LESSONS FROM THE FIELD

AN ASSESSMENT OF SIBAT EXPERIENCES ON COMMUNITY-BASED MICROHYDRO POWER SYSTEMS

Sibol ng Agham at Teknolohiya (SIBAT)

Sibol ng Agham at Teknolohiya (SIBAT)

in collaboration with

Evangelisher Entwicklungsdienst e.v. (EED) and **MISEREOR**,

and production assistance from

Voluntary Service Overseas (VSO)

LESSONS FROM THE FIELD:

An Assessment of SIBAT Experiences on Community-based Micro hydro Power Systems

Authors:
VICTORIA M. LOPEZ
JOVITO L. BENOSA
JENNY B. MONTEAGUDO
REINHOLD METZLER
GARETH LEWIS

Publisher:
Sibol ng Agham at Teknolohiya, Inc. (SIBAT)
4F/5F 40 Matulungin St., Bgy. Central,
Diliman, Quezon City, Philippines
P.O. Box: 1519 CPO Quezon City, Philippines
Tel: (632) 926 8971
Fax: (632) 928 8316
E-mail: sibat01@pldtdsl.net
Homepage: http://www.sibat.org

LESSONS FROM THE FIELD

AN ASSESSMENT OF SIBAT EXPERIENCES ON COMMUNITY-BASED .MICROHYDRO POWER SYSTEMS

Sibol ng Agham at Teknolohiya (SIBAT), Inc.

ACKNOWLEDGEMENT

This wealth of evaluation is a collective task undertaken by SIBAT and through its Renewable Energy Program. With heartfelt appreciation, SIBAT extends its thanks to the communities, partner agencies and individuals that made this study possible notably, the following:

- The ten POs or community organizations – which, in their genuine desire to address a basic need, have emboldened them to harness an indigenous local resource and undertake these community-based renewable energy systems. Their resolve and persistence have been key elements in the success and continued demand for similar CBRES replications across the countryside;

- The partner NGOs, local government units and respective dioceses that have labored with us not only during implementation but also at every project beginning, monitoring and trouble-shooting. Their participation in this study has further enriched and deepened the meaning of partnership;

- The funding institutions and resource agencies – in particular, the Department of Energy (DOE) and the UNDP Global Environment Facility-Small Grants Programme. Without their trust and continued support, we would not have made modest yet successful strides at renewable energy development, promotion and advocacy;

- The former student volunteers (OTP and YFD) namely: Christopher Parkin, Oliver Riley, Alice Tedd, Sonia Duarte and Gareth Lewis – who individually, have journeyed to the remote project sites and embarked on the task of project documentation. Their project feedback and remarkable work became the launching pad for this evaluation; and

- The *Evangelisher Entwicklungsdienst e.v.* (EED) and MISEREOR for the program and institutional support by providing the financial grant so we can undertake this evaluation.

- The Voluntary Service Overseas (VSO) – Philippines, through the European Commission, for financing the production-printing of this publication.

Above all, we are grateful to Mr. Reinhold Metzler for his assistance rendered, for his helpful comments and insights in this evaluation as well as his suggestions on further improving our work and program delivery. His patience and tenacity in numerous revisions and editing of this material has rubbed off to the SIBAT staff proving once and for all, the endless process of learning and relearning.

Again to all of you, ***maraming salamat po*!**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

Community-based renewable energy systems (CBRES) are small, decentralized power supply systems that are established through multi-stakeholder efforts distinctly with the significant participation of organized communities in project development, and are owned, managed and sustained by their local organizations. These community-managed systems do not only provide lighting for the households, but also provide the energy for food and crop processing and livelihood needs for rural households.

SIBAT has facilitated the establishment of these systems since 1994. The first collective effort by seven SIBAT members resulted in the Philippines' first community-based Microhydro Power (MHP) in Ngibat, Tinglayan, Kalinga, in 1994. The successful installation and continuing operation of the Ngibat MHP encouraged SIBAT to sustain the efforts of establishing CBRES.

Until 2005, SIBAT has installed 14 community-based MHP systems and six (6) photovoltaic water pumping (PVWP) systems - considered as the technology niches of SIBAT in rural RE development.

SIBAT regards the period from 1998 up to the present as the initial phase of its RE efforts - the testing and development of the CBRES strategy. It began the work in 1992 with concepts and principles laid down by the project partners and helped translate these into actual projects. There is now a need to review the development process and outcomes of these projects.

SIBAT would like to further develop specific areas to improve its RE work on the ground, according to results of initial studies done. Some areas initially identified for strengthening are: multi-stakeholder organizing, the capacity of SIBAT to do a wide range of RE options for varied conditions, livelihood or economic applications backed by financial and economic studies and innovative resource generation.

Objectives of the Assessment

SIBAT conducts this assessment of over a decade-long RE experience along an overall goal to further develop the CBRES concept in order to enhance its significance in Philippine rural development, and sustainability as a strategy for rural development.

The specific objectives of the assessment are:

Firstly, to understand and assess those factors that are crucial for the *significance* and *sustainability* of the program;

Secondly, to assess the *effects and impact* of the CBRES projects in terms of: [1] the community, groups and individuals; [2] the local socio-economy; and [3] the environment; and

Thirdly, to develop a *best practice approach* to sustainability and significance specifically focusing on financing models, ownership models, and energy end-use models;

The study focuses on the community-based MHP experiences, deemed substantial to meet the objectives discussed below. The MHP experience carries significant community and multi-stakeholder processes sufficient to reveal insights on a CBRES. Due to the different processes with the photovoltaic water pumping or PVWP, it was recommended to look at the latter in a separate study.

Framework of Analysis

The analysis of the effects of SIBAT's CBRES projects follows a *plan/input-output framework*, where the findings on project outputs are examined against the original plans and inputs.

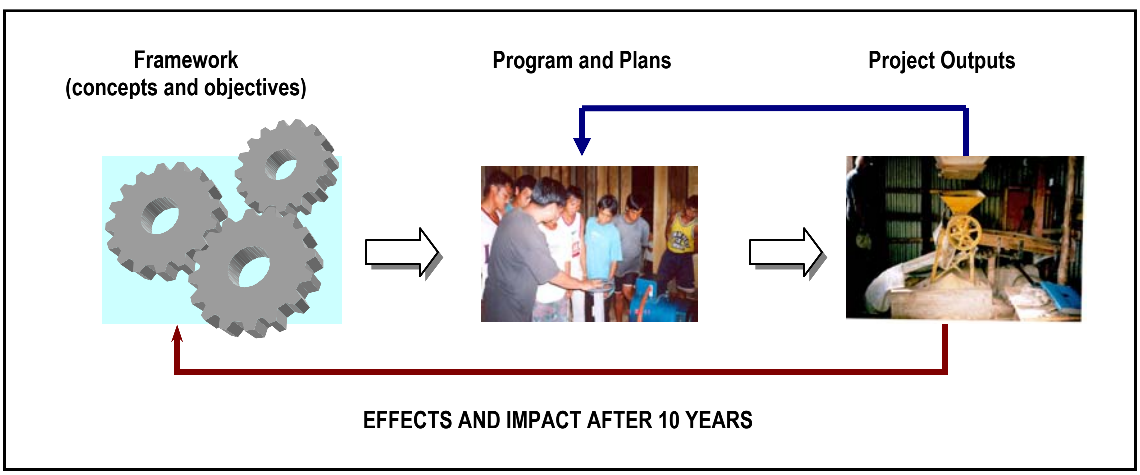


Figure 1. *Study Framework of Analysis*

The above framework suits the summative nature of the assessment (within the 10-year timeframe), where the findings are aimed to help further develop the program in the succeeding phases.

This study looks at effects of the CBRES projects viability and appropriateness of the CBRES to general rural conditions through its effects on households, community, socio-economy and on the environment. Any potential of the CBRES to aid socio-economic development in poor rural communities is deemed to be already be emergent and visible at this stage, and would be revealed by the findings. Hence, models of performance can already be derived from here.

Effects of the CBRES projects on the individual households and community were explored through some changes in social patterns. The effects on the conditions of women were mainly through changes in farm and house work pattern. Effects on socio-economy were through some changes in income directly related to the appropriation of the technology and their uses. Effects on the environment were examined, in terms of the watershed improvement and care that were undertaken.

Significance and Sustainability

The analysis framework springs from the basic concept that the CBRES is a development undertaking by poor organized communities. The concept has the following components, as designed by SIBAT:

- real and direct socio-economic benefits to poor households and communities based on needs with attention to the well-being of women and protection of the environment;
- capacity of the PO and other stakeholders to develop and sustain the CBRES;
- technical sustainability; and,
- financial sustainability.

These components can be summed by two major development indicators, which are: the *significance* and *sustainability* of the CBRES. Two focused questions were examined: *Did the CBRES yield significant changes to the socio-economic lives of the rural people? Can the CBRES be sustained by their community owners and managers?* The two indicators of *significance* and *sustainability* are then further detailed into seven sub-indicators and their corresponding parameters:

Table 1. *Indicators and Parameters for CBRES Assessment*

	Indicators	Parameters
Applications or End-Uses	The range and extent of applications used, the constraints posed by the specific conditions in the area, and the specific benefits derived and the changes that result within the household and community	▪ Range and types of applications ▪ Management of applications ▪ Capacity and utilization rate of scheme
Technology appropriateness	The effectiveness and efficiency of the technology based on performance, and the management of the scheme to attain effectiveness and efficiency	▪ System performance and status. ▪ System efficiency ▪ System downtime and problems
Financial sustainability	The income-expenses report and the analysis of the conditions that give rise to said	▪ Income and expenditures of system operation

	performance, and the capacity to pay in the context of cash-strapped conditions of the rural poor	▪ Tariff valuation and structure ▪ Capacity to pay by households
Roles, management and ownership	The roles of the various stakeholders, that contribute to the realization of the project, the varied aspects of management and their interrelationship that would describe the nature of performance, and the manifestations of the community's sense of ownership	▪ Types and roles of stakeholders in different stages of projects development ▪ Aspects of management ▪ Management efficiency ▪ Ownership issues
Capital cost and financing of the undertaking	The capital costs and its picture in a collaborative situation, the operation and maintenance costs and their relation to system management, and financing sources for capital cost and sustainability	▪ Capital costs compared to benchmarks ▪ Operation and Maintenance costs and management ▪ Financing types, opportunities and limitations
Capacity building for technology management	Training inputs and their outcome	▪ Training types and modules ▪ Training efficiency ▪ Outcomes
Environmental management and protection	Inputs to watershed management and conservation and effects on resource sustainability and community practice	▪ Watershed plans and activities ▪ Outcomes

Scope and Methodology

Ten (10) MHP projects were selected to comprise the sample for the research, selected against the criteria that they had each been operating for at least 4 years.

Table 2. *Samples for the MHP Assessment*

MHP Site	Province	Age (years)
Ngibat	Kalinga	12
Tulgao-Dananao	Kalinga	8
Balbalasang	Kalinga	6
Lon-oy	La Union	6
Tabuk	Kalinga	6
Kapacnaan	Nueva Viscaya	2
Buneg	Apayao	5
Katablangan	Apayao	5
Adugao	Abra	5
Caguyen	Abra	5
Kimbutan	Nueva Viscaya	4

The main methodology used was primary data-gathering through household interviews, focus group discussions (FGD) and key informant interviews. Data-gathering instruments[1] were designed and pre-tested, for use by local enumerators. The respondents (household, group and individuals) were selected by stratified random sampling. Data collection and analysis of findings were accomplished by a team that included senior management, the RE staff of SIBAT, and an external consultant.

Case studies were developed to clearly view the development process and outcomes of specific projects. Four (4) sites were selected for the MHP case studies, highlighted in Table 2 above.

[1] The survey instruments used for primary data gathering are found in Annex section.

CHAPTER 2
HISTORICAL BACKGROUND OF COMMUNITY-BASED MICROHYDRO POWER SYSTEMS IN SIBAT

The CBRES Framework

SIBAT formally conceptualized the development of CBRES, in a consultation convened by its Secretariat for some member organizations in 1994. This consultation was called to draw on network cooperation for the development of renewable energy in the partners' project or service areas. Seven SIBAT Network members attended the consultation comprising the initial spearhead organizations for CBRES development.[2]

The RE framework formulated in said consultation indicated the following features of a community-based RE system:

- real and direct socio-economic benefits to poor households and communities based on needs with attention to the well-being of women and protection of the environment;
- capacity of the PO and other stakeholders to develop and sustain the CBRES;
- technical sustainability; and,
- financial sustainability.

[2] Participating organizations were: Development Agency of Tribes in the Cordillera (DATC), Montañosa Research and Development Center (MRDC), Farmers Outreach Programme (FOP), Farmers Training Center/Consortium for Development, Inc. (FTC/CODEV), Indigenous Technologies Resource Station/BINHI Agricultural Resources Foundation (ITRS/BINHI), Partners In Self-Reliant Technology for development, Inc./Bicol Development Council (PARTNERS/BDC), Visayas Engineering Machine Shop (VEMS), and SIBAT.

CBRES was assumed to come within an overall integrated plan of an organized community, hence should be: (a) demand-based, where priority is given to energy requirements for production; (b) integrated with area plans and/or community development plans.

The CBRES, in the original concept, was established by multi-stakeholder efforts with PO as the main mover and the NGO as main support provider. The tasking in this multi-stakeholder setting proposed to follow a planned and organized scheme to meet the required technical and project development efficiency, yet be participative and encourages full involvement to everyone in the assigned area of work. The process should also be enabling for all stakeholders particularly for the PO.

Hence it was imperative for SIBAT to develop these norms of work in the process of developing the CBRES. It served both as technical service provider and spearhead in testing the community-based approach to an infrastructure development project.

In the community-based concept such as of he CBRES, the PO or local people's organization becomes the project owner and manager. The stake of the PO is established through the community's original stewardship of the natural resource and the peoples' contributions to the project's realization. The PO, as a main stakeholder, needs to be involved in all the project phases, from research to planning and implementation. After the commissioning, the project is turned over to the PO who manages and sustains the project.

The identified priority CBRES technologies and corresponding applications included the following:

- *Microhydro Power (MHP)* development for lighting and powering mechanical and electrical equipment;
- *Biomass* generating power from organic wastes, for heating;
- *Wind* for water pumping, battery charging and other mechanical uses;
- *Solar* for water pumping;
- *Passive solar* for agro-processing such as drying;
- *Mechanical* for agro-processing and water lifting.

The partners agreed on pooling resources and common piloting for the initial breakthrough on CBRES technologies.

Baseline studies for MHP development

It was also in 1994 that SIBAT conducted the Pre-feasibility Study (PFS) for MHP schemes in SIBAT Areas, with the support from the German Appropriate Technology Exchange (GATE), a division of the development cooperation agency of Germany or the *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)*. The objective of the study was to provide the initial information on the existence of actual demand for MHP in the country, and the technical feasibility for MHP schemes in these areas. Three regions of the Philippines were studied: the CAR or Cordillera Administrative Region, Samar in Eastern Visayas Region and the Bicol Region.

The findings of the study led SIBAT to prioritize the Cordillera Administrative Region or CAR for MHP development. The main considerations were: the abundance of river systems that possessed enough hydrologic potential for MHP utilization; the low service coverage of electrification, a large unelectrified area covering the remote barangays, and the presence of partner NGOs to support the pilot initiatives. The findings in the study also helped identify the feasibility of developing programmatic efforts in this field, and particularly helped in conceptualizing the Ngibat MHP scheme.

In 1998, SIBAT produced a study entitled 'The State-of-the-Art of New and Renewable Energy Systems in the Philippines' with the assistance of the UNDP - Global Environmental Facility-Small Grants Programme. This research was undertaken for the purpose of viewing the status of and deriving insights from the early RE experiences in rural communities of the country that would lend to SIBAT's development strategies. The study focused on the scope of the so-called off-grid areas, which then made up 45% of all barangays in the Philippines.[3]

The RE systems included in the study were PV home systems, PV battery charging stations, PV water pumping systems, wind pumps, small biogas systems and a few MHP schemes (that included SIBAT's earliest projects).

The main conclusion was that all the RE systems studied were found to be already past their demonstration and testing phases in rural communities. Their functional uses and technical reliability had already been proven to the community and household users that had already resulted in replication in some periphery areas. Some of these RE systems had been thoroughly adopted by their users, indicated by the near total replacement of the traditional kerosene wick lamps and other traditional forms of fuel found in the previous energy use patterns. The technical success of many of the schemes suggested that modular decentralized systems are compatible with rural settlement patterns and sizes, and can modestly meet village-level energy needs.

Finally, the findings provided insights that validated the original concepts of the CBRES. Small decentralized community-based RE systems, among the systems covered by the study (such as the few MHPs and PVWPs) could be managed and sustained to provide lighting for households and basic services to the community, otherwise almost completely deprived of these due to poverty and the remoteness of facilities to their villages. The findings also revealed the various factors concerning the local community that need to be given consideration (e.g., socio-economic conditions, organizational strengths and capacities) in energy planning.

Capacity building

A major highlight of RE development efforts was the conducting, in 1995, of month-long national/international training on MHP development in cooperation with the Intermediate Technology Development Group UK (ITDG-UK). SIBAT co-organized this event, attended by participants from its partners, representatives from the Philippine DOE, academe and other civil society organizations in the country, and a number of international trainee-participants.

[3] According to Philippine DOE figures.

The comprehensive training was given by experts in MHP development from ITDG, the Germany-based consultancy FAKT and others and covered both technical and social aspects. The *technical* section covered: (a) hydrology and civil works; (b) turbines and drive systems; (c) generators and controllers; (d) electrical distribution; (e) workshop and manufacturing). The *social* aspects included: (a) rural energy planning; (b) planning a MHP scheme; (c) socio-economic feasibility; (c) financial viability; (d) management capability; (e) operation and maintenance; (f) end uses; (g) energy options; and (h) institutions and policy studies; and (I) NGO failures and successes.

This training was a milestone in MHP development in the country, as many of its graduates, in both the DOE-ANECs and NGOs, proceeded to take on MHP development in their respective areas. Two of SIBAT's current program staff were graduates of the said training.

Piloting

The first CBRES pilot project was successfully installed in an indigenous community of 38 households in Brgy. Ngibat, Kalinga in 1994. The scheme was installed by MRDC (Montañosa Research and Development Center) in partnership with the PO (Ngibat Farmers Association). SIBAT assisted in the feasibility study development of the project, while the network's Cebu-based machine shop[4] fabricated the turbine. The 5-kW MHP project had since been operated, managed and sustained by the Ngibat PO.

Development of the SIBAT RE Program

SIBAT's efforts on renewable energy development for the last 8 years had been made through the Renewable Energy Program formally established in 1997 with the setting up of the Microhydro Service Center in Baguio City. It was located in Metro Baguio from where operations were supervised, staffed by a manager and 4 engineers, assisted by SIBAT administrative-finance staff.

The Center became a strategy of SIBAT to make the initial breakthrough and actively promoted MHP development in the Cordillera, following the successful piloting of the Ngibat MHP. As previously stated, Cordillera was selected for active promotion of CBRES based on the result of the SIBAT-GATE Pre FS. Through the Service Center, requests for MHP surveys in the CAR were received.

The SIBAT RE Program carried out specific activities and developed expertise through time, in implementing the projects. These activities include:

- ocular surveys and feasibility studies;
- project proposal development;
- engineering designing;
- supervision of installation and construction;
- training of operators and management;
- post-installation support (advise and repairs); and,
- facilitation of project funding.

[4] Visayas-Mindanao Engineering Shop (VEMS), a project by BINHI, Inc., also a SIBAT Network member.

SIBAT also conducted two regional meetings and one national meeting with project partners to share and assess developments and tackle issues emerging in relation to the projects.

The process of designing an RE scheme

SIBAT had evolved a methodology for developing an MHP design, the rigors depending on the size and complexity of the scheme, basically composed of three steps shown in Section 4. The methodology emphasizes the importance of community consultations in the course of the study.

Project development process

Project development for CBRES differs from the procedures of conventional contractual engineering in certain ways. The project schedule incorporates community counterpart participation in all phases (civil works, electro-mechanical and electrical), hence depends largely on the efficiency of local mobilization. The process begins from a plan that is evolved by the community members – considering their traditional work calendar and the onset of the rainy season, amongst others.

Social preparation that includes capacity building was regarded as very necessary at the implementation stage, to ensure that the PO is properly prepared and able to carry out all of their responsibilities. The implementation process that takes a minimum of one-year becomes the first step of experience for the PO before embarking on the long-term management and sustainability of the CBRES.

Roles of the PO

In the original concept, the sustainability of a CBRES is proposed to be based on the leading role by the PO as representing the community. Hence, SIBAT recognized the importance of certain minimum requirements for a qualified PO: (a) some community organizational experience and track record; (b) ability to forge a consensus among the local people to contribute labor and materials in an organized way; (c) willingness to secure assistance from the LGU and others; (d) willingness to participate in the full project process up to completion; (d) willingness to take the lead in the formulation of project policies; and (e) the willingness to manage and sustain the project after installation or ensure the continuity of the project.

Framework on project financing

SIBAT CBRES projects were mainly carried out through grants sourced by SIBAT and on one occasion, by the church partner. This grant financing scheme consists of a one-time subsidy, after which the PO carries on to sustain the project financially, i.e. produce funds for maintenance, operation and replacement of parts.

In time, SIBAT ventured into projects with components incorporating the enterprise scheme in power generation.[5]

[5] There are two MHPs with enterprise uses which are currently operational but are not covered by this assessment.

CHAPTER 3
FINDINGS ON MICROHYDRO PROJECTS

Section 1. Microhydro Power Schemes

Up to 2005, a total of 1079 household-beneficiaries in 10 barangays and 7 sitios in 5 regions of the Philippines have been serviced by 14 MHP schemes since SIBAT's renewable energy development efforts were started in 1994. Thirteen of these were installed since the establishment of the Renewable Energy Program in 1997 after the Ngibat pilot installation in 1994. Of these 14 sites, 10 were evaluated by this study and highlighted in Table 3 below.

Table 3. *Overview of SIBAT MHP Projects since 1994*[6]

MHP Sites	Province	Region	Coverage	Capacity (kW)	No. of Household beneficiaries	Date of Completion
Ngibat	Kalinga	CAR	1 barangay	5	33	1994
Tulgao-Dananao	Kalinga	CAR	3 barangays	33	264	1999
Balbalasang	Kalinga	CAR	1 barangay	20	154	2001
Lon-oy	La Union	I	1 barangay	15	78	2001
Kapacnaan	Nueva Vizcaya	II	1 sitio	5	11	2001
Tabuk	Kalinga	CAR	Private	2	Pastoral Centre	2001
Buneg	Apayao	CAR	1 sitio	7	33	2002
Katablangan	Apayao	CAR	3 sitio	10	42	2002
Adugao	Abra	CAR	1 sitio	7.5	16	2002
Caguyen	Abra	CAR	1 sitio	7.5	26	2002
Kimbutan	Nueva Vizcaya	II	1 barangay	7	13	2003
Mabaca	Kalinga	CAR	1 barangay	15	70	2003
Bagongbayan	Palawan	IV	1 barangay	21	190	For completion
Binosawan	Albay	V	1 barangay	40	148	2004
Ag-agama	Kalinga	CAR	1 sitio	20	80	2007
Dao	Bukidnon		1 barangay	20	110	For completion
Maducayan	Mtn Province	CAR	1 barangay	25	114	For completion

[6] highlighted are the sites included in the evaluation

Geographical Coverage

All of the projects are found in the major island of Luzon, dispersed in 5 regions. The 10 schemes in the study have been installed in Cordillera Administrative Region or CAR, and Regions I and II of northern Luzon. The concentration of MHP projects in the CAR area was an outcome of the decision made by the SIBAT Network in 1992 (refer to page 16, *Baseline Studies*).

The communities vary in physical accessibility or remoteness from the town centers, but are generally inaccessible by ordinary transportation during the rainy season. At the time of their installation, these communities were listed as un-energized barangays by the DOE, whereby prospects for grid connection were not planned within the next 10 years.

Demographic and Socio-economic Characteristics Communities

The 10 communities in the study are peopled by ethno-linguistic groups or indigenous peoples of Northern Luzon, mostly inhabiting the vast highlands of Cordillera Administrative Region in municipalities ranked 3rd to 5th class in economic classification.

Table 4. *Ethno-linguistic Groups in Evaluated SIBAT MHP Projects*

MHP Sites	Municipality/ Income Class	Region	IP community
Ngibat	Tinglayan/ 5th Class	CAR	Butbut
Tulgao-Dananao		CAR	Butbut and Dananao
Balbalasang	Balbalan/ 4th Class	CAR	Banao
Lon-oy	SanGabriel/ 5th Class	I	Kankanaey and Bago
Kapacnaan	Dupax Norte/ 4th Class	II	Kankanaey, Bugkalot, Kalanguya
Buneg	Conner/ 3rd Class	CAR	Buneg – Mabaka
Katablangan		CAR	Isneg
Adugao	Baay-Licuan/ 5th Class	CAR	Gubang
Caguyen	Malibcong/ 5th Class	CAR	Gubang
Kimbutan	Dupax Sur/ 4th Class	II	Kankanaey, Bago, Bugkalot, Kalanguya

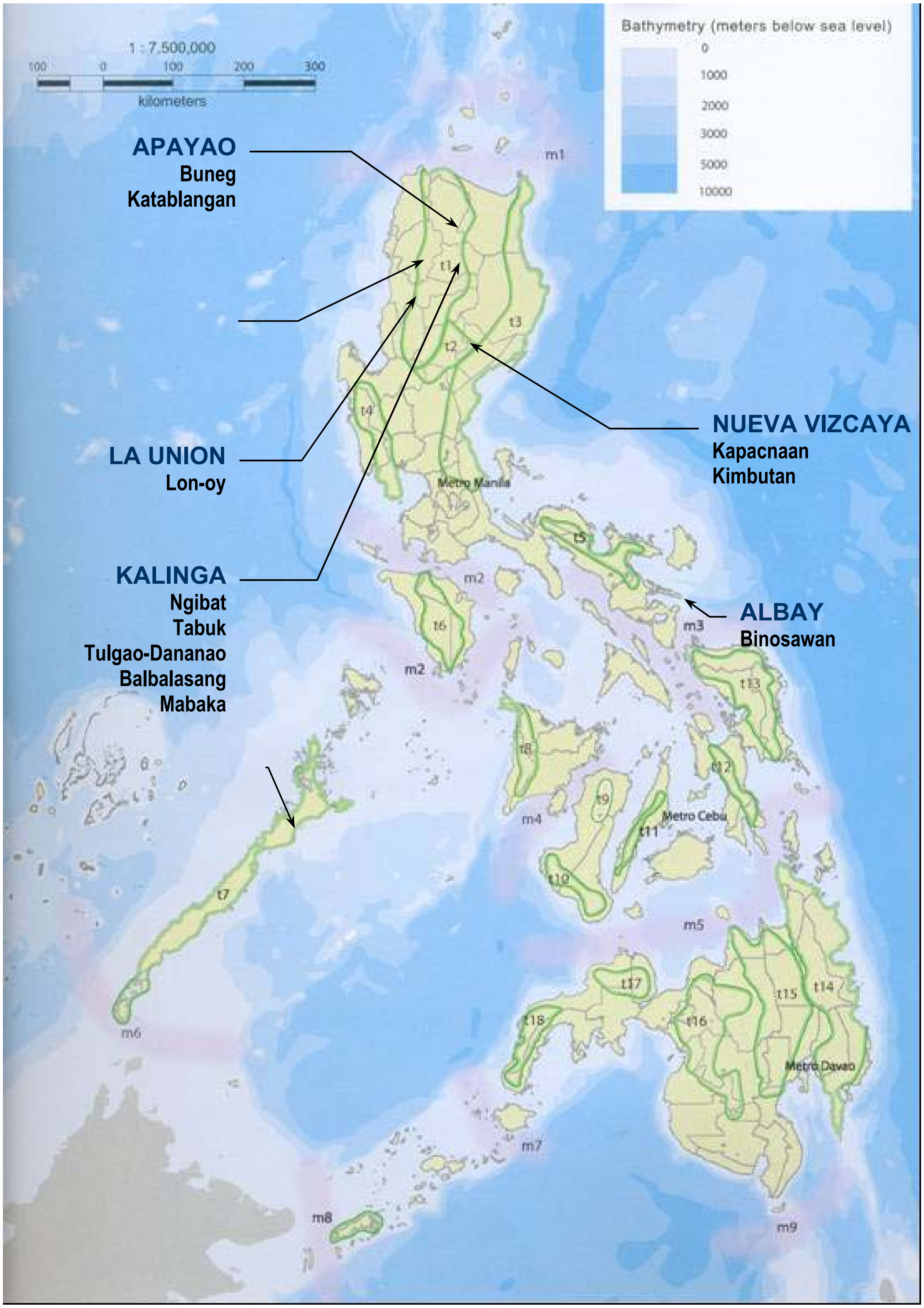


Figure 2. *Location Map of SIBAT Implemented MHP Projects*

The beneficiaries commonly live in difficult upland conditions, and are mostly subsistence farmers who are dependent on wet terraced rice and 'slash-and-burn' cultivation, known locally as *kaingin*. Terraced rice farming is done on limited lands and is dependent on irrigation water. From dry *kaingin* cultivation, the farmers produce upland rice, vegetable crops and fruits. Most areas experience rice shortages every year, called 'lean months', during when the villagers seek cash through wage labour.

Main sources of cash in these areas are classified into two types: seasonal and regular. Seasonal incomes comprise the cash sources for most and include sale of vegetables produced (e.g. legumes) in the *kaingin*, sale of handcrafted goods made from grass or forest-gathered materials (e.g. baskets and brooms), and daily wage labour in government construction projects. Regular cash incomes are derived from regular or contractual employment as barangay or municipal officials and employees, as teachers and as pensioners. Retail stores for household necessities and small cooperative projects such as the bakery project in Lon-oy also yield small regular daily income for owners. Overseas employment contributes substantially for some households. Regular income sources are found mostly in Bgy. Balbalasang and Bgy. Lon-oy.

For Kimbutan and Kapacnaan, the sale of vegetables from the terraced gardens on mountain slopes is the primary source of cash for most households. Crop production by small farmer-gardeners for market characterizes the economy.

There are no economic activities on an industrial scale in these upland areas, where household and small farm-based economic activities (for both consumption and cash) predominate. Increase in food productivity for subsistence and cash, as well as irrigation and potable water supply have been the strongly expressed needs in these communities, at the time of the project establishment and even up to the present.

Lastly, educational and health services are generally inadequate especially in the remotest project sites. Schools for secondary education, i.e. high schools, and hospitals are generally located in the town centres.

Watershed Resource of Indigenous Communities

The conditions of the watershed areas which supply water to the MHP plants vary from site to site. There are some that remain relatively untouched, such as the protected forests of the Balbalasang National Park, and are able to sustain relatively high levels of plant and animal biodiversity. Most other sites meanwhile, have suffered deforestation from varying levels of 'slash-and-burn' agriculture and slope vegetable gardening. The state of the catchment forest is critically important for MHP operation, and hence is carefully examined during the study phase of the project. The protection of the watershed in a relatively deforested area is required for a sustained supply of water to the MHP from its catchment, and hence is made a necessary component of SIBAT's MHP designs.

Table 5. *Watershed Conditions of the Evaluated MHP Projects*

MHP Sites	Region	Topography	Watershed Description	Threats to Watershed
Ngibat	CAR	Steep upland	80% grassland	Active fault line
Tulgao-Dananao	CAR	Steep upland	80% grassland	Active fault line
Balbalasang	CAR	Steep upland	Watershed is within the Balbalasang National Park	Limited expansion of kaingin area
Lon-oy	I	Upland and Sloping	Secondary growth dipterocarp forest	Denudation of forest cover due to expansion of kaingin area
Kapacnaan	II	Rolling upland	Secondary growth dipterocarp forest and grassland	Expansion of vegetable production area
Buneg	CAR	Steep upland	Secondary growth dipterocarp forest	Active fault line.
Katablangan	CAR	Steep upland	Primary growth dipterocarp forest.	None
Adugao	CAR	Steep upland	Secondary growth dipterocarp forest and grassland	Limited expansion of kaingin area
Caguyen	CAR	Upland	Secondary growth dipterocarp forest and grassland	Limited expansion of kaingin area
Kimbutan	II	Steep upland	Secondary growth dipterocarp forest and grassland	Expansion of vegetable production area

The Indigenous Peoples and Their Forest Resources

The watersheds including forest and water resources therein are important to the lives of indigenous peoples. These are regarded as parts of their ancestral domain, i.e., the resource base from which they derive their subsistence and livelihood. These resources are considered communally owned in all MHP sites, and their traditional management, utilization and protection continue to be guided (though at varying levels today) by rules enforced by the community elders. These rules cover practices such as hunting, forest-gathering, clearing for pasture use and agriculture.

This traditional bond between the community and their environment has positively helped the establishment of community-based MHP projects.

Total Capacity Installed

Total installed capacity of the 10 MHP schemes in the study is 128 kW while the total of the 14 MHP schemes so far installed is 195 kW. Of the 10 sites studied, the smallest capacity was 5kW and the largest was 33kW. These are typically small barangay and sitio schemes.

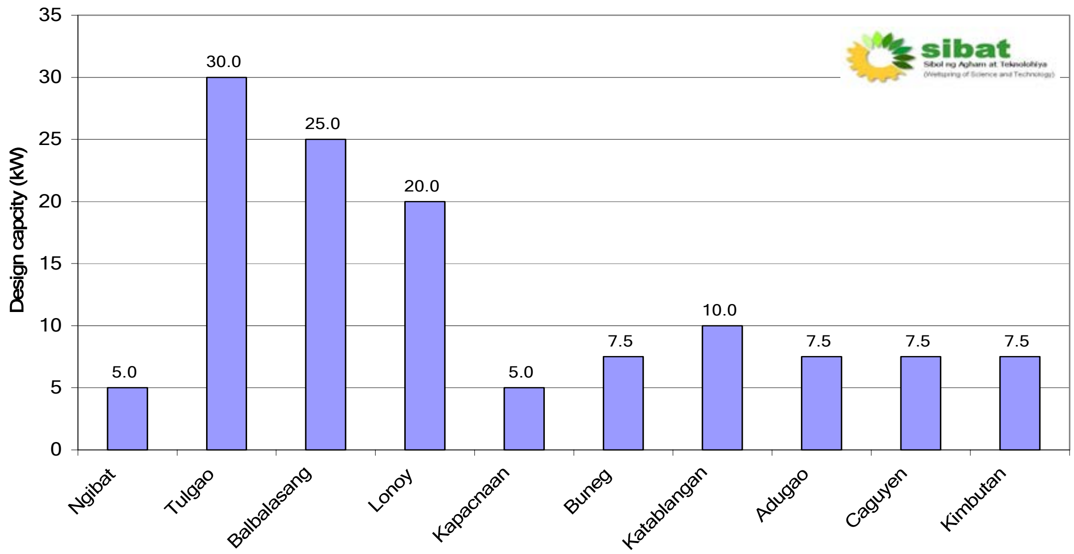


Figure 3. *Design Capacity of the Evaluated MHP Projects*

Section 2. MHP Applications and End-Uses

As described in the foregoing section, the 10 community-based MHP schemes were installed in upland conditions characterized by agricultural under productivity, food resource scarcity, and inadequacy of livelihood opportunities.

The range of uses for energy from the 10 MHP schemes, in said upland context, falls under three categories: household and village electrification, post-harvest uses, and small machine or equipment operation.

All schemes are used for village electrification, i.e. for household lighting, powering small household appliances, street lighting and lighting for barangay hall, clinics and chapel. Other end-uses are shown below:

Table 6. *Applications of MHP Power*

MHP Sites	Major end-uses (aside from lighting)	Installed power (kW)	% of plant capacity	Other Uses
Ngibat	Rice mill Sugar cane press	Direct drive	100%	Planer and other carpentry tools Blacksmithing tools
Tulgao-Dananao	Rice mill	5.5	17%	Planer Sewing machine
	Sugar cane press	1.5	5%	
Balbalasang	8 school computers	2.0	8%	Planer
Lon-oy	None			
Kapacnaan	None			
Buneg	Rice mill	Direct drive	100%	Planer
Katablangan	rice mill			
Adugao	rice mill			
Caguyen	Rice mill	Direct drive	100%	
Kimbutan	None			

Household and Village Electrification

All the MHP schemes provided electrification for households. Household uses of energy include lighting of a minimum of 2 lighting fixtures per household, and powering small household appliances ranging from radio cassettes to colored television sets, VCD players and washing machines. For systems without an electronic load controller or ELC, the use of appliances with bigger loads (e.g. automatic flatirons, washing machines) had been advised against. In smaller systems like in Buneg (without ELC), TV and video players are centrally operated by the PO.

Aside from provision of lighting to every household, the energy generated from the MHPs was also able to provide electrification to public structures such as school buildings, churches, barangay halls and clinics.

There are 6 rice mills currently powered by MHPs in the study. These are all community projects, i.e. being operated and managed by the peoples' organization.

Other uses of energy in these villages include powering small carpentry tools such as planers and high-speed sewing machines. This equipment is mostly privately owned and is used to augment cash income for the households.

