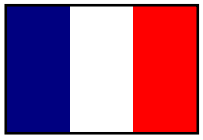
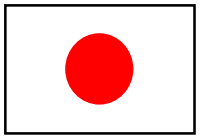
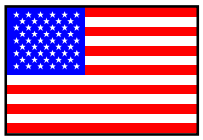
The E7 Network of Expertise for the Global Environment


Project E7-1: INDONESIA
Renewable Energy Supply Systems

Final Report
- Lessons Learned –

March 2001

E7-1 Indonesia - Renewable Energy Supply Systems
Final Report
Lessons Learned

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EXECUTIVE SUMMARY

The E7's mission is to play an active role in protecting the global environment and in promoting efficient generation and use of electricity with a focus on developing countries. In this context, the E7 decided to undertake the Activity Implemented Jointly (AIJ) pilot project of 'Renewable Energy Supply Systems (RESS)' in Indonesia (Project E7-1).

The main objectives of this project were:

- to supply a limited but reliable amount of electricity to households in remote areas of Indonesia;
- to develop and introduce a new sustainable and decentralised management concept for rural electrification;
- to obtain approval as an AIJ project under the United Nations Framework Convention on Climate Change (UNFCCC).

The E7-1 Project was implemented between 1997 and 2000 and comprised of socio-economic, financial, and technical studies, as well as seven rural electrification schemes (200 solar home systems, 4 micro hydropower systems , 1 hybrid system) with a combined generation of approximately one million kWh a year. The project provides electricity to 8 remote communities with more than 4000 people. The calculated CO_2 offset resulting from this project is expected to reach more than 33,000 t during its technical life.

The major lessons learned from this project can be summarised as follows.

Approach

Continuous feedback with the national and local Governments lead to a greater value added within the local project environment. It facilitated a more effective transfer of knowledge, better local capability building, and a stronger empowerment of the local resources.

Implementing this project under the umbrella of the DGEED provided the E7 with more flexibility and independence. However, the involvement of PLN as a consultant for certain field activities proved to be a suitable vehicle for ensuring the continuous support of the regional PLN, even after construction was concluded.

The continuous on-site presence of a project manager, well aware of the technical approaches of each of the implementing companies as well as the local advantages and disadvantages, was a key factor in the successful implementation of the project.

Furthermore, the impacts of task implementation remained positive through close collaboration between the task leaders and the resident management for assessment of the local needs, the local applicability of technology, and the field

feed-back. This approach provided the appropriate flexibility and adaptability to the realities in the local field.

The decision making process used during implementation in the field, where conceptual aspects had to be adapted to local situations, posed some difficulty for the E7 resulting in project delays. Therefore, a - well-defined, "basic communication procedure" should be established well in advance of project implementation.

During the management training sessions performed by the local project manager and the NGO, common management principles were developed for the PLDs and related management tools were adapted to the micro project environment with the local capability in mind.

The potential success of a community development is heavily based on the commitment of the NGOs (facilitators) to effectively adapt the management concept to the needs of the beneficiaries and to carefully guide them in its implementation.

The "transparent", "competent", and "reliable" rural electrification management scheme used by the trusted village-based micro utility (PLD) contributed to the community's acceptance of the project.

Planning and Design

Institutional Aspects

In most cases, the PLD personnel well understood their roles and responsibilities for administrative and technical services. In addition, although not practiced as intensively as expected, other management tools like reporting, documentation, and accounting were utilised. The NGOs/EPO provided continuous support in increasing and monitoring the PLD's capabilities.

Detailed site investigations performed by the task leader guaranteed that sub-project specific selection criteria were taken into consideration and matched the objectives of the sub-project. Expectations expressed by all partners were met.

Site selection based on third party information has the advantage of saving time and money but investing more time to find sites more suitable for the E7 financial sustainability concept would have bee useful.

Financial Aspects

A requirement of the project was for the beneficiaries to be capable of paying full operation and maintenance costs as well as hardware replacements. This is a typical situation when buying "commodities" at own expenses. There is no reason why this should not happen under development assistance. The goal of the E7-1 Project was to attain, wherever possible, a level of financial sustainability, assuming the people's ability and willingness to pay for the electricity.

The payment scheme for the SHS was calculated based on a down-payment, a fixed (flat) monthly fee, and a flat annual fee for a 10 year period. 40% of these monthly payments were used for the PLD management. It was also calculated that under a competent management there would be a 30% recovery of investment after 10 years. Furthermore, the Ownership of the SHS would be transferred from the PLD to the villagers after the ten years.

The financial sustainability analysis was based on the willingness and capability of the users to pay for the electricity services. The appropriate scheme and payment structure based on the local conditions required a considerable amount of work and discussion to identify. In the end, the expected results for full financial sustainability could be achieved for the SHS and HS schemes. The implementation of MHP schemes took more time and are still being monitored.

Nevertheless, the users were still willing to commit to the schemes despite the higher cash contributions than expected and in comparison to the higher-than-predicted information provided by the national players and statistics. The community's acceptance of this can be attributed to the transparent asset/investment management scheme used at the village level and to the fact that the fees are entirely used for services provided by the community-trusted PLD.

Technical Aspects

Domestic safety laws and standards must be applied in order to comply with national regulations. However, when domestic technical standards appear not to be adequate, IEC and/or ISO standards should be applied. Nevertheless, local habits practices should be taken into consideration wherever possible, so long as they do not compromise the quality of safety, performance, and long-term reliability of the system.

Socio-Economic Aspects

Local NGOs are familiar with and understand the needs and resources of the beneficiaries and can provide reliable supervision. They are also often willing to support the PLD activities even once the project has been handed over.

For this project, an NGO with prior community development experience and capabilities in the region was contracted to help bridge the gap between the actors and the players and to document/monitor the ongoing activities and results of the project. The ability to understand the diversity of culture and ethnicity within the context of each project site and to react accordingly was an essential criteria.

Implementation

Technical Aspects

Project managers, contractors, sub-contractors, and NGOs must have well-defined roles with mutual respect for each other in order to reliable and coordinated exchange of information. Without this, controversial and uncoordinated information can be provided resulting in confusion and a lack of trust within the project.

Expectations must be made clear and fulfilled to avoid the de-motivation of the community and a reluctance for it to make commitments.

The strong involvement of local professional suppliers, the quality of system components, the compliance of installations with procurement contracts, and the after-sales-services including guaranty are all a necessity for successful implementation and the overall sustainability of the project.

Despite a strong effort to assure the appropriate incoming inspection and control on manufacturing, it was very hard to get the expected quality from the main contractor. There must be full-time supervision in order to guaranty the maximum quality.

Since the MHP construction project involved civil construction works, specialists were often required to visit the sites to re-examine the details of the design based on the situation. Full time supervision at the sites would have been helpful to maximise the output.

Documented experience proves that the “responsibility according to capability” training approach is appropriate to maintain a reliable O&M management scheme essential for customers to remain satisfied and willing to pay for these services.

With their knowledge of the real community environment, the NGOs (facilitators) contributed considerably to adapting, testing and finalising the management tools..

Training Aspects

The technical and financial efforts put into the management training produced more than expected results. The willingness to pay for electricity services was very high under the resulting service conditions. The quality of service also led to the situation where the increasing demand (bottom-up) could not be satisfied by the PLD (without additional seed funding).

Training of both the PLD and the users on their respective roles and responsibilities is key to the success and sustainability of the project.

Socio-Economic Aspects

Since reliable information on the financing schemes to be implemented was not made available during the mobilisation phase, problems in promoting the financial aspects of project were encountered. As a result, this contradicting information provided by the different project parties created confusion, in some cases, within the community.

Voluntary community participation in each step of the project’s development is a prerequisite for a smooth and results-oriented implementation. Partaking in the progress of a project constitutes an important step in building up social trust.

Competent and experienced partner NGOs must be carefully selected and their fieldwork must be controlled and closely supervised. This emphasises the need for a

local project manager for the duration of the project. A Careful assessment of field officers' achievements and routine discussions with the communities by the local project manager can facilitate quick reactions to any shortcomings experienced in the field.

Village workshops, neighbourhood discussions, training sessions, and the establishment of a village-based management unit (PLD) were all essential in ensuring a high level of community participation and social trust.

Agreement on objectives and a participatory decision process (individual choice) are also two essential cornerstones for earning social trust. For example, the objectives of the electrification schemes were provided in electricity service contracts for the approval of the users and the PLD.

A positive experience with the income generating activities (IGA) in the SHS sub-project may lead to a new concept with a more global approach for remote rural electrification. If the IGA and the region's electrification develops together, cash potential for the local communities can be increased. However, before any decisions are made, there must be a base assessment of the local potential in terms of farming, cattle breeding, handicrafts, available manpower, and most importantly, the capacity of the local markets.

Operation

The E7-1 project selected a portfolio of three different rural electrification technologies (solar, wind micro, hydropower) but chose the same institutional approach for each electrification scheme. The challenge was taken with the notion that the issue of "maintenance management" is the key to success rather than the issue of "maintenance" itself.

Direct contract relations, prompt reply to technical problems, and intensive on-site monitoring during the implementation phase are not sufficient to avoid discrepancies between the actual and expected results. If this is the case, strong decisions should be taken and delivered, even if unpopular.

Providing electric energy to users requires the use of meters in order to collect any revenue. Electricity without meters leads to uncontrolled demand growth and unfair electricity billing.

Clear understanding and agreement on technical specifications before signing the contract didn't represent a guarantee, but allowed to discuss at site and during commissioning in a strong position. Public bodies manage the overwhelming majority of projects with inadequate quality control and compliance with technical specifications. A single project cannot change/improve procedures and technical culture of local companies.

Experience shows that technical problems encountered during operation can be minimised if a strict and comprehensive commissioning is performed based on the verification of each detailed item and specification. The client must have control over the construction details in order to avoid any interpretation or generalisation by the local contractors.

Activities Implemented Jointly (AIJ)

The Project satisfies the requirements of an AIJ Project:

- Compatible and supportive of national environment and development priorities;
- Approved by the Governments of the parties concerned;
- Produces real, measurable, and long–term environmental benefits;
- The financing is 'additional'.

However, the long–term sustainability of the project has yet to be proven as the major components were only recently commissioned in 2000. As for GHG reductions, the relatively low quantity of CO2 avoided is due to the small size of the project. On the other hand, this is typical of decentralised rural electrification projects.

