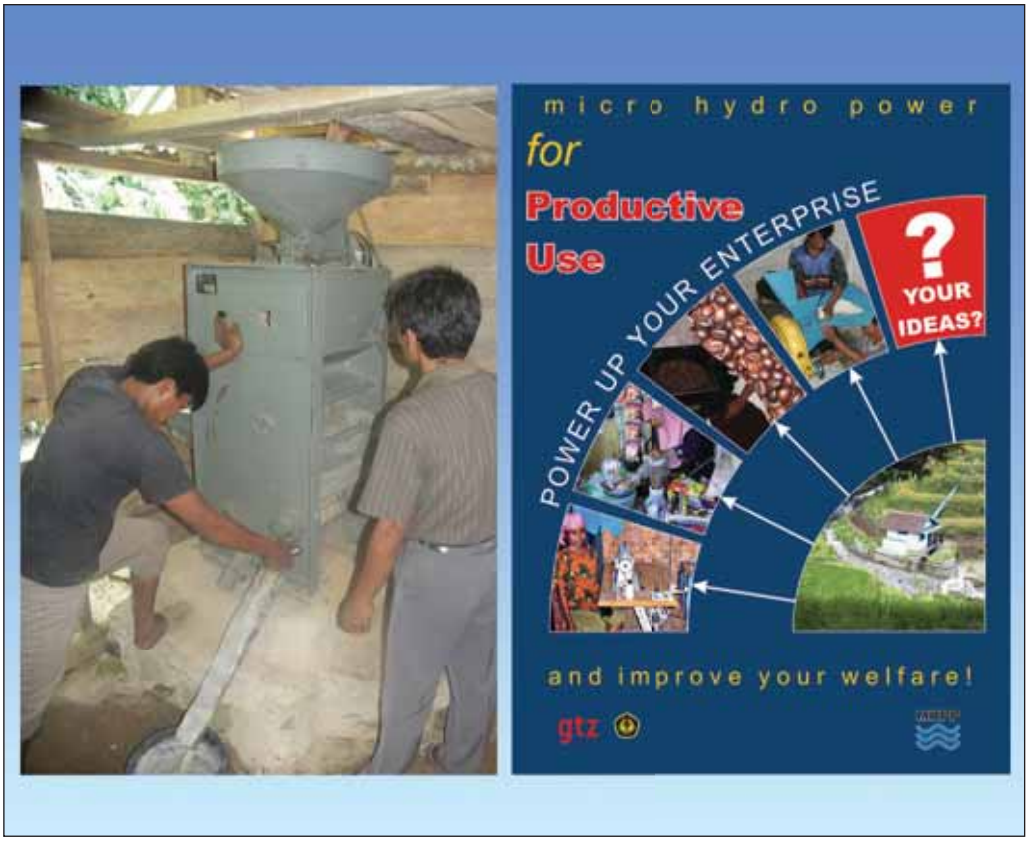
How to make efficient use of energy?

- Choose energy efficient bulbs and energy efficient appliances wherever possible. All kind of energy efficient bulbs are available on the market. Their price is higher but therefore they last much longer, need less energy and help safe a lot of money in the long run
- Whenever you buy electric appliances (refrigerator, rice cooker etc.) look at the wattage and ask for the energy efficient models. Don't hesitate to ask your local MHP operator for support
- Switch-off the light and other appliances if you don't use them
- Paint walls of house in a light colors such as white. This will intensify the effect of light

Note:

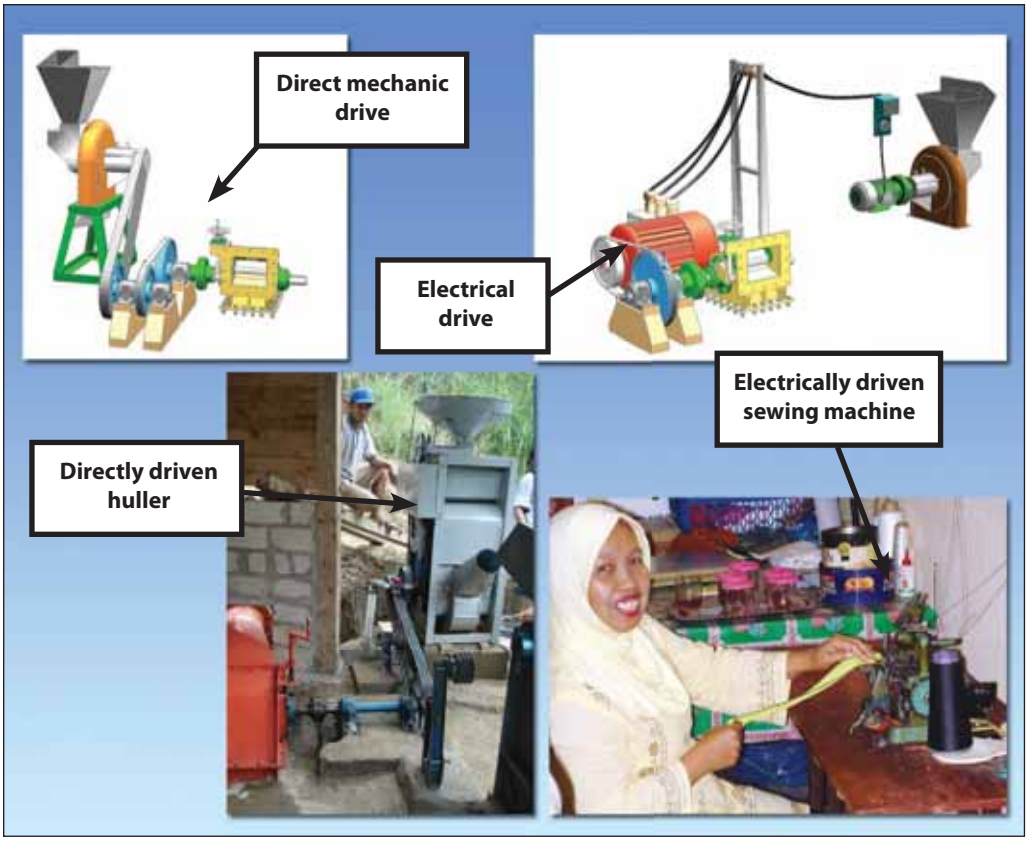
BEING ENERGY EFFICIENT HELPS TO REDUCE PEAK LOAD AND OVERLOAD OF THE MHP SYSTEM!

Get the most benefit from MHP: Use it productively!



Why productive use is so important?

- Once the MHP is built, it provides energy at relatively low-cost. In most cases, using the MHP more does not increase its costs. Therefore it should be used more – especially during daytime when energy is not needed for lighting in households. Productive use is highly beneficial, since it typically uses daytime hours to achieve added value and create additional income or reduce work load
- Productively used MHP can replace existing diesel gensets, e.g. for milling. Diesel and petrol fuel is expensive today and harmful for the environment
- Additional revenues from selling energy to any kind of business improves the cash flow of the MHP system significantly and thus allows for more sustainable operation
- Develop ideas on how to use energy / electricity from the MHP system for appliances which reduce your workload and which can create additional income (e.g. grinding coffee and selling it at higher price than beans, preparing brown sugar with electric stoves thus saving fire wood, producing furniture with electric carpentry machines, welding workshop, sewing workshop etc.)