Coverage of Electrification

The MHP schemes have been able to provide electrification to the majority of households in the community. The majority, if not all households, within the transmission range were easily covered by the facility. The farthest sitios however, could not be reached by transmission lines because of either excessive cost of transmission and power loss along transmission lines.

Three of the evaluated projects, Tulgao-Dananao, Kimbutan and Lon-oy show less than 100% electrification coverage. For Kimbutan and Lon-oy, the principal reason is the inability of some households to shoulder the cost of household installation. The POs in these communities made it a policy that the households who failed to provide labour counterpart should pay a connection fee equivalent to the amount of labour contributed by each household during construction. In Tulgao-Dananao, some of the households were not connected to the scheme due to inability to buy household wiring and lighting fixtures.

Table 7. *Electrification Coverage of the MHP Projects*

MHP Sites	Total Households in the Barangay/*Sitio*	Households beneficiaries	% of Households Served
Ngibat	34	33	97%
Tulgao-Dananao	312	264	85 %
Balbalasang	155	154	99%
Lon-oy	152	78	51%
Kapacnaan	28	11	39%
Buneg	40	33	83%
Katablangan	106	42	40%
Adugao	16	16	100%
Caguyen	36	26	72%
Kimbutan	30	13	43%
		Average	**71%**

Load Allocation and Management

In the MHPs in the study, the installed power was based on total load demand, rather than the actual capacity of the water resource. Household load was also allocated, based on household demand survey and on other major needs expressed by respondents during the feasibility study stage. It was found out that in most cases, the load for appliances used by households exceeded their earlier expressed demand.

Estimates of peak household demand (for lighting and appliances),[7] also show that these are well below the installed capacity[8] of the systems. This indicates that design capacities have made good allocation for household needs with allowances for major applications.

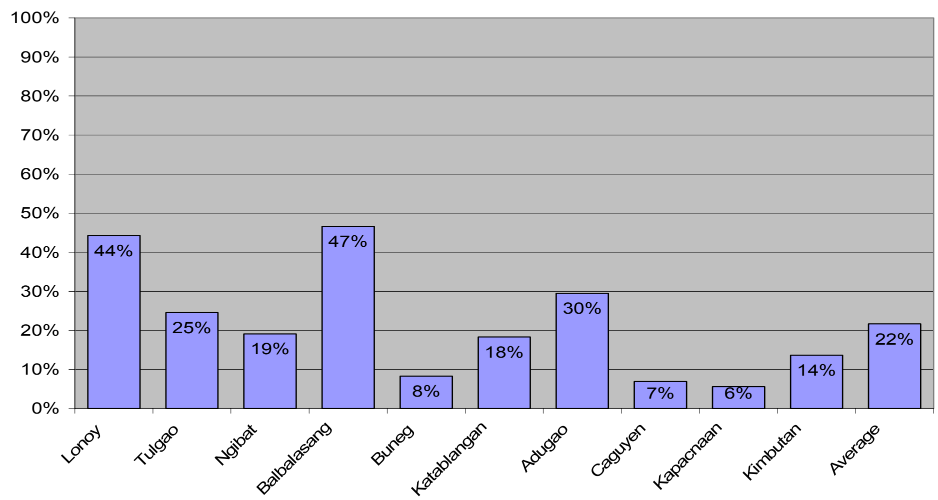


Figure 4. *Peak Household Demand as a % of Installed Power*

Assigning hours of operation for corresponding usage, or load management, was necessary for most MHPs in the study. Despite the 24-hour availability of power from a MHP scheme, less than 24-hour operation is encouraged as a way of extending the lifetime of a plant. Major uses are assigned in daytime while household uses are made for the entire operating hours of the system. Load management too was required for some MHPs during period of limited installed capacity or low water flow in summer.

The community, often through its organization, formulates and enforces policies on load management.

Adjustment to 24-hour operation was subsequently done for one case (Balbalasang) where demand for high-powered household devices had significantly increased over time.

---

[7] The study was not able to find the actual power output of the generators at full flow (apart from those schemes equipped with an ELC), the demand quantity is instead compared to the design capacity. The peak demand (highest demand in kW occurring in the distribution) was calculated here by taking the average wattage from lighting and adding this to the average wattage for appliances, and multiplying the result by the number of households connected to the system.

[8] Installed capacity is the power the turbine/generators unit can provide at full opening.

Table 8. *Energy Use and Schedule of Usage of the MHP Projects*

MHP Sites	Maximum Load Allocation[9] (W/HH)	Actual Lighting Consumption[10] (W/HH)	Energy Use and Schedule of Usage
Ngibat	40	29	Lighting from 6pm to 10 pm Seasonal rice mill and sugar cane press operation during the day Reduction to one (1) lighting fixture per household during summer
Tulgao-Dananao	60	24	Lighting from 5pm to 7 am Seasonal rice mill and sugar cane press operation during the day
Balbalasang	75	54	Lighting from 6pm to 6am Operation of school computers during daytime; presently 24 hours operation
Lon-oy	80	100	Primarily for lighting and powering small appliances Scheduled lighting per *sitio* (rotation of lighting use during dry season); 24 hours operation
Kapacnaan	20	20	Not operational. *the system was damaged by typhoon*
Buneg	55	17	Lighting from 6pm to 6am Seasonal rice mill operation during the day
Katablangan	30	25	Lighting from 6pm to 10 pm
Adugao	100	59	Lighting from 6pm to 10 pm
Caguyen	30	18	Lighting from 6pm to 10 pm
Kimbutan	50	47	Lighting from 6pm to 10 pm Prohibition of television use during summer

Grid Connection in Lon-oy

The local electric cooperative LUELCO which originally had no plan for the electrification of the barangay during the conduct of the feasibility study in 1998 extended the grid to the site in 2002. Today, the MHP system sits alongside the grid. The community decided to use the MHP for lighting and small appliances, and the LUELCO power for larger appliances. Currently, 36 houses are connected to both the grid and the MHP while the rest are solely with the MHP. The grid acts as a back-up supply for low MHP capacity periods during summer.

[9] As decided by the community before installation of the MHP scheme.
[10] Average lighting consumption of surveyed households.

Other Applications

Power from the MHPs has also helped the increase of individual and community-managed economic activities that include the operation of rice mills, sugar cane presses, planers, and blacksmithing tools such as grinders and drills.

Rice Milling

Rice mills can be found attached to the MHP schemes in Tulgao and Dananao, Ngibat, Buneg, Caguyen, and recently in Katablangan and Adugao . The rice mills were not used all months of the year given the seasonality of crops and low production of rice (rice production in these areas generally suffer lean months or shortages). Rice milling costs around P15/can or one small can (500g) per large can (12kg) of milled rice. Households with meager rice production do not avail of the facility.

Rice mill in Tulgao, Ngibat, Buneg and Caguyen costs about P30,000.

Table 9. *Annual Rice Harvest and Income from Milling*

MHP Sites	Annual Rice Harvest (kg/hh)	Average Volume of rice milled (kg/hh)	Equivalent Volume of rice milled (cans/hh/yr)	Annual volume of rice milled (cans/yr)	Milling Tariff (P/can)	Income from Milling (P/yr)
Ngibat	120	120	9.6	317	7	2,220
Tulgao-Dananao	300	120	9.6	2,995	15	44,930
Balbalasang	240	-				
Lon-oy	756	-				
Buneg	780	576	46	1,531	10	15,310
Katablangan	516	No data				
Adugao	300	No data				
Caguyen	396	No data			10	n/a

It is the community who sets the tariff for rice milling based on the prevailing rate in neighboring communities. Ngibat charges a lower milling tariff decided on the basis of the households' capacity to pay. Milling cost is higher in Tulgao-Dananao (being motorized) where 1/3 of the income is allocated for the mill's maintenance costs, another third for the operator and another third for the MHP's operation and maintenance costs.

All four rice milling facilities could cover the operational costs as well as contribute to the MHP operation and maintenance funds, from their incomes. There is in all cases an operator who is paid a portion from the rice milling tariff.

In Ngibat, Buneg and Caguyen, the rice mills are directly coupled with the turbine shaft. The milling in Tulgao and Dananao is motorized as the powerhouse is located far from the settlement area.

Sugar Cane Pressing

Two schemes, Tulgao-Dananao and Ngibat, have since installed sugar cane presses, mainly for *basi* or sugarcane wine which is an important item in the indigenous culture, and sugar for local consumption. The installation of a sugar cane press in Ngibat has increased the number of households producing sugarcane crop from *5* to 20. Requests for training to develop sugarcane or *muscovado* (raw sugar) for market have been received by SIBAT from these communities.

Table 10. *Income from Sugar Cane Pressing*

MHP Sites	Investment Cost (P)	Average Volume of Juice produced (L/day)	Days of Operation per Year	Juice Extraction Tariff (P/day)	Income (P/yr)
Tulgao-Dananao	40,000	342	26	200	5,200
Ngibat	40,000	229	30	150	4,500

Tariff set for juice extraction was based on a daily rate regardless of the volume of sugarcane for pressing. Income from sugar pressing is used to maintain the presser and also contribute to the MHP maintenance and operation costs.

Blacksmithing

The blacksmith component powered by the MHP had for a time produced basic agricultural tools for Ngibat and surrounding communities. The local NGO, Montañosa Research and Development Center (MRDC), had provided the skills training and tools in previous blacksmithing projects. The people of Ngibat (and also Tulgao and Dananao) are known for their skill in the traditional craft. Sustained activities however have been hampered by lack of raw materials, the limited market, their seasonality and the migration of some local blacksmiths to the urban centers.

Blacksmithing as an enterprise and the development of other enterprises utilizing metal works are seen to be feasible if these limitations are addressed.

Woodworking

The MHPs now provide power to electric planers used by individual carpenters (previously using manual planers) to produce furniture from wood products gathered from the forest. In Tulgao, two carpenters, who sell one or two pieces of furniture (cupboards and chairs) per year to their neighbors, were interviewed. The project management team in Tulgao-Dananao has yet to formulate and enforce a policy to charge carpenters for the use of these high-powered tools. It is recognized that stricter enforcement of rules in wood gathering (normally covered and controlled by local barangay ordinances and indigenous laws) is necessary, to ensure that the use of the power tool does not encourage excessive wood gathering practices.

Household-based Handicraft Production

Brooms and basket-making are a common source of cash for households in the upland areas, using the local varieties of reed or grass and materials gathered from the forest such as rattan. About 1/3 of the household population in the surveyed sites are craft producers. No capital is required to produce the items except household labor. Products are sold to the town markets.

An increase in the production of brooms and baskets due to the extended production hours was recorded in 5 out of the 10 sites surveyed. Respondents consider MHP powered lighting is affordable or does not entail undue additional cost to utilize for craft works at night. In Tulgao, a household that previously produced 15 brooms in one month is producing 20 brooms since the MHP scheme was installed. This equates to an additional monthly income of around P500 per month, for the months when tiger grass is available for harvesting. In Buneg, 5 of the 17 households surveyed reported an average additional annual income of P580 from broom-making since the introduction of the MHP scheme.

Utilization Rate

The ratio of the total actual energy usage in kWh per year to the potential energy production yields the 'utilization rate' or the plant factor of a scheme. The power factor can be used as an indicator of how best a system was designed. Low power factor implies costly power. The SIBAT MHP schemes in the study shows an average of 15.6% utilization over an average operation of about 10 hours per day. This implies that the total actual power produced is not fully utilized because other end-uses are used only seasonally and not all-year round (e.g. sugarcane presses are used for only about 2 months of the year). Further, when potential power is computed based on 95%[11], the average utilization factor is further decreased to 6.3%.

Table 11. *Utilization Rate of the Evaluated MHP Projects*

MHP Sites	Actual Usage[12] (kWh/year)	Plant Availability (%)	Potential Power Production[13] (kWh/yr)	Utilization Rate (%)
Ngibat	1,979	95	41,610	4.8
Tulgao-Dananao	22,775	95	249,660	9.1
Balbalasang	30,462	95	208,050	14.6
Lon-oy	16,228	83	146,000	11.1
Kapacnaan	1,201	95	41,610	2.9
Buneg	3,656	95	62,415	5.9
Katablangan	2,639	95	83,220	3.2
Adugao	2,075	95	62,415	3.3
Caguyen	1,394	95	62,415	2.2
Kimbutan	3,170	83	54,531	5.8
Average				**6.3**

[11] Accepted value for realistic operation by a MHP system.

[12] Based on the wattages and hours of use of lighting fixtures, appliances and other end-uses.

[13] Energy realistically and optimally produced if the plant runs at the 95% and 83% availability

The water sources for the MHP schemes in Kimbutan and Lon-oy are used for irrigation during summer giving these plants a lower availability factor.

Section 3. Technology Appropriateness

System Status and Performance

The ten (10) projects in the study are all run-of-the-river schemes, with a low to medium head of specifications shown on the table below. Nine (9) out of these are currently operational, with the oldest scheme running to more than 10 years. One project site (Kapacnaan) had been damaged by heavy landslides caused by a recent typhoon.

The power transmission system of all installations are belt-drive type and the single phase systems all have manual load control whilst 3-phase systems are equipped with ELCs. Three of the four post-production facilities are directly coupled with a belt drive (*See Section 2*).

Table 12. *Summary of Mechanical and Electrical Features*

MHP Sites	Type of Turbine	Design Capacity (kW)	Generator power rating (kVA)	Phase	Transmission Line Length (m)	Transmission Voltage	Status
Ngibat	Crossflow	5	5	Single		230	Operational
Tulgao-Dananao	Crossflow	30	40	3-phase	3,200	480/ 220	Operational
Balbalasang	Crossflow	25	31	3-phase	1,909	440/ 220	Operational
Lon-oy	Crossflow	17	25	3-phase	1,869	416	Operational
Kapacnaan	Crossflow	5	5	Single		220	Non-op'l
Buneg	Crossflow	7	7	Single	272	220	Operational
Katablangan	Crossflow	10	15	Single		220	Operational
Adugao	Crossflow	7.5	8	Single	224	220	Operational
Caguyen	Crossflow	7	7	Single	218	230	Operational
Kimbutan	Crossflow	7.5	8	Single	459	220	Operational

Table 13. *Summary of Civil Works Features*

MHP Scheme	Head (m)	Canal Length (m)	Power Canal Material	Penstock Length (m) and Material
Ngibat	32	75	Earth/concrete	GI
Tulgao- Dananao	40	500	Masonry/concrete	50m HDPE
Balbalasang	34	2,130	Earth/concrete	75m HDPE
Lon-oy	28	240	Concrete	36m HDPE
Kapacnaan	n/a	35	HDPE pipe	(n/a) HDPE
Buneg	52	390	Earth	105m HDPE
Katablangan	10	1,000	Earth/concrete	80m HDPE
Adugao	50	220	Earth	133m HDPE
Caguyen	50	220	Earth/concrete	82m HDPE
Kimbutan	30	120	HDPE pipe	54m HDPE

Systems output

The design capacities of the MHP schemes range from 5 to 33 kW, where the largest system covers electrification of three (3) barangays.

The sites at which power readings could be measured (those with electronic load controllers) were Tulgao-Dananao, Lon-oy and Balbalasang. Of these, Lon-oy is particularly subject to low-flow conditions during two months of the dry season.

Table 14. *Design Capacity and Measured Output of MHP Projects*

MHP Sites	Design Capacity (kW)	Measured Output[14] (kW)	Efficiency (%)
Lon-oy	20.0	15.0	75
Tulgao-Dananao	33.0	22.0	67
Balbalasang	25.0	21.0	84
Average			**75**

Tulgao-Dananao was a pilot project and involved several critical deviations from design which caused the comparatively low measured output.

Measured shortfall between expected and measured design capacity, in all three schemes above is attributable to a number of factors, including canal losses, poor maintenance by local operators and constriction of the penstock caused by plastic welding deformation

The crossflow turbines in the MHPs in the study were locally manufactured according to the SKAT T12 design. The turbines are designed at 70% efficiency. The lack of test facilities did not allow for turbine efficiency testing prior to installation. The lack of high-precision engineering in local turbine manufacture is also assumed as a possible contributory factor in the shortfall between design and measured output.

The cost of local turbines is significantly cheaper than imported ones, and their performance had shown no major problems observed since installation. Observed minor problems however includes unstable shaft and leaks in the oil seal of bearings.

SIBAT meantime, has improved the accuracy of the system efficiency factors used during initial design.

System Downtime

Three of the MHP systems experience downtime periods during the dry season when water flow recedes. Downtime periods are also attributed to the length of time before the problem was acted upon. Delay in responding to problems is mainly due to the lack of

[14] Based on actual measurement at full flow during survey.

mechanism or funds to respond to post-installation repair and troubleshooting needs. An innovative mechanism to do this, involving SIBAT and the communities, is required (e.g. revolving fund for repair and maintenance).

The performance of the schemes (including the non-operational system, Kapacnaan, prior to its stoppage due to typhoon damage) is described on Table 15 below.

Transformer Damage

This took place in Balbalasang as a result of the PO deciding to bypass the transformer circuit breakers causing the tripping and resulting damage to the transformer. Prior to such, breach of policy was found to have been committed by households with the exceeding of load allocation by many households and the simultaneous use of high power devices (e.g. washing machines, electric flatirons). The problem was subsequently corrected through meetings and by an increase in the daily hours of operation.

Canal damage

Of the 10 schemes evaluated, 5 MHP installations have needed civil works repair work due to typhoon damage. The most serious damage was on Balbalasang MHP's 2.1km power canal which became too vulnerable to landslides being not fully built to specifications (some parts were of mixed earth and concrete instead of pure concrete) due to fund limitations. Damaged sections had been reinforced with concrete, with the LGU providing funds for materials and the local people providing free labor.

For future projects, it is recommended that canals be built according to their design specifications, and funds are put up to ensure this.

Table 15. *Downtime of MHP Projects*

MHP Sites	Age (Months)	Daily operation (Hours)	Total Annual Downtime Period		Major Repairs Required	Who conducted the repairs?
			Repair (Months)	Water Shortage (Months)		
Ngibat	156	6	-	-	Generator replacement	SIBAT
Tulgao-Dananao	87	14.5	2.2	-	Dump load	Local electricity cooperative
					Belt replacement	Operators
Balbalasang	72	14.5	2.2	-	Dump load	Local electricity cooperative
					Canal repairs	Local people
					Transformer	Repair shop in Bagiuo City
Lon-oy	72	24	0.13	2	Powerhouse clean-up and components' check-up after	Operators

					flooding	
Kapacnaan	72	0	-	-	Generator replacement	
Buneg	60	8.5	-	-	None	-
Katablangan	60	5	3.1	-	Generator diode replacement	Repair shop
Adugao	60	6	-	-	Generator replacement	SIBAT
Caguyen	60	8	-	1	Generator replacement	SIBAT
Kimbutan	48	12	-	1	None	-

Dump Load Problems

The burning out of dump loads has been experienced in Tulgao-Dananao and Balbalasang, where the operators failed to notice the low water level in the dump load tank.

There was an observed difficulty in operation of systems without ELC, i.e. manual adjustment of gate valve openings with varying load. There were instances when the system shut down abruptly due to load fluctuations. To prevent damage to the system, it has been established as a requirement to incorporate an electronic load control or ELC in the MHP design.

Generator Problems

In four instances (in Caguyen, Adugao and Kapacnaan MHPs), the generator had to be replaced shortly after installation. The generator was of Mindong type, which is not brushless and not specifically designed for MHP applications. It was concluded that an over-speed, must have damaged the generator in these schemes that did not have load controllers to regulate speed when the turbine was running at full flow, and the load being drawn from the generator was too low.

These generators were used due to cost consideration. It is recommended that required specifications for generators and other electrical equipment be strictly followed.

Drive System

Drive belts in the Tulgao-Dananao MHP needed to be replaced every quarter due to turbine and generator pulley misalignment. Belts tend to be replaced on an ad-hoc basis (by non-complying operators) meaning that at times the number of belts in place is insufficient. Further, it was found that loose shaft/pulley connections that threaten damage to the bearing and shaft were observed in Tulgao-Dananao. The problem was probably due to poor workmanship of the turbine shaft.

Water Shortage

Lon-oy, Caguyen and Kimbutan all suffer from water shortage during one to two months at summer time. Lon-oy responds to this shortage problem by switching the power to half at the transformer on the first day, and switching it back the next day.

Flooding and Landslides

The MHP schemes in Lon-oy and Kapacnaan suffered from flooding at the powerhouse site due to the absence of an extensive full hydrology study that included 20 or 50-year flood forecasting. A hydrology training acquired in year 2002 equipped the SIBAT engineers to preclude this occurrence in its succeeding installations.

A major landslide in Northern Luzon in 2004 affected two installations (Caguyen and Kapacnaan) and nearly completely destroyed the latter. It leads to the absolute requirement of proper site selection particularly in vulnerable sites. The destruction of the Kapacnaan MHP is discussed below.

The Failure of the Kapacnaan Scheme

The Kapacnaan MHP, built in 2001, was washed away by a strong typhoon on November 2004. Inspection of the site in 2005 revealed that the river upon which the weir had been built had suffered from so much scouring of its erosion-prone clay banks that it had widened from 5 to 10 meters. This huge surge of water washed away the weir, intake, and headrace pipe, along with half of the penstock and powerhouse, located close to the river bank,. It was assessed that the original site selected for the powerhouse, appraised as suitable, was altered by the community.

The sad aftermath of the MHP had resulted in the disappointment and loss of initiative by the community to recover the project from the destruction of the typhoon, which was articulated during the household interviews.

Section 4. Roles, Management and Ownership

The community-based RE system is built operated and maintained by the community under the leadership of a Peoples' Organization or its representatives. It differs from other RE rural electrification efforts that are externally initiated and where management mechanisms were built afterwards. Under the CBRES concept, the local organizations are pre-existing and have some track record in project development.

Roles of the Project Stakeholders

A multi-stakeholder partnership comprised by SIBAT, PO, NGO partners and LGU, is formed to implement the projects in the study. These stakeholders contributed in the various stages of the projects development. Their main contributions are shown in the table below.

Table 16. *Main Tasks of the Project Stakeholders*

Stakeholders	Tasks in the Partnership
PO or peoples' organization representing the community	Takes the lead role in community organisation and project mobilization
Local NGO or organization based in the locality with institutional relationship with the community	Supports SIBAT and the PO in various responsibilities
SIBAT	Provides the technical works and technical management
LGU (local government unit) – the barangay chairman, officers, etc.	Supports the PO in community mobilization

The NGO and PO partners involved in evaluated SIBAT MHP projects are listed on the table below.

Table 17. *NGO and PO Partners of Evaluated SIBAT MHP Projects*

MHP Sites	NGO Partner		PO Partner	
	Name	**Type**	**Name**	**Type**
Ngibat	MRDC	Farmers' Organization/ Indigenous People's Organization	NFA	Farmers' organization/ indigenous people's organization
Tulgao-Dananao	EDNCP	Church	TDMC	Informal association of MHP beneficiaries initiated by church
Balbalasang	EDNL	Church	BMPC	Loose associations of MHP beneficiaries
Lon-oy	EDNCP	Church	LCDA	Farmers' organization/ indigenous people's organization
Kapacnaan	EDNCP/EDS	Church	IUISA	Farmers' organization/ indigenous people's organization, tribal organization
Buneg	None	None	BMTO	Farmers' organization/ indigenous people's organization
Katablangan	None	None	KUFO	Farmers' organization/ indigenous people's organization

Adugao	SODEC/SVD	Church	SNMA	Church-initiated community association
Caguyen	SODEC	Church	CADAGUPAN	Church-initiated community association
Kimbutan	None	None	KFA	Farmers' organization/ indigenous people's organization, tribal organization

Roles during Project Feasibility Study and Planning

Seven out of the 10 schemes studied were directly requested from SIBAT by church organizations on behalf of their community, and the remaining three were requested from SIBAT by a PO with the help of a local NGO. Three steps are basically followed by SIBAT in responding to a request.

1. **Ocular survey** or site inspection to assess the resource suitability for a potential MHP project. This step which includes a validation of the request from the community is conducted by two staff for 1 to 2 days.

2. **Pre-feasibility study:** a 4 to 5-day field study that conducts a site validation of the findings from the ocular survey. It incorporates an initial socio-economic survey and presents findings to the community. It also provides an initial orientation on the potential project to the community, if feasibility has been determined at this stage.

3. **Feasibility study:** a 20 to 30-day field and desk study that collates the field data and together with the community (in some aspects), develops a design based on the technical option earlier selected. The outputs are: (a) a detailed technical design; (b) an application plan including load management; (c) a financial study; (d) a sustainability plan; (d) a project work plan developed with the community; and (c) a budget. After this study is completed, a funding proposal is drawn up and funding sought.

The communities were consulted to validate the needs indicated in the request prior to any survey by SIBAT. In the projects studied, more than half of the household population had participated during the first community consultations, giving an indication of the communities' initial interest in the project.

Roles during the Planning Stage

Planning itself was accomplished within the feasibility study and took one to two days, conducted by the engineering staff. Planning was undertaken through a number of community consultations where the people agreed on the work scheme and provided the details of their work schedule, considering their farm work and other community activities. The plan then was finalized by a tripartite group comprised by SIBAT, the local NGO and the PO representatives. SIBAT guided the whole planning exercise of this formative management, because of its know-how of MHP project development and technology management. The minutes of the planning constituted the binding terms of the agreement with the community, which were periodically reviewed during the implementation process.

In some areas, active LGU participation in the planning stage was observed. The LGUs in these areas commonly helped facilitate the community meetings and consultations, convene people for meetings, discuss and clarify with the people crucial issues such as labour contributions. In 4 out of the 7 schemes where the LGUs were involved, their participation was appraised as valuable to the projects' take-off and completion.

Roles During Project Implementation

SIBAT acted as the technical service provider and manager of the project, guided by the results of the feasibility study and the plan. SIBAT's tasks consisted of the following:

Table 18. *The Major Technical Tasks of SIBAT in Project Implementation*

Tasks	Description	Personnel	Personnel-Days
Technical supervision	Supervision and directing of the major works (civil, electro-mechanical, electrical)	3 engineers	100 to 150
Purchase of major components	In-charge of major purchases especially those not procurable on the site	1 purchase officer	25
Turbine fabrication	Supervision of turbine fabrication according to the design	1 mechanical engineer	30
Technical and management training	Conduct of trainings after the project commissioning	1 engineer and 1 project manager	10
Coordination with PO and local NGO	Conducts necessary coordination and community meetings	1 project manager	continuing

Table 19. *The Main Tasks of the Local NGO in Project Implementation*

Tasks	Description
Overall local supervision	Supervision and directing of all local activities (transport, hauling) ensuring the compliance to schedule and local assignments
Coordination with the PO and community	Consults with the PO in all matters pertaining to the project
Purchase of local components	In-charge of local purchases

The MHP schemes were installed through local counterpart in terms of labor and local materials contribution, as well as cash donations from the LGU.

At varying levels, the role and involvement of people's organizations in CBRES installations have been widely recognized during planning, implementation and management. The two main factors in the success of the construction phase are the PO mobilization and the effective supervision by the SIBAT technical personnel.

Table 20. *PO Contributions to the MHP projects*

Major Works	Description of contribution
Civil Works	Provision of labour during canal construction, penstock laying, and construction of the powerhouse
Electro-mechanical works	Haulage
Electrical works	Installing the electrical posts, and assist in laying the transmission lines

Organizations with a relatively strong experience in community projects, displayed smoother implementation and shorter completion time, even with some difficulties.

The traditional labour exchange or *bayanihan* practice was invoked in the local mobilization for counterpart labour in these MHP projects. Food for work was shared by all especially those with capability. In Buneg and Katablangan, a food-sharing scheme was devised and accommodation was raffled among residents. The SIBAT staff were also provided with free food and lodging by the community.

During the feasibility study phase, the work schedule was firmed up based on the community's agricultural calendar. Successful MHP work schemes followed the communities' production calendar closely and maximized the availability of labour during construction.

The support of the LGU in some projects also helped to strengthen PO mobilization during implementation. These were in the cases of Ngibat, Buneg, Katablangan, Lon-oy, Tulgao-Dananao and Kimbutan. In the absence of PO Chairman in Buneg, the LGU also took over his role.

Shared leadership between the LGU and the local partner (EDNCP) during project implementation was observed in Lon-oy. This practice helped in sustaining the enthusiasm of the community resulting in the satisfactory and on-time completion of the project. The LGU even assisted in setting up the project management group of the Lon-oy Community Development Association, Inc. (LCDAI).

Problems Met During Construction

There were several problems met during the construction period that were reflected in the varying length of time of project completion. The average construction time for the MHP schemes in the study were 16 months, or nearly 1 and ½ years, i.e. the average length of time from ground breaking to commissioning of the project. Kapacnaan and Caguyen installed their project in the shortest period (8 months), while Kimbutan MHP was completed in 36 months.

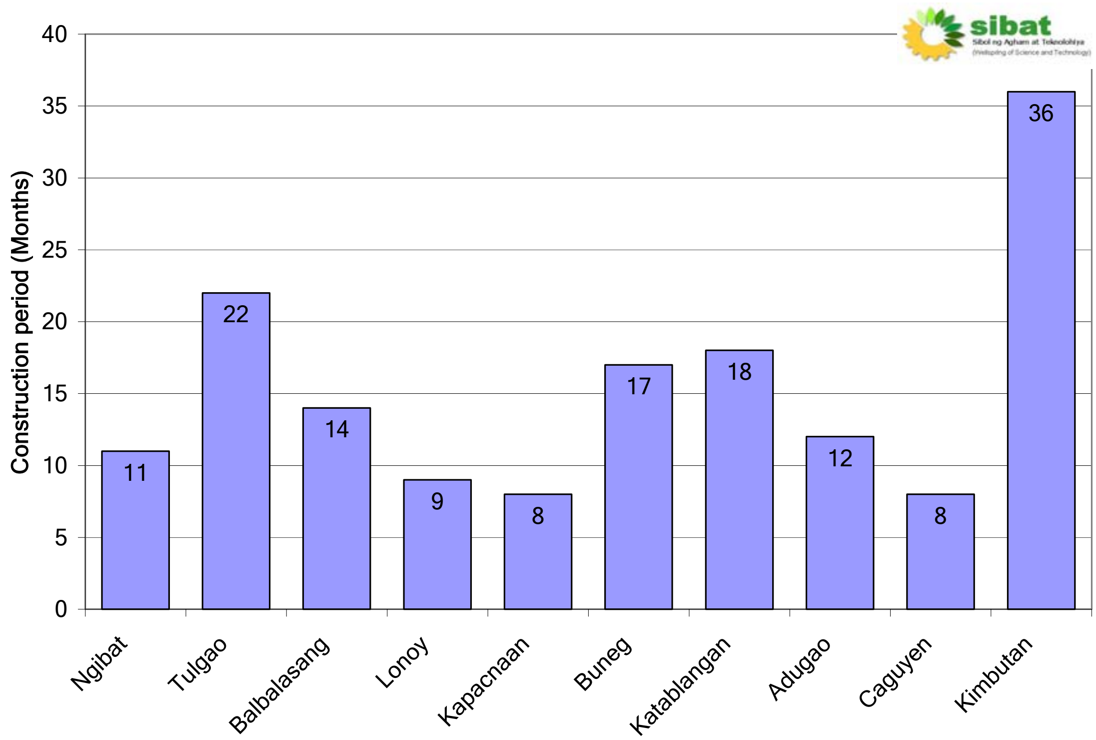


Figure 5. *Construction Time of Evaluated SIBAT MHP Projects*

The delay in Kimbutan completion was due to a very long period of disruption brought about by several factors including inaccessibility of the site and difficulty in securing project funds.

In general, the problems met included the following:

- There were unpredictable occurrences that significantly hampered work such as: extreme changes in weather conditions that impaired road conditions and accessibility and the eruption of tribal conflicts that disrupted movements of the people and project personnel.

- Delay in securing funds for food-for-work especially during lean months or periods of food shortages. The loss of the work force for this reason caused delays in construction.

- The waning of people's enthusiasm and participation mid-course in some projects due to undue delay in project completion;

- Leadership problems too, such as those displayed in the cases of Tulgao-Dananao, Katablangan and Caguyen created difficulty in ensuring sustained and full community mobilization. Mobilization problems pertaining to unclear expectations with church personalities hampered implementation of some projects, particularly in Lon-oy, Caguyen, Adugao, Tulgao- Dananao and Balbalasang.

- The over-eagerness of the people also became a problem in one instance, in Kapacnaan, where the design for civil works alignment (e.g. silt basin, forebay and penstock) was not followed when some community members began work before construction was due to start, i.e. without the knowledge of the supervising engineer.

- One exceptional problem met by the team happened in Balbalasang, caused by the intervention made by one LGU official on the size of the project, after the completion of the study and the approval of the project proposal and funds. After his erroneous claim (that the budget for a 20-kW plant would be enough for a 80-kW plant) was rejected by SIBAT, the official harassed the community to discontinue contributing to its implementation. His actions failed to impact on the project process as the plant was installed according to schedule.

Project Management

In the study, 7 indicators of operational management were used to evaluate each community-based MHP project and scores on a scale of 1 (poor) to 5 (good) indicated by the evaluation team based upon the success of the management in dealing with each area.

Of all schemes evaluated, Lon-oy showed the highest competence in MHP management as a community-based undertaking, with the people gaining relatively greater control and deeper sense of project ownership. This is reflected in the community's high collection rate, absence of major repair, satisfactory policy implementation and load management, good bookkeeping and transparency within the organization.

Performance in project management (from social preparation, implementation, and policy formulation and problem resolution) in projects where organizations had 100% household membership was appraised as relatively satisfactory in comparison with others with incomplete PO membership. Such full PO areas include Ngibat, Buneg, Katablangan, Adugao and Caguyen.

Table 21. *Operational Management Appraisal*

	Based on technical data		Based on observation by survey team					
MHP scheme	Tariff collection	Frequency of repairs	Policy formulation	Policy implementation	Regular meetings	Record keeping	Reporting problems to SIBAT	TOTAL
Ngibat	2	5	2	1	2	4	4	20
Tulgao-Dananao	2	2	2	1	2	4	4	17
Balbalasang	2	2	4	2	2	3	4	19
Lon-oy	5	3	4	5	4	4	3	28
Buneg	4	5	4	4	4	4	2	27
Katablangan	3	1	4	4	4	4	2	22
Adugao	3	5	4	4	3	4	2	25
Caguyen	3	5	4	4	3	4	2	25
Kimbutan	5	5	2	1	1	1	3	18

Policy Development and Enforcement

All project sites formulated their policies immediately after project commissioning. In most cases, the board and the set of officers formulated a draft policy and presented this to the community for revision and approval. Policies covered tariff structure, maintenance schedule, load management, roles and responsibilities of personnel and consumers, and penalty system.

The relative success of the management in Lon-oy MHP was due to it having previous experience in implementing community projects such as road construction, tree planting and the installation of a potable water system. It was also attributed to the significant involvement and contributions by the LGU that also gave teeth to policy enforcement.

The frequency of repairs (e.g. generators' failing-out due to operator's negligence) indicates the level of ability of management in maintaining the MHP scheme. Balbalasang and Tulgao-Dananao are found to be in particular need of improvement in technical maintenance to minimize the frequency of major repairs. *(See Table 21 on frequency of repairs.)*

Leniency is often observed in the enforcement of policies particularly in the lack of firm enforcement of penalties for tariff non-payment. Another issue is the influence of local church leaders on policy formulation, with particular reference to Adugao and Caguyen, where the local people were encouraged by the pastor to make regular contributions to local church funds from the MHP revenues. The authority of the local church in general tended to slow down the development of the ability of the management group to manage their project.

It was observed that the collection rate is strongly linked to the skill of the management team in enforcing its collection policies, such as in Lon-oy, Katablangan and Caguyen**.**

Regular Meeting/Planning of Officers

The conduct of regular meetings by the officers also varied, with projects such as those in Balbalasang and Tulgao-Dananao having the most area for improvement. In Lon-oy, Buneg, Ngibat, Katablangan, Caguyen and Adugao the problems were promptly taken up because of the more frequent meetings of officers.

Record Keeping and Reporting

The state of records and record keeping, as well as bookkeeping, was found to be in varying degrees that needed improvement. In Balbalasang, Tulgao-Dananao and Lon-oy, the records were satisfactory. Those MHP schemes with management personnel of professional background showed relatively satisfactory records.

Role of SIBAT in Project Management

In all projects in the study, SIBAT provided the training on technical and project management immediately after their commissioning. However, SIBAT did not play an active role in the ensuing process due to lack of funding for this activity from funding organizations. SIBAT however, managed to conduct meetings of partners to reveal the problems and recommend solutions.

Formal Ownership of the MHP System

In the concept of the CBRES, formal ownership of the system should reside with the PO which renders the PO the authority to draw up policies, manage the operation, and decide on community applications and to decide on and manage the revenues collected. The PO itself is a legal entity with right to enter into legal transactions (a PO is legitimized with documentary requirements, either as cooperative or association). In the context of rural development work in the Philippines, it is generally acknowledged and desired that projects are formally 'owned' and managed by the community through its PO.