1 Introduction

The E7 is a group of eight leading electricity companies from six G7 countries. Formed in 1992, its mission is to examine and co-operate on major global electricity-related issues, with an emphasis on the global environment and sustainable energy development. The E7 is comprised of Électricité de France, ENEL (Italy), Hydro Québec (Canada), Kansai Electric Power Company (Japan), Ontario Power Generation (Canada), RWE AG (Germany), Edison International (United States) and Tokyo Electric Power Company (Japan).

The E7's mission is to play an active role in protecting the global environment and in promoting efficient generation and use of electricity. The E7 focuses on developing countries and addresses sustainable energy development (SED) issues such as climate change and greenhouse gas reduction, environmental practices, as well as electricity distribution, transportation and generation.

The E7's Network of Expertise for the Global Environment provides pro-bono technical advice, human capability building, and demonstration projects supporting sustainable development to help developing countries and economies in transition with environmental, social, technical, and other challenges in the electricity sector.

In 1996, the E7 developed a Greenhouse Management (GHG) Strategy to provide a framework to guide E7 member actions, both domestically and internationally, to manage GHG emissions. A key implementation element of this GHG Strategy is to demonstrate the value of joint participation projects through participation in Activities Implemented Jointly (AIJ) or the Clean Development Mechanism (CDM). The E7 believes that joint implementation projects are an excellent opportunity for capability building and technology transfer while also representing a cost-effective method for achieving targeted global greenhouse gas reductions. In this context, the E7 decided to undertake three AIJ-pilot projects, one of which is the Renewable Energy Supply Systems (RESS)project in Indonesia (Project E7-1).

The first objective of the E7-1 project was to supply a limited but reliable amount of electricity to households and community facilities in remote areas of Indonesia. By harnessing solar, wind and hydro energies, GHG emissions can be reduced while improving living conditions without generating additional emissions. The second objective was for the project to be approved as an AIJ project under the United Nations Framework Convention on Climate Change (UNFCCC) and by the Governments of the E7 member countries and Indonesia.. The third objective was to develop a new sustainable and decentralised management concept for rural electrification.

In 1994, a project proposal was developed to address the sustainable energy development issues of the area under consideration. In 1995 and 1996, a pre-feasibility study and a feasibility assessment provided the relevant information on the regional project context, the technical options, and the potential opportunities to co-operate with the national and regional governments. A detailed project concept was devised that included preliminary cost estimations , a concept for a socio-economic integration package, and the institutional framework for co-operation with Indonesian government.

By end of 1996, all preparatory assessments and bilateral negotiations with the Indonesian government institutions were concluded, later leading to the signing of the project agreements. In 1997, the E7 established a permanent local project office in Kupang, NTT Province, to co-ordinate and support the project throughout its duration. Each of the E7 member company voluntarily assumed the leadership of one specific sub-project (task) and implemented it under its own technical and management responsibility. Since that time, all of the field activities have been implemented and all construction was completed by mid-2000.

The E7-1 project, using information gathered from its socio-economic, financial, and technical studies, implemented three rural electrification schemes consisting of solar home, micro hydropower, and photovoltaic/wind hybrid systems generating a total of approximately one million kWh a year. The three schemes provide electricity to 8 remote communities with more than 4000 people. As for the GHG reductions, the calculated CO_2 offset resulting from this project is expected to reach more 33,000 t during its technical life.

In addition to gaining practical field experience during the AIJ-pilot-phase, sustainable financing mechanisms for the rural electrification schemes were promoted and implemented. Findings from each of the schemes are expected to help improve the basis for promoters to prepare/evaluate future business opportunities by operating solar home and hybrid systems or micro hydropower plants as economically and socially sustainable facilities on a commercial basis.

The E7 assistance focused on the development and the formulation of bottom-up dissemination concepts that considered both non-technical and technical parameters. Local grassroots community organisations and NGOs as well as locally-based private sector firms have been involved because of their understanding of the local culture and conditions. The E7 provided training to these organisations and the future users on equipment installations, maintenance, and troubleshooting, as well as on financial and institutional models.

The Objective of this report is to summarise the project's development and results (refer to chronology of milestones, attachment 1) in an effort to extract the lessons learned to serve as guidance to other comparable projects (lessons learned appear in boxes within the text).

2. Project Description

The E7-1 Project is recognised by the Indonesian Government within the framework of the UNFCCC as an Activity Implemented Jointly (AIJ). The project provides a limited amount of electricity to 8 remote communities each with the appropriate technical solutions and manageable financing schemes. The project includes approximately 200 solar home systems, 4 micro hydropower units, and one photovoltaic/wind hybrid system. The main objectives were:

(i) to provide a limited amount of electricity to rural communities;
(ii) to achieve a high level of sustainability; and
(iii) to develop an AIJ pilot project.

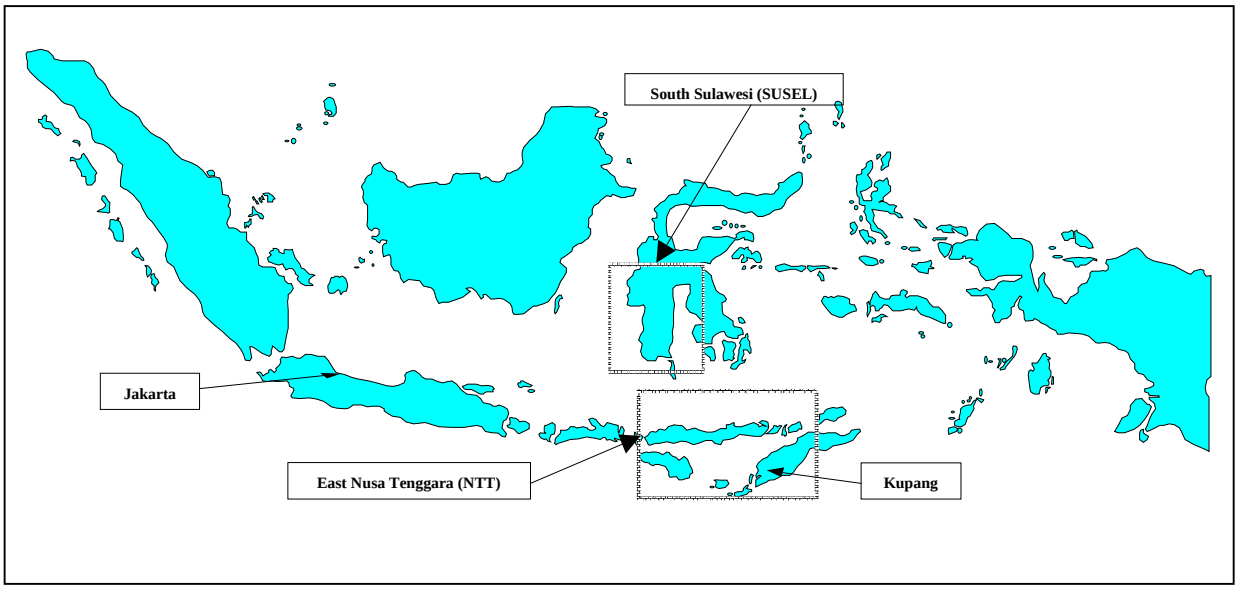
The solar home systems (SHS) consist of 50 W peak units that were implemented in three different villages in the Nusa Tengara Timor (NTT) province : Kualeu and Oelnaineno on Timor island and Lengkonamut on Flores island.

Three micro hydropower units have been installed on the Island of Sulawesi, in the Sulawesi Selatan province. The power output is 50 kW in the village of Ta'ba, 69 kW in Tendan Dua, and 12 kW in Bokin. The power distribution systems supply 100 W of electricity to each connected household. A fourth micro hydropower unit has been implemented in Waikelosawa, on the island of Sumba, in the NTT province. It consists of an IPP project of 15 kW Where the power is sold to PLN (the local power supplier).

The hybrid system was implemented on the island of Rote, in the NTT province and consists of a combination 22 kW PV, 10kW wind and 20 kW back-up diesel system supplying electricity to the villagers through a low voltage distribution grid.

At the project’s completion in end of the year 2000, more than 4000 people were provided with electricity with more household connections being implemented.

Indonesia, Province NTT and SUSEL



3. Approach

The major focus of the project's approach was to ensure its sustainability through the appropriate development/ management incorporating bottom-up planning and active user participation principles. The success of the project depended on the approach(es) adopted by the project team. Consequently, three different management levels were defined and selected:

- ***Program Management (PM):*** Interaction between international/national and local levels of participation (players).
- ***Rural Electrification Scheme Management (RESM):*** Interaction between the PM (players) and the village/user level management (actors).
- ***Asset (Fund) Management (AM):*** Interaction at the village level (actors only).

Program Management (PM)

The basic element of Program Management in a participatory development approach is the interaction among the players. The relative importance and intensity varies with each phase of the program's progress. The Program Management takes this essential issue, as well as any differences in culture or capability, into consideration.

Each of the eight E7 member companies (From 3 difference continents) shared real project responsibilities (6 task leaders) in developing three different rural electrification schemes for two Indonesian provinces characterised by different cultures. Handling these tasks required a diversity experience mixed with a considerable degree of flexibility.

To offset the natural differences between the E7 members and the beneficiaries, the project team appointed a “local” resident manager. The manager was a German expert, fluent in Indonesian and familiar with the culture that had been a resident of the area for many years. He was stationed in Kupang for the duration of the project’s implementation in the E7-1 project office (EPO) in order to carefully manage the interaction between the E7 and all the other parties. He was primarily responsible for co-operation with Indonesian authorities, office management, and for providing assistance in the project’s co-ordination and implementation, as well as for the monitoring/supervision of all the technical and non-technical activities.

The project leader (RWE) was responsible for the overall implementation and management of the project and reported to supervising board, the E7 Steering Committee.

A key factor in the success of the project’s implementation was the continuous on-site presence of a project manager well-aware of the different concepts and technical approaches of each implementing company as well as the local constraints and potentials.

Indonesian Government Institutions (GOI), an integral part of the project, limited their active project contribution to conceptual and design aspects (top-down justification of the project). The project’s implementation itself was closely monitored by the GOI and some relevant collaborative decisions were made during the conceptual project phase. This approach was successful with the exception of the problems encountered because of difficulties between those involved. These difficulties could have been avoided, as in the case of other development projects , through a matching of budget and partner contributions. The E7 approach was one project out of one hand.

Besides typical management tasks and routines, the resident management emphasised the advantage in using locally available resources (material, expertise, etc.) rather than resources provided by external groups. However, external groups only provided for resources and knowledge that were not available locally.