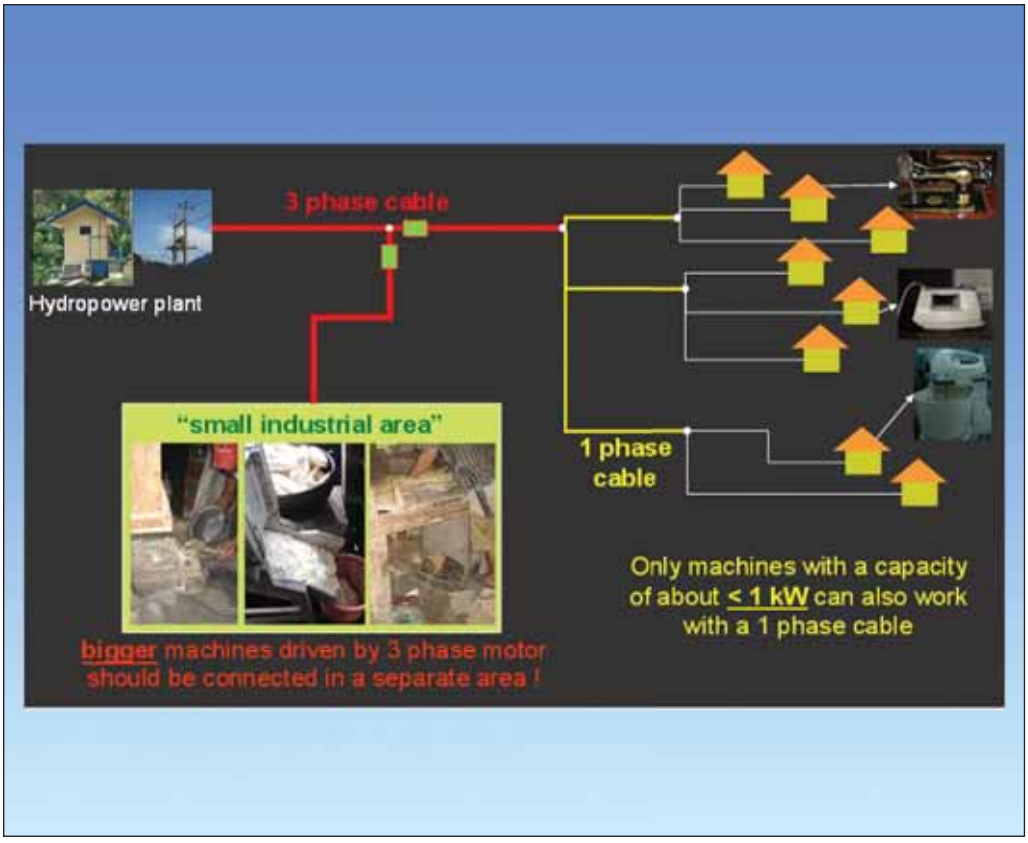
Direct mechanic versus electrical drive

What are the basic technical options for productive use of energy?

- Bigger machines (thresher, huller, grinder etc.) can be driven either directly by the turbine or by electricity
- Pro's & Con's of direct drive: technically easy, no motor required, less conversion losses, system can be controlled manually but machine/s must be installed inside the powerhouse, generator cannot be driven simultaneously
- Pro's & Con's of electric drive: machine/s can be installed almost anywhere, simultaneous electricity supply of households possible if total capacity sufficient, but technically more sophisticated control system for the MHP is required (!), electric motor required (additional cost), 30-60% conversion losses, for starting current the motor might need 3-5 times higher power (!), for bigger machines a 3-phase supply is required
- A combination of direct drive and electricity generation can be the least cost solution providing for productive use in the powerhouse during certain times and electricity supply for households during the rest of the day

What has to be considered for productive use?