In the specific context of the indigenous peoples, ownership of communal resources (communal lands, forests and water resources) has been part of the ancestral domain tradition. Issues such as 'right of use' is settled by existing institutions, often a combination of indigenous and LGU decision-making procedures. Minutes of meetings and certain community declaration papers sufficed to bind the fact of ownership of communal resources for community use. The establishment of MHPs in the study (all sited in indigenous areas) did not meet any legal argument and thus did not require for the ownership matter to be put in a legal document.

This acknowledged ownership is expected to be appreciated by the PO in demonstrating its 'sense of ownership' through active sustaining of the project, which is relatively evident in Buneg, Katablangan, Lon-oy, Ngibat and Kimbutan. It is the practice in these areas to discuss and resolve issues immediately, among the community members without waiting for an authority to lead or intervene. These communities also worked to generate support from their LGUs for repair and maintenance.

Community ownership however is made unclear by certain pre-existing conditions, such as religion-based relationships and authority. In the cases of Adugao and Caguyen, where the Roman Catholic Church contributed to the project establishment, local church authority on MHP concerns seemed to be continually imposed on the community. Some local informants felt that a similar situation in Tulgao-Dananao needed to be improved in order to develop a project management team autonomous from the local church.

There is also a need to clarify the ownership issue with the government's Department of Energy which directly funded four projects (*see Table 29)*. While the project concept paper contained a clear reference to PO ownership, and while the 'sense of project ownership' was then being encouraged verbally by the DOE staff, a formal agreement on the ownership issue is still deemed necessary.

Section 5. Capital Cost and Financing

Capital Cost

The average capital cost per kilowatt of the MHP schemes in the study is PhP 98,900 or US1,980 $/kW[15]. This cost includes all plant materials, tools and equipment, administration costs and SIBAT's fee. It excludes the household connection, labor and the cost of sand, aggregates and lumber, which are provided by the community as its counterpart.

Table 22. *Capital Cost of the MHP Projects*

MHP Sites	Design Capacity (kW)	Total Cost (PhP)	Total Cost (US$)	Cost per kW (PhP/kW)	Cost per kW (US$/kW)
Ngibat	5.0	484,000	9,680	96,800	1,936
Tulgao-Dananao	30.0	2,831,565	56,631	85,805	1,716
Balbalasang	25.0	2,503,594	50,072	100,144	2,003
Lon-oy	20.0	1,875,253	37,505	93,763	1,875
Kapacnaan	5.0	389,271	7,785	77,854	1,557
Buneg	7.5	802,000	16,040	106,933	2,139
Katablangan	10.0	972,000	19,440	97,200	1,944
Adugao	7.5	749,476	14,990	99,930	1,999
Caguyen	7.5	749,476	14,990	99,930	1,999
Kimbutan	7.5	915,400	18,308	122,053	2,441
Average				**98,899**	**1,978**

The low project cost of CBRES compared to the standard average capital cost is attributed to a number of factors that include: the local contribution of labor and materials, local fabrication of turbines and the relatively low fees which SIBAT charges for technical assistance.

The local contribution is integral to the community-based scheme, a factor that reduces capital costs. Contributions are in the form of labor by both men and women, valued according to prevailing local rates, and local materials sourced in the general vicinity. The difficult haulage from vehicle delivery point to site was also rendered by local people.

Breakdown of Capital Costs

The breakdown of capitals costs shows materials forming 80% of the total capital costs. Other non-material costs (administration expenses and SIBAT's technical fee) comprise the remaining 20%.

[15] Used in this document is P50/US$

Table 23. *Components of the Capital Costs*

Cost area	Elements
Civil Works	Cement, steel, penstock, tools
Mechanical and Electrical (M&E) Works	Turbine, Generator, ELC
Transmission	Transmission line, transformers, ancillary electrical equipment
Administration	Travels, communication
SIBAT fee	Surveys, design, supervision of construction, overseeing the work of all project partners, commissioning, monitoring after commissioning

Table 24. *Breakdown of Capital Costs*

MHP Sites	Civil %	M&E %	Trans-mission %	Haula ge %	Admin %	SIBAT fee %
Tulgao-Dananao	26	30	24	9	8	4
Balbalasang	24	27	25	6	10	8
Lon-oy	16	33	31	8	7	5
Kapacnaan	33	23	15	3	21	5
Buneg	25	18	26	6	15	9
Katablangan	30	17	29	5	12	7
Adugao	22	28	20	7	14	10
Caguyen	22	28	20	7	14	10
Kimbutan	34	17	13	15	12	-
Average	**26**	**25**	**23**	**7**	**13**	**7**

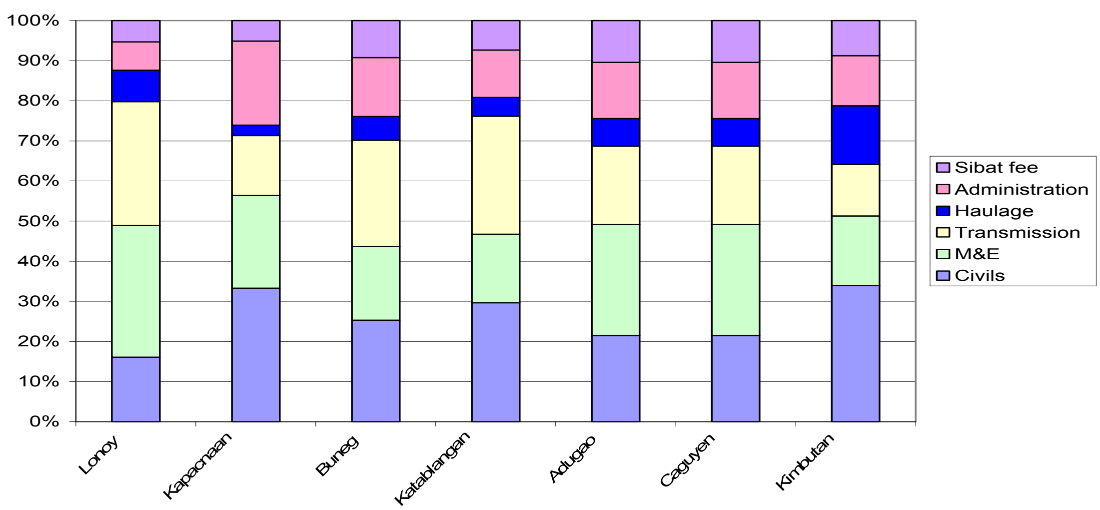


Figure 6. *Breakdown of Capital Costs*

Cost Differences due to Civil Works Design

The comparatively high cost of the Kimbutan MHP is due to the use of a headrace pipe to conform to site topography, i.e. a 25m ravine and 87m long erosion prone section.

A combination of concrete and earth channel was used in all other MHP schemes where open channels are safe and economical to use.

Cost differences due to Electro-mechanical Design Works

Tulgao-Dananao and Lon-oy have the highest electro-mechanical costs due to the 100% import tax charged on the equipment price of the Chinese-built ELCs, i.e. doubling the costs of the imported item.

Technical Fee

SIBAT's technical fee amounted to an average of 7% of the total project costs, which is low compared to the standard 15% charged by private engineering firms. The technical fee covers engineering design, site visits, site supervision and commissioning. In addition, SIBAT also finds or facilitates funding, co-ordinates with the community and partners, and monitors the scheme after implementation to ensure long-term operation, all of which require funding for wages, travel and materials.

Grant funds sourced out for the projects did not pay even for the operational costs of the pre-feasibility and feasibility studies, hence, funds to defray for labor of engineers had to be paid from SIBAT's institutional funds.

For project implementation, SIBAT charged from PhP 90,000 to 100,000 per scheme, regardless of MHP size or capacity. These amounts were guided by the ceilings set by the donor agencies for technical fees. As a result, SIBAT struggled to cover the full actual costs of the project, from feasibility stage to long-term monitoring drawing from its internal funds for the deficit.

Table 25. *SIBAT Fees as a Percentage of Project Cost*

MHP Sites	Project Cost	SIBAT fee	
		Amount, PhP	%
Ngibat	484,000	-	
Tulgao-Dananao	2,831,565	110,000	4 %
Balbalasang	2,503,594	200,000	8 %
Lon-oy	1,875,253	93,000	5 %
Kapacnaan	389,271	20,000	5 %
Buneg	802,000	70,000	9 %
Katablangan	972,000	70,000	7 %
Adugao	749,476	75,000	10 %
Caguyen	749,476	75,000	10 %
Kimbutan	915,400	-	

Budget Deficit

The majority of the projects suffered budget deficits due to a number of reasons foremost of which is the increase in prices of materials over time, from proposal submission to approval that took from 6 months to a year. It is necessary that funds carry contingencies for such increases and other unexpected expenses during the construction period, estimated from 5% to as much as 20%.

Due to the delay in project completion, i.e. extension of construction time beyond contract period, about 59% of the funds for Kimbutan was shouldered by SIBAT to complete the project. Kimbutan, along with Balbalasang, Lon-oy, Kapacnaan and one solar water pumping system were funded by the DOE as one big project. SIBAT's contract with the DOE specifies that, as a penalty SIBAT should pay the amount equivalent to $1/10^{th}$ of 1 percent for every day of delay in project completion.

Table 26. *Cost Overspends*

MHP Sites	Actual total cost (PhP)	Grant (PhP)	Balance (PhP)	Overspend %
Ngibat	484,000	484,000	0	0
Tulgao-Dananao	2,831,565	2,781,065	-50,500	2
Balbalasang	2,503,594	2,496,000	-7,594	0
Lon-oy	1,875,253	1,595,000	-280,253	15
Kapacnaan	389,271	386,500	-2,771	1
Buneg	802,000	802,000	0	0
Katablangan	972,000	972,000	0	0
Adugao	749,476	731,500	-17,976	2
Caguyen	749,476	731,500	-17,976	2
Kimbutan	915,400	375,314[16]	-540,086	59
Average				**8%**

Operational Costs

Operation and Maintenance

Generally, the O&M expenditures of SIBAT MHP schemes are found to have been above the expected amount based on 1% of the material cost of the project per year. Lon-oy and Tulgao-Dananao spent twice the projected operational costs, largely on personnel. Maintenance costs currently cover belt replacements and oil and grease changes.

[16] Amount left from the grant money after deducting SIBAT's penalty

Table 27. *Operational Costs of MHP Projects*

MHP Sites	Total Operational Costs (P)	Expected Operational Costs[17] (P/yr)	Operational Costs		
			Repairs %	Maintenance %	Personnel %
Ngibat	5,395	4,840	18	38	44
Tulgao-Dananao	50,240	23,603	24	4	72
Balbalasang	113,202	21,143	77	2	21
Lon-oy	30,290	15,970	1	20	79
Kapacnaan	4,665	2,978	56	44	0
Buneg	6,369	6,620	9	61	30
Katablangan	12,773	8,320	15	63	22
Adugao	1,987	6,288	9	91	0
Caguyen	6,840	6,288	0	30	70
Kimbutan	2,040	5,410	0	100	0
Average			**21%**	**45%**	**34%**

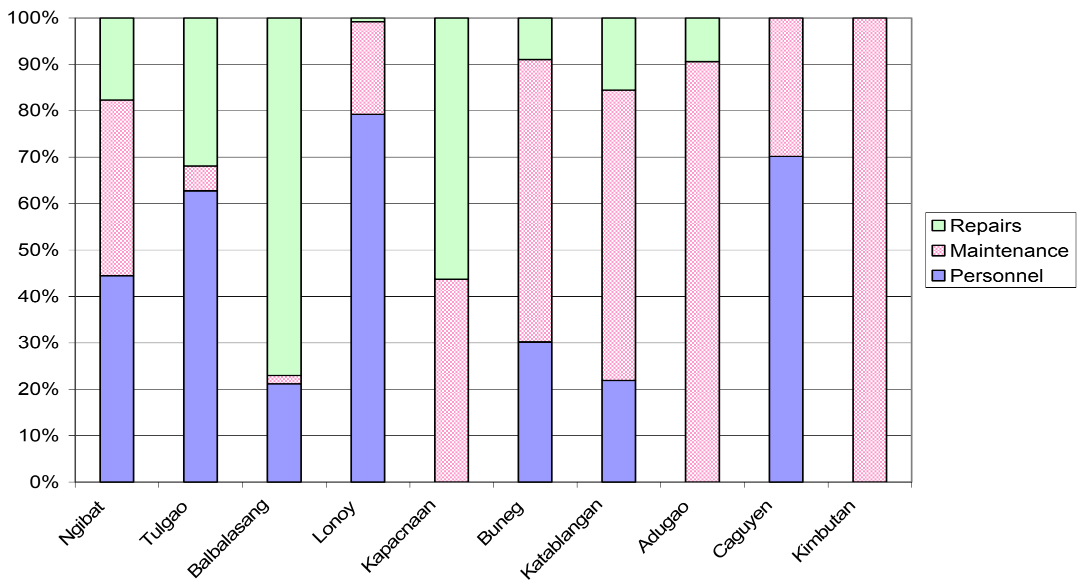


Figure 7. *Repairs and Operational Expenses of MHP Projects*

Repair Costs

The nature of technical problems encountered by the schemes and met by repairs is shown on Table 15 and the corresponding total costs incurred are shown in the table below.

[17] Based on 1% of the total material cost of the project per year.

Balbalasang spent a relatively large amount of money on operational expenditure – almost 6 times more than expected. Of this, over 75% has been on repairs; mainly on the 2.1km long power canal of mixed earth and concrete that became particularly vulnerable to landslides. Kapacnaan on the other hand, spent around 20% more than expected, with 56% of this being spent on mechanical repairs. The high proportion of spending on M&E repairs highlights the problem with the generators, as examined in *Section 3*.

Table 28. *Breakdown of Repair Costs*

MHP Sites	Breakdown of Repair Costs		
	Civils %	Electro-mechanical %	Transmission %
Ngibat	-	100	-
Tulgao-Dananao	8	92	-
Balbalasang	78	13	9
Lon-oy	100	-	-
Kapacnaan	-	100	-
Buneg	35	65	-
Katablangan	-	100	-
Adugao	-	100	-
Caguyen	-	-	-
Kimbutan	-	-	-

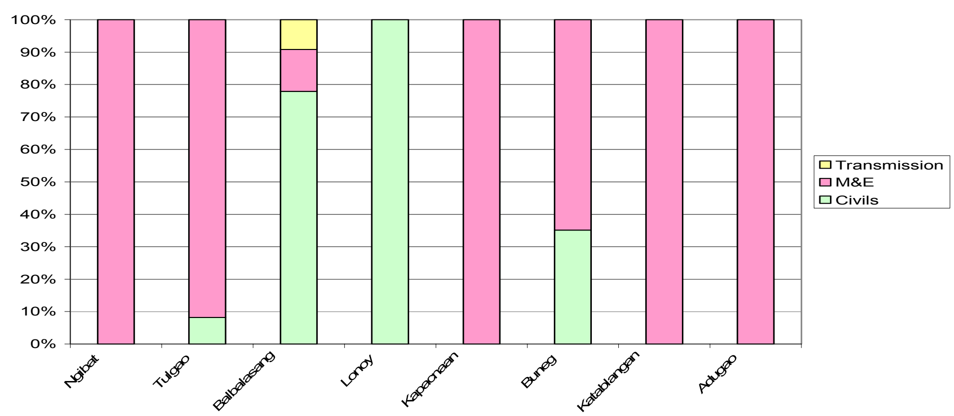


Figure 8. *Breakdown of Repair Costs*

Project Financing

All projects were established through grant financing, as shown on Table 29 below. SIBAT developed the project proposals and facilitated the funds for most of the projects with the donor agencies. Fund sourcing which was done individually (except for the four DOE projects which came within one grant package) generally took from six months to a year, and significantly determined the pacing of projects. The purposes for which the funds were contributed varied, depending on the nature of the agency.

Table 29. *Financing Schemes for Evaluated SIBAT MHP Projects*

MHP Sites	Funding Agency	Type of Funding	Description	Project Proponent	Funding Facilitation
Ngibat	Montañosa Research and Development Centre (MRDC)	Grant	Development Fund from EED (Protestant Churches in Germany)	MRDC	MRDC
Tulgao-Dananao	Kiyosato Experimental Education Project (KEEP)	Grant	Community development fund	Episcopal Diocese of Northern Philippines (EDNP)	EDNP
Balbalasang	Philippine Department of Energy (DOE)	Grant	Barangay electrification 'O Ilaw' Fund	SIBAT	SIBAT
Lon-oy	DOE	Grant	Barangay electrification 'O Ilaw' Fund	SIBAT	SIBAT
Kapacnaan	DOE	Grant	Barangay electrification 'O Ilaw' Fund	SIBAT	SIBAT
Buneg	UNDP-GEF-SGP	Grant	Biodiversity and watershed conservation under the climate change programme	Local PO	SIBAT
Katablangan	UNDP-GEF-SGP	Grant	Biodiversity and watershed conservation under the climate change programme	Local PO	SIBAT
Adugao	UNDP-GEF-SGP	Grant	Biodiversity and watershed conservation under the climate change programme	Local PO	SIBAT
Caguyen	UNDP-GEF-SGP	Grant	Biodiversity and watershed conservation under the climate change programme	Local PO	SIBAT
Kimbutan	DOE	Grant	Barangay electrification – 'O Ilaw' Fund	SIBAT	SIBAT

Funding Partners and Collaborators

Grants for global climate change through the United Nations Development Program – Global Environment Facility – Small Grants Programme (UNDP-GEF-SGP) have enabled the establishment of SIBAT's MHP schemes especially in remote rural communities qualifying under the criteria of environmental solutions to climate change. Further, MHP projects easily qualified for the PO and community-based requirement of SGP-funded projects. The UNDP-GEF-SGP fund also ensured the inclusion of watershed management in the MHP projects and hence was more comprehensive in purpose compared to other contributions.

The DOE's 'O Ilaw' Programme aimed at the expansion of electrification to remote rural barangays, and opened up to civil society for partnership in 2001. DOE's provision of grant contribution to four MHP projects was its first collaboration with an NGO on rural electrification.

Local NGOs such as MRDC are an important vehicle for the CBRES because of their rural development framework. MRDC was a member of the original SIBAT network who contributed to efforts to study, design and pilot an MHP scheme in the Philippines.

The effort to construct an MHP scheme at Ngibat was a pioneering response to an expressed demand by Cordillera indigenous communities for electrification. Ngibat was one of the communities which opposed and deterred the construction of the Chico mega-dam project for electrification in the 80s, which threatened the widespread displacement of tribes in the Cordillera.

One-time Grant for Sustainability

For SIBAT, the grant funds fell within the concept of one-time enabling capital costs, which included materials and equipment, supervision and training and all that is necessary to install the plant. These upfront costs cover the installation of the project which the community then operates and sustains, through returns from the project itself. Hence, operation and maintenance costs and costs to replace major parts and equipment are to be the responsibility of the community.

Local Community Counterpart

The communities provided labour and locally available materials (e.g. sand, gravel and lumber for the civil works), reducing total capital costs by some significant amount (5 to 15%). These counterpart contributions constituted the communities' equity in project development, and their claim to project ownership. The communities also shouldered the costs of household connections.

The Dearth of Funding Sources

For most projects, preparation funds (for pre-feasibility and full feasibility studies) were funded from SIBAT's institutional funds combined with some contribution from the NGO Winrock International in 2000. The lack of project preparation funds slowed down SIBAT's response to many project requests. It should be mentioned that grants did not provide the full funding required (technical fees were often insufficient), putting a strain on certain deliverables, particularly of SIBAT.

There is recognition of the difficulty in locating funds for projects, especially because capital funds involved large sums of money. Program continuity was often at risk for lack of committed funds for the projects. SIBAT began to involve itself with developing innovative funding possibilities.

Section 6. Financial Sustainability

Sustainability Framework

An initial concept to sustain the project was formulated and recommended by SIBAT to partners where the tariff payments constituted the main source of sustainability of the project. In this concept, the tariff was to generate: payments for operation and maintenance, savings for a sinking fund (replacement of major components) and savings for a community development fund. The tariff then became the main basis for MHP sustainability.

Tariff = O&M costs + sinking fund + development fund

The tariff rates for these MHPs were decided by the communities, i.e., with minimal intervention from SIBAT. Generally, it was affordability or capacity to pay which became the main basis for their tariff setting.

Income from Lighting Tariff

Three different modes of monthly tariff have been adopted. For all three tariff schemes an additional flat fee is charged for the use of different appliances, irrespective of how much they are used. (No SIBAT scheme to date has employed metering for domestic connections purportedly due to the additional cost of meters.)

- The first type is the flat rate tariff where everybody pays a fixed amount as agreed by the community regardless of the usage.

  Households pay a fixed rate for a uniform wattage for each household, however, because some households use more power than the allocation allows the fairness of the fixed rate scheme is put into question.

- The second tariff is the variable rate where each household pays per watt capacity of lighting.

- The third tariff is the combined tariff, with a flat rate for the first 2 lighting fixtures, and a variable rate, for each subsequent lighting fixture.

Presented in the table below are the project sites and their adopted tariff scheme.

Table 30. *Tariff Scheme and Average monthly Tariff*

MHP Sites	Tariff Scheme	Average monthly tariff
Ngibat	variable tariff	22
Tulgao-Dananao	variable tariff	30
Balbalasang	combined flat and variable tariff	110
Lon-oy	flat-rate	50
Kapacnaan	variable tariff	20

Buneg	combined flat and variable tariff	19
Katablangan	combined flat and variable tariff	25
Adugao	combined flat and variable tariff	25
Caguyen	flat-rate	34
Kimbutan	flat-rate	30

Capacity to Cover O&M Costs

Costs for operations and maintenance covered personnel, maintenance and repairs. The amounts varied, particularly on personnel and major repairs. It is interesting to note that Lon-oy, Tulgao-Dananao and Balbalasang spent around 10 times more than other schemes on personnel because of comparatively higher salaries paid to operators (P1000-P1500 per month). Further, major repairs such as the canal repair for Balbalasang needed external support (i.e. could not be classified as regular O&M) and could not be drawn out from the tariff payments.

From a review of the projects' data on income and expenditures *(Table 32),* it is observed that five of the evaluated projects made some savings aside from being able to support their operation; these are Lon-oy, Ngibat, Balbalasang, Buneg and Kimbutan. However, Ngibat and Balbalasang only registered savings because of external funds provided to pay for repairs. Balbalasang, solicited for required external funds from the LGU to meet at least half of the high cost of canal repairs. For Katablangan and Caguyen, the net income figures yielded a deficit. The informants said that income generated by the project is just about enough to cover the O&M expenses, i.e. deficits were covered by spending less.

Table 31. *Annual Expense Data*

MHP Sites	Personnel (P/yr)	Maintenance (P/yr)	Repairs (P/yr)	Total Annual Expenses (P/yr)
Ngibat	2,400	2,040	955	5,395
Tulgao-Dananao	24,000	2,040	12,200	38,240
Balbalasang	24,000	2,040	87,162	113,202
Lon-oy	24,000	6,040	250	30,290
Buneg	1,923	3,877	569	6,369
Katablangan	2,800	7,990	1,983	12,773
Adugao	0	1,800	187	1,987
Caguyen	4,800	2,040	0	6,840
Kimbutan	0	2,040	0	2,040

Table 32. *Annual Income and Net Profit Data*

MHP Sites	Annual Income, PhP			Total Annual Income	Annual Net Income	External funds[18] (P/yr)	Annual Savings (PhP)
	Household tariff	Rice Mill	Sugar Cane Press				
Ngibat	6,336			7,291	941	955	1,896
Tulgao-Dananao	24,552	12,600	1,612	39,652	524	1000	1,524
Balbalasang	53,227			123,339	-59,975	70,112	10,137
Lon-oy	40,480			40,480	10,190	0	10,190
Buneg	4,214	5,740		9,954	3,585	0	3,585
Katablangan	7,470			7,470	-5,303	0	-5,303
Adugao	2,487			2,487	500	0	500
Caguyen	5,830			5,830	-1,010	0	-1,010
Kimbutan	4,680			4,680	2,640	0	2,640

Plotted on Figure 9 below are the project incomes of each evaluated sites at actual collection rate and without the funds from outside donors. It is shown that 3 of the evaluated MHP sites (Balbalasang, Katablangan and Caguyen) can not support the annual operating expenses of their MHP schemes. Balbalasang however was able to solicit donations for canal repairs allowing them to have savings as shown in Table 32.

In other words, the capacity to cover O&M costs by the systems over their given lifetimes was precariously small. It is estimated that the income from tariffs would not be able to meet sinking and development funds.

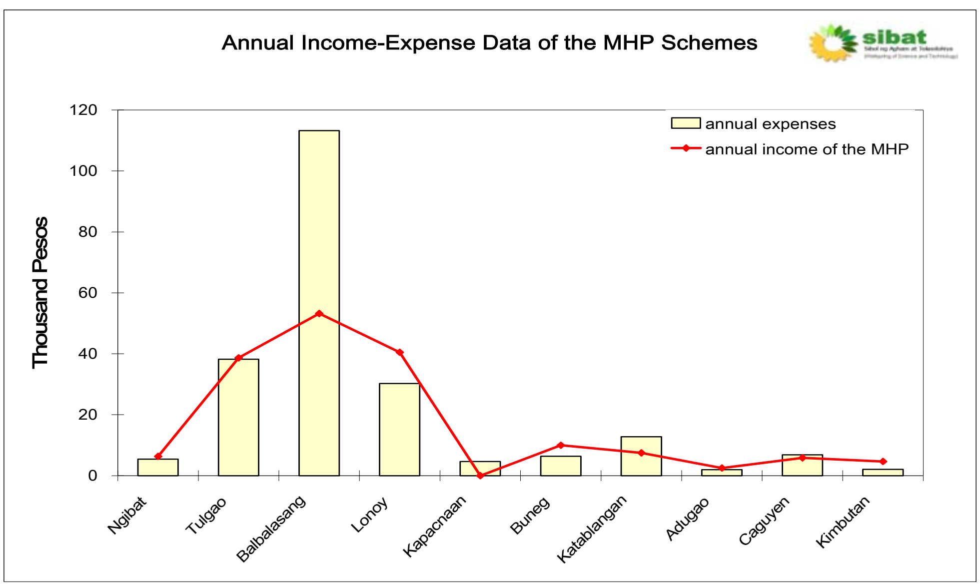


Figure 9. *Income – Expense Graph of Evaluated MHP Projects*

[18] An average figure, dividing the total external funds contributed to the scheme by the age of the scheme (annualized).

Tariff Collection

It was found that the tariff collection rates varied greatly among the MHP schemes, from a low 21% (Ngibat) to a high 100% (Kimbutan). Poor collection for some schemes is found to be attributed to: unavailability of cash, poor enforcement of policies, lack of collection targets, and weak acceptance of policies by a few. The failure to collect regularly, i.e. inefficiency in tariff collection is also due to the lack of incentives for collectors.

The slow response to breakdowns or shutdowns in one case (Kapacnaan) resulted in a lack of confidence on the system that led to a waning of interest in paying the tariff for a time. Also, the system was damaged by a typhoon after its repair.

In two schemes with low collection rate (Balbalasang and Tulgao-Dananao), survey results revealed the perception by some community members that they should be exempted from paying a tariff having already provided labour counterpart, revealing their lack of acceptance of community policies.

Further analysis of the collection rate and the level at which the tariff has been set showed no correlation between the cost of the electricity and the number of people who pay.

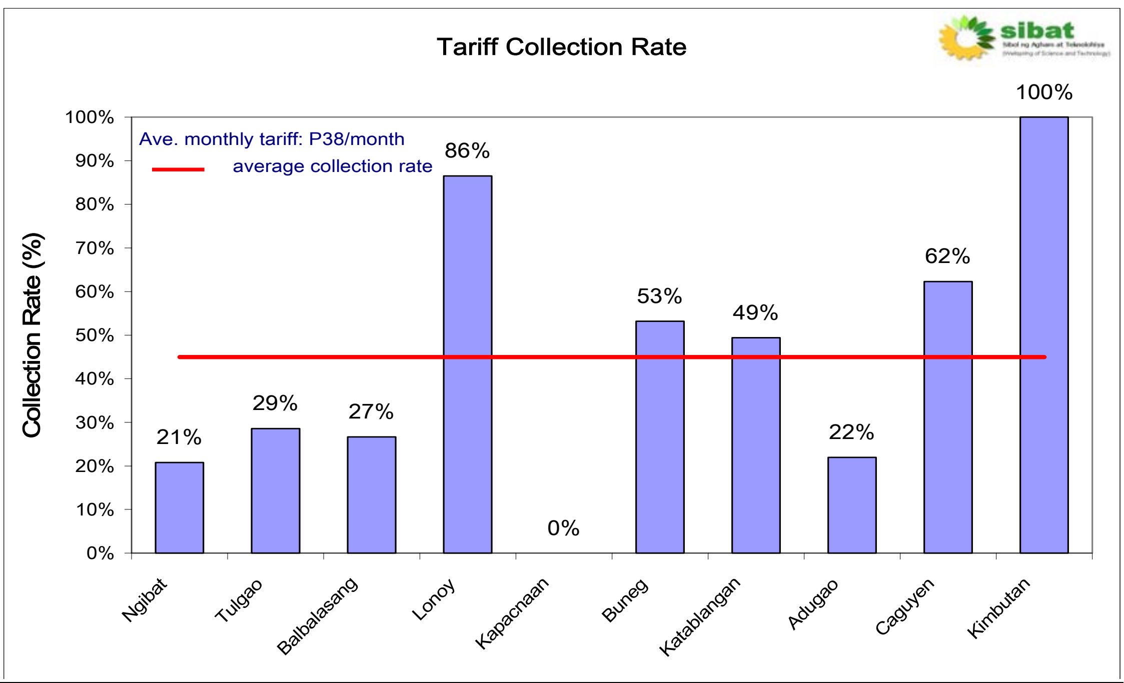


Figure 10. *Tariff Collection Rate*

While the tariff was commonly agreed upon by members of the community (and are regarded by respondents as generally affordable), it was determined that the there were several causes for low tariff performance; (1) weak enforcement of policy, (2) the lack of follow-up after non-payment of tariffs and (3) the lack of dispensable cash among the beneficiaries. This highlights the vital role of the PO in managing the collection task, and the role of SIBAT in systematically and painstakingly advising on the objective of project sustainability. Tariff monitoring should be built into the post-project development process.

Poor tariff collection only partly explains the negative incomes registered for some schemes. Tulgao-Dananao, Balbalasang, Katablangan, Caguyen and Adugao – *need to increase their collection rate to cover for the deficit incurred in operating the system.*

Capacity to Pay

It was found that the availability of regular cash is generally a main factor in achieving an acceptable collection rate as shown in the good cases of Kimbutan and Lon-oy. The members of the community with regular incomes (teachers, municipal employees, barangay officials) are those who have shown the capability to pay regularly.

The lack of regular available cash, meantime, makes payment difficult in the cases of Ngibat, Buneg and Tulgao-Dananao, as expressed by respondents. The main sources of cash in many upland areas (where most MHP schemes are found), are seasonal farm labor, handicraft and selling vegetables. In the case of Tulgao-Dananao, payment in kind has been ineffective, as the disposal of the produce for cash was slow. Buneg meanwhile derived its net income from the rice mill, even with a low tariff collection rate.

Analysis also showed that the common assumption that the community's capacity to pay is equivalent to the average monthly expenditure on kerosene is not completely valid as communities only buy kerosene when cash is available. The study also did not find a correlation between the size of farmland (i.e. production) and collection rate.

A source of regular cash income is found to be the most desirable option to meet costs for O&M, and for other costs that would warrant sustainability of the MHP.

Tariff Valuation and Structure

Tariff Valuation

Based on a 100% collection rate, the tariff rates decided by the communities are shown on *Table 33* below. A tariff/kWh was calculated for each scheme based on 100% collection and 95% plant availability (a maximum production figure). This reveals that with the current tariff, only Balbalasang can cover their operation and maintenance expenditures and save on system replacement assuming they attain 100% collection rate.

The rest of the project sites should study accurate valuing of "goods" as tariffs, and improve their collection rates to cover operating costs.

Tariff Structure

Shown on Figure below is the price a household pays for its energy consumption. The income level was assumed to be their ability to acquire appliances and the need for more lighting fixtures in their houses. The graph shows that the flat rate policy is to the disadvantage of the households belonging to the low income class as they pay more for their energy consumption.

The data further shows that users do not pay for what they actually consume. As it should be, the tariff structure should be adjusted. One option for the community to take up, is the adoption of a flat tariff for the installed capacity (P/W/mo) but a prepaid load limiting device to be installed per household to regulate the consumption. In this manner, defaulters can be avoided.

A fair and just tariff structure must always be sought – one that will not unduly favor the economically advantaged households or bear down on the economically disadvantaged ones.

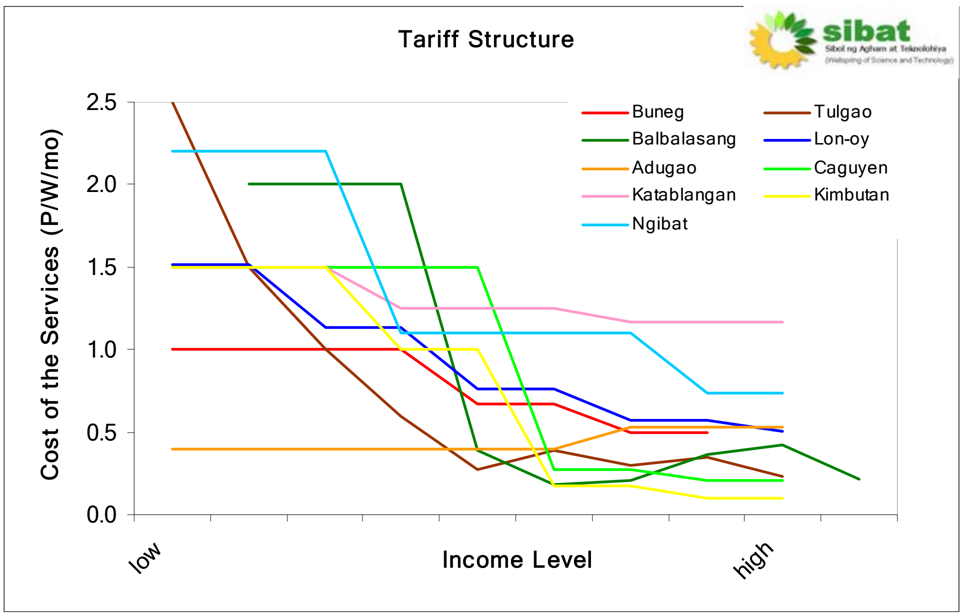


Figure 11. *Tariff Structure of Evaluated MHP Sites*

Cost Covering Tariff and Utilization

The cost covering tariff is the amount the beneficiaries need to pay for their electricity in order to be able to pay for the annual cost of the system. The annual cost assumed is the capital recovery of the plant after 15 years plus % of the capital for O&M cost. As energy cost depends largely on plant utilization, and all of the evaluated sites are presently underutilized (Table 11), the tariff necessary to cover the annual cost appears high in the calculations made here. Thus, *to lower the annual costs, higher utilization of the MHP system is desired.*

The cost covering tariff at 60% plant utilization (or plant factor) is the optimum plant factor for a grid-connected scheme[19]. This factor was used the maximum possible utilization of the evaluated MHP plants.

[19] Source: The Worldbank Completion Report for an Energy Services Delivery Project, 04 June 2003

Table 33. *Tariff Paid and cost covering tariff*

MHP Scheme	Actual Tariff Paid (P/kWh)	Cost Covering Tariff[20] Present Utilization Rate (P/kWh)	Cost covering Tariff 60% Utilization (P/kWh)
Ngibat	5.6	18.8	1.41
Tulgao-Dananao	5.4	9.5	1.38
Balbalasang	7.9	6.3	1.46
Lon-oy	2.9	8.9	1.37
Kapacnaan	2.8	24.8	1.14
Buneg	4.4	16.8	1.56
Katablangan	6.8	28.2	1.42
Adugao	3.0	27.7	1.46
Caguyen	8.7	41.2	1.46
Kimbutan	1.8	22.1	1.78
Average	**4.93**		**1.44**

The actual tariff paid by the users was computed at the current monthly tariff considering the total load and the number of hours these loads were used.

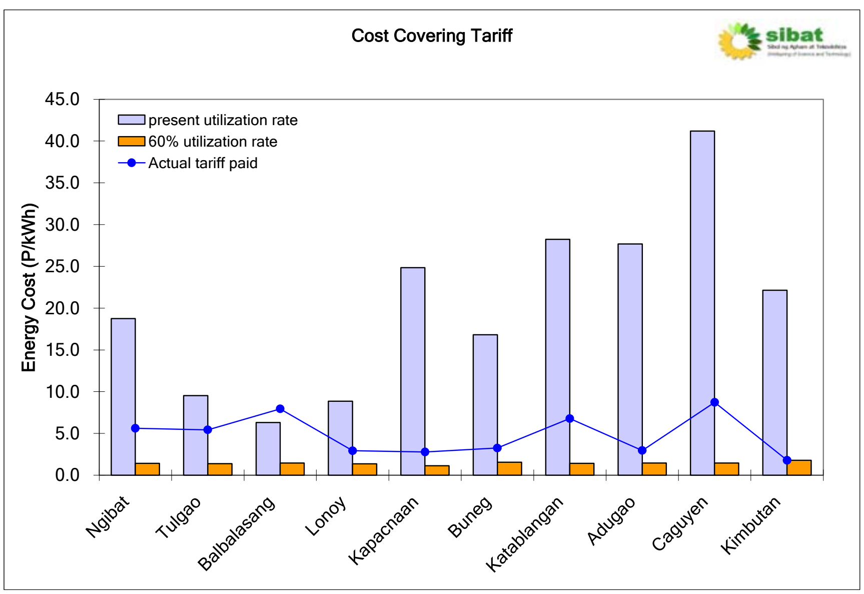


Figure 12. *Cost covering tariff of the evaluated MHPs*

Figure 12 shows that at the actual tariff paid by the users, only Balbalasang will be able to save for system replacement assuming they have 100% collection rate.