The chosen approach added greater value to the local project environment through an effective transfer of knowledge, efficient local capability building, and a strong empowerment of the local resources.

Implementing this project under the umbrella of the DGEED provided the E7 with more flexibility and independence. The involvement of the local PLN as a consultant for certain field activities proved to be a suitable vehicle for ensuring the regional PLN's support, even after the conclusion of the construction.

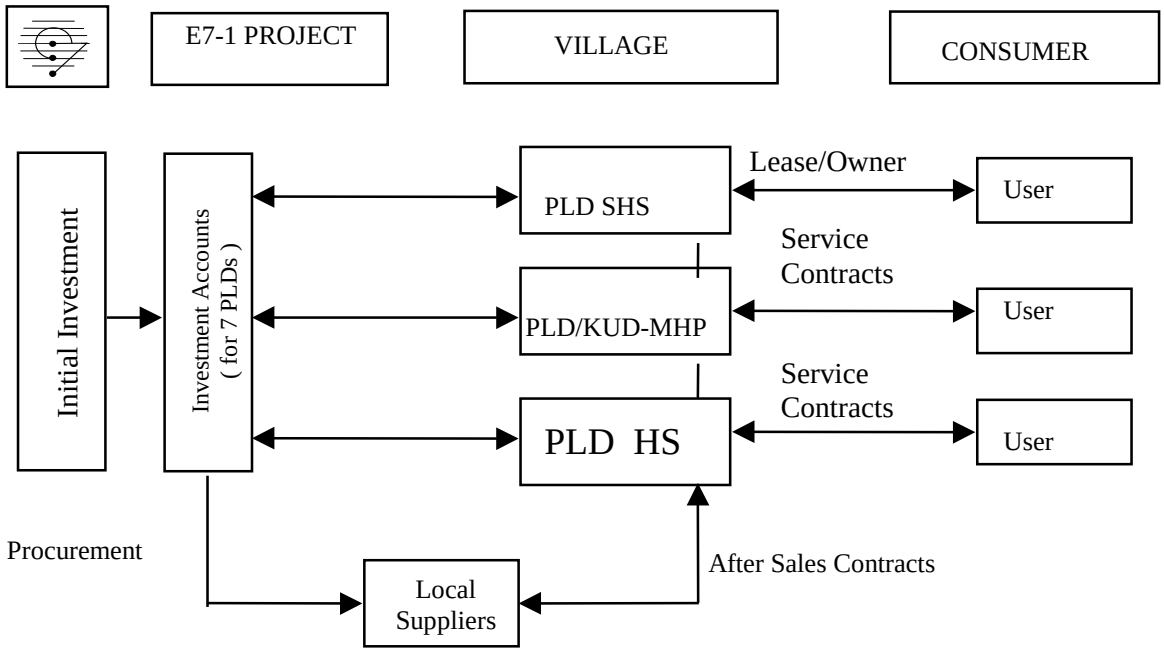
The impacts of task implementation remained positive through close collaboration between the task leaders and the resident management for assessment of the local needs, the local applicability of technology, and the field feed-back. This approach provided the appropriate flexibility and adaptability to the realities in the local field.

The decision making process used during implementation in the field, where conceptual aspects had to be adapted to local situations, posed some difficulty for the E7 resulting in project delays. Therefore, a - well-defined, "basic communication procedure" should be established well in advance of project implementation.

Rural Electrification Scheme Management (RESM)

The initial project environment was characterised as an area consisting of many different communities that had never before benefited from electricity nor the management of their community facilities.

Institutional Framework E7-1 Project:



The co-ordination and implementation of the project's activities were managed by the task leaders while also closely supervised and monitored by the resident management. The guiding and supervising of the NGOs and Field Officers as well as the co-ordination and implementation of the sub-projects were organised and managed according to the players' decisions and the local needs.

With the objective of successfully achieving a high level of sustainability, , it was a priority to keep the community based organizations and local social units (actors) involved in the implementation, maintenance, and management of the designed rural electrification schemes.

On of the main institutional aspects of the project was to concentrate on establishing community ownership and a village level management body for the electric facilities to be provided. In order to establish these management mechanisms, field officers (NGO personnel) were stationed in each project village for a period of up to two years in order to establish and train the electricity management units (PLD). This process helped to develop traditional community behaviour into advanced micro-utility management skills.

During the management training sessions performed by the local project manager and the NGO, common management principles were developed for the PLDs and related management tools were adapted to the micro project environment with the local capability in mind.

The driving force for establishing and maintaining vital interactions was the creation of incentives such as new jobs with salaries based on work achieved, the possibility to change one's social status within the community, the opportunity to join training sessions or study tours, and last but not least, the chance to receive "light". This business-oriented approach focussed on empowering a single village entity rather than empowering the community as a whole. As a result, the PLD is seen as the mediator between the project intervention (players) and the individual users (actors). This approach avoided the misconception of viewing communities as entities of social unity when in reality the interests of community subgroups are versatile, differ considerably, and can often work against collective actions.

The potential success of a community development is heavily based on the commitment of the NGOs (facilitators) to effectively adapt the management concept to the needs of the beneficiaries needs and to carefully guide them in its implementation.

The "transparent", "competent", and "reliable" rural electrification management scheme used by the trusted village-based micro utility (PLD) contributed to the community's acceptance of the project.

Asset (Fund) Management (AM) at the Village Level

Decisions on which options to select for implementing rural electrification schemes (non technical) should always be made by the users themselves within their capability (technical, resources, etc.) rather than having them imposed by higher level administrators. In order to assure that this was the case, many project decisions were based on focus group discussions (FGD), on-the-spot assessments (field studies), and individual interviews with the actors.

The Asset Management concentrated on the management of funds, in terms of the electricity facilities provided, in an applicable, sustainable, and documented manner. Fee and budget management, after-sales-services and essential - reporting routines - were introduced and maintained by the PLDs. It was important to achieve a commitment from each user for the scheme with (signed contracts) and to maintain the payment mechanisms. Therefore, the PLD and the users were free to finalize their own financial schemes, taking the task recommendations into consideration.

The performance and evaluation of a mid-term capability analysis that was drawn up for each of the PLD staff provided valuable input to the PM (Program Management) for initiating corrective measures or for tailoring the management approach. The resident management, together with the NGO, was in a position to provide feed-back to each PLD staff member to upgrade their management capability and to conduct institutional restructuring.

A PLD magazine, published quarterly and distributed by the involved NGO (facilitator), provides the opportunity for any PLD issues and information to be communicated and shared within the communities.

Inauguration of PLD Kualeu (SHS) by Government of NTT

4. Planning and Design

4.1 Institutional Aspects

A major focus of ensuring the project's sustainability was the designing of the appropriate institutional concept incorporating all of the human resources available at the grassroots level. The project promoted the establishment of village-based electricity management units (Pengelola Listrik Desa – or PLD) to assume responsibility for the electrification schemes and to become the focal point for all project interventions within the communities. Management at the village level seemed promising due to a high level of acceptance by the users, open and responsive communication , and the promising ability of the communities to accept and to maintain ownership of their electrification facilities.

The PLD can be seen as a micro project developer, assessing the potential for customers, providing and managing electricity services, and ensuring that a reliable fee collection system is in place and operating as expected.

The focus of this institutional set-up was to ensure that the quality of technology was accepted according to the expectations of the users, that there is an effective and long-term management of O&M services, and that user-support services are provided. The management and execution of a reliable and routine fee collection scheme remains a major challenge.

Modular management training was provided to the PLD at various occasions during their first year of operation. Monitoring and use of the introduced management tools made it possible to collect real field information about the technical and non-technical performance of the electrification schemes, even after being handed over. Therefore, the project was constantly in a position to address any persisting problems, to initiate related actions or corrective measures, and to increase awareness for guarantee matters.

In most cases, the PLD personnel well understood their roles and responsibilities for administrative and technical services. In addition, although not practiced as intensively as expected, management tools like reporting, documentation and accounting were utilised. The NGOs/EPO provided continuous support in increasing and monitoring the PLD's capabilities .

4.2 Site Selection

Good site selection is another criterion for a sustainable rural electrification development. Despite the remoteness of some sites, it is particularly important to avoid a situation where these sustainable village electricity systems are rendered useless and obsolete because the area is reached soon after by the national grid providing central, and often subsidised, energy services.

SHS The SHS sub-project team selected their sites based on the findings of a comprehensive, statistical, household income survey (SHIS) that was conducted by EDF and the EPO in 1997, before the project construction started. The main selection criterion was that PT. PLN (PERSERO), the Indonesian national utility, did not plan to electrify the respective villages or the surrounding region within the next ten years (the areas were to remain remote). Other criteria evaluated from the SHIS was the ranking of villages according to their assessed income situation (still well below the national level), whether the communities showed a solid basis for implementing institutional arrangements (a well organised village), and the availability of sufficient sunshine throughout the year.

HS A different selection approach was chosen by the HS sub-project. In 1998, several villages were inspected by E7, jointly with the EPO, on Timor, Rote, and Sumba Islands. In this case, the basic criterion was the availability of good renewable energy resources, wind and sun in particular. The size of the village (the length of Low Voltage distribution network) and the number of consumers were also criteria. These two aspects had to match the technical constraints imposed by a limited budget for hardware. Furthermore, the village was not be included for grid extension in the near future according to the national electric distribution plan.. The potential consumers also needed to have the economic capacity to demonstrate the economic «self-support» of the renewable power plant. Two final sites were selected for evaluation and were visited jointly by the EPO and an E7 company representative.

Oeledo village, on Rote Island was selected because of its strong match with the above criteria, despite its risk of high corrosion effects dues to its proximity to the seashore. With the objective to promote the HS project, get the entire village involved, and assemble support for E7's activities, the EPO established a Field Office (FO) on-site a year before the project construction started.

MHP The MHP sub-project team accepted to reconstruct a run-off-river hydro power station in West-Sumba, NTT that had been damaged by lightning and rendered inoperable for decades. The MHP was reconstructed as an IPP to sell power to the local supplier (PLN). Therefore, the site selection criteria were not applied.

Since the above project was not "rural electrification" venture, E7 took the initiative to investigate some other potential, off-grid, rural MHP projects. - An international government aid agency and the Indonesian Ministry of Cooperatives, Small and Medium Enterprises (MOC) originally investigated several MHP sites on Sulawesi Island. Three MHP sites on Sulawesi were then selected by the task leader based on the MOC's investigation of rural areas in need of electrification. This site selection approach was effective in saving both time and money. These three additional MHP sites on Sulawesi required the construction of a distribution system to supply power to the local communities.