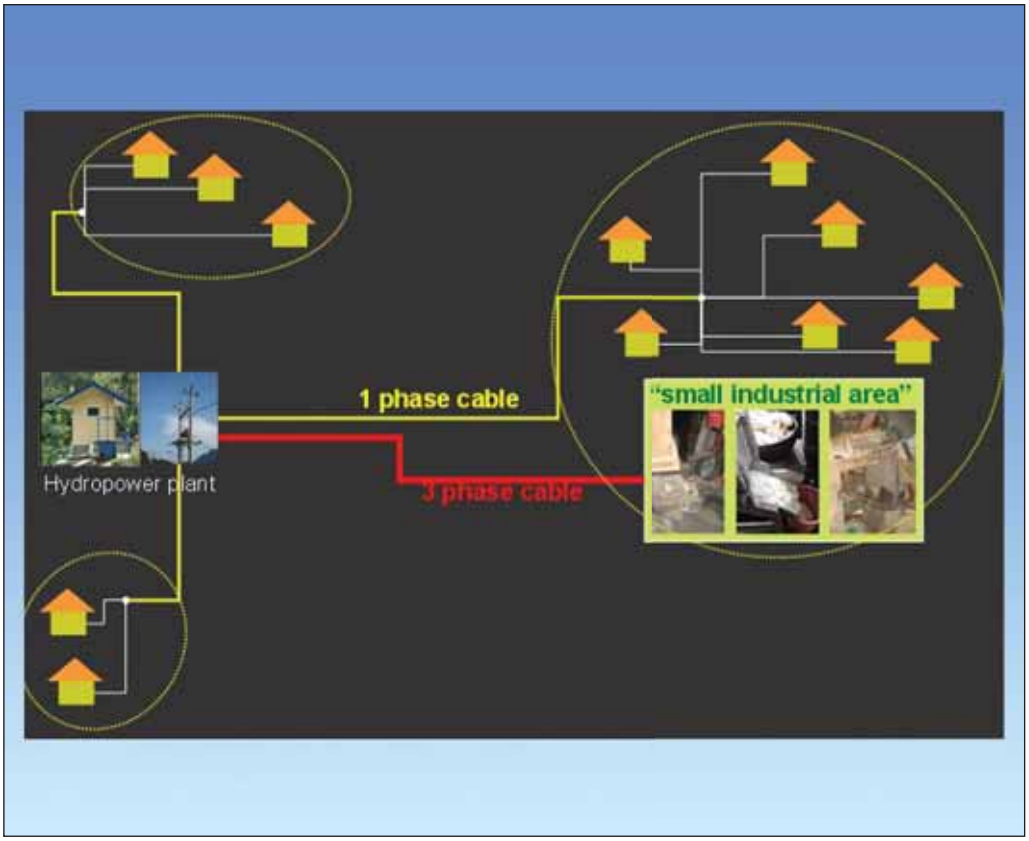
- What is the capacity available from the MHP system? What kind of machines can be used?
- At what time of the day is the capacity available (consider needs for irrigation, drinking water, etc)?
- Make a brainstorming on options for productive uses in the village and prioritize
- Start with "low hanging fruits"! It is easier to start with activities like threshing, hulling etc. which are already common to the villagers than to produce completely new things for which they do not yet know the market
- Who is actually interested? Should it be organized as a "community activity" or as an individual "private business"?
- Collect information about investment and operation cost for the productive use and analyze the cash flow (look for external support when needed)
- Which tariff should be applied for productive use of electricity? Make it attractive for the users (of machines etc) but also profitable for the MHP operating institution
- The more individual productive uses, the more complex is the technical control requirement and/or the need for coordination. Evaluate the possibility of establishing specific "small industrial areas" where productive use is bundled