The graph below presents how the electricity production cost is affected by the utilization rate. The energy production cost is the amount necessary to cover for the annual cost of operating a power system divided by the annual energy produced.

[20] Computed at O&M = 1%of total project cost and capital recovery after 15 years.

The horizontal line is the cost of energy using diesel generator. The annual operational cost of the diesel engine and the annual energy produced are related to operating time resulting to a constant tariff at varying utilization rate. Whereas a hydro plant still has maintenance cost (for replacement of components due to corrosion) even if it is not used. Therefore the MHP's annual cost is independent of utilization. To be able to cover for these costs, the plant should operate and sell.

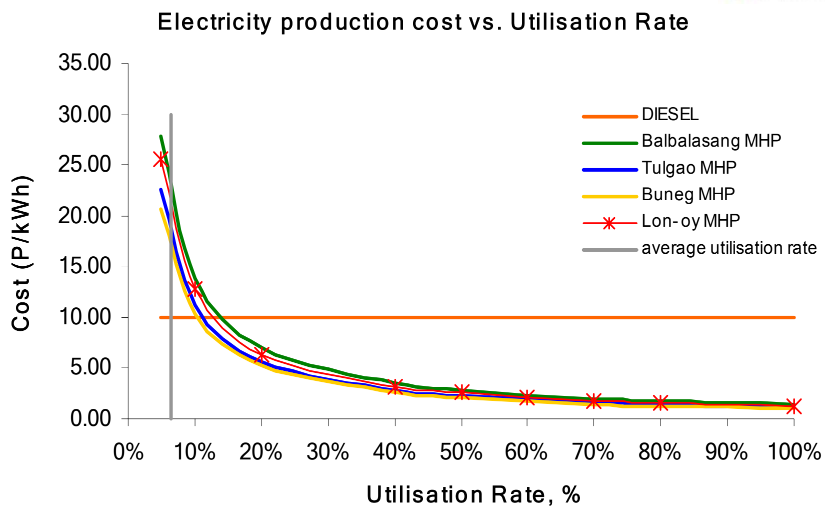


Figure 13. *Production Cost vs. Plant Utilization*

The graph shows that at the average present utilization (vertical line on the graph), energy cost is cheaper with a diesel generator. Only Balbalasang with a utilization rate of 14.6% gains the economic advantage of using their MHP. But given the adopted tariff in each village (Table 33), the energy cost for the diesel generator is way above the beneficiaries' capacity to pay.

The low utilization of the evaluated MHP schemes was due to a number of reasons: (1) the uninstalled livelihood components (rice mill, sugar cane press, wood working tools) in some of the project sites, (2) due to lack of funds, most of the systems were without an electronic load controller making the 24-hour operation not practical. Without an ELC the plant should be manually adjusted and operated to avoid damage of the electro-mechanical equipment due to load variations.

If the plant utilization rate at the average 10-hour operation per day is used, all of the evaluated MHP plants are more economical to use for power generation compared to that of a diesel generator.

Study on the Ability for Loan Servicing

At this point, we present how the villages may perform if the project was funded with a loan component. As previously stated, grant funds are decreasing and some project components are at risk of being not implemented due to lack of funds.

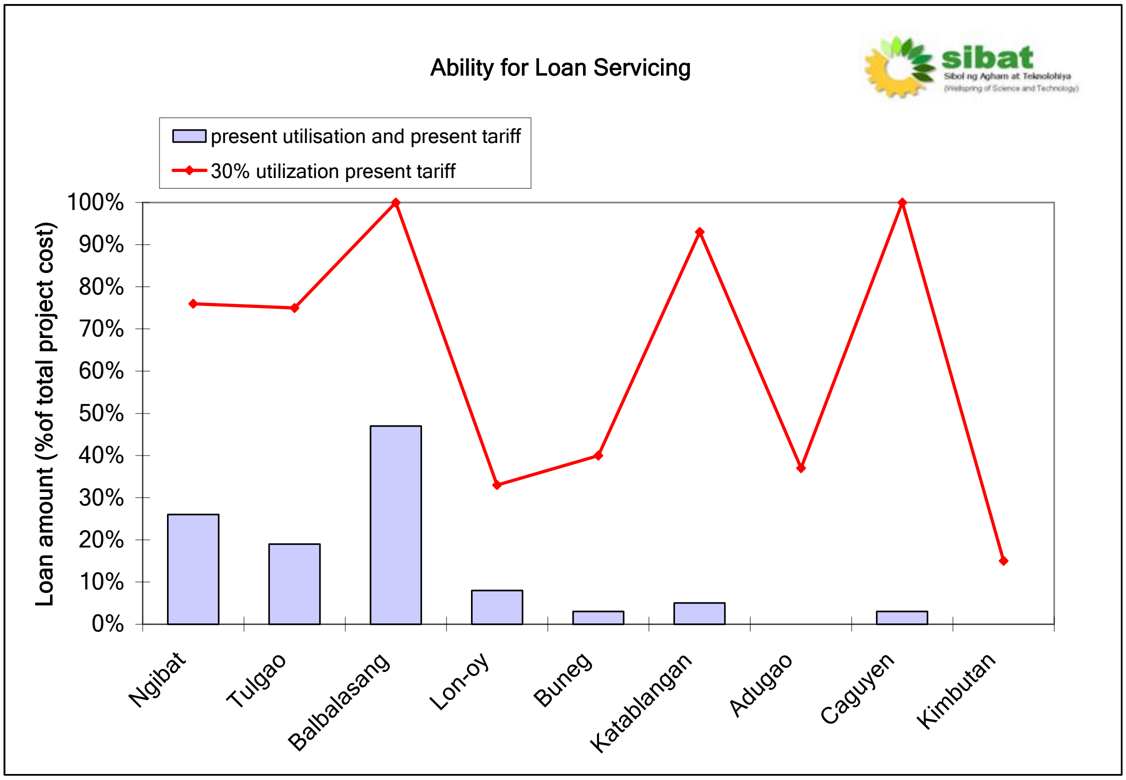


Figure 14. *Ability for Loan Servicing of the Evaluated MHP Sites*

Should there be a need for loan financing, analysis showed that at the present tariff and utilization rates, only 3 out of the 9 evaluated MHP sites, have the ability to pay at least 20% of the total project cost as loan at the prevailing bank rates of 12%, namely Tulgao-Dananao, Balbalasang and Ngibat. Adugao and Kimbutan set a tariff that is way too low to be able to accommodate loan repayment. The computation was made at a 10-year repayment period.

With increased utilization meanwhile i.e. 30% as shown on the graph, the minimum project cost that the plants can serve as loan is at 15 % of the total project cost (Kimbutan).

Section 7. PO Capacity Building for MHP Management

To help sustain and manage the MHP schemes, the management team and local NGO partners were provided with training after project installation.

Table 34. *Training Given to Beneficiaries (POs) of the MHP Projects*

MHP Sites	Technical Trainings			Project Management	Watershed Management
	Basic	Advanced	TESDA		
Ngibat	x	x		x	
Tulgao-Dananao	x	x			
Balbalasang	x		x		
Lon-oy	x	x	x		
Kapacnaan	x	x			
Buneg	x	x			x
Katablangan	x			x	x
Adugao	x				x
Caguyen	x			x	x
Kimbutan	x			x	

Basic Technical training

SIBAT provides basic technical training for operators and managers immediately after successful commissioning, using a Training Manual for Operators. The training consists of modules on: (i) MHP operation and maintenance; (ii) Household wiring; and (iii) Electricity theory.

Advanced Technical Training

SIBAT conducted a review technical training for operators and managers operators in February 2005. This consisted of: (i) an overview of the civil works and electro-mechanical plant; (ii) review of operation and maintenance; (iii) household wiring; and (iv) electricity theory.

The Technical Education and Skills Development Authority (TESDA), a government institution, provided household wiring and practical electricity training for Balbalasang and Lon-oy.

This training enabled the operators operate the MHP schemes. However, some operators were replaced with operators who did not undergo the basic course, and merely relied on the inputs of their predecessor. The problems in operation and maintenance were felt to be largely a result of the inadequate training of the operators.

Formal Project and Financial Management Trainings

These were provided to POs by local partners (e.g. project and financial management trainings in Caguyen and Adugao were conducted by the De La Salle University (DLSU) and were not undertaken by SIBAT.

Management problems were also seen to have resulted from inadequate trainings and follow-up from both local NGO partners and SIBAT.

Watershed Management Training

Trainings on watershed management and protection was given to (four) 4 POs with projects having a watershed management component. The formal training given to POs consisted of: (i) basic introduction to watershed management; (ii) assessment of traditional forms of watershed management; (iii) training in agro-forestry; (iv) collecting saplings from the forest; (v) setting up a nursery and (vi) planting of seedlings.

Said projects also received training from SIBAT on watershed management, sustainable agriculture orientation, community seed banking and sloping agriculture land technology – as upland sustainable farming was considered part of the holistic approach to watershed management.

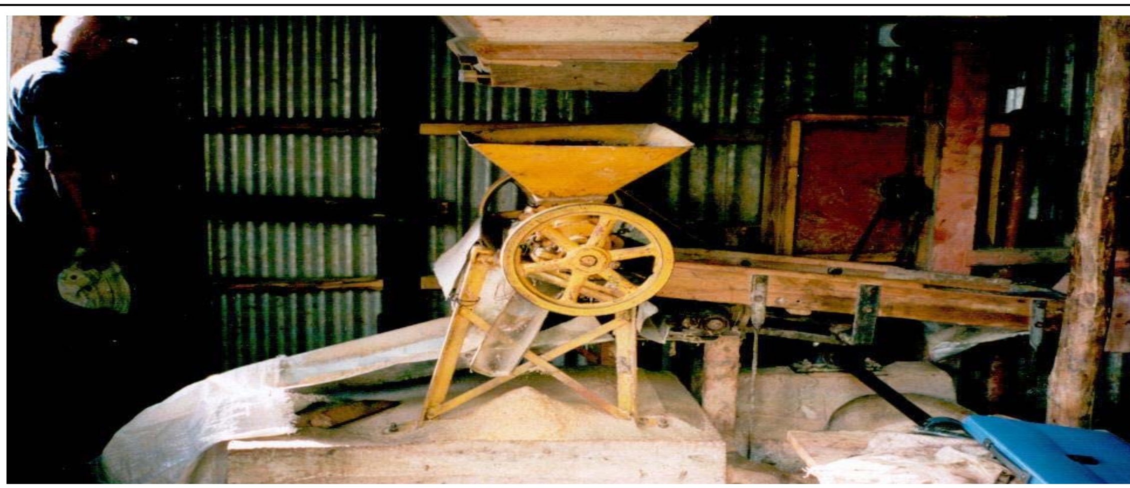
To ensure sustainability, it is recommended that capacity building on various aspects of management (organizational, financial, and technical) be instituted into a post-installation scheme or plan. There is a need to monitor the performance and capacity building of the management team and of the operators, and ensure their continuing development to meet the requirements of a CBRES.

CHAPTER 4
MHP EFFECTS

The assessment looked into the various effects of the MHP schemes on households and communities. The areas that were investigated by the study were: effects on household economy (particularly on income and expenses) and on health and social well-being of household members; effects on community strengthening and development; and effects on the environment. The changes in certain conditions of women were also considered.

Effects on Household Income and Expenses

The study revealed that there were concrete economic benefits by households in terms of: first, net savings from traditional kerosene; second, savings from charges on rice milling; third, additional income in increased household-based handicraft (more work hours with little corresponding costs); fourth, income from the use of small power tools such as for woodworking and blacksmithing; and fifth, income in operating small retail establishments. The income by the community from rice milling and sugarcane pressing went to maintaining the facilities and the MHP.



Savings with Electric Light

To determine the savings the households achieved with substituting kerosene with hydropower, the annual equivalent cost of wiring, replacement cost of lamp and energy cost was computed based on the prevailing tariff in each of the evaluated sites. For Buneg, Katablangan, Adugao and Caguyen, the cost of household wiring were provided by the project as grant.

Five out of the nine evaluated MHP sites proved to have savings with the electric lights. The beneficiaries in Lon-oy, Ngibat, Katablangan and Caguyen however greatly appreciates the better lighting provided by the MHP compared with that of kerosene lamps. They expressed that they felt a sense of improvement in their situation which could not be expressed in Pesos.

Table 35. *Annual Savings with Electric Light*

	Type of lamp	Ave. number of lighting fixtures	household wiring, PhP	Lamp replacement Cost, PhP	Energy Cost, PhP	TOTAL Annual Expenses, PhP	Kerosene Costs, PhP	Annual net savings, PhP
Ngibat	fluorescent	2	60	535	301	896	600	**(296)**
Tulgao-Dananao	fluorescent	2	60	535	320	915	1,128	**213**
Balbalasang	CFL [21]	3	60	1,095	528	1,683	2,196	**513**
Lon-oy	fluorescent	3	60	803	122	985	744	**(241)**
Buneg	Philips CFL	1	Grant	220	266	486	654	**168**
Katablangan	fluorescent	2	Grant	535	300	835	540	**(295)**
Adugao	incandescent	2	Grant	134	300	434	1200	**766**
Caguyen	fluorescent	2	Grant	535	420	955	840	**(115)**
Kimbutan	fluorescent	2	60	535	360	955	1224	**269**

The savings provided some small net augmentation to some household incomes as expressed by respondents, which was partly alleviating a need by the communities in the context of their income scarcity.

Savings from Rice Mill and Sugarcane Press

The households utilizing the rice mills and sugarcane press also made savings on charges, which were significantly lower than those charged by private owners of mills, where these were available. The typical charge was P20-30 for every 12kg can of un-milled rice, compared to P15, which is the standard charge for MHP powered rice mills. They also saved on transportation costs for bringing the produce to the towns for milling.

[21] CFL is compact fluorescent lamp

Sugar pressing was traditionally conducted using a carabao turning a wooden press. Using an electric sugar press was not only faster and more efficient, but it removed the need to hire a carabao.

Table 36. *Average Savings on Rice Milling and Sugarcane Pressing Expenses*

	Rice Milling	Sugarcane Pressing
Savings on MHP powered Rice milling / HH/kg	PhP 5 to 15	
Total Milled Rice, kg/HH/yr	405 kgs	
Total savings / hh/ yr	PhP 2,025 to 6,075	
Savings on transportation / HH/milling, P	P30	
Savings on cost of hired carabao/ HH cluster		P250 - 300

Expansion of Irrigation Facilities

The MHP projects had other beneficial effects on farm work. In five villages, the water from the MHP tailraces and overflow from forebay and canal increased the supply of irrigation water for the rice terraces. The power canals also had served as additional access paths to their farms.

Income from Increased Handicraft Production

In 5 out of the 10 sites in the study, there was an evident increase in the production of existing broom-makers, basket-weavers and other handicraft producers. This is the result of the availability of lighting at night, the time available for these activities. The chart below shows the increase in income from the production of handicrafts since the introduction of MHP.

One Tulgao respondent claimed that his winnower products increased to 20 pieces from 15 pieces per month with the availability of electricity. This gives the household an additional P750 to P1000 per month.

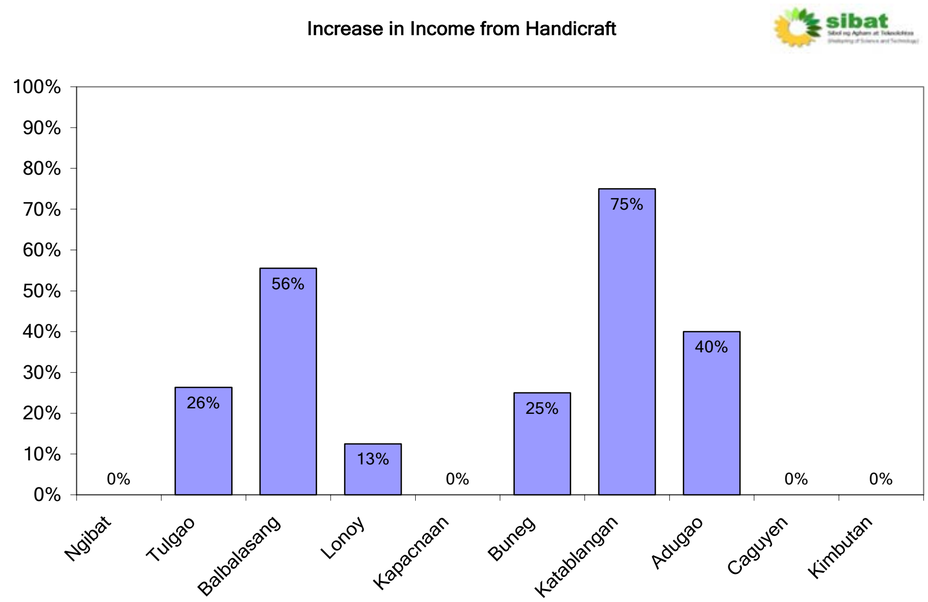


Figure 15. *Percent of Population with Increase in Income from Handicrafts after Installation MHP Projects*

The most number of households interviewed who experienced an increase in income from handicraft was Katabalangan (75% of the interviewed population). This was due to the availability of raw materials for basket weaving and broom making. Due to a higher market value, more households were encouraged to venture into handicraft instead of marketing their rattan as raw material.

Overall increase in Income

The actual increase in income could not be ascertained at the time of the research. However, evidence was gathered from the expressed satisfaction of the households interviewed. They stated that they had small net increase in household incomes, which was partly alleviating a need in the communities in the context of their income scarcity.

Community Strengthening

Strengthening Community Organizations and Solidarity

Most respondents declared that projects became opportunities for the people to improve their organization and management skills to be able to operate and sustain the projects. The experience of working together and meeting a positive outcome was inspiring for them. The traditional cooperative and mutual labor-exchange practices were further strengthened, even in communities where the people experienced paid labour. Key respondents said that for their organizations and for the communities, the MHPs were the most trying and challenging project in their lives, and succeeding projects were far easier.

Mitigation of Tribal Conflict

The project in Tulgao-Dananao effected an improvement on the peace and order condition in the area by mitigating the traditional tribal conflict between the Tulgao and Dananao tribes. Concretely, the installation of the MHP in the Buneg Creek situated in the middle of the Tulgao and Dananao barangays and the opportunity to work together on the project, had lessened the potential of tribal conflicts and emphasized the need for unity and working together. Hence, community solidarity has been enhanced by the community-based project.

Development Enabling

A Catalyst for Further Development

The MHP projects in some cases facilitated or opened up other infrastructures, such as in Katablangan where the MHP power canal was utilized as access road to their swidden farms and rice fields.

The successful completion of MHP projects has encouraged some community organizations to undertake other projects, and specifically, approach the LGU for community project funds. Such were the cases for the rice mill and satellite TV in Buneg, and irrigation project in Ngibat.

The MHP projects also became showcases on appropriate technology and have been opened to public visits.

Social Benefits

Health and Well-being

There are a number of benefits derived from the electrification of the community in terms of the health and well being of the family, particularly of children. In Tulgao-Dananao, it was mentioned that children now can read and study at night, and through the introduction of television, have an increased awareness of what is happening in the world outside their barangay. Women also mentioned that the family had more time to sit and talk in the evening.

The burning of pine wood for lighting results in the production of thick black smoke, which is known to cause breathing difficulties. The women of Tulgao-Dananao noted that their families could breathe more easily since the introduction of the MHP scheme, since there was no soot coming from *saleng* or *pine pithwood* anymore. Replacing pine wood as a fuel for lighting with electric lighting reduced the risk of respiratory and eye diseases. During the discussion with the women, participants mentioned that child delivery is much easier now. Traditionally women in Tulgao-Dananao give birth completely alone and the electric light helped them feel more comfortable during birth.

Education

It was commented by many participants in the survey that the introduction of electric lighting had extended the time available for schoolchildren to study at home. In addition, with the help of foreign missionaries connected to the local diocese in Balbalasang, a computer lab equipped with 8 computers was set up to train schoolchildren in Information Technology, using electricity from the MHP scheme.

Effects on Women

Reduced Manual Labor of Women and Children

Women and children, meanwhile, saved time and labor on rice pounding, which is an all-season activity they normally do. On average, an hour a day was spent on pounding rice to produce 2.5kg of milled rice. The introduction of rice mills allowed more time to be devoted to other household chores and farm work. (*See Box 1 below*) Aside from this, the rice bran from the milled rice (mechanical milling still retains some bran) is a good source of feeds for pigs and other livestock. Twelve kilograms 12kg of un-milled rice, when milled produces a total of 1kg of rice bran, to supplement livestock feed and reduce gathering time and labor of women.

Reduction of Drudgery on Women and Children

The Tulgao Rice Mill

Rice pounding is one of the major tasks of women and girls in a community. In a survey conducted during the feasibility study of the MHP, it was found out that the number of hours spent in pounding rice or palay every day is 1.15 hours in Tulgao east and 1.70 hours in Tulgao west. The quantity of rice milled in an hour is 2.5 kilos. With the set-up of the rice mill in 2002, women and girls were relieved of this task since most of them availed of the services of the rice mill. The rice mill was a donation from the European Union and the Australian Board of Mission through the facilitation of the Episcopal Church. The rice mill was fabricated by the Department of Engineering of the Benguet State University. The charge for milling was 15 pesos per can (approximately 18 kilos) if the client had provided labor or materials during construction of the rice mill. In cases where no labor or materials had been provided, the milling charge was P20.00 pesos per can. Moreover, the rice milling also provided rice bran as feeds for livestock. The earnings of the rice mill were divided into three equal parts, going to the operators, the church and the MHP project.

Impact on Women's Tasks as a Result of Improved Lighting

According to respondents in the focus group discussions, women's work at home is said to have been made easier with the introduction of MHP powered electricity. Coming home from a hard day's work in the rice field or swidden (where women generally do daily and tedious tasks on crop management), better lighting has enabled them to more easily accomplish daily chores at night. The women of Tulgao and Dananao specifically mentioned the daily task of peeling sweet potatoes (for viand and livestock feed) now being much easier. The women mentioned too that they could now prepare food early in the morning. Further, reduced use of pine wood and reduced soot on white clothes has made clothes washing, which is the women's task, much easier.

Environmental Protection

Watershed Protection and Management

Four of the 10 projects (Buneg, Katablangan, Caguyen and Adugao) had a specific component on watershed protection and plans were individually formulated through: (i) orientation on agro-forestry systems, sustainable agriculture and watershed management; (ii) resource assessment techniques, e.g. mapping and identification of existing forest wildlife and indigenous forest species; and (iii) community watershed management planning workshops. The plans were implemented in the critical catchment areas. The reforestation part included collecting saplings from the forest, setting up agro-forest nurseries, and planting of seedlings.

These projects reinforced the traditional practice of forest protection by the four indigenous communities, and further enhanced the peoples' environmental awareness. This led to the revival of the old and environment-friendly closed and open hunting season practiced by the tribes. Community policies to safeguard water resources were formulated that also meted penalties to those found guilty of contaminating the water bodies.

The consciousness on the ancestral forest domain was reinforced by the mapping activity done as part of the rehabilitation project.

Reduced Pine Pithwood Gathering

Pine pithwood or *saleng was* traditionally used as for lighting in upland communities, and a typical family consumes around 1m^3 per month. In Tulgao-Dananao, both men and women in the focus group discussions mentioned that with electrification, less pine pith wood was being gathered from the forest. Watershed training was a component of some MHP schemes, and incorporated replanting of pine trees. The preservation of the trees within the catchment of the MHP scheme ensured a good supply of water for the MHP and the community.

Reduced Battery Use and Disposal

For all sites, the reduction in the use of batteries as a result of the shift to MHP power resulted in less disposal of and contamination by these items. There had been no safe disposal method for such in these areas.

Other Effects

Observed Adverse Effects on Children

It was mentioned by respondents in Tulgao-Dananao that a major concern of parents and community organization is children stealing (for instance, pithwood) for payment for watching videos. Films were being shown for a charge of P5 per film, but children were resorting to petty thievery to afford to watch a film. The parents are also worried on the exposure of children to objectionable scenes from the videos they watch. The feasibility study initially foresaw some problems with the introduction of TV, on its possible effect on cultural and social norms if not properly handled.

CHAPTER 5
ANALYSIS AND CONCLUSIONS

The sustained operation and effectiveness of 9 out of 10 systems in the assessment demonstrates the viability of CBRES in the hands of organized communities in remote and poor areas that are far from the grid. Furthermore, in the form of CBRES, it is concluded that these systems provide benefits over and above that of the provision of household lighting. In other words, the CBRES presents a potential development tool for the rural poor, and not a mere electrification technology.

Socio-economic Benefits to Poor Upland Households and Communities

There are two ways the villagers use the energy provided by the MHP schemes: for household and village lighting; and for operating post-harvest processing equipment and small hand tools. The study reveals that households achieve concrete economic gains with the MHP, through:

- provision of reliable electricity for household uses, with potential net savings if proper efficient bulbs are used;
- operation of rice mills, which rendered savings from lower charges for milling and benefited women and children through cutting on all-season labor on rice pounding;
- additional income from increased household-based handicraft or operation of small retail establishments due to the availability of light; and,
- income from the use of small power tools such as for woodworking and blacksmithing.

The CBRES concept makes it possible to realize these benefits as the community-based character of the project (i.e., people deciding on the tariff) makes electricity affordable, i.e. made more accessible to them. This access has immediately opened up an opportunity to expand existing economic activities within the poor communities.

Affordability is shown by this study as a crucial element to ensure access of poor households to electricity, and was ensured by decision-making that is lodged in the community.

Effects of MHP Systems on Households and Communities

The assessment reveals a range of effects on households directly resulting from the community-based MHP undertaking. On the financial side, fuel savings and income generating schemes enhanced by the introduction of lighting is seen to enable a net increase in household income, as previously discussed in the chapter on Applications. This net increase, against the existing cash levels in these communities, can be significant. While this study did not go into the extent of weighing such significance, this conclusion can be safely drawn from a general knowledge of cash-strapped conditions in subsistent and semi-cash economies in the upland communities of the country.

The post-harvest production facilities, such as the rice mills and sugar presses reduce the cost of processing and create labor savings, as well as provide an additional income stream to cover O&M expenditure. A comparison with the households' milling expenses show that the difference, again, is significant, especially on transport costs.

This net increase in income is enabled by *affordable tariff fees* for electrification and other end-uses. Hence, the community-managed scheme, along with the decision-making lodged in the PO/community, can lead to direct and concrete benefits for the household users, by instituting acceptable and affordable tariffs.

The MHP projects have benefited farm production by supplying the water from the MHP tailraces and overflow from forebay and canal, to increase the supply of irrigation water for the rice terraces. The power canals also serve as additional access paths to their remote farms. While the study did not delve further into these outcomes of the projects, their significance on the lives of upland farmers should be stated here.

For households which used to manually pound rice, the post-harvest facilities also result in the reducing the labor, especially of women and children. Women's work in the house has also been made easier through improved lighting. This is important for indigenous women who carry out most farm work in the rice and swidden farms. This study recommends to the PO management of the CBRES, the improving and creation of equal and beneficial productive roles for women in the community.

The impact on health has not been exactly measured in the study. Some observations made on reduced respiratory discomfort and ailments as result of the reduced burning of pine pithwood for lighting, and child delivery of women being somewhat easier now with better lighting – are regarded as indicative of the positive impact on health and health services, with the change from traditional kerosene or pithwood to MHP.

The impact on the environment is measured here in terms of improving local protection of watershed areas. This lends to the improvement of the forest micro-environment, the sustaining of the water supply, and even to the creation of additional food through agro-forest. The introduction of resource mapping skills, too, is important for indigenous communities ancestral land claims. Resource assessment and identification of forest wildlife and indigenous forest species are important for biodiversity conservation. Significant too, for strategic watershed resource protection is the revival of traditional communal forest and water protection practices in some communities, as an outcome of the MHP projects.

While the above findings are immeasurably significant from community and environmental perspectives, the study would have been made complete in this aspect if it included a measurement of carbon dioxide mitigation, as a result of watershed management activities and the reduction in pithwood burning for fuel.

There are other significant impacts on peoples' lives shown in the study. One is the peace and order outcome, the mitigation of conflict between tribes, as a result of unifying effect of collective labor and a joint ownership of the system. Most other MHPs express unifying outcome of their work around the MHP on solidarity among community members.

The people themselves managing development opportunities, including improvement of cash sources -- resulting from internal motivation – is a positive picture depicted as an outcome of the MHP projects. In the context of indigenous communities, especially, who are vulnerable to external incursions in the name of 'development', development coming from within, no matter how small in view of conventional norms of change, bears concrete, real and significant gains to people's lives.

Adverse impacts of new technologies on children's minds have also been revealed by the assessment, specifically due to the introduction of television. The community can collectively decide on how to deal with the adverse effects of new technologies.

The community-based management of the CBRES is a mechanism that could powerfully address these issues, through consultations, awareness-raising and local policy formulation. There are practices presented in the assessment that illustrate this. The adverse and unexpected impact of new technologies may be redirected and averted, with full exercise of community ownership and management.

Technology Appropriateness

Technology appropriateness was measured by looking at three factors: reliability of the system, adoptive quality (measured through quality and ease of maintenance and operation, and the capacity of the community to manage the system), and functionality or uses for which the systems had been designed.

System Reliability

The assessment shows that the reliability of the systems is yet a continuing area of improvement in the systems studied. Although nine of the 10 systems remained operational and maintained operation for most of their lifetime, there are however downtime periods (for reasons of water shortages and major repairs related to some electro-mechanical equipment) and measured shortfalls between expected and measured design capacity of the systems.

The assessment reveals on the whole that the reliability of equipment needs to be improved and repair cost needs further reducing – which can be done by improving designs. Certain recommendations were made here to improve system reliability. Downtime resulting from operator negligence will be minimized as skills in operation are enhanced and systematized through improved operator training.

The study reveals that hydrology designing that includes powerhouse location needs to be improved, particularly in vulnerable sites given the increasing occurrences of ravaging typhoons and landslides in the upland areas. The problems of the one failed project provided valuable lessons in technical designing and management, which should be the focus of efforts in the future.

The lack of an installed prompt response and monitoring mechanism caused inadvertent delay in attending to projects demanding repair. Again, this should be critically attended to.

Adaptive Quality

Most problems surfaced pertaining to operation is operator negligence, resulting in many technical problems and downtime recorded in the study. This is proposed to be overcome by continuing training, intensive monitoring of and guidance to operators, as well as sanctions by the PO in extreme cases. For systems without ELC (i.e. manual adjustment of gate valve openings with varying load), some abrupt system shut down occur due to load fluctuations. To prevent damage to the system, it has been established as a requirement to incorporate an electronic load control or ELC in the MHP design.

Functionality

The uses for household electrification and for running facilities and power devices have been shown by the MHPs studied. However, the utilization rate of evaluated schemes at the time of the study is only 15%, on the average, of the design capacity of the scheme. This reflects the low energy demand typical of poor upland communities (seasonal uses for post-harvest facilities), as well as the potential for further expansion of uses. Increase in food crop production should be aimed at (as a need for low producing farming communities and as the real basis of increased energy utilization). Opportunities for livelihood end-uses should be sought to increase the utilization rate, particularly during off-peak periods.

Capital Cost and Financing

Lower Capital Costs for a CBRES

The capital costs of the MHPs compared to those of other projects which apply imported equipment and foreign expert consultants are found to be relatively lower. This is while completely ensuring the integrity and reliability of the system. Comparative costs attribute the difference to a number of factors that include: the local contribution of labor and materials, local fabrication of turbines, and the relatively lower fees which SIBAT charges for technical assistance. The local contribution (in the form of labor by both men and women, valued according to prevailing local rates, and local materials sourced in the general vicinity) is integral to the community-based scheme, a factor that reduces capital costs. The capital costs of the plants can be further reduced through improvement in technology choices and optimization of plant size to the actual requirement.

Grant Financing

A one-time grant financed the capital costs for the ten (10) MHPs in the study, covering materials and equipment, supervision and training and all that is necessary to install the plant. Said upfront costs installed the projects that the communities then subsequently operated and sustained through returns from the project itself. Hence, in a CBRES, operation and maintenance costs (O&M), and costs to replace major parts and equipment (sinking fund), are the corollary obligations of the community. The community contributed through local counterpart funding, which constituted the community's equity in project development, and their claim to ownership of the plant.

Limitations of Grant Financing

Firstly, there is an expressed recognition of the difficulty by SIBAT in locating funds for projects (for project preparation and capital costs), especially because capital funds involved large sums of money. There is only one donor agency which has more open and flexible funds for PO-based MHP schemes (UNDP-GEF-Small Grants Programme). The lack of easily accessed project preparation fund poses a hindrance to prompt responses to requests, a fact which has slowed down CBRES projects diffusion and development. Fund ceilings, in certain cases, limited expenditures for more expensive but more quality equipment and materials, jeopardizing system reliability. Improvement in and expansion of grant mechanisms for CBRES is necessary, even in the face of dwindling grant sources.

Ability for Loan Servicing

The ability for loan servicing for capital costs of MHP projects has also been looked into in this study. It is shown that with increased collection and utilization rate – MHP systems to be installed in poor upland locale can service a certain percentage, even a small one, of the total project cost. In other words, it is found feasible, in the event of dwindling grant sources, to develop a loan-grant-sweat equity mix type of financing for community-based MHP systems. It is deemed, further, that with an appropriate loan share in the financing mix, the community's commitment to and sense of ownership of the project will be enhanced.

Financial Sustainability

Ability to Sustain Financial Needs for Operation

The study reveals that all projects were just able to modestly or barely support their operation and maintenance costs and pay for parts replacement through income from the projects and in some cases by applying for funding from outside agencies (i.e. external funds). The revenues from tariff collections are found barely enough to sustain neither operations (O&M) nor appropriations for sinking fund. At this point, the systems are not operating as viable power enterprises.

Tariff Issues

Tariff collection ranges from poor to satisfactory – a situation that needs to be improved in order to realize revenues to sustain the system. Poor collection rates are observed in some systems, and are partly attributed to weak collection management. This requires resolving the problems or finding solutions at the level of PO management.

In addition, there is a need to more appropriately structure the tariff system in the specific economic conditions of poor communities. The development of an appropriate tariff requires an in-depth knowledge of the amount and seasonality of household cash income. Hence, the current practice of community consensus on tariff may be further improved by developing and suggesting innovative tariff schemes to ensure that all households are able to pay.

The study reveals that the cost covering tariffs (the amount the beneficiaries need to pay for their electricity in order to be able to pay for the annual cost of the system) which were decided by the communities were insufficient to cover at least the maintenance and operation. Certain lessons have been yielded by the study. One is on tariff valuation: the projects should study accurate valuing of "goods" as tariffs, and improve collection rates to cover operating costs. The second is on tariff structure: a fair and just tariff structure must always be sought – one that will not favor the economically advantaged households or bear down on the economically disadvantaged ones.

The assessment also revealed the concept of metering as helpful in enforcing use-based tariff. Also, in order to ensure the long-term operation of the scheme, the tariff must incorporate savings for major component replacements.

Capacity to Pay

It was found too by the study that the unavailability of regular cash poses a real difficulty in a regular tariff system. It has also been revealed in the study that one main underlying cause of non-compliance to regulations (particularly low tariff collection rate), apart from management shortfalls, is the lack of capacity to pay and to pay in cash, especially by the majority of members deriving cash from seasonal sources. Hence, computing tariff based on average energy expenditures prior to system provision is inadequate and falls in the face of economic realities.

Income Generation through Increased Utilization

The current low power utilization rate (because power produced in the schemes is mainly used for lighting) allows amply for increased usage in all systems. Future efforts need to find end uses (increased power utilization) which would add value to products and thus generate income for households and the community. Additional income sources will augment the otherwise meager cash capacity to pay for energy usage by the household.

Critical Improvements and the Need for Resources to Address Sustainability

While the potential to improve is there when tariff management problems identified are confronted, there are appropriate solutions identified by this study (PO capacity building, project monitoring, developing PO enterprises) that would require further resources.

PO Capacity Building for MHP Management

The assessment found a wide room for improvement pertaining to PO capacity building. Operator negligence however, could have a big impact on the sustainability of the scheme; this is clearly shown by the study in many downtime instances. The study reveals that lodging the maintenance and operation to POs is still viable, but training and monitoring needs to be improved. Formalization through an accreditation scheme and systematization of training for management and operators is encouraged.