Detailed site investigations performed by the task leader guaranteed that sub-project specific selection criteria were taken into consideration and matched the objectives of the sub-project. Expectations expressed by all partners were met.

Site selection based on third party information has the advantage of saving time and money but investing more time to find a site more suitable for the E7 financial sustainability concept would be helpful.

4.3 Financial Sustainability Analysis (FSA)

In general, commercial rural electrification schemes are cost prohibitive to implement due to high up-front investments and low capabilities to financially manage the investment. Most of the "top down" projects created a situation where bureaucracy and politics were matched with technology and financing. As a result, the end users do not pay the fees imposed which leads to the financial and operation failure of the scheme. The E7 project's criteria for financial sustainability did not consider give-away prices or fees.

An important constraint to the financial sustainability of an RE project is the willingness and ability of the users to pay for the electricity in a reliable and routine manner. Despite often promoted for socio-political reasons, the E7 schemes avoided, for financial sustainability of the project, charging fees comparable to those of the kerosene consuming, lower-income groups.

This willingness to pay for electricity services can be severely and negatively impacted if the introduction of rural electrification schemes is not accompanied by good equipment performance and reliable service, when needed.

The give-away approach was never taken into consideration in this project. The sustainability criteria was a major concern of the project since the beginning. The absolute minimum requirement was that the villagers would pay for electricity services in order to be able to maintain their facilities under their own responsibility and management. Appropriate, user-oriented financing arrangements were developed, including a reliable financing management scheme. The PLD management seemed promising from the perspectives of both the demand- and supply-sides. A business-oriented approach was also chosen to provide opportunities to generate sufficient revenues to cover administration/management, service, and O&M costs, as well as to support a maximum extent of replacement costs.

A "minimum" requirement of the project was for the beneficiaries to be capable of paying the full operation and maintenance costs as well as any hardware replacements. This is a typical situation when buying "commodities" at own expenses. There is no reason why this should not happen under development assistance. The goal of the E7-1 Project was to attain, wherever possible, a level of financial sustainability.

It is important to mention that E7 funds were granted to the Indonesian Government under a bilateral project collaboration between the Ministry of Mines and Energy (DGEED) and the E7. All revenues collected from the users are kept and managed exclusively by the PLD in order to cover O&M costs as well as replacement expenditures.

A financial sustainability analysis (FSA) was carried out for two major purposes: To calculate the minimum tariffs for electricity services required to achieve project sustainability and to determine financial management procedures to be implemented that would maintain and operate these systems throughout their lifetimes. Sustainability, in this case, is defined as assuring the technical reliability of the systems for a determined period (i.e. the technical life of the equipment) and ensuring investment management during this period.

Socio-economic studies were conducted in all the project regions to assess the potential for, and acceptance of decentralized electricity supply. Focus Group discussions (FGD) were also conducted to assess the ability and willingness of the potential users to pay for the provision and management of electricity services.

The set-up of the general model was aimed at designing payment schemes that took both the local economic situation and the sustainability criteria into consideration. The model was tested using EXCEL spreadsheet calculations several times until the model matched the realities of the field. Several scenarios were investigated such as Full Cost Recovery, No Capital Cost Recovery, and Minimum Payment, as well as High and Low Inflation.

A cash flow model was also developed and adapted to each different sub-project with cost parameters based on the technical concept. Local versus foreign component procurement was also taken into consideration. Furthermore, monetary parameters were included such as inflation, interest , and exchange rates (Rp/US $), based on IMF projections and an analysis of OECD .

Since the project was implemented under the AIJ pilot phase, all external capital costs were borne by the investor (an AIJ guideline) with the expectation that the recipient(s) would cover all the locally occurring costs. The objective of this guideline is to show that the project provides a net economic benefit to the recipient(s) and ensures the sustainability of the project.

The model's hypothesis was that the PLD could implement a devised financial concept to assure the successful implementation and operation of the systems. The bottom-up approach was chosen and retained throughout the project's

implementation. In addition, the payment/financing schemes were adjusted to the field realities. In fact, in some cases, they were even downgraded to match with users' expectations and to take the local economic situation into account.

The procurement and installation were accompanied by various non-technical activities ensuring a sustainable scheme performance. The PLD implemented and managed the financing schemes in a transparent and competent manner. The PLD offered electricity to the villagers under standard conditions with a down payment (roughly equivalent to 3% of the investment costs or 175,000 Rp), and an average monthly fee per user (10,000 - 36,000 Rp). Only in the case of Waikelosawa/Sumba, was a long term contract (PPA) signed with PLN (the Indonesian national utility) as the only purchaser of electricity and where a separate tariff rate was employed. The two elaborate schemes exceeded the subsidised tariffs offered by the national utility.

SHS: *The scheme calculated a down-payment of roughly 175,000 Rp (3% of investment cost), a fixed (flat) monthly fee of 10,000 Rp and a flat annual fee of 320,000 Rp for a 10 year period. 40% of the monthly payments were provided to the PLD management. The monthly and annual payments were equivalent to an average of 36,666 Rp/month. A calculated 30% recovery of investment after 10 years is assumed under a competent management performance. The batteries are replaced through revenues in years 3, 6 and 9. Ownership of the SHS would be transferred from the PLD to the villagers after year 10.*

HS/MHP: *This scheme assumed a willingness of the users to pay for high quality electricity (220V/50Hz/ up to 200 W) costing up to 30,000 Rp./month. A more utility oriented arrangement was chosen with a net down-payment of 175,000 Rp. The monthly capacity fee was calculated at 5,000 Rp./0.5A MCB with a monthly energy consumption fee of 800 Rp./kWh. The energy consumption pattern of a usual household in a remote area was defined as 100W capacity and an equivalent of 18 kWh per month. Ownership remains with the PLD (after a transfer from the government).*

The collection of the communities electricity fees is an aspect requiring very careful handling in order to avoid any social conflicts. An appropriate banking concept and financial supervision process is essential to maintain transparent management, to avoid the misuse of funds, and to ensure the availability of cash when system components need to be replaced.

A banking concept with two separate bank accounts was devised to guarantee security for the collected fees.. One of the bank accounts is local and for wages and PLD operation expenditures. The signing authority of this account is the chairman of the PLD and a fixed amount of the collected fees is transferred monthly to this "PLD account".

A second bank account serves to finance O&M as well as expenses for component replacement. The major share of fees collected is transferred by the PLD to this "O&M account". It was determined that the signing authority for this account would be the resident project manager or management body with authority shifting to the NGO in year 2000, and then shifting to the PLD in 2001. The transition of financial

control from the players to the actors is not without risk and requires supervision and control over those involved.

This concept ensures that the project will operate satisfactorily for its lifetime , after the initial seed-funding and without external intervention. It also guarantees that the operational burden does not fall on the implementing agency once the project funding ends. Most governments are not in a position to give priority for subsidizing renewable energy projects that cannot cover their running costs.

The management of the accounts is monitored by analysing the quarterly reports submitted by the PLD and the balance sheets of the O&M account. The NGO involved assists the PLD in preparing their standard formatted reports. If proven necessary, corrective measures will be proposed and implemented in the case of inaccurate accounts. Monthly print-outs of the O&M account balances are provided to the PLD office making sure that the funds management remains transparent.

The financial sustainability analysis was based on the willingness and capability of the users to pay for the electricity services. The appropriate scheme and payment structure based on the local conditions required a considerable amount of work and discussion to identify. In the end, the expected results for full financial sustainability could be achieved for the SHS and HS schemes, however, the implementation of MHP schemes took more time and are still being monitored.

Nevertheless, the users were still willing to commit to the schemes despite the higher cash contributions than expected and in comparison to the higher-than-predicted information provided by the national players and statistics. The community's acceptance of this can be attributed to the transparent asset/investment management scheme used at the village level and to the fact that the fees are entirely used for services provided by the community-trusted PLD.

4.4 Technical Aspects

4.4.1 Project Design

SHS: The SHS implemented were standard sized, 50 W peak, pole mounted systems with all components in accordance with Indonesian and/or international standards. The availability of all components in the local market was a priority.

The system was to provide each home with light in the evening through 3 neon lamps (10W) and one power outlet for a radio or TV. The battery (100 AH) was sized to enable sufficient electricity storage and supply and to also address the need to extend the solar generator's capacity once the users are accustomed to using the electricity.

HS: A nominal 50 kVA Photovoltaic/Wind/Diesel Hybrid System to supply electric energy to one village was designed. Neither the E7 nor the DGEED provided particular instructions for the design of the electrical and mechanical works. Therefore, IEC international standards and the best practices in renewable energy projects were applied.

The Indonesian partners expressly requested the installation of a hybrid system that included a wind generator. However, the comparatively low reliability of wind data and the unreliability of the local wind source led to prioritisation of the sun as the primary source (photovoltaic generator).

Concerning the long-term reliability and technical sustainability, the design had to incorporate suitable redundant components for the most critical occasions (DC/AC converter) and to include a diesel generator for emergency back-up.

The system was designed to deliver an average of 48 kWh/day to 120 households by means of approximately 4 km of an overhead LV distribution network with house connections. A detailed map of the village including each home, the LV distribution plan, and list of potential consumers was prepared.

Technical Standards. Domestic safety laws and standards must be applied in order to comply with national regulations. However, when domestic technical standards not to be adequate, IEC and/or ISO standards should be applied. Nevertheless, local habits practices should be taken into consideration wherever possible, so long as they do not compromise the quality of safety, performance, and long-term reliability of the system.

MHP: Since the MHP project included basic construction techniques and the facilities utilised basic technology, it was decided to employ locally available equipment for power generation and distribution facilities because of the advantage that maintenance, repair work, and operation are simplified.

The potential power output of the generator was determined based on the results of a local water flow survey. Furthermore, the maximum potential number of houses to be supplied with electricity was based on the assumption that each house would require approximately 100 watts of electricity.

Micro-hydropower plant (MHP) Tendan Dua - Powerhouse

4.4.2 Procurement

SHS: A small pilot project was set up in 1997 where18 SHS, all out of order under a failed government scheme and after only 2 years of operation, were reconstructed. This case study provided the E7 with a valuable and comprehensive experience with locally available SHS components and local contractors. It also provided important information on the management of SHS that would later become of use in the other SHS implementation.