Technical requirements for bigger electric drives

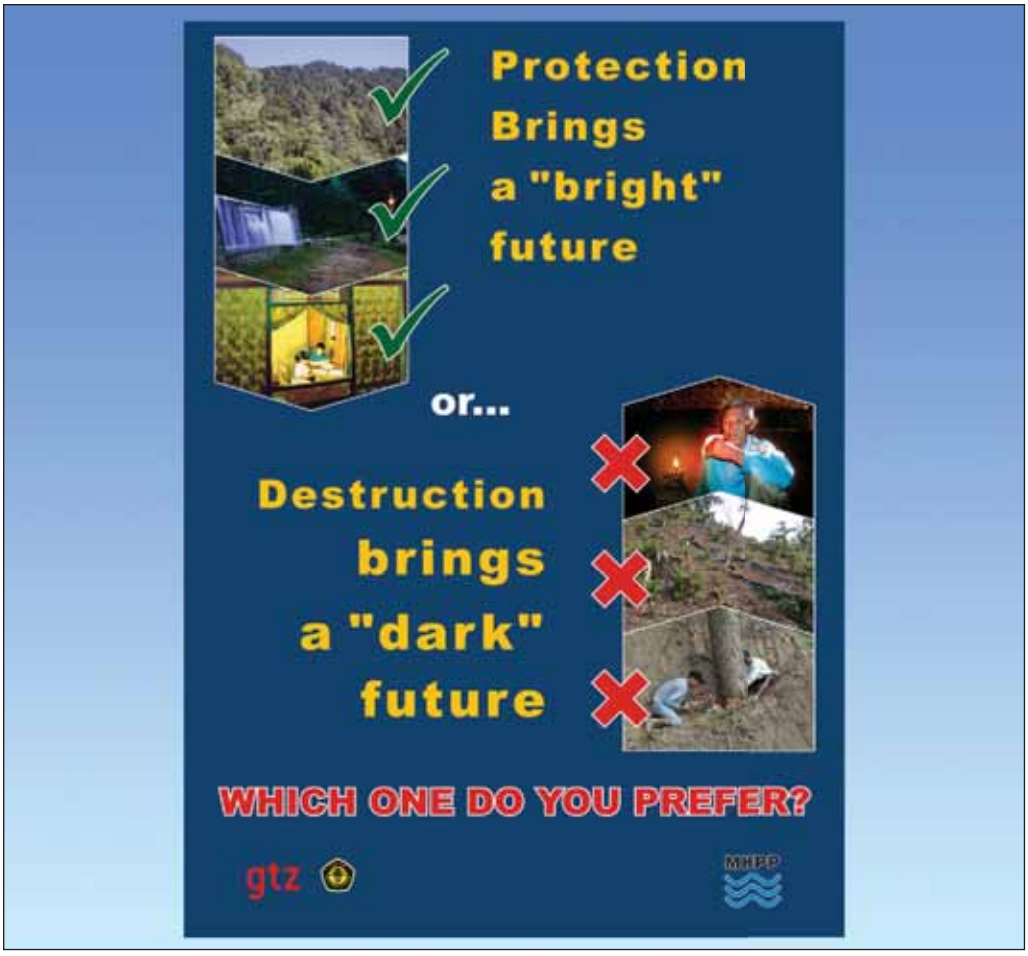
What has to be considered for driving a bigger machine by electricity?

- An electric motor of sufficient capacity to drive the machine (e.g. replacement of a diesel or petrol genset) is needed
- The network design must provide a 3 phase connection (380 V) at the location where the machine (> 1 kW) is going to be installed
- The required starting current must be available at the respective location; a soft starting facility can be used to reduce this starting current
- A load control device (e.g. ELC electric load controller, flow controller) must be installed, because appliances of higher capacity provoke significant load fluctuations when being switched on and off. These fluctuations need to be managed automatically by the system
- If total capacity of the MHP system is not enough for household and productive consumption times of usage must be defined and controlled by switches (■ in the picture)



Alternative setting for productive use:

- The load on each phase should be about the same
- Small industrial areas often need a 3-phase connection



Beneficial utilization of energy requires
comprehensive awareness creation

- Beneficial utilization of energy from MHP depends on a multitude of aspects which can be handled easier if also the beneficiaries of the MHP are well aware of them
- Awareness creation on environmental aspects is crucial! Deforestation in the catchment area affects a river's flow: it will decrease in dry season and rain fall will bring destructive floods. Both results in energy shortage