The successful management of CBRES requires a number of specific skills, some of which may already be present within the community, and some of which may need to be provided by other stakeholders. Management training, provided by SIBAT or other stakeholders, needs to be extended. The course for PO managers should include modules in project, supervision, load management, tariff management and end-use management.

Some of the shortfalls of management committees found by the study, such as leniency, weak enforcement of policies, patronage in one instance and disproportionate LGU authority in another needs to be corrected. It is recommended that the PO/community itself is the highest layer in the project management hierarchy, should be guided in properly selecting the members of the management committee, and in enforcing local resolutions to enable the successful operation of the scheme.

The sustainability of the CBRES is initially assured by ownership lodged within the community through its organized core, the PO. This sense of ownership begins from the people's contribution or a share in project construction, and grows through management process after completion. This is revealed in the model examples among the 10 MHPs in the study.

On Roles, Management and Ownership

The completion of the MHP schemes in the assessment demonstrated the feasibility of cooperative action by the community to install MHP schemes, and manage the range of problems that surface throughout the development of a project.

Further, the potential residing in the communities' POs to manage a project is revealed in the study. With their meager and somewhat untested capacity to manage a relatively complex project, they were able to put into play latent and indigenous capacities – in the various stages of project establishment and operation. The ranges of tasks that the PO can carry out, as revealed in the study are:

- **during implementation:** participatory involvement of the community in consensus and policy building; the organized mobilization of the members of the community in various stages up to project completion for local contribution and equity; conflict resolution; and drawing on local skills for the project;
- **after completion:** formulation and enforcement of community policies on load management, O&M, tariff structure and collection, roles and responsibilities and penalty system; and
- **in operating and maintaining the installation:** enforcement of policies, management of operation, decision-making on community applications and on managing the revenues collected.

However, the experiences reveal too that the various levels of community capacities in managing the 10 MHP projects are deemed more complex and demanding than the usual rural community development projects. It was found that it was important that the community had a minimum track-record regarding the organizational capacity to successfully undertake a CBRES. Thus, grounding requirements have been identified to improve community management. These include:

- a scheme for intensive social preparation preceding actual implementation, to ensure on-time and cost-effective mobilization (i.e., to avoid long delays), to secure food-for-work funds, and to smooth out or mitigate potential sources of conflicts;
- a scheme for intensive preparation of the community prior to commissioning; and
- intensive guidance during the post-installation phase on management (financial sustainability, tariff, O&M, enterprise development, etc.) and strengthening of the CBRES framework.

Multi-stakeholder Roles

CBRES, as revealed in this study, incorporates a wide variety of stakeholders in its establishment. POs, church groups, NGOs and LGUs are all involved and, to ensure the success of the project, each stakeholder is often tapped to contribute their skills. In most projects, this multi-stakeholder cooperation shows the NGO-PO partnership to be the key moving force. The LGU is often a facilitative force.

In doing the baseline studies, it is shown here to be important to adequately appraise the preparedness of a PO based on a range of criteria, as well as the other stakeholders that will cooperate with the PO on the project, to ensure that they are able to fulfill their responsibilities to a high standard.

Social preparation is a process that consists of on interplay of needs assessment, validation, awareness-raising and designation of responsibilities that precedes all other stages of project development. Multi-stakeholder participation is an important part of social preparation.

The experiences basically reveal that the various levels of community capacities in managing the 10 MHP projects are deemed more complex and demanding than the usual rural community development projects. It was found that it was important that the community had a minimum track-record regarding the organizational capacity to successfully undertake a CBRES. Thus, grounding requirements have been identified to improve community management. These include: (a) a scheme for intensive social preparation preceding actual implementation, to ensure on-time and cost-effective mobilization (i.e., to avoid long delays), to secure food-for-work funds, and to smooth out or mitigate potential sources of conflicts; (b) a scheme for intensive preparation of the community prior to commissioning; and (c) Intensive guidance during the post-installation phase on management (financial sustainability, tariff, O&M, enterprise development, etc.) and strengthening of the CBRES framework.

SIBAT as Intermediator

The study confirms that SIBAT undertook a crucial role in undertaking various forms of intermediation on many tasks required to implement a successful microhydro project. These are usefully considered as an extension of the concept of 'intermediation'. Intermediation here not only includes the task of organizing the necessary finance, but intermediating in the field of technical, social and organizational aspects thereby facilitating the efficient stakeholder cooperation, such as:

- designing and supervising the installation of MHP systems according to a set of accepted procedures;
- providing social orientation to the community and local NGO using participatory processes (research and planning) and consultative style of work with all stakeholders;
- providing technical and management training and retraining to local operators, developing the training modules;
- securing funds for projects through project proposal development and negotiation with funding agencies; and
- procurement of major equipment.

The assessment reveals that as a consequence of lack of funding mechanism for project administration SIBAT was not able to provide sufficient services, particularly to address:

- post-installation problems, including monitoring and response mechanism for repairs;
- efficient and professional technical management of the projects;
- gaps in local coordination and community organizing; and
- sustained technical and management advisory.

In all projects in the study, SIBAT had provided the basic requisites to establish the projects, including trainings on technical and project management immediately after their commissioning. However, SIBAT failed to actively intervene in the ensuing process to ensure proper management, and install neither regular nor interim monitoring of management performance as they influenced the sustainability of the system. This was mainly due to lack of resources to do this phase of work, and the lack of personnel to develop the post-installation phase of projects. SIBAT however, managed to conduct meetings of partners to reveal the problems and recommend solutions.

Conclusion

CBRES, as studied here, is an approach to integrating energy options for rural development, which embody the elements of community participation, appropriate technology and sustainability. The MHP experiences in this study basically reveal that the CBRES have afforded greater access to energy by poor households (affordability) and direct benefits to them which extend beyond mere provision of energy.

The significance of the CBRES had been established by the real benefits derived by poor households, as revealed in this study. Aside from the list of recommendations (e.g. on system reliability and lowering of capital costs), there are **three (3) key areas of improvement** found, and are in the subject of sustainability. First, would be improvement on the organizational model –to improve the capacity by stakeholders, including the main stakeholder (PO/community) to meet the financial responsibilities and accountabilities of sustaining a CBRES. Second is improvement on income generation through productive energy use that would augment the economic capacity of poor households as well as their capacity to pay the cost-covering tariff. *Third* is on the type of financing that would meet the capacity of poor households to put up the system with minimum reliance on grant money.

- **The organizational model needs to reflect an innovative type of ownership and management**

  Clearly, while the study reveals the potential of the PO/community to manage and own the system, it is recognized that its capacities need to be further developed. Innovative concepts are needed regarding ownership and management models for the projects, where the other stakeholders could better contribute and PO/community capacities and roles could be given full play within. The future ownership arrangement could be a cooperative formed by the various stakeholders, where the PO/community is the major one and the terms of reference reflect mutual benefits for all.

  Further, the nature of the CBRES project that involves financial sustainability (i.e., through tariff payments), require greater responsibilities on the owning PO and household users, i.e., accountabilities to the project by both the organization and the households.

  The consultant of this evaluation posits the possibility of a shareholder ship scheme, especially if the project is a loan, where benefits are shared amongst paying households as well.

- **Income needs to be generated through productive energy use**

  The low utilization factors of the installations result from using the electricity mainly for lighting (under-usage), among others. There is ample potential to realize a more intensive use of the energy during daytime for productive applications especially to add value to agricultural produce by processing. A major effort is needed to establish small enterprise activities e.g., in milling, oil expelling, baking, drying of high value goods, preservation of fish and meat through cooling or ice making, home based handicraft and blacksmithing and others.

A model of a power enterprise is also looked at, as a social enterprise that generates income for community development through enterprises financed by revenues from it. In this way, the power enterprise becomes more closely linked to the community's well-being, food security, availability of vital water for drinking and irrigation, and increase in income.

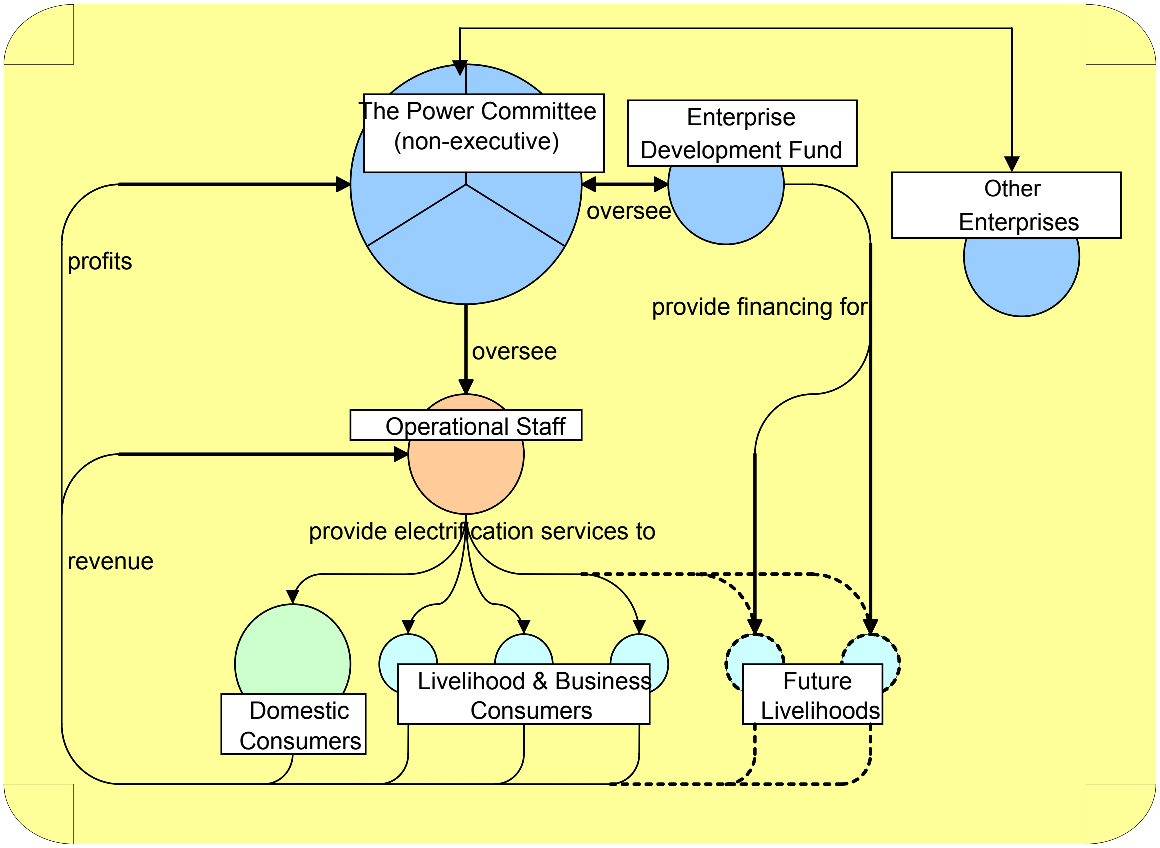


Figure 16. *Power Enterprise Model*

- **Financing of the investment needs to be through a mix of grant, loan and sweat equity**

SIBAT needs to find and develop innovative, appropriate schemes to finance the entire investment for a renewable energy project, as grant money continues to become scarcer. It is necessary to find an appropriate mix of grant, loan and sweat equity. Any loan scheme needs to consider the potential income through productive end use of the power, the limited capacity of people to pay, and the expense-debt pattern that is prevalent in poor rural communities.

It is supposed that the integration of the loan component into the existing financing model would significantly reduce the dependency on the availability of grant money. Further it would aim to introduce stability for economic and sustainable operation of the plants and an increased motivation by stakeholders to make full use of the income earning potential of the energy offered by the plant. The loan component would require the NGO intermediator and the community to analyze the financial potential of a project thoroughly and negotiate the appropriate loan conditions with a financial institution.

The loan component necessarily links to the enterprise or productive end-use, i.e., in order to repay its loan, the community needs to develop a pattern to generate a regular stream of income from the plant. After the loan is repaid, this regular income becomes fully available for the development of the community.

Competence on project management is expected to improve as loan repayment asks for financial and managerial discipline. Once a credit line appropriate to CBRES is established with suitable local financial institutions, the time and effort spent by the NGO intermediator and the community to source funding for new projects will be significantly shorter.

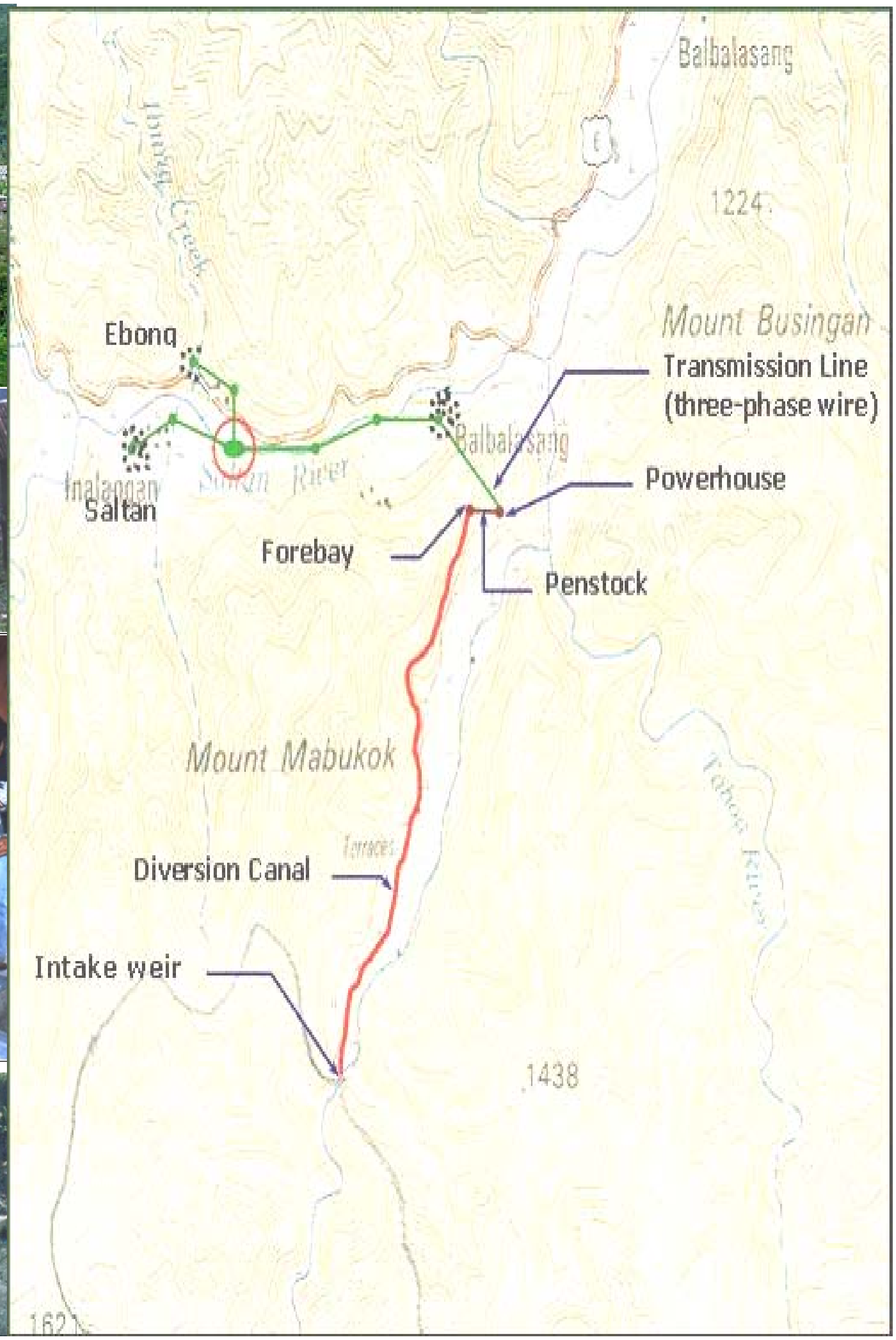
Further, the CBRES is shown to require more from the NGO intermediator. Either fund sourcing or management is passed on to another entity, or the NGO intermediation expands in scope to cover these concerns.

CHAPTER 6
CASE STUDIES OF COMMUNITY-BASED MICROHYDRO POWER PROJECTS

- BALBALASANG MICROHYDRO PROJECT
- BUNEG MICROHYDRO PROJECT
- TULGAO MICROHYDRO PROJECT
- LON-OY MICROHYDRO PROJECT

Balbalasang Micro Hydro Power Scheme

A Case Study of a Community-based Renewable Energy System



Balbalasang Micro Hydro Power Scheme

A Case Study of a Community-based Renewable Energy System

Name of Project	Balbalasang Micro Hydro Power Scheme
Location	Bgy. Balbalasang, Balbalan, Kalinga, Philippines
Project Partners	▪ Sibol ng Agham at Teknolohiya (SIBAT) ▪ Episcopal Diocese of Northern Luzon (EDNL) ▪ Philippines Department of Energy (DoE)
Construction Start-up Date	October 1999
Project Inauguration	January 2001
Households Connected	154
Design Power Output	25 kW
Total cost	PhP 2,503,594

Introduction

The installation of a micro-hydro power (MHP) scheme utilizing the Balas-iyan River in Bgy. Balbalasang, the farthest barangay of Balbalan, Kalinga located in the mountainous Cordillera region of the Philippines was requested by the local church, the Episcopal Diocese of Northern Luzon (EDNL). The request carried the expressed objective of providing lighting for the households, and with the concept of developing the project as a community-based undertaking. The Department of Energy (DoE) provided the funding support under the O' Ilaw Program.

It was the Barangay Development Council (BDC) which took the lead in the development of the project, representing the Local Government Unit (LGU) as well as the traditional political authority of the indigenous community. The project thus proceeded with the community, the BDC, EDNL and Sibol ng Agham at Teknolohiya (SIBAT), serving as a group coordinating efforts to build the MHP for a period of 14 months.

The Land and People of Balbalasang

Location and Accessibility

Made up of 3 sitios, Bgy. Balbalasang lies in the municipality of Balbalan in the province of Kalinga. The province is located in the northernmost part of the Cordillera region in the Philippines, bounded on the northwest side by the province of Abra; southward by the province of Apayao, on the east by Cagayan and the Mountain Province on the South.

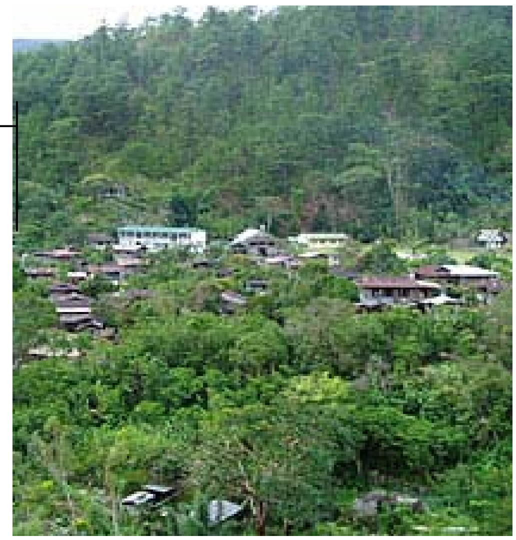


Figure 17. *Balbalasang Community*

Balbalasang can be reached by a regular 6-hour jeepney ride from Tabuk, the capital town of Kalinga or a 4-hour ride from Bangued, Abra, which is quite irregular and operates only during the dry months. An all-weather type of barangay road connects the three sitios of Balbalasang to the barangay proper.

The topography of Balbalasang is typical of the Cordillera region. Generally, the area is mountainous and hilly with narrow valleys and steep mountain slopes. Primary forests cover about 88% of the land; the rest is considered as agricultural area, comprised by rice terraces and swidden farms. About 6% of the forests comprise its communal forest and pastureland. The state of forest cover is found to be relatively lush and pristine, with high biodiversity of flora and fauna found especially in the dense mossy forests falling within the declared protected Balbalasang National Park.

The Saltan River, which is the major river system in the area, traces its headwaters from the upper forest areas of Balbalasang. Several smaller creeks (Ibong, Uling, Tapao) and waterfalls form part of the network of tributaries that drains into the Saltan River. In 1993 the National Power Corporation (NAPOCOR) studied the feasibility of putting up a 24 MW mini-hydro power project using the Saltan River.

The watersheds including water resources therein are important to the lives of the Banao tribe, being regarded as parts of their ancestral domain, i.e. the resource base from which they derive their subsistence and livelihood. Their collective development and utilization of these resources for the good of the community is compatible with their worldview, and strengthens their bond with the land.

The Banao Tribe

The residents of Balbalasang are indigenous peoples belonging to the Banao tribe of the Kalinga ethno-linguistic group. The Banao tribe occupies several barangays in Balbalan and adjacent barangays in the province of Abra, along the Malanas Ridge. There are a total of 155 households in the barangay.

The people of the Banao tribe define their watershed as forming the entire ancestral land occupied by its forests, pastureland, swidden, irrigated ricelands and settlement areas or villages. The Banao tribe is known as the most peaceful among the brave and proud warriors of the Kalinga tribes.

Subsistence Upland Farming

The majority of the residents of Balbalasang are subsistence farmers, depending on terraced land and swiddens for rice growing. The farming activities are seasonal, engaging most members of the household. (See cropping calendar in table below.) Land preparation to post-harvest are all done manually. Rice hulling meanwhile is done mechanically using four privately-owned diesel-powered rice mills.

From the survey, it was found that the present land area used in terraced cultivation was limited to produce for adequate subsistence. It is estimated that lean months for rice supply occur for 5 to 8 months of the year.

Rice is the primary crop grown in two croppings in the irrigated terraced ricelands, while corn, sweet potato, cassava and other root crops are secondary crops planted in swidden farms, locally known as '*uma*' using the 'slash and burn' method. There are also a variety of fruit trees such as banana, pineapple, pomelo, avocado and citrus. Coffee is also grown for household use. Vegetables are basically for consumption and are partly sold to buy basic household needs such as salt and sugar. Chemical farm inputs and pesticides are rarely used.

Table 37. *Cropping Calendar in Balbalasang*

Planting	Harvesting	Location
October	January	Rice field
May	August	Rice field
October	December	Swidden Farm

Sources of Cash Income

Main sources of cash can be either seasonal or regular. Seasonal incomes comprise the cash sources for most and include sale of vegetables produced (e.g. legumes) in the *kaingin*, sale of handcrafted goods made from grass or forest-gathered materials (e.g. soft brooms, basketry and woven floor mats) and daily wage labor in government construction projects.

Regular cash incomes are derived from regular or contractual employment. The population includes a relatively high number of professionals – teachers, health workers, municipal employees, government officials – that receive regular cash incomes. Families also have a number of pensioners and overseas workers who similarly receive regular income.

Many of the men of Balbalasang work in the gold mines in the nearby area of Ga-ang, a 6-hour hike from the community.

Permanent and seasonal out-migration is common among the Balbalasang residents. Reasons for leaving the community are to pursue higher education, to seek work (e.g. farming or construction) or to marry. There are approximately 1.7 people per household with jobs outside the community. The majority of residents outside the community live in Tabuk, Kalinga and Baguio City, Benguet.

Inadequate Social Services

The immediate health and medical needs of the community are served by a clinic operated by EDNL with two health workers and one midwife, and the Barangay Rural Health Unit managed by a midwife. Services provided by these clinics include immunization, pre-natal, family planning and consultation. Serious ailments are referred to the nearest hospital found in Salegseg 33 kilometers from Balbalasang.

There are two public elementary schools and one private high school with a boarding house that is operated and managed by EDNL. Many of the students come from the surrounding barangays to attend the high school and take up their boarding in Balbalasang.

Potable water systems with individual household taps are present in all three sitios installed by the local communities with financial and technical assistance from the LGU and EDNL.

The community claims that the absence of electrification kept the levels of social services to a minimum. Facilities at the clinics and in the schools were inadequate to meet the needs locally.

Project History

Micro-hydro power generation was not new to the people of Balbalasang since there had been two systems operating in the nearby barangays of Sesec-an and Talalang, installed with the assistance of the Department of Social and Welfare Development (DSWD) in the early 1990s. Aware as well of MHP projects assisted by SIBAT in other sites, EDNL approached SIBAT to carry out surveys of Balbalasang to determine the feasibility of an MHP scheme utilizing the Saltan River.

At the time of the study, Kalinga was considered the least served province in the Cordillera Administrative Region with only a small number of its barangays being energized. The nearest electric grid was more than 50 kilometers away from Balbalasang. The cost of extending the existing grid to this area at that time was prohibitive due to the distance and the mountainous terrain. The Kalinga Electric Cooperative (KAELCO) expressly supported the project as it did not have, at that time, any plan to extend the grid to Balbalasang within 5 years. SIBAT then concluded that the MHP scheme was not under threat from being superseded by a grid connection.

Multi-stakeholder Partnership in Project Development

A multi-stakeholder partnership between SIBAT, the community, EDNL and the LGU, was formed to implement the Balbalasang MHP. These stakeholders contributed in the various stages of the projects development.

Table 38. *Main Tasks of the Project Stakeholders*

Stakeholder	Tasks in the Partnership
Community with several organized groups within, entrusting the authority on the elders within the Barangay Development Council	Took the active role in project development
Local Church - EDNL	Supported SIBAT and the PO in various responsibilities
SIBAT	Provided the technical works and technical management , and fun ding facilitation
Barangay Development Council through the barangay chairman, officers, etc.	Supported through community mobilization

Two steps were basically followed by SIBAT in responding to the request from EDNL.

First was an ocular site inspection conducted in 1997 to assess the resource suitability of the source potential for the MHP project, and immediately, the conduct of a pre-feasibility study which made a site validation of the findings from the ocular survey. It also incorporated an initial socio-economic survey, where findings were presented to the community. It also provided an initial orientation on the potential project to the community, after the feasibility was determined. Second was the conduct of the feasibility study which contained: a detailed technical design; an application plan including load management; a financial study; a project work plan developed with the community; and a budget. After this study was completed, a funding proposal was drawn up and submitted to several agencies.

Planning was undertaken through a number of community consultations where the people agreed on the work scheme and provided the details of their work schedule, considering their farm work and other community activities. The plan then was finalized by SIBAT, EDNL, Barangay officials and community representatives. SIBAT guided the whole planning exercise of this formative management, because of its know-how of MHP project development and technology management. The minutes of the planning constituted the terms of agreement with the community, which were periodically reviewed during the implementation process.

LGU participation was notable in Balbalasang, where the local officials actively aided in facilitating the community meetings and consultations in the discussions on crucial issues such as labour contributions. This LGU participation was appraised as valuable to the projects' take-off and completion.

Social Preparation Phase

The project's social preparation phase consisted of numerous consultations that discussed the CBRES concept and the role of the community. The community that was being addressed then was without a single association or group undertaking the leadership – but an aggregation of households led by the LGU representing as well as the traditional authority of elders, and the church. Whilst without an organization, the community demonstrated the willingness to contribute the labor and time of the men and women able-bodied, participate in the full project process up to completion together with the other sectors (church and the LGU), to formulate their own policies, to manage and sustain the project after installation or ensure the continuity of the project.

Community meetings were a tradition in this indigenous community, an argumentative process of consensus building that facilitated the clarification of issues. The ideas of articulate professionals were evidently influential in these meetings.

The full feasibility study was conducted in November 1997, which included detailed engineering designing of civil, electro-mechanical and electrical components of the scheme. SIBAT also developed a funding proposal subsequently submitted to donor agencies. By April of 1999, after two failed attempts with donors, the DoE confirmed its funding through the "*O Ilaw*" Rural Electrification Program.

Energy Demand Study

Expressed priority needs of the community and population growth projection were made as the basis for the demand estimate. These were to reduce the amount of money they spent on kerosene and reduce the use of *saleng* (pine pithwood) for lighting, which has the effect of leaving black soot inside the house.

Kerosene and pine pithwood were traditionally used for lighting, firewood and liquefied petroleum gas (LPG) for cooking, and batteries for flashlights and radios. Every household owned about 2-3 kerosene lamps and each household consumed about 8 liters per month. Almost every household owned a radio that served as a source of news and information. On average, 2 pairs of dry cell batteries per month were used per household prior to the MHP scheme. The average expense on traditional energy source per household was estimated at P132.50/month.
During the FS conduct, rice mills were identified as one of the potential end-uses of the MHP but from consultations with the then Development Officer of the church, the option to put – up a community owned and managed rice mill was dropped as this could compete with the existing rice mills. Owners of the diesel-powered rice mills were not consulted as to whether they wanted to shift to the MHP power during the FS phase.

The 184 household population of Balbalasang was initially allocated 75W each totaling to 13.8 kW. This number was used in the estimation of energy demand. It was later found during wiring installations that the community has only 155 households.

The system initially planned to have 5 kW allocations for a rice mill and another 5 for other community needs. With this, the total peak demand during the day would be 18[22] kW. The higher of the two peaks was used as the basis of designing system capacity of 25 kW using a 1.25 factor for future growth. This design capacity was then used to arrive at the design discharge that was to be supplied year-round by the water resource. It was found out that in most cases, the actual usage and types of appliances by households exceeded their earlier expressed demand.

Implementation

The Terms of Agreement between SIBAT and EDNL was forged and signed prior to the official project start-up in October 1999.

The construction took a little over 14 months, passing through periods of disruptive typhoons and lean months.

SIBAT was responsible for the supervision, ensuring that designs for the civil, mechanical and electrical works were rigorously followed. EDNL, through its priests, together with the Barangay Development Council (BDC), was in-charge of community mobilization and organization for the project.

Figure 18. *Installation of the alternator*

[22] Sum of all non-lighting loads

Table 39. *The Major Technical tasks of SIBAT in Project Implementation*

Tasks	Description
Technical supervision	Supervision and directing of the major works (civil, electro-mechanical, electrical)
Purchase of major components	In-charge of major purchases especially those not procurable on the site
Turbine fabrication	Supervision of turbine fabrication according to the design
Technical and management training	Conduct of trainings after the project commissioning
Coordination with PO and local NGO	Conducts necessary coordination and community meetings

Table 40. *The major tasks of the EDNP in project implementation*

Tasks	Description
Overall local supervision	Supervision and directing of all local activities (transport, hauling) ensuring the compliance to schedule and local assignments
Coordination with the community	Consults with the PO in all matters pertaining to the project
Purchase of local components	In-charge of local purchases

The 14-month construction of the Balbalasang MHP scheme involved the cooperation of the majority of the Balbalasang residents. The Barangay council, with help from the local EDNL priest and lay leaders of the church, acted as foremen and organized the people into 5 work teams of approximately 20 people each, both men and women. The teams were rotated daily, while on Saturday all teams worked, and work paused on Sunday. The community provided food and snacks for the workers, and even the children helped where they could, hauling sand and gravel to the site.

SIBAT supervised all phases of the construction. A SIBAT Engineer was present during all critical activities, assisting the foremen and ensuring the design was followed. These included canal construction, turbine and generator installation of the transmission line, among others.

People's Contribution

The community was required to provide free labor for the construction of the MHP scheme. Their work included expansion of the irrigation canal and construction of the forebay and powerhouse, hauling of materials, laying of the transmission lines and clearing the areas to be built on. The community also provided local materials for construction such as lumber, sand and gravel. The lumber was used in the construction of the powerhouse and sand and gravel were used to make concrete to build the canal and powerhouse.

Morale throughout most of the construction phase was high, even when small lengths of the refurbished irrigation canal were washed away during the rains.

Obstructive LGU Intervention

A complaint made by one former LGU official on the size of the project, after the completion of the study and the approval of the project proposal and funds disrupted the smooth implementation of the project for a time. After his erroneous claim (that the amount for a 20-kW plant would be enough for a 80-kW plant) was rejected by SIBAT, the official harassed the community to discontinue contributing to its implementation. He fed erroneous information on the labor counterpart that aimed to confuse the community. His actions however failed to considerably impact on the project process as the plant was installed according to schedule.

Commissioning and Post-Installation Trainings

The final commissioning and official inauguration was held during the barangay fiesta in January 2001. SIBAT provided basic technical training for operators and managers immediately after the commissioning. The training consisted of modules on: MHP operation and maintenance; household wiring; and electricity theory. The operators failed to attend a major follow-up training for all MHP operators offered by SIBAT in 2004.

Project Management

Description of the Management System

While it was the Church which initiated the efforts to build the Balbalasang MHP through a request to SIBAT, the system was built through the collective efforts of the members of the community that enabled them to subsequently build their organization dedicated to MHP management. Presently, the system is being operated and maintained by the community under the leadership of its Peoples' Organization, the Balbalasang Micro-hydro Association (BMHA).

Management of the system presently resides in the Balbalasang Micro-hydro Association (BMHA), which is an informal organization of 155 resident MHP subscribers. The unofficial project organizational structure during project implementation headed by the former barangay chairman has been retained and carried over up to the present since February 2002. Five residents mostly employed and influential leaders in the community comprise the board of directors, along with 3 designated operators, 1 collector, a chairman and a treasurer.

The project's organizational structure is as follows:

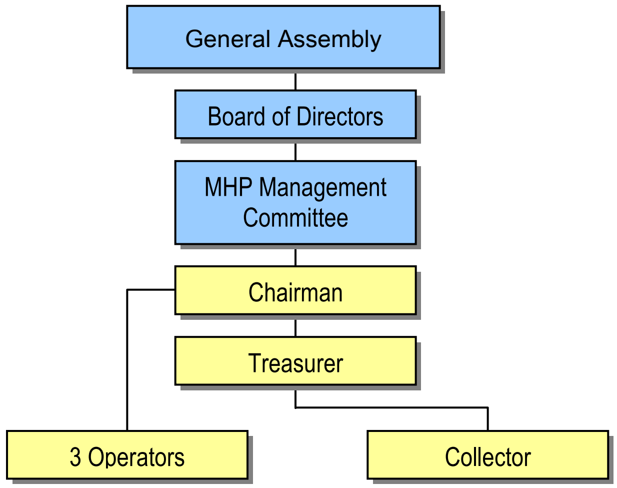


Figure 19. *Organizational Structure*

The structure has a General Assembly of members that elect the officers and formulate the policies. As per by-laws, the BOD, as the policy-making body, is required to meet monthly to draft, review and amend policies to guide household load management, tariff formulation, daily operation and maintenance activities of the MHP as stated in their by-laws but there was an observed laxity in the said policy. Community consultation remains as the accepted practice for resolving issues and arriving at policy consensus.

Figure 20. *Meeting between SIBAT and Balbalasang Community*

Problems with Management

While there are good practices of management (such as the satisfactory state of record-keeping of the management personnel with professional background), there were major problems attributable to weak management of the system.
First, leniency was observed in the enforcement of policies particularly in tariff. The poor collection rate is attributed to a lack of enforcement of tariff collection by the Management Committee. The tardiness of the designated collector remains unchecked; some conscientious users resorted to visiting the treasurer themselves to pay their bills. This resulted in unavailability of cash for repairs and rehabilitation of the canal. During one of the consultations with the community where funding limitation was discussed, they agreed to raise the amount for concreting of the remaining earth canal out of their savings from the MHP operation.

Second, the conduct of regular meetings by the officers needed to be improved. Problems were not promptly addressed because of rather irregular meetings of officers.

While SIBAT provided the training on technical and project management immediately after commissioning, SIBAT needed to actively intervene in the ensuing process to ensure proper management, and install regular monitoring of management performance as they could influence the sustainability of the system. This was partly due to lack of resources to do this phase of work, and the lack of local personnel to develop the post-installation phase of projects.

Operation

The MHP was ran 14.5 hours a day with an average of 8.5 hours for lighting and 6 hours for powering school computers during daytime
The system initially ran for 12 hours from 6pm to 6am every day but was extended since people used high-powered appliances such as washing machines and flat irons, at the same time. Extending the hours of operation to 14.5 hours allowed users to spread out their usage, reducing the risk of overloading the system, which resulted to the transformers tripping.
There were two operators who took turns in starting and monitoring the system. They were also responsible for day-to-day upkeep of the system such as cleaning the forebay of silt, stones and debris.

Load Allocation and Management

Load allocation was based on household demand data yielded by the feasibility study. SIBAT, together with the community, fixed the maximum load per household at 75 W, which was adopted by the community as their policy.

The survey of the actual household load (lighting and appliances) shows that these are well below the installed capacity of the system. This indicates that the design capacity of the Balbalasang MHP has made good allocation for household needs with allowances for major applications.

System Downtime

In its 4 years of operation, the Balbalasang MHP had experienced a total of 9 months of downtime periods mainly due to repairs of canal, dump load and transformer. It took longer time to attend to these repairs mainly due to the lack of any ready mechanism or funds to respond to such. Canal repair also needed funds which took time sourcing from the LGU.

Table 41. *Repairs for Balbalasang MHP*

Major Repairs Required	Who conducted the repairs?
Canal repairs	(Local people
Transformer	(Repair shop in Baguio City)
Dump load	Local electricity cooperative

System downtime due to canal repairs of the earth sections are experienced annually as canal damages are caused by typhoons which visit the place every year.

Tariff and Collection Rate

The community originally set the tariff at PhP 0.25/Watt. It was subsequently realized that collection based on this tariff was not enough to pay the operators and make savings for parts replacements. Supposing that the households would use up the full allocation of 75W the total collection would result in only PhP 34,650 per year which would not be enough to cover the annual operating cost.