The project called for tenders in Indonesia to implement 100 SHS under a turnkey contract and a competent, local company was selected. The turnkey procurement contract was signed in July of 1998 and the construction was concluded in February of 1999. The procurement and installation was executed without major constraints.

It was important to select a reliable local supplier to guarantee quality services such as repairs, quality assurance, and after-sales-services in remote areas.

HS: In order to guarantee high quality critical system components were purchased in abroad (DC/AC converter and electric box) in accordance with very strict specifications.

As the most effective solution for the works carried out on-site, turn-key contracts were signed with local companies for the following tasks and based on the following detailed specifications:

(i) Civil works, diesel generator, transports on site, mechanical assembling, cabling, warehousing, insurance, etc.;
(ii) Installation of the LV distribution network and home wiring, according to the PLN standards; and
(iii) Installation of the wind generator.

MHP: Since the use of the existing MHP technology was proven to be advantageous, as previously mentioned, the task leader selected an experienced Indonesian engineering NGO as the local subcontractor for the construction phase of the project. This NGO used Swiss water mill technology and rural electrification concepts that it received from the GTZ, a German public aid organization. This NGO had experience in more than 35 rural electrification projects. Furthermore, the use of locally available materials and labour kept construction costs within budget and better facilitated maintenance.

Although various aid organizations have dealt with rural electrification projects in the past, many of these projects were not successful. One of the lessons learned from past successes and failures in rural electrification is the potential risk of applying technologies that are only available in developed countries. Local people may not be familiar with these higher level technologies and therefore cannot carry out operation and maintenance by themselves. There is also the risk that they would face difficulties in procuring parts if something breaks.

4.5. Socio-Economic Aspects

4.5.1 Approach

The E7-1 project undertook the challenge of addressing the major problems encountered in the field when using renewables (e.g. local needs, ability to pay, financing, management and O&M experiences) by mainstreaming technical and non-technical aspects in three different electrification schemes. The approach was to ensure sustainability by designing an appropriate Socio-Economic Integration (SEI) concept, incorporating top-down/bottom-up planning, active and responsible user participation, and the utilisation/empowerment of local (regional) resources.

A Top-Down Justification could be achieved between the E7 and GOI **(players)** during the design and negotiation phases of the project at several administrative levels and expressed in frame agreements with the Indonesian government (LOI and MOU). Control and supervision over all activities as well as their performance was essential to this process.

The Bottom-Up Planning and implementation of the project was important in order to ensure direct contact with the users **(actors)** as well as with local agencies, departments, etc.. A two-way communication was necessary to facilitate the integration of the economic and social realities of the field. This was achieved through several field surveys or assessments, a village based management concept, and an intensive review of activities and supervision.

Vital interaction and active communication between players and actors were essential for achieving the expected results and for earning the necessary social trust for the project intervention. The project cooperated with local NGOs **(facilitators)** since they constituted the appropriate vehicle for 'translating' the project objectives to the grassroots level (the local people) and for facilitating the SEI concept implementation.

The rationale was not to assure technical sustainability alone, but more the challenge to establish the institutional and management conditions under which commercially-oriented rural electrification schemes could be developed using one approach and could be maintained with a high level of grassroots participation and user responsibility.

4.5.2 Public Participation

The E7's guidelines emphasise the need and importance for the integration of social concerns into projects. Fair compensation (land utilisation) and the improvement of social conditions are among the priorities put forward in E7 projects. Taking this demand into account, the NGO experts in community development (field officers) were stationed, for a period of up to two years, in the project villages in order to organize user groups and to strengthen the PLD's management organisation..

Gender issues were of particular interest in the way decisions are taken and respected. Special care was taken during the entire implementation to address this issue in the appropriate context in order to avoid gender-related discrimination.

Throughout the project period, various E7-1 experts trained the actors and monitored the project impacts, thus creating an impression of concern for the development of the community and a feeling that the actors would not be abandoned after the completion of construction.

This approach was used to ensure a smooth transition of the active responsibility for the electrification schemes from the players to the actors once the technology and its management was in place. Comprehensive efforts were therefore undertaken, from the very beginning, to achieve a common understanding about the objectives and goals of the project among the project partners, the NGOs, PLDs, and user groups, in particular.

4.5.3 NGO Activities

The participatory approach of the project emphasised, as much as possible, the integration of resources and knowledge that are already available locally. The appropriate solutions summon the respect of the local context rather than the neglecting of the real, existing project environment. Using local human resources is the best method for the success and acceptance of the project.

For this project, an NGO with prior community development experience and capabilities in the region was contracted to help bridge the gap between the actors and the players and to document/monitor the ongoing activities and results of the project. The ability to understand the diversity of culture and ethnicity within the context of each project site and to react accordingly was an essential criteria.

The Kupang-based NGO coordinated as many as six NGOs working at the village level. They provided assistance in conveying and translating the SEI concept to the target groups (actors), in facilitating the SEI implementation, and in documenting the results (short-term) and achievements. The resident management ensured that the coordinating NGO, as well as the village NGOs, understood the project's rationale and concept and that they monitored all achievements.

Local NGOs are familiar with and understand the needs and resources of the beneficiaries and can provide reliable supervision. They are also often willing to support the PLD activities even once the project has been handed over.

Installation of Solar Home System in Kualeu

5. Implementation

5.1 Technical Aspects

5.1.1 Construction

In most of the cases, a strategic alliance between the project (players), the NGO (facilitator), and the contractors could be defined based on the specified contracts that reached commitment levels beyond the common practices in Indonesia. These contracts included aspects such as clear technical specifications, extended guaranties, progress payments, tight repair/replacement procedures, detailed commissioning procedures, etc. Both the Responsibilities that were assigned and the interfaces that were clearly set-up were well respected throughout the project. This alliance encouraged the PLDS to set-up after-sales-arrangements with the contractors and to consider them as a reliable partner within the electrification process.

Project managers, contractors, sub-contractors, and NGOs must have well-defined roles with mutual respect for each other in order to reliable and coordinated exchange of information. Without this, controversial and uncoordinated information can be provided resulting in confusion and a lack of trust within the project. Expectations must be made clear and fulfilled to avoid the de-motivation of the community and a reluctance for it to make commitments.

SHS: Implementing Solar Home Systems today is still far from routine business and requires competent resources for the system to last a long time. However, significant experience was gained by implementing the two SHS schemes. For instance, one of the SHS schemes was financed by the project itself and the other was financed by a third party, however, both schemes were managed under the same institutional approach.

The technical difficulties experienced with the third party package (rehabilitation of 75 SHS) actually led to an increase in motivation for the PLD management, because of some acceptance of the project and of the PLD itself, as an institution. However, there were still expectations of the community that could not be fulfilled. The source of the problem was the system's lack of technical reliability since the SHS were originally constructed with a 'Quantity before Quality' philosophy. The project team addressed this problem by supporting the PLD and by taking the initiative to entrust the SHS reconstruction to a reliable supplier. As a result, a minimum technical standard was achieved.

The strong involvement of local professional suppliers, the quality of system components, the compliance of installations with procurement contracts, and the after-sales-services including guaranty are all a necessity for successful implementation and the overall sustainability of the project.

HS: The main contractor was selected on the basis of call for tenders among the local experienced companies capable of performing the civil and electrical works. In order to avoid misunderstandings within management, information loss, and inappropriate relations among the players/actors, no subcontracts were allowed and a clear line of communication was required among all contractors.

Preliminary meetings with the local companies were held at the EPO to explain the E7's objectives and to discuss the peculiar features of the HS project. At that point, the technical specifications were adjusted according to the local capacity (before concluding the contract) without compromising the expected quality standards.

In order to make certain that the works conformed with the technical specifications, there was a program of on-site inspections and meetings with contractors and partners. This approach was enhanced by contracting some independent technicians as full time site supervisors. They were coordinated through the EPO office and reported directly to the task leader.

Unexpected events, difficulties, and improvements during construction required a great deal of flexibility. For this purpose, 10% of the amount for the contracts was put aside for contingencies, if needed, without requiring an amendment to the contract.

Despite a strong effort to assure the appropriate incoming inspection and control on manufacturing, it was very hard to get the expected quality from the main contractor. There must be full-time supervision in order to guaranty the maximum quality.

Hybrid-System (HS) Rote Island

MHP: The MHP contractor was selected through a bidding procedure. The selected contractor dispatched an engineering expert, the General Manager of the contractor's Indonesian Office, to choose the well-experienced MHP construction subcontractors.

The MHP construction started in January of 1999. The construction work ran smoothly, was completed in a short time span, and commissioned occurred as scheduled.

Since the MHP construction project involved civil construction works and low voltage power line works TEPCO specialists were often required to visit the sites and to re-examine details of design based on the situation. Full time supervision at the sites would have been helpful to maximise output. It was decided to employ locally available equipment for power generation and distribution facilities because of the advantage that maintenance, repair work, and operation are simplified.

The MHP task leader and the contractors tried with every effort to respond to the initial problems encountered before and after the commissioning of the projects such

as water leakage, mud accumulation around the water intake areas, and malfunctions in the mini-circuit breakers (MCBs).

Since the MHP construction project involved civil construction works, specialists were often required to visit the sites to re-examine the details of the design based on the situation. Full time supervision at the sites would have been helpful to maximise output.

5.1.2 Training

SHS: Remote and sparsely located solar home systems can lead to high maintenance costs and even potential failure unless a dedicated and qualified maintenance (management) staff is within the reach. This issue was addressed by designing a comprehensive training program specifically for the local project environment using the following "responsibility according to capability" approach:

Step 1: The PLD technician candidates, along with the rest of the PLD staff, were elected by the villagers during the project mobilisation phase. After all, it is the villagers themselves that are best suited to decide who is reliable, has practical talents, is well rooted in the village.

Step 2: This step involved an analysis of the villagers' capabilities and a determination of the potential level of responsibility that could be handled in the long-term. The success of any training program depends to a high degree on its ability to make the trainees understand the material and incorporate the programs objectives into their existing capabilities The link between the projected responsibility (player) and the accepted responsibility (actor) is the key to success.

Documented experience proves that the "responsibility according to capability" training approach is appropriate to maintain a reliable O&M management scheme essential for customers to remain satisfied and willing to pay for these services.