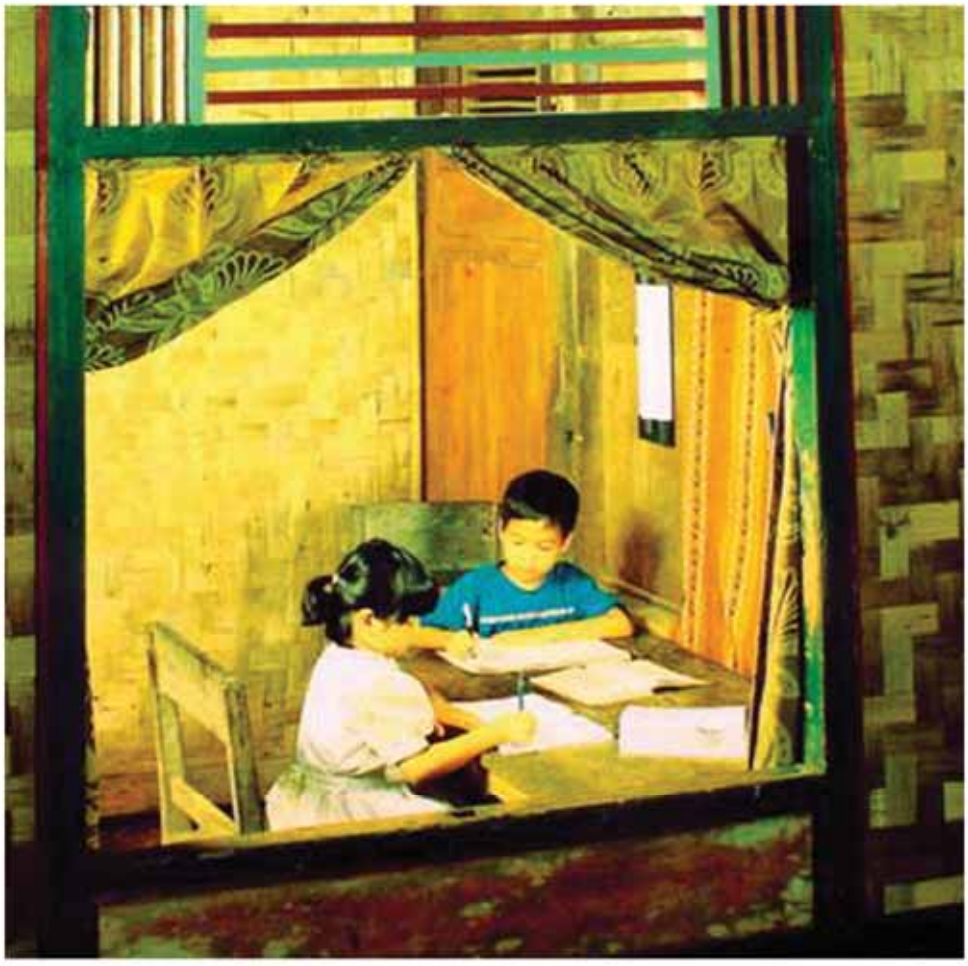
Note:

PEOPLE APPRECIATE ELECTRICITY FROM THEIR MHP. INSTRUCT THEM THAT IT WILL BE GONE WHEN THE NATURE IS DESTROYED. MAKE THEM PARTNERS IN PROTECTING THE ENVIRONMENT!

If badly handled, electricty is dangerous …

COMMON PEOPLE DO NOT HAVE ANY EXPERIENCES WITH USE OF ELECTRICITY.
THEY NEITHER DO KNOW ABOUT THE DANGERS!

IT'S NECESSARY TO INFORM THAT ELECTRICTY IS DANGEROUS
IF NOT CORRECTLY HANDLED!



… and a blessing, if done right!

ELECTRICITY IS THE CONTRIBUTION
TO A BETTER FUTURE
FOR OUR CHILDREN!

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