The costs of maintaining and replacing the MHP system were presented to the community by SIBAT and EDNL five months after inauguration. This made the community realized the necessity of raising the tariff and to think of new income generating projects that could support the MHP scheme. It led to increasing the tariff to P2/W/month for lighting and a flat rate for appliance. While the households paid their lighting tariff according to the set policy, the policy on tariff for appliance was not enforced.

At the time the policy was formulated, the selling rate of energy from the KAELCO was P6/kWh. SIBAT helped in coming up with the tariff rate that was comparable with that of their expenses on kerosene for lighting and that of KAELCO rates.

On its 5th year of operation, the MHP registered poor collection rate at 27%, which led to a shortfall in money available for repairs. At the tariff set, the MHP is expected to earn P199,584 from lighting alone but their collection was only 53,888 per year. The deficit for repairs was partly offset by the provision of free labor for civil works repairs by the barangay and funding for materials by the provincial LGUs. It was found that the long down-time period discouraged the people to pay their dues on time. There were also some attitude problems of the people, laxity in the enforcement of policy and lack of policy regarding the defaulters.

Poor collection needed to be solved by the organization. Despite the high proportion of the regular income earners in the community, the collection was still low. Weak follow-up by management and lack of firm policies on penalty for non-payment has been pointed out as the main cause of the problem. However, the seasonal earning households needed to be further studied and assisted to improve collection.

Effect of Poor Collection Rate

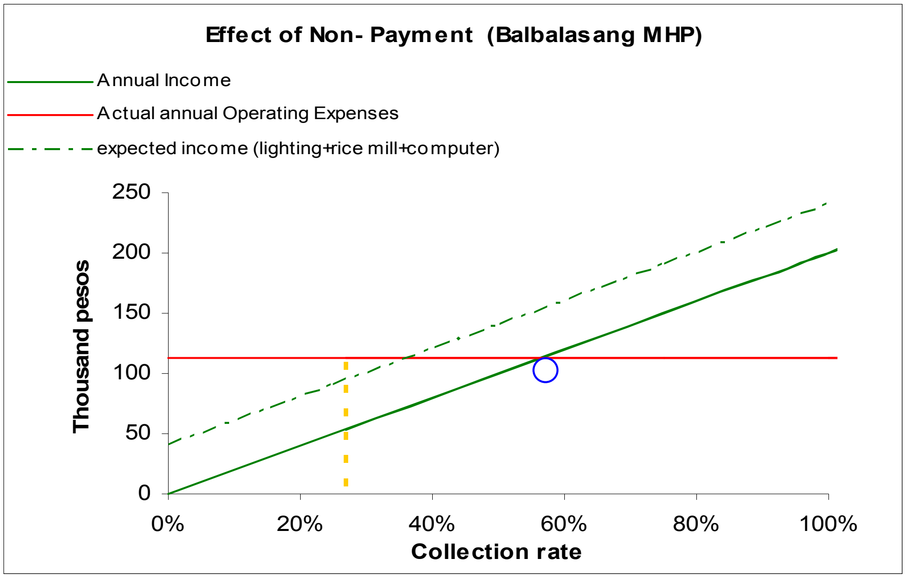


Figure 21. *Effect of Non-payment in Balbalasang*

The current collection rate, shown as a yellow dotted line on the graph, shows that the project was running on deficit. The annual O&M expense of the MHP is shown on the graph as a red line (operating expenses covering operator's salary plus repair and maintenance costs.)

The community at present was able to meet the deficits incurred due to repairs of the canal, by providing free labor and soliciting funds from the LGU. However, the graph shows that should they improve on collection, they would be able to attain break-even (point O on the graph) if at least 60% of the households connected to the MHP grid were paying their monthly tariff.

Aside from improving on their collection to at least attain break-even, the community could look into possible energy uses that could generate additional income for the scheme such that they would not have to pay for the operating expenses nor source this out from other donor.

Energy Cost and Household Income

Shown on the table below is the price a household pays for its energy consumption. The policy that the household pays only for the lighting but not for the appliances is to the disadvantage of the households with a low income level. The table and graph below show this characteristic.

Table 42. *Energy Cost*

Balbalasang			
tariff rate for lighting	P2 / W		
tariff for appliances	none yet		
Income level of HH	**Equipment Installed**	**Cost of the Services (P/W per month)**	**Cost of the Energy (per kWh)**
low	1 CFL	2	7.84
	2 CFL	2	7.84
	4 CFL	2	7.84
	2 CFL and radio cassette	0.39	2.92
	2 CFL and Stereo	0.18	0.67
	2 CFL and TV + VCD	0.21	0.91
	4 CFL and stereo	0.36	1.13
	4 CFL and TV + VCD	0.42	1.49
high	4 CFL and TV + VCD + stereo	0.22	0.43

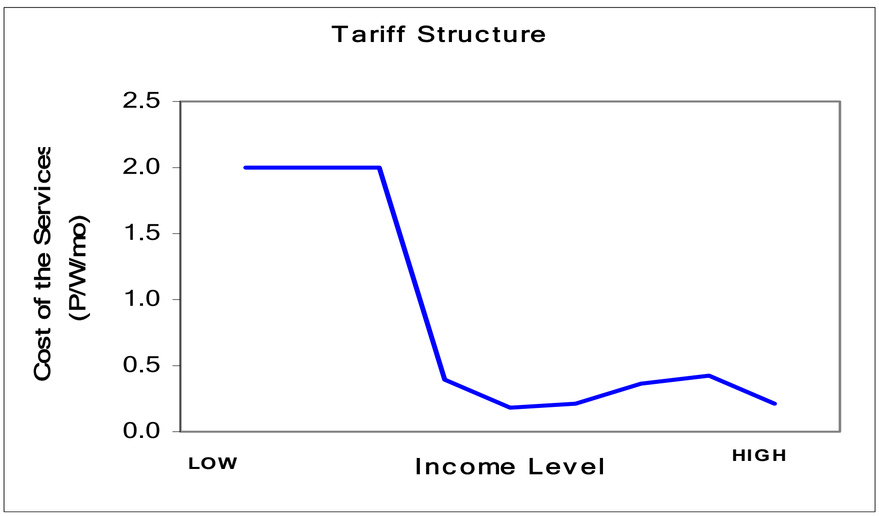


Figure 22. *Tariff Structure*

This data shows that the users did not pay for what they are actually consuming. As it should be, defaulters should be penalized or to prevent future injustice, the tariff structure should be adjusted. Should the community agree, a flat tariff for the installed capacity (P/W/mo) could be adopted but a prepaid load limiting device should be installed per household to control the consumption. In this manner, defaulters can be avoided.

Technical Description

The Balbalasang MHP, a decentralized barangay electrification scheme, is primarily used for lighting and running small appliances.

Household lighting consist a minimum of 2 lighting fixtures per household and powering small household appliances such as radio cassette, colored television sets and VCD players. A number of residents also use automatic flat irons and washing machines.

The system was able to provide electrification to 3 sitios, up to 1.9 kilometers from the powerhouse. Aside from provision of lighting to most households, the energy generated from the MHP was also able to provide electrification to school buildings, churches, barangay halls and clinics.

Other uses of energy in Balbalasang include powering small carpentry tools such as planers. These planers are privately owned and were used for woodworks that were sold for cash.

A recent addition to the MHP end-users was the 8 computers for the school which were used by the high school students of the locality.

Technical Design

The Balbalasang MHP followed the run-off-the-river scheme of development where a portion of the river's flow was diverted and made to pass a pipe to generate power. The project made use of an existing irrigation canal constructed through the assistance of the CIDSS[23]. The MHP plant was originally designed to have the entire 2.1 km of canal lined but this led to a very high project cost thereby resorting to concreting only the critical portions. Seven (7) channel crossings had to be made to avoid erosion along these parts of the canal.

A forebay having a volume capacity of 14.4 m^3 impounds water and diverts it to the power plant through a 75m long 250 mm diameter penstock pipe. The forebay is located at an elevation of 988 meters above sea level (masl). Occupying a floor area of 36 m^2, the powerhouse is located at an of elevation 954 masl.

A locally manufactured cross-flow turbine, of 25kW installed capacity was attached to a 31KVA (rated power) synchronous generator through a belt drive system, was used to provide electrification to the community.

The project lay-out and technical details of the installation is presented in the succeeding figure and table.

[23] Comprehensive Integrated Delivery of Sustainable Services, an EU funded organization.

Civil Works Components

Table 43. *Description of Civil Works Components*

Weir	Material	Loose stones
	Width	10m
Canal	Type	Earth/concrete
	Length	2,130m
	Width	0.64m
	Depth	0.6m
Forebay	Size	$49m^3$
Penstock	Material	HDPE
	Length	75m
	Diameter	6 inches
Gross head		34m
Inlet Valve	Type	Butterfly valve

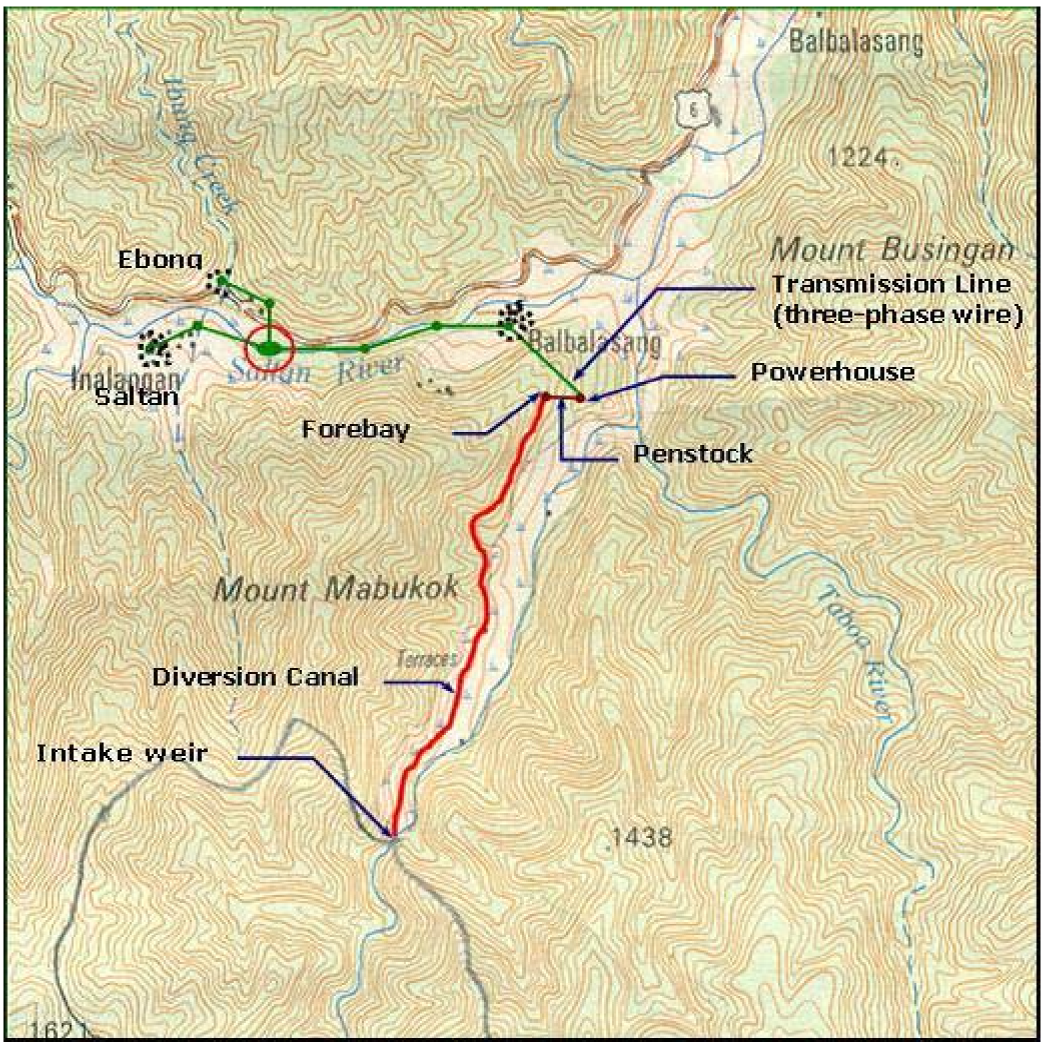


Figure 23. *Project Lay-out*

Powerhouse Equipment and Transmission / Distribution System

Table 44. *Description of Mechanical and Electrical Components*

Component	Description	
Turbine	Type	Cross-flow
	Manufacturer	Pangasinan State University
	Width	200mm
	Diameter	260mm
	Design power	25 kW
	Design flow	110 l/s
Drive System	Type	Belt Drive
	Type belt	V-belt
	Generator Pulley rpm	1800 rpm
Generator	Type	Synchronous brushed
	Manufacturer	Stamford (UK)
	Rated power	31 KVA
	Voltage	440 V
Load control	Type	ELC
	Ballast	30kW
Transformers	Size	10 + 15 kVA 416/220 V
Transmission Line		3 wire 440 V
Distribution Line		3 wire 220 V

Transmission posts were made of 6-m high 3 inch diameter BI pipe as the community is within a protected area. Community policies do not allow cutting of trees to be used as transmission posts. The transmission post height was designed in conformation with the PEC Art. 2.30.2.4(b) which states that the vertical clearance from the ground should be not less than 5.5 m over public streets, alleys, roads and areas subject to truck traffic and not less than 4.6 m for lines not crossing the road such as in the case of Balbalasang.

Load

Balbalasang MHP at present was used mainly for consumptive use such as for lighting, household entertainment (TV and video players) and a few high-powered appliances (1 washing machine and flat iron).

The four rice mills in the village were ran by diesel engines, but could be converted to electric motors. The total load at present is as follows:

Table 45. *Total Load of the Balbalasang MHP*

Load	Description	Wattage	No of users or units	Hours used per day	Total Load
Household lighting	CFL and Fluorescent tube lamps	Average 54 W/HH	154	8.5	8.32 kW
Appliances	TV, video players, radio cassettes, washing machine and flat iron	Variable	16	Variable	6 kW
Computer lab		250	8	6	2 kW
				TOTAL	16.32 kW
				Peak Load	**14.32 [24]kW**

Technology Appropriateness

There were problems encountered in the operation of the MHP due to the following:

Civil Structures

Balbalasang MHP's 2.1 km power canal was vulnerable to landslides as it was not fully built according to specifications (some parts were of mixed earth and concrete instead of pure concrete) due to fund limitations. This left some of the sections at risk of being washed out. Yearly, typhoons caused landslides and destroyed critical portions of the canal requiring more than the usual siltation check-ups. Damaged sections were repaired and reinforced with concrete, the LGU provided funds for materials and the local people provided free labor for the repairs.

This could have been avoided if there were funds available during the construction and the original design, i.e. an aqueduct in the critical portion was followed instead of an open canal as suggested by the beneficiaries. This resulted to the higher repair costs incurred compared to that of the budget intended for the aqueduct.

Mechnanical Components

The installations with electronic load controllers allowed recording of the actual power delivered. These were the installations in Tulgao, Lon-oy and Balbalasang. The actual performance of the unit at 100% turbine opening was measured by reading the meter of the ballast load. Instead of the design capacity of 25 kW it produced actually only 21 KW i.e. 84% of what it was designed for.

[24] The peak demand is from the load curve and occurs from 6 to 8 in the evening.

Table 46. *Performance of Balbalasang MHP*

Design Capacity, kW	25
Measured Output, kW	21
Ratio of Measured Output/ Design Capacity %	84

The observed significant shortfall of output can be attributed to a number of factors such as canal losses, excessive losses in the penstock due to poor butt welds and probably poor design and low quality of the manufactured turbine. This indicated that the manufacturers needed more support to produce more predictable and reliable equipment

Generator and Control

Incorrect tensioning of the v-belts resulted to replacement of the belt twice a year when the belts could last for more than 5 years with proper alignment. This problem was due to the use of a jockey pulley instead of a screw-type belt tensioner mechanism. The community with SIBAT's advice replaced the jockey pulley with the proper tensioner where the generator could slide along the base plate to attain the proper belt tension.

Another problem met was the burning of the dump load due to the disconnection of one of the water supply pipe's coupling and the operator failed to notice the low water level in the dump load tank. This could have been avoided with improved monitoring system of the supply pipeline. Also, water for the dump load could be tapped directly from the penstock or revising the technical design such that the dump load is immersed in the tailrace but with proper considerations on safety.

Transmission and Distribution System

The transformer in Balbalasang was damaged due to bypassing the transformer circuit breakers that tripped during overloads. Bypassing the circuit breaker damaged the transformer. Prior to such, breach of policy was committed by households by exceeding on the load allocation and the simultaneous use of high power appliances (e.g. washing machines, electric flatirons) especially during the peak lighting hours. The problem was corrected through meetings and by increasing the daily operating hours of the system.

Another problem in the transmission system was the low power factor brought about by the load which is mainly inductive and not compensated. This resulted in unnecessary high current in the transmission system and reduced the number of lighting fixtures that could be installed. This problem needed to be corrected by adding capacitance to the system. With proper compensation, the number of lamps connected could almost be tripled.

In the transmission and distribution system an earth-leakage circuit breaker must be installed to avoid lethal shocks. This device trips if a person comes in contact with bare wires.

There are doubts whether the concept of the transmission system was optimal in terms of choice of transmission voltage, safety and cost effectiveness. There is a definite need to evaluate experience gained with other concepts.

Project Effects

Power for Household Use

The MHP scheme has provided electric lighting, allowing users to work longer in the evening. The different types of work that people engage in are extra household chores, basket weaving, broom making, mat weaving, sewing, reading, playing games, watching TV and studying. As yet, no full assessment of increases in income from extra work was made. However the monitoring visit showed that community members engaged in activities like basket weaving, broom making and mat making were able to produce more since installation of the MHP scheme.

Many members of the community were using appliances but not on the scale they preferred. The earliest impact survey (four months after the start of operation) indicated that they would like to have washing machines, TVs, videos, flat irons, refrigerators, planers and electric stoves.

Power for Livelihood

- ***Other applications.*** The MHP also provided power to electric planers used by individual carpenters (previously using manual planers) to produce furniture from salvaged wood. It was recognized that stricter enforcement of rules on wood gathering (normally covered and controlled by local barangay ordinances and indigenous laws) is necessary, to ensure that the use of the power tool would not encourage excessive wood gathering practice.

- ***Household-based handicraft production.*** Brooms and basket-weaving were common source of cash for households in Balbalasang, using the locally growing varieties of reed or grass and materials gathered from the forest such as rattan. No capital was required to produce the items except household labor. MHP powered lighting was affordable or did not entail undue additional cost for craft works at night. Products were sold to the town markets in Balbalan and Tabuk, the Provincial Capital. As a result of the availability of lighting at night there was an increase of about 56% in the production of broom-makers, basket-weavers and other handicraft producers in Balbalasang. Nighttime is usually the time allotted for these activities.

Employment

The project employed two operators and provided cash income to otherwise cash poor households

Education

Since the introduction of electric lighting from the MHP, the local schools observed an increase in the attentiveness of pupils and the quality of homework. This was because the children could read and study better at night since with the electric lights compared to that provided by the kerosene lamps used before.

In addition, an Australian missionary working for the EDNL, provided 8 computers for a small computer laboratory of the high school. This was a big success, and was very popular with the children who, after initial training from the missionary, quickly taught each other on how to use the computers. These computers were used mainly to familiarize the students on the basics of computers such as making reports and doing their calculations and presentation papers. The introduction of these computers would have never been possible without the MHP scheme.

Environment

The use of pine pithwood for lighting decreased considerably. As a result, the number of pine trees felled was reduced through the installation of the MHP scheme, thereby reducing damage to the watershed. Aside from protecting the watershed resource, the labor requirement for pithwood gathering was also reduced immensely. The people of Balbalasang appreciated the contribution of the state of watershed area to the sustainability of their MHP that they designated a sizable portion of their forest area as protected site. About 1000 hectares of forest in the Malanas watershed areas which covers the Kalinga-Banao and Abra-Banao tribes were declared as protected.

Financial Analysis

System Cost

The total capital cost of the installation amounted to P 2,503,594. The material costs constituted 76% of the total cost of the project, with the remaining 24% covering haulage, administration, including training and site visits and the SIBAT fee which covers all surveys, full and preliminary studies including design work, construction supervision and post-installation support.

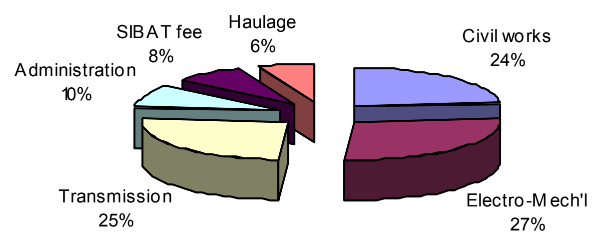
The relatively high electro-mechanical costs are due to the 100% import tax charged on the equipment price of the Chinese-built ELCs, doubling the costs of the imported item.

The funds contributed by the DoE were for the materials and did not include labor cost that was provided by the community as their contribution. The owners donated land directly used by the project also as their contribution to the project. Rendering material contribution by the community, including free labor, was consistent with the traditional communal practice of ownership and sharing.

Pre-feasibility and feasibility studies conducted by SIBAT for Balbalasang MHP (1997), as well as post-installation expenses were not included in the project cost.[25] The result of this is that SIBAT struggled to cover the full actual costs of the project, from feasibility stage to long-term monitoring. For project implementation, SIBAT charged P200,000.

Table 47. *Breakdown of Capital costs*

Civil works	P	609,920
M&E	P	664,772
Transmission	P	634,452
Administration	P	248,579
SIBAT fee (supervision)	P	200,000
Haulage	P	145,872
Total	**P**	**2,503,594**
	US$	**50,072**
Total grant	**P**	**2,496,000**
Cost per kW installed	**$/kW[26]**	**2,002**
Cost per household	**$/HH**	**325**



Mode Of Financing

It was the DoE through the O' Ilaw Program for rural electrification, who contributed the amount of P2,496,000 which was capital cost based on the project planning. This was the first engagement of the DoE with an NGO for energy provision. The difference between planned and actual cost was shouldered by SIBAT.

For SIBAT, the grant funds fell within the concept of one-time enabling capital costs which included materials and equipment, supervision and training and all that were necessary to install the plant. Said upfront costs were used to install the project which the community then operates and sustains, through returns from the project itself. Hence, operation and maintenance costs, and costs to replace major parts and equipment will be the responsibility of the community.

Operation and Repair costs

Balbalasang spent a relatively large amount of money on operational expenditure, almost 6 times more than was expected. Of this, 75% was for repairs; mainly on the 2.1km long power canal of mixed earth and concrete that was vulnerable to landslides.

[25] For most projects, preparation funds (for pre-feasibility and full feasibility studies) were funded from SIBAT's institutional funds combined with some contribution from the NGO Winrock International in 2000.
[26] Computed at P50/$

Table 48. *Annual OperationalCost of Balbalasang MHP*

Cost Item	Amount (PHP)	% of Total
Personnel	24,000	21
Day to day running costs	2,040	2
Repairs	87,162	77
Annual Operational costs	113,202	
Expected Operational costs[27]	21,143	

The repair cost was divided among the civil, electro-mechanical and transmission components as follows:

Table 49. *Breakdown of average annual Repair Cost*

Cost Item	% of total	Amount (PHP)
Civils	78	67,986
Electro-mechanical %	13	11,331
Transmission %	9	7,844
Total Repair cost		87,162

Financial Sustainability

Income from lighting was the main source for financial sustainability of the system. The actual tariff of P2/W/mo for lighting, supposing an 8.5 hours usage resulted in an energy cost of 7.83 P/kWh.

A study of its income-expense records indicated that Balbalasang was running on deficits due to poor collection rate and high repair cost, but was able to sustain the operation evidently because of external funds solicited from the LGU and church organisations. These donations met at least half of the cost of canal repairs.

Table 50. *Annual Income-Expense for Balbalasang MHP*

Cost Item	Amount (P/yr)
Annual Operational Cost	113,202
Annual Income	
Household lighting	53,888
Household appliances	0
Total actual annual income	53,888
Net profit	(59,314)

[27] Based on 1% of the total material cost of the project per year.

The P2/W tariff for lighting could be adopted for the utilization of household appliances as well. It was gathered that the users were not paying for this end use, as the community had not drawn an agreeable policy for appliance usage.

Quality of Lamps Used and Their Replacement Cost

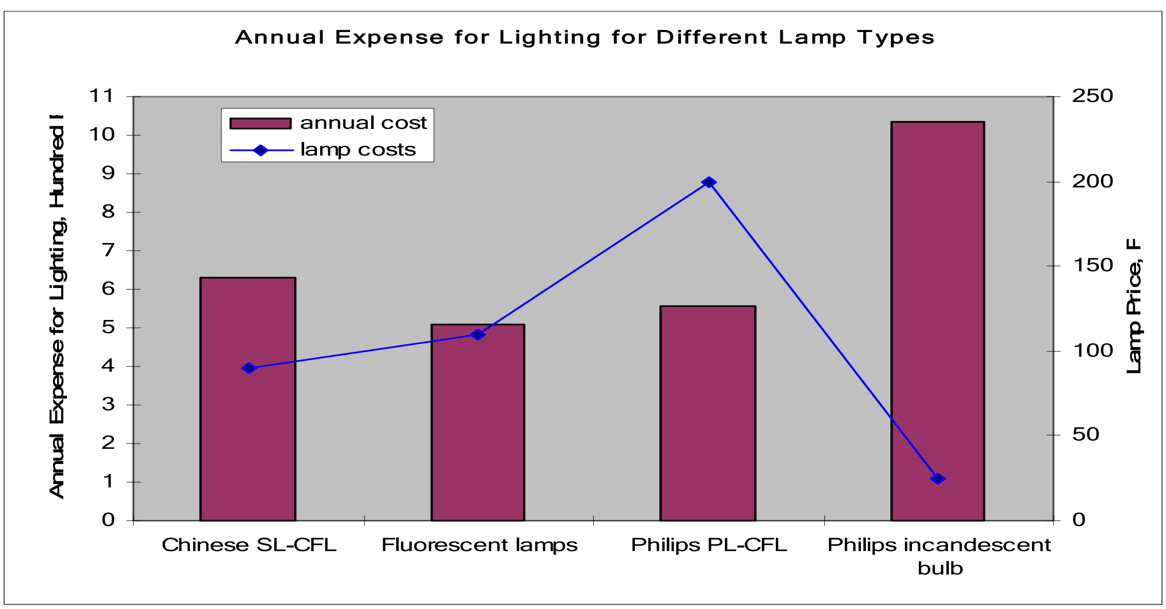
The community is presently using different lamp types which have a significant influence on the amount a household spent on lighting. This is shown in the table below.

Table 51. *Annual Expense for Lighting for Different Lamp Types*

Lamp type	Wattage	Price (P)	Lifetime (H)	Annual replacement cost (P/yr)	Tariff (P/W/mo)	Annual Energy cost (P)	Annual expense for lighting (P)
Chinese CFL[28]	11	90	765	365	2	264	629
Fluorescent lamps	10	110	1,275	267	2	240	508
Philips CFL	18	200	5000	124	2	432	556
Philips incandescent bulb	40	25	1,020	76	2	960	1,036

The graph below shows that the cheaper the lamp, the higher the annual expense. The household would be better off to purchase the lamp with the lowest annual cost.

Figure 24. *Comparison of Annual Expense for lighting for Different Lamp Types*



A household spends PhP 1,584[29]/ yr on kerosene. To determine the savings the household can achieve with substituting kerosene with hydropower, the annual equivalent cost of wiring, replacement cost of lamp and energy cost was computed:

Table 52. *Annual Cash Savings per HH with the Electric Light*

Cost Item	Calculation	Annual Cost (P)
Cost of wiring	P1,200 / 20 yrs	60
Lamp replacement (for 2 Chinese CFL lamps)	P365 *2	730
Energy Cost for two lamps	P 264 * 2	528
TOTAL Annual Lighting Cost		1,318
Saving on Kerosene		1,584
Annual Net Saving		266

The saving is small, but could be further improved by increasing the utilization rate of the plant, which would allow lower monthly tariff as will be discussed in the next section. A non cash savings is the time saved from not collecting pine pithwood, though people still need firewood for cooking.

Utilization Rate

The ratio of the total energy used per year to the potential energy production yields the utilization rate of a scheme, which in the case of Balbalasang amounted to 14.4%. This implied that the potential the installation offers is underutilized.

Table 53. *Utilization Rate of Balbalasang MHP*

Energy Use		
Lighting Load	kWh/yr	25,800
Appliances	kWh/yr	1,668
Carpentry Tools	kWh/yr	432
Computers	kWh/yr	2,160
Actual Energy Used	kWh/yr	30,060
Potential annual production	kWh/yr	208,050
Utilization Rate		**14.4%**[30]

The tariff necessary to cover production cost is dependent on the utilization of the plant in the case of hydropower. This is in contrast to the well known diesel generator set where the

[29] From the actual expenses on kerosene before the MHP P132/mo
[30] Based on 8300 hr/yr plant operation or pant availability of 95% of the time

production cost per kWh is practically independent on how much it is used. This particularity of a hydro plant needed to be considered when analyzing the financial situation. Fig. 9 makes clear that under a certain utilization rate the diesel generator set can produce cheaper energy than the hydro. To take full advantage of economics of a hydro plant high utilization rates needed to be aimed for. The graph also shows that the more energy can be sold the lower the tariff per kWh can be made.

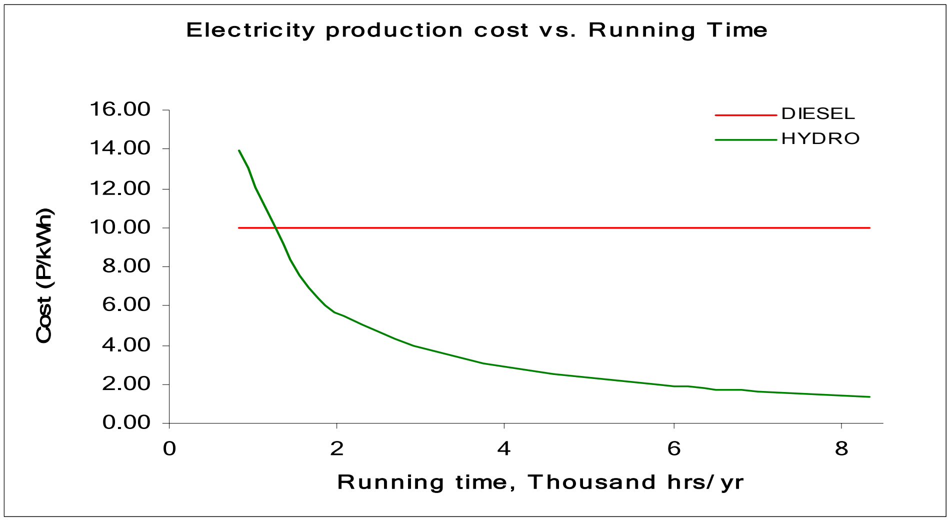


Figure 25. *Production Cost vs Plant Utilization*

Possibilities to Improve Plant Utilization (Rice Mill Change-Over)

Possible MHP power users are the 4 diesel-powered rice mills in the community. With the continuing price increase of diesel fuel, it would be more economical if these mill owners shift to MHP power. Should these owners decided to use MHP for their mills; the plant will have an increase in utilization from 14.4% to 15.7%. Presented in the table below is the rice milling data for Balbalasang.

Table 54. *Energy consumption of a rice mill*

average rice production	kg/yr/hh	1133
no of households		155
Volume of rice milled annually (assumed 60% of total production)	kg/yr	105,397
milling tariff	P/kg	1,25
milling capacity	kg/hr	200
Operating hours necessary	hrs/yr	527
rice mill motor	kW	5
Energy consumption	**kWh**	**2635**

On the average, a household in Balbalasang harvests 1133[31] kgs of rice annually which a huller with a capacity of 200 kgs/hour can process in 527 hours. With its 5 kW motor, the huller would consume 2635 kWh/yr.

If the rice mills use the power from the MHP, the scheme would have an additional income of PhP31,260/yr from the sales of electricity and income from the mill.

Table 55. *Cost Comparison of Using MHP and Diesel-Powered Mills*

Assumptions:			
Fuel Consumption	Li/kWh	0.225	
Diesel cost	P/li	39	
interest rate	%	12%	
project life	yr	10	
Net profit computation:		**MHP**	**Diesel**
Investment for rice mill equipment	P	30,000	
Tariff for electricity	P/kWh	7	
Annual cost			
Energy Cost	P/yr	(21,519)	(29,673)
Operator salary	P/yr	(12,000)	(12,000)
Annuity of the loan for the investment	P/yr	(5,310)	
Total Annual Costs	**P/yr**	**(28,209)**	**(41,673)**
Income			
Milling Tariff to cover costs	P/kg	0.11	0.17
Actual Tariff charged	P/kg	1.25	1.25
Annual volume of rice to be milled	kg/yr	122,964	122,964
Income w/ present tariff	**P/yr**	**153,705**	**153,705**
Net Profit w/ present tariff	**P/yr**	**123,344**	**112,032**
Community Income			
Income generated by the hydro		23,671	
income generated by the mill		153,705	
Total Income generated by a new mill		**177,375**	
Rice Mill Owners Net Savings (Change -Over)		**11,312**	

The rice mill owners will have an annual net savings of P11,300 resulting from the lower energy cost of the MHP plant and the community could realize an additional income of P23,600.

Therefore, to convert existing rice mills from diesel to electric would be of economic advantage to both, the millers and the community itself. It is in the interest of the community to explore further productive end uses of the energy and aim for a significantly higher utilization of the installation.

[31] From SIBAT's Community-Based Resource Management Project Report

Cost Covering Tariff

Though the project was a grant, the schemes cost covering tariff to cover system replacement was calculated such that the village can save the amount needed after the project's useful life was determined using three utilization rates. The annual costs considered were system replacement cost (depreciation cost in 25 years) and the annual O&M cost that was assumed to be 1% of the investment.

The community's expected performance if the project was funded with a loan component was also analyzed. The schemes cost covering tariff to cover loan repayment was determined also with three utilization rates. The loan capital was assumed to be 50% of the total project cost payable in 10 years at 12% interest rate. Result of the analyses is presented in the table below.

Table 56. Cost Covering Tariff of Balbasang MHP

Cost Item	tariff to cover system replacement	tariff to cover loan repayment and system replacement
System Replacement	100,144	100,144
Annual O&M	25,036	25,036
Loan Repayment (50% of capital)		221,548
TOTAL Annual Costs	125,180	346,728
tariff at 14.4 utilization	4.18	11.57
tariff at 30% utilization (lighting)	2.01	5.56
tariff at 100% utilization	0.60	1.67

This tariff should be applied by the community in order to be able to service a loan for the capital cost or to replace the system. **Error! Reference source not found.** shows that the community needs to find ways to increase the MHP's utilization in order to afford lower tariffs.

With the community's present tariff on energy (7.8 P/kWh) they need to attain at least 60 % collection rate at the current utilization to have the amount needed for system replacement after 25 years.

Capability for Loan Servicing

In order to determine the project's capability of servicing a loan, the cost covering tariff was calculated for various levels of loan covering the capital cost of the project. In **Error! Reference source not found.** the tariff necessary to pay the loan and the annual O&M cost is shown versus the loan percentages. For the loan an interest rate of 12% and 10 year repayment period was assumed.

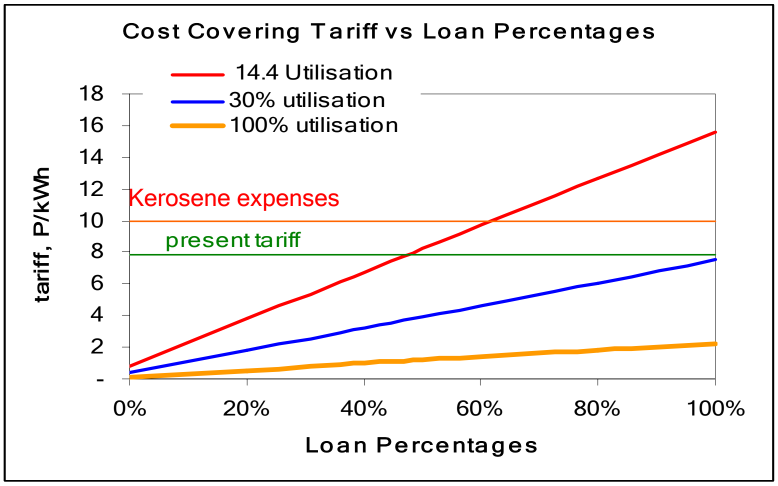


Figure 26. *Cost Covering Tariff w/ Varying Loan Percentages*

The figure above shows that the project can pay for a loan equivalent to 50% of its total project cost at the present plant utilization of 14.4% assuming 100% collection rate, If the kerosene expense is taken as ability to pay, the tariff could be raised up to this level.

With increased utilization meanwhile, the blue line represents the maximum utilization rate of the plant for lighting only. At this utilization level the plant is able to cover a 100% loan assuming 100% collection rate. At a 100% utilization, which would be the case if the plant is connected to the grid and could sell all the energy it produces, the plant could easily serve a 100% loan.