Step 3: This step was to define the training content. technicians were trained in "O&M" (management) and in "system trouble-shooting" to lead to the success and sustainability of the system. However, it was not favoured to train villagers in repairing/replacing the SHS components because it was something that was often practiced and more often failed. Therefore, the responsibility for SHS component repair/replacement was placed in the competent hand of the after-sales-services people.

Step 4: This step involved the designing and testing of the appropriate training tools. A simple and mobile SHS simulator for trouble-shooting (TS) training was constructed to enable training directly at the supplier's training facilities or on the spot, under real field conditions.

Trouble-shooting is only effective with strict documentation and the proper communication to the competent O&M levels. Trouble-shooting flow charts were developed, field-tested, and retailored many times to provide a visual guideline for trouble-shooting, leaving no space for poor results. The trouble-shooting reports/formats were communicated by PLD to the local supplier.

The NGOs (facilitators) contributed considerably to the tailoring, testing, and finalising of the management tools through their knowledge of the real community environment.

Step 5: After-sales services were arranged between the PLD and the local supplier which created an incentive, on both sides, to maintain long-term cooperation. On one hand, the supplier expressed his interest in playing in this market segment (PV, regional) and in increasing his presence in the region. The PLD, on the other hand, gained a competent partner for the technical/financial matters while receiving financial incentives for the promotion and sales of additional SHS. These respective arrangements were appropriate tools to ensure a reliable cooperation.

The technical and financial efforts put into the management training produced more than expected results. The willingness to pay for electricity services was very high under the resulting service conditions. The quality of service also led to the situation where the increasing demand (bottom-up) could not be satisfied by the PLD (without additional seed funding).

The commonly known “Drop-Out” syndrome (trainees leave the project after successful training) was addressed by providing the villagers with the opportunity to choose their own PLD personnel. The villagers are most suited to make that choice based on who they trust, deem reliable, and feel are best qualified.

Training both PLD and users on their respective roles and responsibilities is key to the success and sustainability of the project.

Solar Home System Simulator Training

HS: Since the beginning of the HS sub-project, the villagers showed a great interest and willingness to participate, despite their initial sense of suspicion resulting from the unreliable policy of the local authorities and the unusual features of this project. As the project progressed, however, the villagers' became more familiar and their trust was earned.

With the assistance of the EPO's training programs that were performed at village level involving users as well as PLD staff, three technical plenary sessions were conducted focussing on the E7's objectives, the main features of renewable energy projects, the benefits for the village, the perspectives of development connected to the project, a description of the HS project, and a discussion of the financial scheme and technical details.

Two sessions were conducted involving the users on the safety and use of electric appliances, energy saving, and the evaluation of consumption and running cost of appliances. Participation in these sessions was open to all the villagers, including women and children. There was a very positive reaction in terms of attendance, with approximately 75% of the household participating. At the end of the sessions, the NGO held an evaluation by means of a quiz competition among the groups of young people representing the different areas of the village. Most of the other people took part in this competition as members of the audience or the jury. Prizes and awards were handed out on the basis of the participant's final classification.

The practical education and training of the technicians (PLD) was performed on the spot, during the construction, in order to familiarise the trainees with the components and their installation and assembly processes. The PLD technicians participated in the preliminary running tests in order to get a working knowledge of the operation

and maintenance procedures. Theoretical education material and O&M manuals were supplied to the technicians (PLD) in the Indonesian language. A final exam consisting of theoretical and practical tests given to each candidate provided the final step for selecting the PLD technicians.

MHP: The sustainability of MHP operations is highly dependent on the quality of the maintenance and operation. Although the MHP was designed for very simple operation, it still requires a qualified operator with a good knowledge of how to properly operate the MHP.

The subcontractor provided the operation and maintenance training programs to the candidates that were chosen by the PLDs in Tana Toraja and the KUD in Waikelosawa. The training program consisted of 40% theory and 60% fieldwork. At the beginning of training, pre-tests and interview were given. Since many of the candidates did not know the basics of electricity and engines, additional lessons to raise their basic electrical and mechanical knowledge were arranged. The trainees were required to pass both an interim examination and a final examination in order to become certified. Only two of the candidates were unable to graduate because of their low level of education.

It was originally planned to start the above operation and maintenance training at the beginning of the MHP construction so the trainees could be given the chance to visit the manufacturers and get to know the machine assembly process at the MHP facilities. This kind of training is especially effective for trainees working as operators or maintenance staff. However, because of the delay in establishing the PLDs, the selection of the candidates could not be finished until the end of the MHP construction. The trainees were then given intensive and successful training before the commissioning.

The operation and maintenance manuals were compiled and delivered to the operators by the subcontractor. The training program graduates now work as leaders or senior operators at each MHP site. The E7 hopes that these graduates will continue to take leadership in the daily operation and maintenance to ensure the project's sustainability.

5.2 Socio-economic Aspects

5.2.1 Mobilisation

During the mobilisation phase, local human resources were identified in the villages and the user profiles were assessed. Both the NGOs (facilitator) and the target groups were assembled to help them understand the project's objectives and its expected results, including its risks and benefits. Facilitation sessions were held and monthly reporting and quarterly review meetings were initiated. The NGO(s) were supervised by the EPO in the appropriate way to ensure a high standard of quality.

One important aspect during the mobilisation phase was the earning of social trust among the project partners (players, facilitators, and actors). Since most rural electrification schemes only provide a limited amount of electricity, the users were informed about the potentials and the limits of their system. The goals of this was to clarify each individual partner's expectations and to develop an appropriate system operation with care and responsibility. It became evident that the users really wanted electricity services (first, regardless of the amount supplied per day). The only thing that mattered was the costs that would be associated with this new service.

Since replicable information on the financing schemes to be implemented was not made available during the mobilisation phase, problems in promoting the financial aspects of project were encountered. As a result, this contradicting information provided by the different project parties created confusion, in some cases, within the community.

5.2.2 Community Based Activities

The greatest benefits of electrification for rural communities are better lighting quality and the education benefits associated with extended lighting at night. Other benefits include an improved access to information, better health for women and children, particularly through better indoor air quality, and an expansion of indoor income generating activities. Not to be underestimated, are the effects of a more modern life and its links to the rest of the world.

Community participation with focus group discussions (FGD) where the different project interventions and financing schemes were discussed. Initially, there was considerable interest among participants mixed with many feels of suspicion. The promotion of the PLD concept and the starting of construction began to transform this enthusiasm into trust. The result was that the intervention was well understood and positively accepted, harmoniously and democratically, within the community.

The communities began to responsively participate during the construction period when the physical progress of the project could be seen. In turn, this encouraged all the actors to commit to their duties and to become familiar with their responsibilities. Maintaining the high level of motivation and guiding the actors towards understanding and accepting their own electrification scheme was a major aspect during this phase.

Creating and ensuring the actors' willingness to participate in the electrification schemes and to develop their sense of ownership was essential during this period.

Voluntary community participation in each step of the project's development is a prerequisite for a smooth and results-oriented implementation. Partaking in the progress of a project constitutes an important step in building up social trust.

How was this level of participation achieved? The NGO activities were managed by an NGO based in Kupang and also in charge of up to 7 local NGOs and FOs. In some cases, however, the local NGOs and/or FOs had to be changed because of the remoteness of the site, a minor understanding of the project approach, or a low acceptance by community.

In order to avoid any misunderstandings about the facility management, the ownership, or the beneficiary of the electrification schemes, the PLD members were unanimously elected by the community with the assistance of the NGOs. Responsive discussion and the clear formulation and conclusion of the financing schemes and service/lease-ownership contracts (between PLD and users) reflect the fact that there was an identification with, and sense of ownership for, the electrification schemes.

The many field-training sessions for the PLD staff and user groups strengthened their positive attitude towards assuming responsibilities. In the case of the users, the appropriate use of electricity was a major issue of importance for the PLD management and the project objectives.

Competent and experienced partner NGOs must be carefully selected and their fieldwork must be controlled and closely supervised. This emphasises the need for a local project manager for the duration of the project. A careful assessment of field officers' achievements and routine discussions with the communities by the local project manager can facilitate quick reactions to any shortcomings experienced in the field.

The appropriation of the project by the community, an important issue for the project's sustainability, was stressed. Each household (bottom-up) was given the choice to join the electrification scheme at their own free will. Nobody was forced to join the scheme (top down) nor was anyone connected if he/she was unwilling.

Both women and men participated in the Focus Group Discussions (FGDs) that were initially conducted. Both male and female Field officers that were living in the villages during project's implementation, were selected. Both men and women also attended the discussions on the electricity service contracts and both contributed to the final conclusion. In addition, house installations were mostly made based on the recommendations provided by women.

Village workshops, neighbourhood discussions, training sessions, and the establishment of a village-based management unit (PLD) were all essential in ensuring a high level of community participation and social trust.

Agreement on objectives and a participatory decision process (individual choice) are also two essential cornerstones for earning social trust. For example, the objectives of the electrification schemes were provided in electricity service contracts for the approval of the users and the PLD.

Besides establishing the PLD organisation, the project team was also deeply involved in enhancing the project's operation in promoting its mission to manage the electricity services in the villages. The technical reliability of the system and the meeting of local expectations was a prerequisite for increasing the awareness of the electricity services provided by the PLD. In most cases, the expectations were met. If these expectations were not met, there was a high risk of institutional failure and social mistrust. Indicators such as an active communication between the PLD and GOI and/or EPO, the rejection of an interconnection with the national grid, an open criticism for some technical issues, among others, showed that the PLDs and the communities developed a strong sense of ownership and trust for their electrification scheme.

5.2.3 Income Opportunities

Poor people in remote areas pay a disproportionately greater share of their income for their more expensive daily energy costs. As a result, they are unlikely to accumulate the wealth needed to invest in energy saving equipment. Furthermore, poorer people flock to the cities in search of jobs. The positive attributes of migration can be achieved and the negative impact avoided if similar job opportunities are created locally, in the rural communities. The project addressed this issue by establishing the rural electrification management at the village level.

The project created about 4-6 additional jobs per village and the opportunity to work for the newly established PLD.. About 50 % of the new, monthly cash income from these jobs is sufficient to cover the monthly electricity fees. Furthermore, agriculture, livestock, handicraft activities can be continued as before and even better.

Some of the PLDs operated kiosks providing the necessary spare parts, appliances (provided by the contractor up-front), and day-to-day commodities (planned) to generate additional income to pay for their electricity bills. The commitment of the contractors for after-sales-services (paid by the PLD, included in the FSA) was essential in this context for ensuring a competent and trusted partnership.