The analysis showed that a higher utilization would increase the project's ability to service a loan significantly. This higher utilization can be achieved by livelihood or income generating end-uses and no increase of tariff is necessary. Therefore a loan would not result in a higher cost for the beneficiaries.

Table 57. Potential Profitability w/ Improved Utilization and Collection Rate

	Actual collection rate, PhP/yr	**100% collection, PhP/yr**
Annual Expenditures		
O&M costs (1% of the capital cost)	25,036	
Total actual annual expenses	25,036	25,036
Annual Income		
Household tariff (Lighting and appliance)	58,514	216,718
tariff for the computers	16,941	16,941
tariff for the carpentry tools	3,388	3,388
Income from rice mill	20,666[32]	20,666
	140,505	298,709

[32] Rice mill (and other end-users) income = kWhr /yr x the equivalent P/kWhr tariff

Total actual annual income		
Net Profit at 15,7% utilization rate	115,469	273,673
Net Profit w/o the rice mill	94,803	253,007

Supposing the community is able to enforce its own policy and obtain 100% collection rate and further supposing that the daytime energy is used for a rice mill the potential income generated by the plant at the present utilization rate could amount to P253,000 annually. Part of this income needs to be set aside for the replacement of the equipment after it has reached its lifetime. The remaining amount is available to the community for development.

Buneg Micro Hydro Power Scheme

A Case Study of a Community-based Renewable Energy System

Buneg Micro Hydro Power Scheme

A Case Study of Community-based Renewable Energy System

Name of Project	Buneg Microhydro Project
Location	Sitio Buneg, Bgy. Nabuangan, Conner, Apayao
Project Type	Micro Hydro Power System
Project Partners	▪ Buneg Mabaca Tribal Orgnaization (BMTO) ▪ St. Williams Parish, Conner Catholic Mission ▪ Sibol ng Agham at Teknolohiya (SIBAT) ▪ United Nations Development Programme (UNDP GEF-SGP)
Project Status	Completed
Project Start Date	March 2000
Project Inauguration	September 11, 2002
Design Power Output	7.5 kilowatt

Folklore

The Mabaka folk trace their ancestral roots to Dulao, Malibcong town in upper Abra Province. Sometime shortly before World War II, a Mabaka hunter from Dulao, Malibcong, Abra pursued a wild boar until he reached the mountain ranges of Apayao. He saw rivers, springs and small valleys, which, he knew early on, promised plentiful living. For a time the hunter stayed in the newfound land. He was fortunate that earlier settlers in what is now Bobog gave him upland rice grains to plant in an area he cleared for an upland swidden farm. After harvesting his crops, he went back to Dulao, Malibcong to convince his family to live with him in the land he discovered. A few families came with him. The hunter and the few families that came with him were the pioneers of what is now Buneg. The hunter was the father of Andanan Agagen, 75, the community's eldest member. Barely seven or eight years old when he came to Buneg with his late father, Andanan remembers carrying a special kind of stone, which his late father used to sharpen farming tools such as bolos or machetes.

Introduction

Regarded as one of the least accessible installations of all community-based renewable energy systems in the Philippines, the Buneg Micro Hydro Power (MHP) Scheme is a showcase of the potential strength of community cooperation. For close to two years, the indigenous community of Buneg, belonging to the Mabaca ethno-linguistic group traversed 36 kilometers of mountainous terrain daily and left no stone unturned to complete the installation.

The project idea was conceived when local residents visited their relatives in Bgy. Dulao, Malibcong, Abra and chanced upon a 10 kW MHP scheme in Dulao and immediately wished to replicate the scheme in Buneg. They requested Bro. Alois Goldberger, of the local Catholic diocese, SVD, who lead the Dulao MHP, to visit their village and help them assess their community's potential for micro-hydro potential.

With technical appraisal conducted by Engineer Chris Alfonso, in 1999, Bro. Alois recommended harnessing hydro energy for post-harvest utilization and household electrification. SIBAT assisted in the project proposal development and waited for 8 more months before the UNDP Global Environment Facility through its Small Grants Programme gave its final approval for the project's implementation.

Along with another village in Apayao and 2 sites in Abra, the Buneg project was successfully completed in 2002.

Land and People of Buneg

Location and Accessibility

Buneg, the project area, is the farthest sitio or sub-village of Barangay Nabuangan, Conner town in northern Philippines' Apayao Province. Apayao is bordered on the North-East by Cagayan, Kalinga on the South, Abra on the South-West and Ilocos Norte on the North-West. Buneg is approximately 36 km west of the center of Conner.

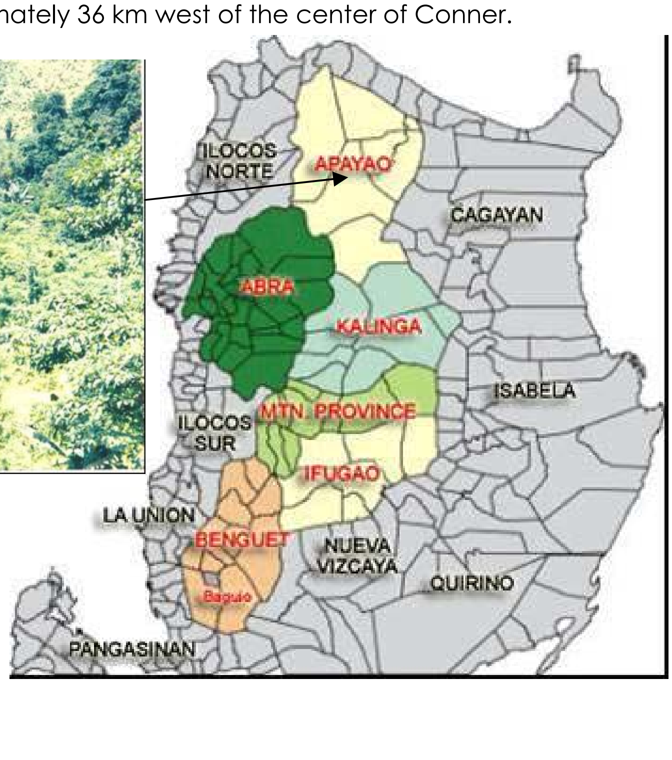


Figure 27. *Buneg Community*

Bgy. Nabuangan consists of four sitios or sub-village: Buneg, Bubbog, Nanawatan and Lapat, all of which are located along the banks of Nabuangan River. According to local sources, Buneg is the largest of the sitios in terms of household population with 36 households; Lapat has 15 while Nanawatan has 16 households. Bubbog has the least with around 13 households but it serves as the barangay center. Of these four sitios, Buneg is the farthest from the road head, while Lapat is the nearest. With no established barangay road, Buneg, and all the other sitios, is accessible only by foot. From the nearest road in Malama, Conner, the local folk take an average of five to six hours to trek to their village. For the uninitiated it takes eight hours to nine to reach.

Sitting on a small valley surrounded by forested hills and mountains, Buneg is home to 36 farming families belonging to the indigenous Mabaka folk. All of the families live in corrugated iron-roofed houses in a closely-knit settlement.

Compared to the other sub-villages of Nabuangan, Buneg is relatively a young community. The name Buneg was derived from bunog, a local finger-size fish, which along with other fish species teem in a river within the Mabaka community.

The Mabaca People

Tough and hardy, the Mabaka people are gentle, friendly and hospitable. They immediately welcome visitors with coffee, rice cakes, and camote or sweet potato. Once visitors partake of the coffee and the snacks the Mabaka folk offer, they are already welcome in the villagers' homes.

As a people, the Mabaka are among the indigenous people of the Philippines who have a strong culture of cooperation and unity. Each community member, for example, would readily help build a neighbor's house. If a family did not have the money with which to buy materials to repair its houses, neighbors would contribute some amount, which the family could repay later. This practice of cooperation also applies in farm work such as planting and harvesting rice and proved to be a success factor in the implementation of the Buneg MHP Project.

Agricultural Condition

Although it is the farthest sub-village in Nabuangan, Buneg is the most self- sufficient in rice in the whole barangay. With Buneg's abundant springs and tributaries, most rice fields are irrigated, enabling the Mabaka folk to cultivate their rice fields twice a year.

The community is practically self-sufficient in food. There are three croppings in Buneg as noted in the table below. Residents grow only traditional rice varieties. However, despite the number of croppings, the community experiences lean months during occurrences of El Niño or extreme drought condition. To cope, members of the community engage in hunting, rattan gathering, and fresh water fishing while others seek seasonal work in town centers.

Table 58. *Planting Calendar of the Mabaka Tribe*

Planting	Harvesting	Location
December	March	Rice field
June	December	Rice field
June	September/October	Swidden Farm

For their protein source, the Mabakas would hunt wild pigs and deer in the forest and fish and eels in their rivers. They also cultivate root crops such as sweet potato, yam, and cassava. Fruits such as banana, guavas and rattan fruits and wild vegetables such as edible ferns, palms and others abound in Buneg. The only food commodity that they have to import from lowland Conner is salt and sometimes sugar.

Inadequate Social Services

As the farthest sub-village of Nabuangan, Buneg is the most inaccessible and the most neglected. Assigned health personnel rarely visit the community. But the community is fortunate to have a teacher -- a Mabaka herself, who teaches four grade-levels – Grades I to IV. Once they are old and strong enough to walk a longer distance (36 km), the school children pursue their studies in lowland Conner or in Dulao, Malibcong. These children would stay with kinfolk and would usually go home on weekends to get food supply from Buneg. Some school children go home only on long holidays. Some Buneg children continue to pursue their high school education in Dulao.

Although sufficient in food, community folk still suffer from diseases, which could be prevented, if not minimized, through proper nutrition and immunization. The top disease affecting both young and old, particularly children, is upper respiratory infection, according to the January 2003 municipal medical mission report for Buneg. At least one out of six community members suffers from upper respiratory infection, which can be traced largely to a deficiency in vitamins. Almost the same ratio applies to bronchitis, another disease that can be traced to nutrition problems. Members of the medical mission also monitored a few cases of primary complex or tuberculosis, parasitism, anemia and common seasonal ailments such as flu.

Given the lack of school and health assistance, the Mabaka people sought to help uplift their own lives through cooperative self-help efforts. They thus found the MHP scheme as one way to help ease the difficult life in their remote community.

Project History

The idea of a MHP scheme did not just flash in the minds of the Mabaka people of Buneg. They got the idea after they saw a MHP scheme which community folk in Dulao, Malibcong (Abra Province) built through cooperative efforts in 1995. Helping facilitate the MHP scheme was the Roman Catholic Diocese of Abra.

It also helped that the Mabaka folk of Buneg, who trace their ancestral roots to Dulao, would visit from time to time their kinfolk there. .

After seeing the Dulao scheme, the Buneg Mabaka folk felt that the Dulao scheme could be replicated in Buneg. Buneg folk knew they had a cutting edge: their ever-flowing springs. Unlike Dulao, Buneg's springs don not dry up during summer.

The Buneg people's next concern was how to start the project in their community. They thus sought the advice and help of Brother Alois Goldberger of the local Roman Catholic Diocese who helped facilitate the technical and funding support for the Dulao project. Brother Alois, as Goldberger is fondly called, soon responded to the Buneg people's call for help.

Taking a hunter's trail from Dulao, Brother Alois and Chris Alfonso, an engineer who helped supervise the Dulao project, arrived one day in Buneg in 1997. They inspected the area, appraised the water resource's potential and found that a MHP scheme was feasible in the community.

After the site appraisal Brother Alois requested help from the *Sibol ng Agham at Teknolohiya* (SIBAT). SIBAT in turn responded and assessed the situation and needs of the community folk. Based on its initial study, SIBAT proposed a project with two components – watershed management and conservation, and electricity generation.

The watershed management and conservation component would ensure that the vital creeks and springs would not run dry. These vital water systems also irrigate the village's rice fields.

As planned and envisioned, the objective of the project was to help install "a community-based, community-owned and community-run" MHP system.

SIBAT then submitted the proposal to the United Nations Development Programme through the Global Environment Facility - Small Grants Programme (UNDP GEF-SGP), which extended an amount for the material and equipment of the MHP scheme. As their counterpart, the community folk would take charge of the labor and locally sourced materials.

Multi-stakeholder Partnership

A multi-stakeholder partnership between SIBAT, the Mabaka tribe of Buneg, the Roman Catholic Church and the Barangay LGU, was formed to implement the project. These stakeholders contributed in the various stages of projects development.

Table 59 *Main Tasks of the Project Stakeholders*

Stakeholder	Tasks in the Partnership
Community entrusting the authority on the elders within the Barangay Council	Took the active role in project development
Local Church	Supported SIBAT and the village in various responsibilities
SIBAT	Provided the technical works and technical management, and funding facilitation
Barangay Development Council through the barangay chairman, officers, etc.	Supported through community mobilization

LGU participation was notable in Buneg, where the local officials with the help of village elders actively aided in facilitating the community meetings and consultations in the discussions to address crucial issues such as on labour contributions. This LGU participation was appraised as valuable to the projects' take-off and completion.

Social Preparation Phase

The project's social preparation phase consisted of numerous consultations discussing the CBRES concept and the role of the community. Even before SIBAT got involved in the MHP scheme, the community folk were already organized under the Buneg Peasants' Organization. Through their organization, they were able to raise farm-related issues, which included lack of government support or facilities such as irrigation and social services such as health and education

Willingness to contribute labor of all able-bodied villagers was expressed during these consultations. Aside from labor, the villagers also committed participation in the entire project process together with the other sectors (church and the LGU), formulation of policies, and managing and sustaining the project after installation.

Energy Demand Study

Residents complained about the lack of cash for basic needs (e.g. salt, kerosene, matches and medical expenses). During the 1998 feasibility study, kerosene was found to rank fourth in a common household's monthly expenditures. On average a household used 3.75 liters of kerosene for lighting. This was then equivalent to P54 per month. During times when they did not have cash to buy kerosene, the villagers depended on bamboo and wood for illumination. Sometimes the Mabaka collect broken branches and logs from the forest or, after a strong typhoon, along riverbanks.

It was during the FS when villagers articulated the need for a rice mill. Usually, a can (12 kg) of milled rice would entail a 4-hour work for children doing manual pounding and threshing. Unlike other typical Cordillera tribes however, both male and female members of the family share the rice pounding activity. Hence this was one of the expressed community needs to ease their burden in rice milling.

Project Implementation

Prior to project implementation, a Memorandum of Agreement between SIBAT and the Buneg Mabaka Tribal Organisation (BMTO) was forged.

The Buneg MHP construction began on March 2000. As a contractual staff of SIBAT, Engr. Alfonso started to supervise the Buneg MHP project along with the other project in nearby Katablangan, also in Apayao.

It took 2 years and 5 months before the project was finally completed. Implementation of the scheme met delays as it encountered two phases of construction supervision. The first phase suffered delays because of the limited supervision provided by the first engineer who could stay only overnight in the community, and to give instructions rather than oversee the works. The Mabaka wished to have a supervising engineer who could directly supervise them for longer periods. Since the project needed to be completed within the timeframe agreed by UNDP-GEF-SGP and SIBAT, the SIBAT management decided to send its own engineer to closely supervise the project, and pursue more intensive supervision.

A SIBAT Engineer entered Buneg in October 2001 with adjustments in the original design. A meeting with the Buneg community was immediately held to assess what jobs were done, what materials were already hauled, and what needed to be done. It was inspiring that on their own initiative, the Mabaka folk had already brought to Buneg the turbine, generator, wires and other accessories. The only materials that had yet to be hauled were the pipes, reinforcement bars and cement. Haulage was finally completed in July 2002. Although the canal had already been built, it needed improvement.

Table 60. *The Major Technical tasks of SIBAT in Project Implementation*

Tasks	Description
Technical supervision	Supervision and directing of the major works (civil, electro-mechanical, electrical)
Purchase of major components	In-charge of major purchases especially those not available on the site
Turbine fabrication	Supervision of turbine fabrication according to the design
Technical and management training	Conduct of technical trainings while the project is in construction to give the trainees hands-on exercise and management training after the project commissioning
Coordination with PO and local NGO	Conducts necessary coordination and community meetings

The close supervision of the project proved fruitful. With the engineer around during the installation of the penstock, turbine, generator, and electrical wires and lights, the Mabaka actually learned on the spot some basic skills, which they could only acquire in electrical and mechanical engineering schools.

While implementing the project, the peoples' organization (BMTO) ensured that the people did not abandon their rice fields and swidden farms. They decided through consensus to divide themselves into four groups to work on the project in rotation schedule. The idea was to ensure that while one group was working on the project, the rest of the community had time to plow their fields, plant their rice seedlings, and eventually harvest their ripe grains.

During implementation, the villagers also had to adjust to factors beyond their control, which included weather disturbances such as typhoons and monsoons. They would haul materials and equipment during the dry season. But on days when the weather was unpredictable, they would ensure that the bags of cement they had to carry, for example, were carefully wrapped in cellophane so that these would not get wet when it rained.

Figure 28. *Widening of the irrigation canal cum power canal of the MHP*

On scheduled days when the engineer was in the community to supervise the work, typhoons and monsoons did not stop the work on the project. When they could not connect the penstock pipes with the hot plate because of the rains, the community folk and the engineer worked indoors, installing the household wiring in every household.

The Mabaka folk's cultural practice of *innabuyog* (cooperative labor) was a big success factor in the arduous task of haulage. To carry the turbine, for example, eight men at a given time had to carry the machine, which was tied to a bamboo pole. Other men were on the ready so any of them could relieve someone who got tired even after a few meters. They did the same technique in hauling the other heavy materials and equipment. For their part, women would bring in packed lunches and snacks for the men.

Aside from hauling, all able-bodied members of the 36 families of Buneg helped in other activities for the project. Women and children hauled sand and stones from a river and helped dig the canal. The men, on the other hand, used the stones to build riprap walls for the canal.

Project Commissioning

The Mabaka continued to work together until the project's completion. On the evening of September 11, 2002, after commissioning, the whole village finally saw the light from fluorescent lamps. Literally left in the dark for years, the villagers on that day jumped in jubilation, hugged each other, cried for joy, as the women sang songs to celebrate a long-awaited prize for their hard work and cooperation. The project was officially completed on September 20, 2002.

As a consensus, Buneg agreed it was time to arrange for a full inauguration and thanksgiving for the project that they themselves had implemented with the support of their partners.

In preparation for the project's inauguration, the Buneg people solicited the help of their local officials and a few responded by providing some amounts. The community members took charge of the bulk of the expenses for the inauguration of the project. They sacrificed one carabao (water buffalo), their work animal, for the affair and each community member contributed to be able to produce a total of 2 pigs and 47 chickens. Others were assigned to hunt food from the wilds and were able to catch 4 adult deer, 47 wrist-sized eels, and were able to gather 72 anibong (an edible wild palm) shoots.

After harvesting their rice, the Buneg people invited SIBAT and the UNDP along with guests from the church, provincial and municipal governments to witness the blessing and inauguration of the MHP scheme on January 17-18, 2003. Visitors did not only join in the Buneg people's celebration of success. The MHP scheme taught visitors about the possibility of energizing similarly remote villages that have enough water resources. Curious visitors also learned that a river does not need to be dammed completely to produce electricity.

Figure 29. *Buneg MHP Turbine and Rice mill.*

After Inauguration, the next task of the community was to establish a system to manage their MHP scheme.

Project Management

Description of the Management System

The Buneg-Mabaka folk have two inherent qualities, which paved the way for a good partnership with SIBAT and the UNDP-GEF-SGP: their high-level of organization and cooperation and a high degree of initiative and resourcefulness. Even before SIBAT got involved in the MHP scheme the community folk were already organized under the Buneg Peasants' Organization. Through their organization, they were able to raise farm-related issues, which included lack of government support or facilities such as irrigation, and social services such as health and education.

Brother Alois advised the villagers to get organized. The Buneg Peasant Organization was thus transformed officially into the Buneg Mabaka Tribal Organization (BMTO), whose leaders supervised and coordinated the MHP scheme. The organization is structured as follows:

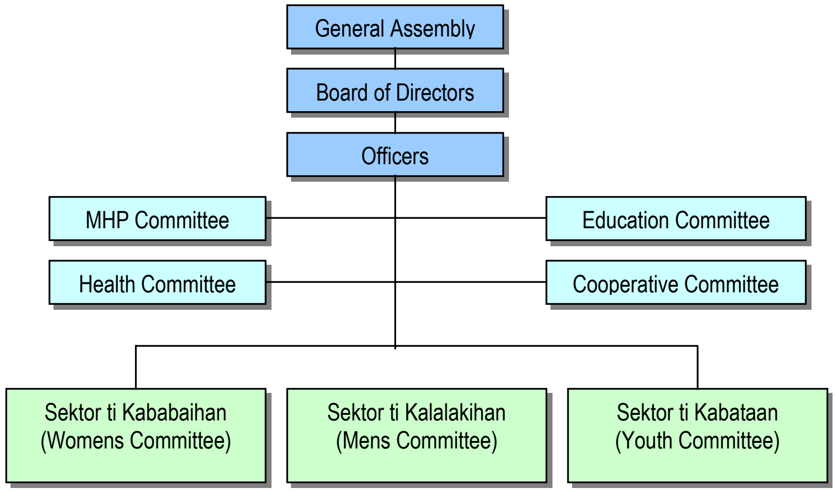


Figure 30. *Buneg MHP Management structure*

Although a definite term of office for officials is stipulated in their constitution and by-laws, the current set of officers have been holding office since the former chairman had been elected barangay chairman in the 2002 local election. According to members they still prefer the present set of officers due to their good performance.

Currently, management for the project resides in the MHP Committee, composed of 4 community members who also act as operators and collectors. Its members were selected by the community based upon knowledge and skills required for the daily operation, maintenance and management of the project.

Leadership Issue

It was recently learned that the BMTO Chairman had misused the UNDP allocated community seed fund for the watershed component, through unauthorized withdrawals. After an investigation by the BMTO Board of Directors, the Chairman was held culpable, asked to payback the borrowed amount and a penalty meted out. Although the issue has tarnished the record of the organization, BMTO has immediately called for systematization of their financial procedures and a general election during their general assembly meeting (June 2005). SIBAT has pledged to conduct training on project and financial management.

Operation

The system currently operates for 7.5 hours/day after it was agreed to extend the original hours of operation. On average, each household used two lamps drawing a total of 26W for lighting alone.

To ensure that the project could function when the community folk were left on their own, the engineer trained at least eight young men on maintenance and operations. Operating in shifts, the trained operators are assigned in pairs at the powerhouse. Their job is to switch on the power at 4:00 AM and switch it off at 6:30 AM and turn it on back again at 5:00 PM and off at 10:00 PM. On special occasions the power is switched on for

24-hours daily, such as during the two-day inauguration in January 2003. The powerhouse in Buneg is so near the community that it is very convenient for the operators.

As part of the operation and maintenance, the community has set aside every Sunday, usually after their worship service or Mass, during which they visit the canal and the forebay to clean up debris that clog the flow of water.

Load Allocation and Management

Load allocation was based on household demand data yielded by the feasibility study. SIBAT, together with the community, fixed the maximum load for lighting per household at 75W, which was adopted by the community as their policy.

The survey of the actual household load (lighting and appliances) shows that these are well below the installed capacity of the system. This indicates that the design capacity of the Buneg MHP has made good allocation for household needs and other end-uses and still has allowances for major applications.

System Downtime

In its 4 years of operation, the Buneg MHP had experienced a total of 6 weeks of downtime period mainly due to repair activities for the canal, penstock and bearing replacement. The unselfish attitude of the Mabaka folks made the prompt response to the repairs possible.

Table 61. *Repairs for Buneg MHP*

Repairs Required	Who conducted the repairs?
Canal repairs	Villagers
Penstock leaks	Villagers
Bearing replacement	Villagers

Tariff and Collection Rate

Based on a community consensus, BMTO collects a monthly tariff P10/mo for the first 10 W lamp and additional P10 for the next lamp. This tariff rate is equivalent to P3.42/kWh at 7.5 lighting hours a day for the average 26 W for lighting. The organization does not have a tariff set for appliance use as the power is mainly used individually for lighting. The only appliance in the village was a communal television set donated by the mayor. Children are allowed to watch TV only on Friday nights and weekends.

This flat rate for all consumers is still enforced and there have been no complaints, or problems with non-payment. The organization claims to have 100% payment of tariff among its beneficiaries. A closer look into the records however reveals a lower collection than the expected income at 100% tariff payment. Based on the BMTO's 2003 Financial Report, gross annual income from household lighting amounted to PhP 4,214. This is lower than the expected collection of PhP 10,296 at the average P20/mo tariff paid by the beneficiaries. At this income, the organization's collection rate is only 41% and not 100%, as they claim.

In the organization's policy, 30% of the monthly collection should be set aside for operations and maintenance, 25% for depreciation of equipment, 20% for organizational fund, and, 25% for operators, who are also the bill collectors. Those unable to pay on time were given a five-day grace period. For monitoring, the collectors were required to keep a record book of all the collections.

Effect of Poor Collection Rate

With its 41% collection rate for lighting use among its beneficiaries, Buneg MHP was able to sustain its operation and have an annual net profit of P 5,125. The low annual cost incurred by repairs and the income from rice milling helped the project to have savings.

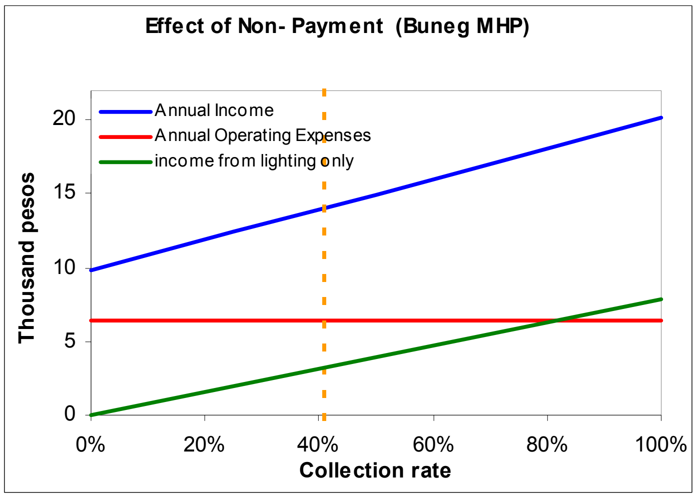


Figure 31. *Effect of Collection Rate in Buneg*

The assumed income at 100% collection rate was computed based on the result of an interview with 24% of the household beneficiaries. This percentage of households interviewed may be too small and does not represent the actual setting in Buneg causing the discrepancy in the actual and expected collection. As the record show 100% household payment, the management may need to improve on their monitoring and book keeping.

Tariff Structure

Shown on the table below is the price a household pays for its energy consumption. The village has an almost homogenous income level among its villagers. But even a small village such as Buneg has a level of bias in the tariff followed.

As there were no appliances to speak of the household's income level, the number of lighting fixtures needed per household was used. The table shows that the policy is to the disadvantage of the households belonging to the low income class as they pay more on their energy consumption

Table 62. *Energy Cost at Different Income level*

Tariff rate	P10/mo for the first lamp + P10/mo for the succeeding lamp installations			
Income level of HH	**Equipment Installed**	**Cost of the Services (P/W per month)**	**Cost of the Energy (per kWh)**	**Tariff Paid (P/mo)**
low	1 FL	1.00	4.44	10
	2 FL	1.00	4.44	20
	3 FL	0.67	2.96	20
high	4 FL	0.50	2.22	20

The cost of energy per kWh was computed at the actual tariff paid of the beneficiaries and the average lighting hours of 7.5 hours/day and wattage of 10W per lamp.

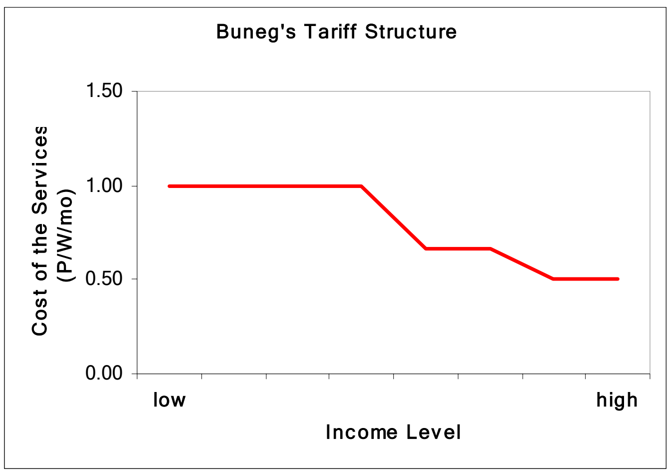


Figure 32. *Tariff Structure*

Even with lighting alone, the data shows that the users do not pay what they are actually consuming. As it should be, the tariff structure should be adjusted. Should the community agree, a flat tariff for the installed capacity (P/W/mo) could be adopted but a prepaid load limiting device should be installed per household to control the consumption. In this manner, defaulters can be avoided.

Technical Description

Technical Design

The Buneg MHP followed the run-off-the-river scheme of development. Water from the Palpag Creek is diverted by a 9m-wide weir, made of stones and travels along a 384m earth canal to an 18.89m^3 forebay. The forebay is made of grouted riprap and has a built-in silt trap and a breather pipe (1.5" diameter GI). Water then passes down a 105-m long, 6" diameter penstock – made of combined high and medium density polyethylene pipes (HDPE and MDPE). The pipes are fused through butt welding. The penstock is attached directly to the turbine located inside the powerhouse.

The crossflow turbine was fabricated locally by the Pangasinan State University (PSU). As the water drives the turbine shaft, it transfers the power to the synchronous generator (Mindong brand) by a belt drive system. The Buneg MHP system does not have a kilowatt-hour meter nor ELC installed.

In 2005, the community purchased a brand-new 10 kVA Mindong type generator as an upgrade to the installed 7.5 kVA generator. On their initiative the organization through their officers asked SIBAT on the appropriate generator frame size to buy. They used the barangay internal revenue allotment and their savings from the MHP operation to buy the new unit. The 10 kVA unit is still not installed as of this time as the old generator is still functional.

Electricity is delivered to the 33 households through a 220V, single-phase 2-wire transmission system. The total length of transmission is 441 meters around the community. It utilizes #14mm2 cable wires and wooden transmission posts (6m).

Technical specifications of the overall design are presented below.

Civil Works Components

Table 63. *Description of Civil Works Components*

Component	Description	
Weir	Material	Stones
	Width	9m
Canal	Type	Earth
	Length	384m
	Width	1.20m
	Depth	0.6m
Forebay	Size	$18.89m^3$
Penstock	Material	MDPE
	Length	105m
	Diameter	6 inches
Gross head		52m
Inlet Valve	Type	Swing valve

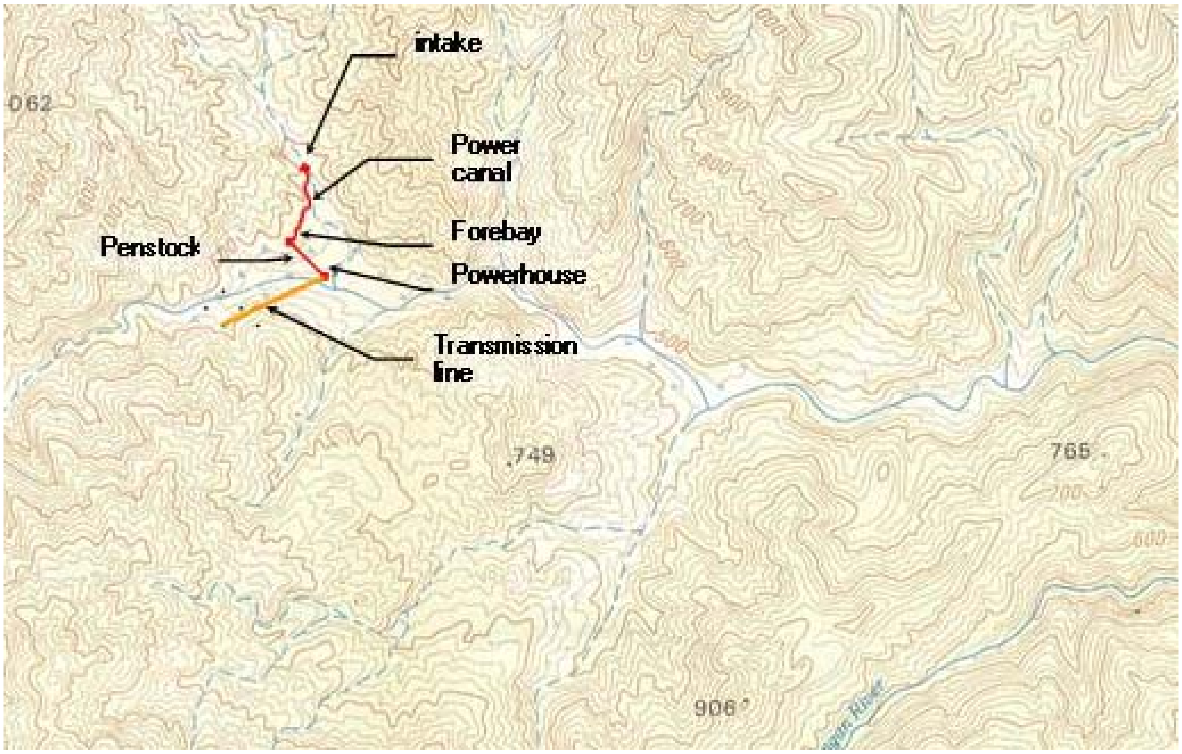


Figure 33. *Layout of the Buneg MHP*

Powerhouse Equipment and Transmission / Distribution System

Table 64. *Description of Mechanical and Electrical Components*

Component	Description	
Turbine	Type	Cross-flow
	Manufacturer	Pangasinan State University
	Width	50mm
	Diameter	250mm
	Design power	7.5 kW
	Design flow	20 l/s
Load Control		NONE
Generator	Type	Synchronous brushed
	Rated Power	7.5 kVA
	Voltage	220 V
Drive System	Type	Belt Drive
	Generator Pulley rpm	1800 rpm
Transformer		NONE
Transmission line		2 wire 220 v

Load

The power produced by the MHP are used both for consumptive and productive uses. Thirty-three households benefit directly from the 7.5 kW of electricity harnessed from the Palpag Creek. As discussed in the energy demand section each household was allocated 75W for lighting during the feasibility study as per desired use of the residents. However the recently concluded evaluation found that on the average, each household is using 26W for their lighting.

The community articulated that they wanted an MHP scheme, which could not only provide electricity for households but also a rice mill. Unfortunately, the goal of electrification was prioritized and post-harvest facilities were not covered by the UNDP Small Grants Programme so funds were not available for a rice mill. A rice mill was later added after a congressman from Apayao donated it. This reflects the community's ability to source funds independently.

The Rice mill is second-hand and suitable for the community's modest milling demand. The mill was installed in September 2004; exactly 2 yeas after the MHP scheme was inaugurated. It is directly driven by the turbine. BMTO has set a 3-day each week for milling. The villagers can go to the rice mill at any time of the day during milling schedule. The installed rice mill in the area has 100 kg of milled rice per hour capacity. Residents can pay either in cash (PhP 10/can of milled rice) or in kind (580g rice/can of milled rice).

Most recently, the community, counting on the province's congressman generosity, became the proud recipient of a 21" satellite television set. Immediately, BMTO organized schedules for community viewing (4:00 p.m. - 7:00 p.m. on weekdays; and 1:00 p.m. – 6:00 p.m. on weekends) and adopted guidelines to regulate TV programs or shows suitable to specific ages or sectors. The community however is yet to strictly enforce a reasonable tariff scheme to make the public television viewing sustainable. At present, it is the barangay captain (who was the former BMTO chairman) who shoulders the cost of the satellite TV subscription.

Despite the arrival of the satellite television set, the Mabaca folk did not rush to buy television sets or appliances. Women, especially mothers, were particularly worried at the beginning that television sets would stop their children from studying their lessons. They were thankful that BMTO has come up with schedules and regulations for public TV viewing. Neither did they ever seek to buy refrigerators. According to the women, refrigerators are irrelevant in Buneg where all food is fresh. The only amenity that mothers and fathers unanimously sought to acquire was a transistor radio. They say they need the radio to get updated about what's happening outside their community and to be forewarned about disasters such as a forthcoming typhoon or storm. Right after the project completion, at least five families had acquired transistor radios with cassette players.

Figure 34. *Wooden Transmission post of Buneg MHP*

Technology Appropriateness

Civil Structures

The system has undergone a series of repairs and maintenance checks since its installation in 2002. In September of 2004, repairs of penstock leaks, build-up of shafts as they were worn out; and change of generator bearings were completed alongside the installation of the rice mill. In all repairs, collective participation of BMTO members was instrumental in the manual tasks of repair. Repairs were also carried out in February 2005, and involved clearing and rip rapping of damaged sections of the earth canal as a result of a typhoon.

From the last project monitoring in March 2005, the following have been the observed problems of the system. Firstly, leakage from cracks in the penstock sections where MDPE pipes were used. The community resorted to using this type as the penstock turn out to be longer than that in the design. To remedy the leakage, SIBAT advised the community to cover the leaks with concrete. The leakage problem could have been avoided if the penstock line had been measured thoroughly. Secondly, it was recommended that the butterfly valve be replaced with a gate valve to prevent necking in the penstock. The community committed to attend to these repair works as soon as possible.