Neighbourhood and family meetings, weddings, etc. can now be held at night. Economic activities like wood carving and threading for weaving can now also be extended into the evening or night.

Income-generating activities (IGA) among IGA groups (consisting of customers) were initiated to provide additional cash income to pay for electricity services. Two types of IGAs were developed in parallel; one by the E7-1 project directly (IGA/E7) and the other (TUP) by the NGO using financial resources provided by a third party donor[1]. Both activities took the local agricultural potential and traditions into consideration.

Nevertheless, it must be realised that when developing electrification under these conditions, penetration limitations can be faced because of economic reasons. The usual high up-front costs of electrification (even with subsidies) make its purchase difficult, even if the long-term energy rationale and related benefits are well understood. For many in remote, rural communities, electricity is still not a first priority. However, the renewable energy option is the choice that provides better benefits.

A positive experience with the income generating activities (IGA) in the SHS sub-project may lead to a new concept with a more global approach for remote rural electrification. If the IGA and the region's electrification develops together, cash potential for the local communities can be increased. However, before any decisions are made, there must be a base assessment of the local potential in terms of farming, cattle breeding, handicrafts, available manpower, and most importantly, the capacity of the local markets.

[1] An international non-profit organization based in New York, known as the Trickle Up Program helps low-income people start small businesses to help themselves out of poverty.

6. Operation

6.1 Operation and Management

The monitoring and evaluation of the performance of this AIJ pilot phase project have not yet been decided. After the commissioning and guarantee, the PLDs are responsible, like other private enterprises, for their technical and financial results. However, the evaluation of these results for the purposes of extracting technical and non-technical lessons is another question.

So far, a possibility for an extension of the PLD service area in some cases has been observed. Some 10-15 additional SHS could be promoted to new customers in local markets through a partnership between the PLD and a contractor. All related payments are channelled to the contractor through the PLD, thus creating incentives for the involved parties. There is also the possibility for the PLDs operating the MHPs to electrify some 80 additional households that were not covered by the project implementation..

Problem Solving. Direct contract relations, prompt reply to technical problems, and intensive on-site monitoring during the implementation phase are not sufficient to avoid discrepancies between the actual and expected results. If this is the case, strong decisions should be taken and delivered, even if unpopular.

SHS: Routine technical inspections were conducted every 2 months during the guarantee period as well as other inspections conducted based on reports about failures that were submitted by the PLD. The technical problems were all solved within a few days, as stipulated in the procurement contract. Better cooperation with the local supplier could motivate and strengthen the PLD to improve their service performance towards the customers.

The PLD and the local supplier have agreed on an After-Sales-Services (written agreement) contract to be renewed every 6 months. Both parties have committed to this agreement thus far, and their respective work procedures, cost reimbursements, etc. have all been to the satisfaction of the project.

As a result of the SHS, the kerosene consumption for lighting has been reduced considerably. Before a typical SHS project, a household uses an average of 3 lamps with a consumption of 15 kerosene bottles per month, whereas with a SHS, the kerosene consumption for lighting is reduced to a minimum.

More than a year of operation results for the initial SHS scheme indicate that the PLDs are able to manage their facilities, satisfy the expectations of their users, properly document activities, and satisfactorily manage the funds.

HS :

The PLDs were trained to conduct regularly scheduled monitoring of the HS and LV distribution network. Monitoring forms are periodically filled-out that summarise the results of the system's performance. The forms are submitted via an intermediary to the task leader.

The HS is running according to the design expectations. Nevertheless, after the first month which was free of charge, the users reduced their consumption progressively. Generally, the first electricity bill has an impact and may reduce the average consumption, However, little by little, as the benefits of electricity are realised, the gap increases between expenses for the bills and the new profits due to increased economic activities and consumption levels increase slowly. This dynamic process is typical of new consumers that have never used electricity.

Meters. Providing electric energy to users requires the use of meters in order to collect any revenue. Electricity without meters leads to uncontrolled demand growth and unfair electricity billing.

MHP:

Some initial problems were encountered and dealt with quickly such as when the replacement of malfunctioning MCBs was reported and the subcontractor promptly replaced them under the guarantee.

Furthermore, some villagers and local operators from the PLDs coped with a few initial technical problems such as water leakage and small landslides by using their traditional skills and the maintenance manual. As a result, with the PLD's efforts, the number of connected houses has increased as has the bill collection.

At the Taba site local residents highly appreciated E7 MHP system reliability because the MHP rarely had outages though it is located in deep mountain area.

6.2 Commissioning and Handing Over

The consolidation phase began after the construction was concluded and the systems were commissioned and set into operation. The SHS sub-project was commissioned in March 1999, the MHP sub-project was commissioned in February 2000, and the HS sub-project in July 2000. Within days after commissioning, the transfer of ownership of the sub-projects from the E7 to the DGEED was achieved.

Guarantee matters were handled according to the terms stipulated in the handing-over arrangements, the procurement contracts, or the EPC contracts. The transfer of ownership between the DGEED and the local government (PEMDA), including all

technical responsibilities was also concluded. The PLDs were also authorized to operate and manage the facilities until the ownership is officially handed over to them.

The official inauguration of the projects by representatives from the government underlines the importance of the projects to the community. This event, essential to creating a sense of ownership within the community, has only been done for the Kualeu rehabilitation project.

Contracting. Clear understanding and agreement on technical specifications before signing the contract didn't represent a guarantee, but allowed to discuss at site and during commissioning in a strong position. Public bodies manage the overwhelming majority of projects with inadequate quality control and compliance with technical specifications. A single project cannot change/improve procedures and technical culture of local companies.

SHS: The commissioning of the 100 SHS in many different locations was performed by two teams, within two days. Incorrect and inadequate house numbering on the reports made by the commissioning teams caused difficulties. The commissioning had to be repeated in order to match the number of installed systems to the number of households.
The final commissioning results showed only a few minor technical shortcomings, according to the specified services and procurement. All items were improved/repaired on the spot.

All SHS are operating according to expectation. An analysis of the technical problems encountered in one village that was documented during the first year of operation shows the following component failure: BCU (1%), batteries (2%), battery accessories (2%) and lamp inverter (0.3%). Repairs were executed under guarantee.

HS: E7, and EPO, Contractors, PLD and GOI representatives carried out three days of detailed inspections along with the commissioning of the hybrid system. Jointly signed reports were provided showing a list of works not in accordance with the specifications and the required improvements. A second commissioning was successfully carried out by the EPO in order to verify the total compliance of the requested improvements in relation to the specifications.

Some failures occurred with components that were provided by the contractors (mainly capacitors for reactive power correction of neon lamps and MCB). The PLD handled the ordinary maintenance and reported the troubles they encountered requesting the contractors to do the repair. The components were repaired within the following weeks. To date, operational results indicate that the HS is running in accordance with design expectations.

Commissioning: Experience shows that technical problems encountered during operation can be minimised if a strict and comprehensive commissioning is performed based on the verification of each detailed item and specification. The client must have control over the construction details in order to avoid any interpretation or generalisation by the local contractors.

MHP: From February 2-9, 2000, after the construction phase was completed in January, all of the representatives from the DGEED, E7, contractors, and the PLD/EPO joined the detailed inspection of the three MHPs in Sulawesi and the MHP in Waikelosawa. This inspection included both an operation and a running test with each party filling out Test Checklist Forms at each site.

On February 10th, both the DGEED and E7 representatives confirmed that the MHPs were technically completed and ready for full operation. Both parties signed the document entitled “Agreement on Transfer of Ownership” for the transfer of ownership to the DGEED.

The transferred power generation output of each site and the number of electrified customers are shown below.

Site	Output	Number of Customers
Taba (Sulawesi)	50 kW	202
Tendan Dua (Sulawesi)	69 kW	158
Bokin (Sulawesi)	12 kW	69
Waikelosawa (Sumba)	15kW	Electricity is sold to PLN through an inter-connection.

(As of Feb.10, 2000)

Micro-Hydro-Plant (MHP) Taba – Powerhouse, headrace and penstock

7. Activities Implemented Jointly (AIJ)

In December of 1996, the State Ministry of Environment (KLH) and the E7 agreed in a Letter of Intent to implement the project(s) under the AIJ-Pilot Phase according to the principles of the UNFCCC.

The baseline alternative to this project was the business–as–usual scenario under which:

- The households would continue to use a combination of kerosene for lighting and diesel-based battery charging for other end-uses
- The village co-operatives would operate off-grid diesel generators to provide electricity to health stations, schools, small isolated village grids, etc.

This scenario was compared to the planned situation, where:

- 194 households changed from kerosene and batteries to electric lighting and photovoltaic-based battery charging for other end-uses. Electricity is provided by 50 Wp SHS per household.
- Five village co-operatives are operating four micro hydro power plants and one photovoltaic/wind hybrid system instead of diesel generators with an equivalent capacity.

The calculation of the CO_2 offset resulting from the use of a SHS instead of the conventional appliances mentioned above is about 522 kg (maximum) CO_2/a or 1519 t CO_2 for 194 SHS over an expected panel lifetime of 15 years.

The resulting CO_2 offset from the MHPs is about 3180 t/a (after the initial phase) and almost 33,000 t for the four systems (total project) over the expected lifetime.

The resulting CO_2 offset from the HS is almost 49 t/a (after the initial phase) and 993 t over a lifetime of 20 years.
In July of 1999, these results were submitted in an AIJ Report for approval by the national Governments of the E7 companies and by the Government of Indonesia in the UNFCCC Uniform Reporting Format (URF).

The Government of Germany and the Government of Indonesia have approved the project as an AIJ Project (GOI on September 2, 2000). Following this approval, the Project was submitted to the UNFCCC where it was also approved as an AIJ Project. It will appear soon on the next updated List of AIJ Projects at the beginning of 2001.

After all of the sub-projects have been implemented, the environmental impact situation can be summarised as follows: The main parameters are changing with the number of clients and amount of consumption per household. For this reason, at least in the initial phase, the figures are varying even if the overall impact is not substantially changing the total of CO2 avoided.

After the AIJ Pilot Phase was established at COP 1, the E7 decided to use the project as an example for the viability of AIJ and each E7 member companies decided to provide funding.

Important questions remain: Does the project satisfy the fundamental criteria for AIJ projects? Which are the basic criteria according to UNFCCC?:

1. Compatibility with national priorities
2. Approval of the Governments of the participating parties
3. Environmental benefits
4. Additionality
5. No credits for emissions avoided

Responses:
1. The project is compatible with the national priorities as stipulated in the National Plan (Repelita).
2. The Governments of the participating entities approved the project as an AIJ
3. 'Real, measurable, and long-term environmental benefits' which would not have occurred in absence of the project are evident. However, measuring this is difficult. For instance, the long-term benefits have to be proven over time and the project has only just started.
4. The financing is additional because the project would not have been realised without the AIJ aspect.
5. No credits resulting from the reduced emissions were given to any party involved.

A lack of experience in rural electrification projects and AIJ within the E7 and the relevant Indonesian Authorities made the project difficult to start. Future AIJ (or post-COP6 CDM or JI projects) projects should be designed taking into consideration the lessons learned in this document. Furthermore, local authorities should be actively involved from the beginning. There are now about 140 pilot projects worldwide that have contributed to a better understanding of the Kyoto Mechanisms.

In addition, the rules of the AIJ process were difficult to co-ordinate within the E7 (with 8 investing parties and 6 governments involved). The internal rules between investors should be very clear before implementing a project.

The main goal of the project, to gain experience with the Kyoto Mechanisms and its related political aspects, was achieved and the E7 has shared its experience extensively with other companies and organisations.

Some deviations between the realities of the project and what is outlined in the URF have been observed. These deviations (whether negative or positive) should be observed, reported, and compared to the planned CO2-avoided objective or other objectives. Therefore, this reporting requires defined responsibilities and a monitoring procedure, items which do not yet exist for AIJ projects. A possible

monitoring phase for this project may be able to provide more input on how to develop these procedures and measurable indicators.

The baseline, or base case, should be discussed in detail with the local authorities responsible for AIJ and CDM projects. In the case of E7-1, there were no comments from the Indonesian side concerning the assumptions for this project. It would have been useful to discuss or share experiences before, or during the development of the URF.

The environmental additionality of the project is difficult to determine because the project was developed with many different objectives in mind.

The sustainability of the project also cannot be fully assessed because it has been in operation for such a short period. The measurement of sustainability in terms of environmental, social, and economic impacts is an open issue that requires monitoring on a medium to long-term scale. Possible indicators for this assessment are being developed for the above-mentioned potential monitoring phase.

Due to the difficult circumstances of the project, the transaction costs have been high. This has led to extremely high costs per ton of CO_2 avoided. Furthermore, Emission Reduction Credits (ERCs) have not been integrated into the financial reports (by definition the question and use of ERCs were not permitted during the AIJ pilot phase anyway).

Renewable energy projects are of interest to JI/CDM. But they have to be examined very carefully against the background of the world wide discussion and the UNFCCC policy.

8. Conclusion

Sustainability: What Makes the Difference?

There is no more important lesson to be learned from past rural electrification efforts than the issue of operation and maintenance (O&M). Although already well known, this issue is most often not addressed properly. It has been said that O&M is the key to determining the chances of success for an implemented technology. The E7-1 project selected a portfolio of RE technologies (solar, wind, and micro hydropower) but used the same institutional approach for each electrification scheme. The challenge was taken with the notion that the issue of “maintenance management” is the key to success rather than the issue of “maintenance” itself.

The E7-1 financing schemes were recommended to the community but not imposed. The users then decided on a financial option to select after having received all the relevant information from the players, the facilitators, and the PLD. It was concluded that those who have to take the risks should have the strongest voice. The final set-up showed a better understanding of the scheme and of its management and technology.

In most cases, the recommended yearly payments could be sustained; only the payment mechanism was adjusted to the local environment (yearly-monthly payments, capacity-energy payments). It can be concluded, however, that if the promoted expectation are fulfilled, the community’s willingness to fulfil their own commitments is rather high.

Projects in remote locations definitely require the involvement and support of the local people. With the appropriate financial scheme, a community-based institution can have the capacity to take care of the O&M services, under the supervision of the village authorities (technical and management) with the bills collected from the users.

The communication of views, positions, objections, and activities from the players to the actors requires competent expertise. Local NGOs are considered to be the most suited for this challenging role. However, the results are only as good as the efforts put into the supervision and control of both the NGO’s activities and their interpretation of objectives within the project environment. Constant, on-site supervision by the FO in the villages allows for the necessary flexibility and any in-progress adjustments.

Procurement of reliable technology, competent construction, and rigorous commissioning, in accordance with clear specifications and documents, is a precondition for successful rural electrification projects.

The PLD technicians and user groups were trained according to their capabilities, with the appropriate and innovative training materials, and an approach tailored to the project environment.

As a result, the PLD services (O&M, replacement) were executed to the satisfaction of the users. Fast repair services (well-organized after-sales-service) increased the communities' trust and confidence in the PLD management. Consequently, their willingness to pay for services increased and they are very close to achieving the financial scheme.

The PLDs were also able to manage the rural electricity and administer after-sales-services in a documented way and based on routine management procedures. The PLD's acceptance by the community was because this trusted, village-based, micro utility managed the rural electrification scheme in a "transparent", "competent" and "reliable" manner. The community expressed acceptance of the PLD with settled payments and a dramatically increasing service demand.

A capable and reliable local resident manager is essential to the success of the project. He or she must be a coordinator with regional experience that knows the laws and cultures of the region. The local resident manager is the interface between local bodies and the national Government, supports the project logistics, and is in a position to link the technical with the non-technical activities.

Clear, rigorous, and realistic technical specifications are also needed for achieving the best results. Flexibility and the ability to face unexpected situations, without compromising the project, are also key to success.

Domestic safety laws and standards must be applied in order to comply with national regulations. However, when domestic technical standards appear not to be adequate, IEC and/or ISO standards should be applied. Nevertheless, local habits practices should be taken into consideration wherever possible, so long as they do not compromise the quality of safety, performance, and long-term reliability of the system.

Whether or not the project is successfully completed and remains sustainable largely depends on the involvement of local residents in terms of project-related decision-making (i.e.cash outlays, operation & maintenance learning process) and on the effectiveness of the PLD.

It is recommended that externally assisting parties maintain the role of an observer. Otherwise, they run the risk of becoming entangled in complex, multi-ethnic, and multi-religious situations such as found in regions like Indonesia.

MHPs, unlike HS, use more traditional and long established technology. Therefore, the employment of locally available technology and equipment gives MHPs the chance to achieve technical sustainability. Although the fact remains that some

locally available parts can still malfunction or cause quality problems, we still favour the use of local parts because of their easy application and maintenance.

The Project satisfies the requirements of an AIJ Project in that it is compatible and supportive of national environment and development priorities, it has been approved by the Governments of the parties concerned, it brings real, measurable, and long-term environmental benefits, and the financing is 'additional'. However, the long-term sustainability still has to be proven since the major components were only commissioned in 2000. The relatively low quantity of CO2 avoided in this project is typical for a decentralised, rural electrification project of this size.

List of Abbreviations/Acronyms

AIJ:	Activities Implemented Jointly
BFS:	Bankable Feasibility Study
BPPT:	Agency for the Assessment and Applications of Technology
CD:	Community Development
CDM:	Clean Development Mechanism
CM:	Community Mobilization
CP:	Community Participation
DGEED:	Directorate General of Electricity and Energy Development
EPO:	E7-1 Project Field Office, Kupang
FGD:	Focus Group Discussions
GHG:	Green House Gas
GOI:	Government of Indonesia
HS:	Hybrid System
IPP:	Independent Power Producer
KLH:	Indonesian State Ministry of Environment
LV	Low Voltage
LOI:	Letter of Intend
MHP:	Micro Hydropower
MM:	Minutes of Meeting
MOU:	Memorandum of Understanding
NGO:	Non Government (Non Profit) Organization
NTT:	Province of East Nusa Tenggara, Indonesia
PLD:	Village Utility (Perusaan Listrik Desa)
PLN:	PT. PLN (PERSERO) = National Electricity Company
PM:	Program Management
PMU:	Project Management Unit
POA:	Plan of Action
PU:	Department of Public Works
QM:	Quality Management Guidelines (ISO 9000)
RE:	Rural Electrification
REPS:	Rural Electrification Planning System
REPLASYS:	Rural Electrification Planning System in PLN
RER:	Renewable Energy Resources
RPM:	Resident Project Manager / Kupang
SEI:	Socio-Economic Integration
SFC:	Self Financing Concept
SFM:	Self Financing Model
SHS:	Solar Home System
SHIS:	Statistical Household Income Survey
UNFCCC:	United Nations Framework Climate Change Conventions
URF:	Uniform Reporting Format
WB:	The World Bank
WTP:	Willingness to Pay

ANNEXE

1 . Short Technical Design Specification of Equipment Installed:

Solar Home Systems (SHS)

PV modules:	Siemens SR50 – 50 Wp
Battery charge regulator:	Siemens SR08
Battery:	12V 100Ah

Micro Hydro Power Plants (MHP)

Site: Waikelosawa, Sumba Island

Max.Output:	15 kW
Available Discharge:	0,5 m3/sec
Head:	5,706m
Plant type:	Ground type
Turbine:	Skat T-12 cross flow turbine
Generator:	23kVA
Distribution:	20kV 600m

Site: Taba, Tana Toraja Province, Sulawesi -Selatan

Max.Output:	50 kW
Available Discharge:	0,25 m3/sec
Head:	35,0m
Plant type:	Ground type
Turbine:	Skat T-12 cross flow turbine
Generator:	73kVA
Distribution:	20kV 2600m
	380V 5080m

Site: Tendan Dua, Tana Toraja Province, Sulawesi-Selatan

Max.Output:	69 kW
Available Discharge:	0,35 m3/sec
Head:	30,0m
Plant type:	Ground type
Turbine:	Skat T-12 cross flow turbine
Generator:	85kVA
Distribution:	20kV 1100m
	380V 4000m

Site: Bokin, Tana Toraja Province, Sulawesi-Selatan

Max.Output:	12 kW
Available Discharge:	0,10 m3/sec
Head:	22,85m
Plant type:	Ground type
Turbine:	Skat T-12 cross flow turbine
Generator:	85kVA
Distribution:	20kV 0m
	380V 2000m

Hybrid System

Site: Oeledo, NTT, Rote Island

PV field:	256 modules, nominal power 21,8kWp
Wind generator:	three blade wind turbine AC power 10kW
Battery storage:	120 Pb-acid elements, C10 capacity of 144kWh
Inverters:	two 20 kVA self commuting converters
Diesel generator.	Back-up, 20kVa
Battery charging station:	three 12V output battery chargers