Figure 35. *Buneg MHP's Canal*

Electro - Mechanical Components and Control

Aside from the problems discussed above, the system has not experienced any problem in its electro-mechanical component and controls.

Transmission and Distribution System

This installation has not experienced problem in its transmission system so far. However, on the transmission and distribution systems an earth-leakage circuit breaker must be installed to avoid lethal shocks. This device trips if a person comes in contact with bare wires.

Initial Project Effects

Socio-Economic


Figure 36. *A household beneficiary in Buneg*

The MHP scheme made immediate impact on the livelihood of community members. Andanan Agagen, the village's oldest elder, for example, used to weave rattan strips into baskets only during daytime. Under bright fluorescent lamps , Mr. Andanan can now weave baskets even in the evenings and has doubled his output from 3 to 6 baskets monthly. Native baskets fetch a high price of P250/unit in barangays Malama or Caglayan. These two barangays are market centers located in the main town of Conner. Following Mr. Andanan's example, around 10 young male residents have also adopted the lucrative pastime (hobby) of basket weaving, not only augmenting their household income but also preserving the indigenous skill and craftsmanship.

Villagers can also maximize their time working in their fields. Before the MHP scheme was finished, they had to rush home from the fields to beat the daylight just to pound rice but not anymore. The donated rice mill unit has literally liberated the men and women in Buneg from the difficult task of manual pounding. On average, a family saves 1 to 2 hours of rice pounding each day as a benefit from the microhydro.

Education

Another effect of the project can be seen in the field of education. According to Rosalina Dangli, the lone multi-grade teacher in the community, the grades of her pupils remarkably increased after the introduction of electric lights. The teacher noted how her pupils were more enthusiastic to read their lessons and to do their school homework under the bright lights. Parents also echoed Dangli's testimony, saying their children were more inclined to read books now than before when they were using kerosene lamps.

Not only grade school pupils read their books in the evenings. Village elders read books and other literature related to their work and line of interest. Health volunteer Benigno Balani, for example, said he would read books and magazines about health and medicine before he retires in the evening. As Barangay secretary, Anselmo Taclawan could also review and type minutes of barangay council meetings in the evening. Like the rest of the community, both Balani and Taclawan work in their fields during the day and do their other extra-curricular activities only in the evenings.

Environment

Aware that the other component of the MHP project was watershed management, the Buneg people vowed to protect the watershed that feeds the creek, which supplies water for the MHP scheme, and other water systems. They assured SIBAT and the UNDP that watershed conservation was part of their indigenous natural resource management system. In fact, under the Mabaka traditional natural resource management system, no one is allowed to clear vital watersheds for their swidden farms. Even in forest areas where they can hunt and gather wild products, the Mabaka people follow certain rules and regulations. If they gather rattan, for example, they make it a point to gather only the mature plants. It is part of Mabaka practice not to indiscriminately cut young rattan plants just to get to the mature ones. This practice has one good reason: it takes a year for a rattan seed to germinate and at least 10 years for it to mature.

Taking off from the success of the MHP project, the Mabaka folk continue to chart their future. Through their culture of cooperative self-help, they intend to expand their rice fields not only for more food production but also for environmental-protection reasons. With expanded rice fields, they need not clear the forests for swidden farms for food production; thus conserving their remaining verdant forests.

They also intend to reforest former swidden farms with "wildlings" or wild seedlings endemic to the area. They are wary about introducing imported seedlings, which, they fear, would displace their indigenous forest species.

Governance

Buneg has become the political powerhouse for the whole barangay of Nabuangan since the last barangay elections (2002). Gaining confidence from heading and supervising the Buneg Mabaka Tribal Organization (BMTO), which directly implemented the MHP scheme, BMTO president Pablo Agagen ran for Barangay Captain in the last elections and won. At least four of the eight Barangay Council members along with the Sangguniang Kabataan (Youth Council) chairperson come from Buneg.

To focus on his responsibilities as Nabuangan Barangay Captain, Agagen delegated his BMTO position to another Buneg leader. The BMTO position became a training ground and stepping-stone to an elective position in the barangay.

BMTO likewise continues to hone the leadership and management skills of the organization's leaders. Ever since the project implementation stage, the people learned about the committee system, for example. The project demands a certain level of management skill, which they have to maintain and sustain.

Buneg became a role model for the other sitios in Barangay Nabuangan. Elders from the neighboring sub-village of Bubbog, for example, had already approached SIBAT about their desire to build an MHP scheme. The Buneg community is willing to help their neighbors in Bubbog who helped haul materials for the Buneg project. Residents of the other sitio of Lapat also expressed the same desire to have their village energized through an MHP scheme.

Financial Analysis

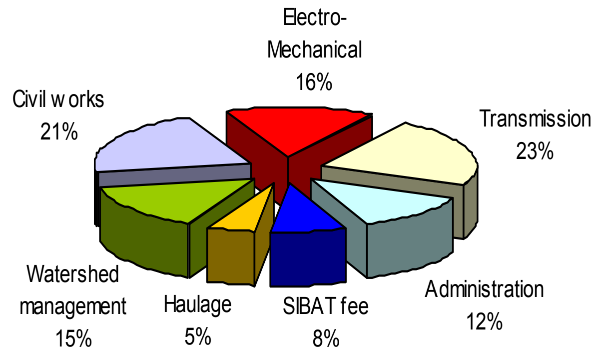
System Cost

The total investment cost amounts to PhP802, 000 including a PhP60, 000 community seed fund for the watershed conservation and protection component.

The material costs of the project made up 59% of the total cost of the project, watershed management was 15% of the total budget, and the remaining 26% covered haulage, administration costs such as community organization, training and construction supervision. SIBAT's consultancy fee for surveying, design work and proposal development were not included in the project cost. This was part of SIBAT counterpart.

Table 65. *Breakdown of Capital costs*

Civil works	*P*	*172,000*
M&E	P	125,000
Transmission	P	180,000
Administration	P	100,000
SIBAT fee (supervision)	P	62,500
Haulage	P	40,000
Watershed management	P	122,500
Total Project Cost	**P**	**802,000**
	US$	**16,040**
Total grant	P	802,000
Cost per Household	**$/hh[33]**	**486**
Cost per kW Installed	**$/kW**	**2,138**



Mode of Financing

After receiving Buneg's request for assistance in installing a MHP system, SIBAT sought the financial assistance of the United Nations Development Program (UNDP). With SIBAT as partner-NGO, the UNDP, through its GEF-SGP[34], granted financial help for the Buneg project. As part of the grant's condition, Buneg must take care of the labor and locally sourced materials as their counterpart. To the community's recall, the cash value of their local contribution amounted to PhP740, 000.

The grant funds fell within the concept of one-time enabling capital costs which included materials and equipment, supervision and training and all that is necessary to install the plant. Said upfront costs install the project which the community will operate and sustain, through returns from the project itself. Hence, operation and maintenance costs, and costs to replace major parts and equipment will be the responsibility of the community.

The condition was no problem for the Mabaka people. They simply resorted to their tradition of cooperative self-help in implementing the project. It also helped that their neighbors in Bubbog, a 2 hour walk away, helped in hauling materials and equipment for the project. Under an age-old tradition, the Buneg people would also extend their help should the Bubbog villagers need help in the future.

[33] Computed at P50$

[34] Global Environment Facility – Small Grants Program

Figure 37. *Women and youth contributing labor counterpart*

To support the project, BMTO leaders solicited the help of some officials in the province and the private sector, but community leaders were disappointed that the officials and other people they approached were not keen on supporting the project. Only the Department of Social Welfare and Development (DSWD) favorably responded by giving a cavan (50 kilograms) of rice, and later, they received the rice mill.

Operation and Repair Cost

Buneg's annual expense which is at P 6, 370/yr is about 0.8% of the total project cost. The bulk of the project's annual cost goes to the maintenance and salaries of operators. The repair cost incurred was from the repair of the canal and penstock leaks while maintenance cost was bearing replacement and building up the turbine shaft as it had worn from the loose pulley.

Table 66. *Annual Operational Cost of Buneg MHP (Actual)*

Cost Item	Amount (PHP)	% of Total
Personnel	1,920	30
Maintenance	3,880	61
Repairs	570	9
Annual Operational costs	6,370	
Expected Operational costs[35]	8,020	

The repair cost is shared between the civil, electro-mechanical and transmission components as follows:

[35] Based on 1% of the total material cost of the project per year.

Table 67. *Breakdown of Repair Costs*

MHP Component	Annual Cost (P)	% of Total
Civils	200	35
Electro-mechanical	370	65
Transmission	0	0
TOTAL Annual Repair Cost	570	

Financial Sustainability

Income from lighting and rice milling tariff are the sources for financial sustainability of the system. The actual tariff for lighting (average of P20/month) results in energy cost of 3.42P/kWh.

A study of its income-expense records indicate that Buneg was able to sustain its operation with an annual net profit of P3,680.

Table 68. *Annual Income-Expense for Buneg MHP*

Cost Item	Amount P/yr)
Annual Operational Cost	6,370
Annual Income	
Household lighting	4,200
Rice mill	9,840
Total actual annual income	14,000
Net profit	7,685

The rice mill income is from the tariff paid by the beneficiaries for milling. The organization set P0.83/kg of milled rice as tariff which can also be paid in cash. Using the annual volume of rice milled (17,472 kg/yr) the rice mill is expected to earn P14,560 per year. With the recorded income of the rice mill, the percentage of households who are actually paying in cash is only 68%.

The low annual expenses on operator's honorarium helped the scheme to gain profit. Buneg registers the lowest paid operators which is 80 P/mo. As stated in the operation and repair cost, the Buneg scheme's annual operational cost is lower than the expected 1% annual cost for an MHP scheme.

Quality of Lighting and Replacement Cost

The community is presently using different lamp types which have a significant influence on the amount a household spends on lighting. This is shown in the table below.

Table 69. *Annual Expense for Lighting for Different Lamp Types*

Lamp type	Wattage	Price (P)	Lifetime (H)	Annual replacement cost (P/yr)	Tariff (P/W/mo)	Annual Energy cost (P)	Annual expense for lighting (P)
Chinese CFL[36]	11	90	765	322	1.0	133	455
Fluorescent lamps	10	110	1,275	236	1.0	121	357
Philips CFL	11	200	5000	110	1.0	133	243
Philips incandescent bulb	25	25	1,020	67	1.0	301	368

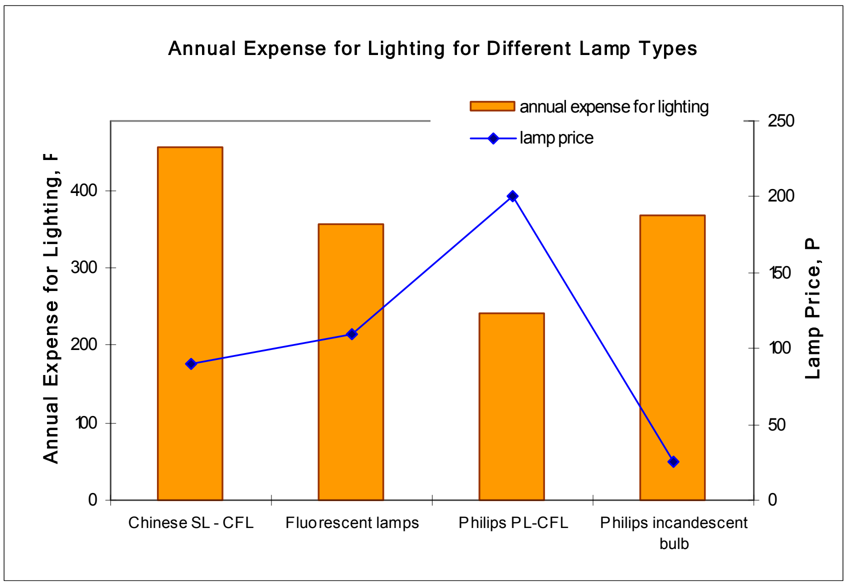


Figure 38. *Comparison of Annual Expense for lighting for Different Lamp Types*

The graph above shows that the households would be better off to purchase the lamp with the lowest annual cost, which is the more expensive Philips CFL lamps.

Savings with Electric Light

A household spends PhP 654[37]/ yr on kerosene. To determine the savings the household can achieve with substituting kerosene with hydropower, the annual equivalent cost of wiring, replacement cost of lamp and energy cost was computed:

[36] CFL is compact fluorescent lamp
[37] From the actual expenses on kerosene before the MHP of P54.50/mo

Table 70 *Annual Cash Savings per HH with the Electric Light*

Cost Item	Calculation	Annual Cost (P)
Cost of wiring (provided as part of grant funds)		
Lamp replacement (for 2 Philips CFL lamps)	P110 *2	220
Energy Cost for two lamps	P 133 * 2	266
TOTAL Annual Lighting Cost		486
Saving on Kerosene		654
Annual Net Saving		168

Table 70 above shows that the Buneg households saving is small, but could be further improved by increasing the utilization rate of the plant, which would allow to lower the monthly tariff as will be discussed in the next section. The small saving impacts on the Mabaka giving them a sense of improvement in their situation which cannot be expressed in Pesos.

Utilization Rate

The ratio of the total energy used per year to the potential energy production yields the utilization rate of a scheme, which in the case of Buneg amounts to 5.9%. This implies that the potential the installation offers is under utilized.

Table 71. *Utilization Rate of Buneg MHP*

End-Uses	Energy Consumption (kWh/yr)
Lighting Load	2,349
Rice mill	1,310
Actual Energy Used	3,659
Potential annual production	62,415
Utilization Rate	**5.9%**[38]

The tariff necessary to cover production costs is very dependent on the utilization of the plant in the case of hydropower. This is in contrast to the well known diesel generator set where the production cost per kWh is practically independent on how much it is used. This aspect of a hydro plant needs to be considered when analyzing the financial situation. **Error! Reference source not found.** shows that under certain utilization rate the diesel set can produce cheaper energy than the hydro. To take full advantage of economics of a hydro plant higher utilization rates need to be targeted. The graph also shows that the more energy can be sold the lower the tariff per kWh can be made.

[38] Based on 8300 hr/yr plant operation or pant availability of 95% of the time

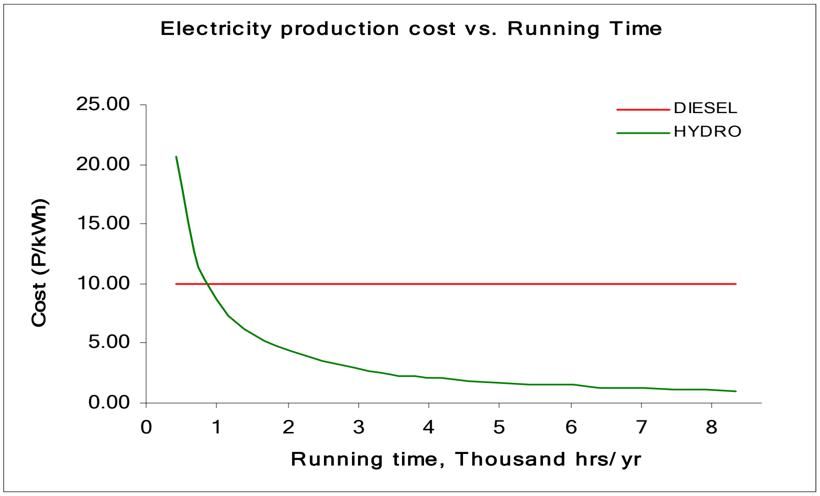


Figure 39. *Production Cost vs Plant Utilization*

Possibilities to Improve Utilization

As the Buneg MHP scheme is under-utilized, the community could identify other ways by which the utilization could be increased with the installation of livelihood support end-uses. Rattan-stripping for example, for the basket –weaving activity in the village could be mechanized to make use of the excess MHP power and also free the villagers of the manual stripping.

Cost Covering Tariff

As the project is a grant, the cost covering tariff to cover system replacement was calculated such that the village can save the amount needed after the project's useful life. To cover system replacement the annual cost of P61, 490 was used. This is the project's annual O&M cost also at 1% of the investment plus P53, 470 which is the annual cost of the project in its 15-year project life.

The community's expected performance should the project was funded with a loan component was also analyzed. The schemes cost covering tariff to cover loan repayment was determined using three utilization rates and annual cost of P149,960. This is the projects annual O&M cost that is assumed to be 1% of the investment (P8,020) plus the annual repayment of P141,940 for a loan with 10 years repayment period and 12% interest.

Table 72. *Cost Covering Tariff of Buneg MHP*

Utilisation Rate (%)	Energy Use (kWh/yr)	Tariff to cover system replacement (P/kWh)	Tariff to cover loan repayment [39](P/kWH)
5.9 (present rate)	3,659	16.8	40.98
30 (lighting)	18,720	3.30	8.01
100	62,415	1.00	2.40

[39] If the project was funded through loan

This tariff should be applied by the community in order to be able to service a loan for the capital cost or to replace the system. **Error! Reference source not found.** shows that the community needs to find ways to increase the MHP's utilization in order to afford lower tariffs.

With the community's present tariff on energy (3.5 P/kWh) they need to attain at least 30% utilization rate and 100% collection to have the amount needed for system replacement after 15 years.

Capability for Loan Servicing

In order to determine the project's capability of servicing a loan, the cost covering tariff was calculated for various levels of loan covering the capital cost of the project. In **Error! Reference source not found.** the tariff necessary to pay the loan and the annual O&M cost is shown versus the loan percentage. For the loan an interest rate of 12% and 10 year repayment period was assumed.

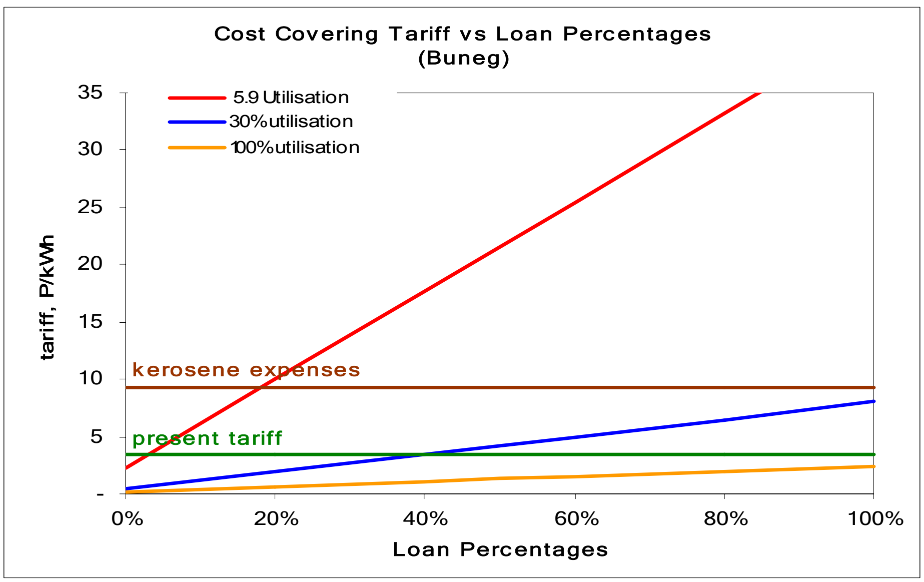


Figure 40. *Cost Covering Tariff w/ Varying Loan Percentages*

The figure above shows that the project could not afford to service a loan with the present plant utilization and tariffs even assuming 100% collection rate, If the kerosene expense is taken as ability to pay, the tariff could be raised up to this level.

With increased utilization meanwhile, the blue line represents the maximum utilization rate of the plant for lighting only. At this utilization level the plant would be able to cover a 40% loan assuming 100% collection rate.

The analysis shows that a higher utilization would increase the project's ability to service a loan significantly. This higher utilization can be achieved by livelihood or income generating end-uses and no increase of tariff is necessary. Therefore a loan would not result in a higher cost for the beneficiaries.

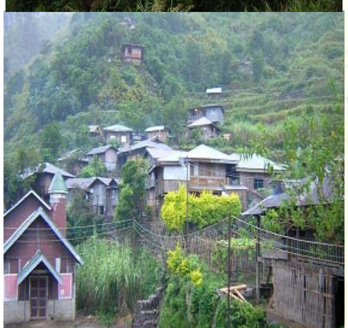
Table 73. *Potential Profitability w/ Improved Collection and Utilization Rate*

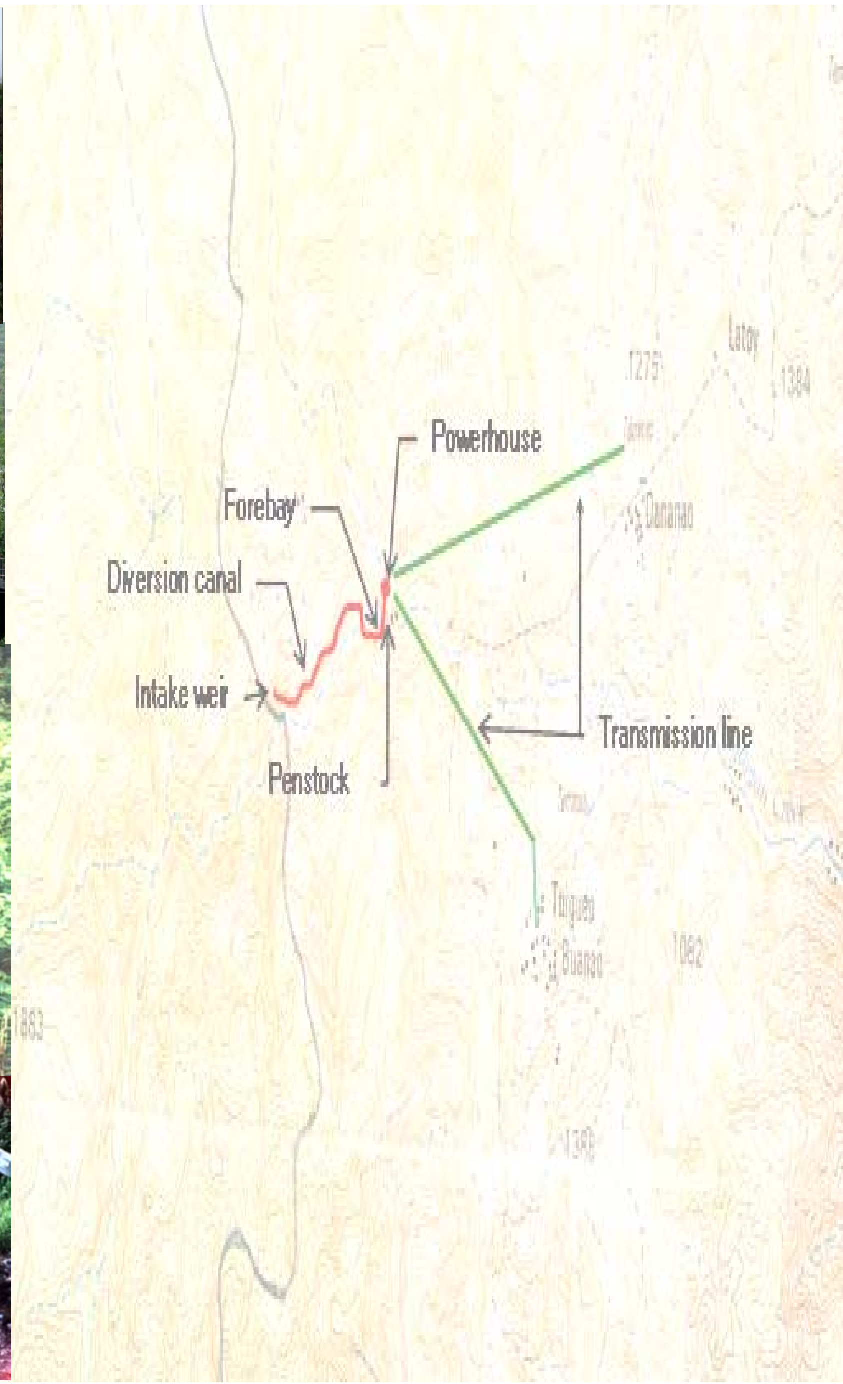
		Actual Collection	100% collection	
Annual Expenditures				
Annualized Cost of Replacement		(53,467)	(53,467)	-
O&M costs (1% of the capital cost)	P/yr	(8,020)	(8,020)	(8,020)
Total actual annual expenses	**P/yr**	(61,487)	(61,487)	(8,020)
Annual Income				
Income from Lighting	P/yr	4,214	7,951	
Income from rice mill	P/yr	9,840	9,840	
Total annual income	P/yr	14,054	17,791	17,791
Net profit/ deficit at actual utilization	P/yr	(47,433)	(43,696)	9,771
Net Profit/Deficit at improved utilization (30%)	P/yr	(27,559)	2,529	

Supposing the community is able to enforce its own policy and obtain 100% collection rate, the potential net profit generated by the plant at the present utilization rate could amount to P9,700 annually if they did not save for capital recovery. But if the village agrees to include some amount for capital recovery, they would need to have an additional P44,000 per year to cover the annualized replacement cost of P53, 470 assuming a project life of 15 years. Therefore, there really is a need for the village to increase the utilization rate to be able to save for the system's replacement.

Tulgao Micro Hydro Power Scheme

A Case Study of a Community-based Renewable Energy System





TULGAO MICRO HYDRO POWER SCHEME

A Case Study of a Community-based Renewable Energy System

Name of Project	Tulgao Micro Hydro Power Scheme
Location	Bgys. Tulgao West, Tulgao East and Dananao, Tinglayan, Kalinga, Philippines
Project Partners	▪ Sibol ng Agham at Teknolohiya (SIBAT) ▪ Episcopal Diocese of Northern Philippines (EDNP) ▪ Kyosato Experimental and Educational Program (KEEP)
Construction Start Date	January 1998
Project Inauguration	November 1999
Design Power Output	30 kW
Households connected	264
Total project cost	PhP 2,831,565

Folklore

In the beginning, floodwaters covered most of the earth, except for the mountain summits. At the top of one mountain lived a woman and her dog, and on top of another, man. One day, the man lit a fire to keep him warm. The woman saw the smoke from the fire and sent her dog to bring back the fire. As the floodwaters receded, the woman and the man descended the hill. One day, the dog came back, and led the woman to a spring of fresh water, located among many tall trees. There she met the man, and they settled down and became the first inhabitants of Tulgao. When they had their first children, the eldest child grew up to be strong and jealous of his younger brothers. In order to escape their cruel and violent brother, some of the children moved to the other side of the mountain, and formed the villages surrounding Tulgao.

Introduction

This report gives an overview of the Micro Hydro Power (MHP) project in the barangays of Tulgao East, Tulgao West and Dananao in Kalinga Province, Philippines. It also includes a description of the area in which the project is located, as well as the social, economic and political background of the community. It covers organizational, technical and financial aspects and issues that have impeded the smooth execution of different aspects. An attempt has been made to decipher reasons for these so that lessons can be learnt for future SIBAT projects.

MHP schemes use the energy of moving water to turn a turbine, like a water wheel. The turbine is linked by a drive belt to a generator which produces electricity. The amount of electricity produced depends upon the height (head) that the water falls and the volumetric flow of water flowing into the turbine. Bunog creek, which runs along a valley that divides Tulgao and Dananao, provides the water for the MHP scheme. The powerhouse site is positioned approximately 1.5 and 1.2 km respectively from Tulgao and Dananao.

The lead organizations involved in the project were Sibol ng Agham at Teknolohiya (SIBAT) and the Episcopal Diocese of Northern Philippines (ENDP). SIBAT was responsible for the technical aspect of the project and EDNP for the social organizing. The project was funded by Kyosato Experimental Education Program (KEEP), a Japanese church- based organi-zation. The community organized committees to perform tasks during the implementation as their counterpart role in the project.

Figure 41. *The Monitoring Team walking back along the terraces to Tulgao from the powerhouse*

The project is community owned and operated, with Fr. Buyagan, the local ENDP priest, heading the management committee. He reports to the Board of Directors of the Tulgao-Dananao Micro Hydro Power Cooperative (TDMHPC). The cooperative has 100% membership of all beneficiaries. Beneficiaries pay a monthly tariff to cover the operating costs of the project.

The MHP scheme provides electricity for household lighting and small appliance use, as well as in communal buildings such as the church, school and health clinic. During the day it powers communal post-harvest processing facilities, thus generating additional income for the community.

Land and People

Location and Accessibility

Barangays Tulgao West, Tulgao East and Dananao are part of the Tinglayan municipality in the Kalinga Province. Kalinga is located within the northern part of the Cordillera Mountain region in Northern Luzon, bordered by the provinces of Apayao, Cagayan, Isabela, Mountain Province and Abra. Originally one barangay, Tulgao was split into two barangays, East and West as the population grew.

There is a long history of rivalry and disputes between the tribes of Tulgao and Dananao over territories that have often erupted into tribal wars. A steep valley, at the bottom of which flows Bunog creek, separates Dananao and Tulgao forming a natural boundary between the two tribes.

Figure 42. *View of Dananao along the foot trail from the powerhouse site to Tulgao*

Tulgao West and Tulgao East are accessible by foot from Tinglayan Proper or from Barangay Maswa (3-4 hour hike). The route from Tinglayan to Tulgao can occasionally be accessed by public transport, or is a steady uphill hike for 3 hours during the rainy season, followed by a steep descent to the settlement that is accessible only by foot. It takes around 1 hour to hike between Dananao and Tulgao. Dananao though has a separate road connecting the barangay to the municipal center which is accessible also by a 4-hour hike from Tinglayan proper.

The Butbut and Dananao Tribe

The residents of Tulgao and Dananao are of the Kalinga ethno-linguistic group but are from the *Butbut* and *Dananao* tribes, respectively. Although all 3 barangays are predominantly Christian, they retain many tribal cultural practices. Traditional wedding rituals are still practiced. Parents sometimes make the arrangements and without their consent, marriage cannot take place. As all barangays are agricultural, status is given to a man or woman according to the number of rice fields and animals they own. It is rare for marriage to be consented to between a man and a woman of different status.

The people of Kalinga are also renowned for their tribal wars and head hunting. Before 1997, the barangays of Tulgao and Dananao had a deadly conflict over their borders, although now the emphasis within the region is on negotiating peaceful solutions rather than resorting to fighting. Since 1997, also the beginning of MHP project conceptualization, no fighting has broken out between the three barangays, and all disputes have been resolved without violence. The people of Tulgao East and West claim to have no serious animosity between themselves, but there exists a disparity between them, which seems to only extend to faith affiliation and verbal antagonism. This probably derives from clan differences.

Subsistence Upland Farming

Tulgao and Dananao rely on agriculture and grow traditional rice varieties as its primary crop mainly for household consumption. Irrigated terraced farming is the predominant form of rice agriculture supplemented by upland cultivation in swidden farms or *uma*. In both cultivation practices, rice is produced organically.

After harvesting, farmers leave the rice fields uncultivated for several months to allow the regeneration of soil nutrients before the planting starts. Traditional varieties of rice have been noted to have stronger resistance to pests, thereby removing the need for applying pesticides. Canals built from streams and springs to the farmland irrigate the fields. Wet-rice production in these highlands remains limited to an average of 600 bundles, or 300kg of unmilled rice per household. On average, a household owns 2-3 rice fields, which is approximately 1/8 of a hectare. Due to climate and their traditional rice variety, the community has one rice harvest per year, planted in January, and harvested in June/July. This causes lean months to some of the tribesmen.

During harvest time, all the people helped, irrespective of ownership of the land (*bayanihan*). In this way harvesting is done faster, and there exists a mutual cooperation between the people.

The lack of appropriate machinery and technology has hampered the expansion of farmland in this mountainous area. The use of simple hand tools and a few carabaos for ploughing make land improvement a laborious process.

Sugar cane is an essential secondary crop, not for making sugar but because it is used to make *basi*. Basi or sugar cane wine holds an important place in the cultural practices and rituals associated with agricultural production.

Prior to the introduction of the sugarcane press powered by MHP, the harvested sugar cane was processed manually. Sugarcanes were brought to the *dapilan*, a wooden cane juice extractor worked by a carabao, and the extracted juice is boiled in a vat until about two inches has evaporated. Two cans of boiled cane juice are taken out and cooled for making *basi* later. What remains in the vat, after further taking out the molasses for making sugar, is cooked until it darkens, and the cane juice stored in the cans is poured into the vat and brought to boil. Once the boiled juice cooled down, it is poured into a wine jar called *amoto*, and fermented with seeds of a local plant, *kabu*. The resulting *basi* is then stored from three months to two years depending on the owner's taste.

Swidden farms provide a secondary source of income for most households in Tulgao. These are planted with legumes, native cabbage, tobacco and sugar cane. Swidden farming in Tulgao involves both men and women, though women play greater roles in the production of legumes and vegetables. Men are more inclined to grow sugar cane and tobacco, which are largely consumed locally.

Women sold legumes, cabbage and other vegetables in nearby towns to earn extra money for household expenses. There are bananas, papaya, and some citrus trees near the village, and the people tend to sell these fruits rather than consume them.

Table 74. *Swidden Farming Calendar*

Months	Activity
March-April	Land preparation
May	Planting (first crop)
June – July	Weeding
August	Harvest (first crop)
September-October	Land preparation
December	Planting (second crop)
January-February	Weeding
March	Harvest (second crop)

Sources of Cash Income

Aside from the modest volume of vegetable produced in the swidden farms, other sources of cash in the locality are basketry, blacksmithing and seasonal hired labor. The men of Tulgao produce several handicrafts using traditional weaving methods and produce are mostly sold in Bontoc, the provincial capital of Mt. Province. Other skills in both Tulgao and Dananao include blacksmithing; goods are produced for local use and sometimes sold outside the village. For other families, men and women do manual labor, sometimes outside the community, to generate additional income. If there are young children in a family, only the father will go away to work, but once the children are older, both parents will work. Depending on the employer, men can earn PhP 150-200, and women are usually paid half of the prevailing wage rate. The work may be within the locality or outside the village where there is higher rates.

The average family income in all 3 communities is well below the poverty line set by the Philippine National Census and Statistics Office (NCSO). Kalinga province meanwhile is classified as one of the poorest provinces in the Philippines.

Inadequate Social Services

As with most upland rural communities in the Cordillera, social services in both Tulgao and Dananao are insufficient. Though each barangay has a resident midwife, and two barangay health workers, only the minor cases are administered. There is a separate building in Dananao for the midwife to work while in Tulgao the midwife has an office at the Episcopal multipurpose center. Both midwives provide pre and post-natal assistance and training, including family planning. The leading causes of mortality are tuberculosis, acute respiratory illness, and pneumonia, with respiratory complaints increasing during the rainy season. BCG (for tuberculosis), DPT (diphtheria, polio, tetanus) and measles vaccines are given in the health centers. Hepatitis A and B are only given when there is excess from Tabuk (Kalinga's capital town). Drugs available at the barangay health center are reserved for emergencies and are normally single dose only. In Dananao a two-way radio is available for emergencies. This could be used to communicate with the nearest hospitals in Tabuk and Bontoc.

Each of the two barangays has an elementary school with a complete set of teachers, i.e. one teacher per class. The average class size in both villages is around 30 students. A new school building was commissioned in Tulgao in 2005 providing 3 new classrooms. SIBAT and MHP operators installed wiring during a training session held in February 2005. Students travel to Tinglayan where the nearest high school is located for their secondary education. University education is rare without assistance from outside funding as few people can afford to send their children to university. Those who had their degrees normally find jobs outside of the municipality; the present mayor and congressman both originally hail from Tulgao.

The area was blessed to be adopted by KEEP that provided the other basic services which the government cannot give. Both barangays had several community projects carried out for the improvement of the local area, both by LGU's and NGO's, most of which with funding from KEEP, who also funded the MHP scheme. In Tulgao, the principal of the elementary school heads the women's organization KALIPI *(Kalipunan ng Liping Pilipina)*. Most of the women belong to this organization, which assists in upholding welfare and order in the barangay. Other Peoples Organizations include a farmers association, and a church-led youth group.

Project History

The Episcopal Church has been active in Tulgao and Dananao for many years, but is focused on Tulgao West. Many of the improvement schemes such as the potable water system and concrete footpath in Tulgao were proposed and lobbied for by the Episcopal Church.

EDNP identified Tulgao and Dananao for an MHP scheme from as early as 1993, when they ask for the help of a private organization to do Pre-feasibility Studies (PFS) in four (4) of their service areas, including Bunog Creek. The creek was identified as technically viable for a hydro power scheme, but due to the large cost involved and community opposition to the minihydro scheme, the project was not pursued. The source's potential was 1.2 MW according to the NPC's site appraisal.

In 1997 EDNP approached SIBAT to revisit the proposal for a micro hydro power scheme.

The nearest electric grid was more than 30km away from the communities but operated by MOPRECO, a local electric cooperative serving the Mountain Province. The nearest grid connection of KAELCO, the electric cooperative for Kalinga province, was 70 km away. Interviews with these cooperatives during the conduct of FS concluded that Tulgao and Dananao were not included in the electrification plans for the next 10 years due to high transmission cost. At that time (1996) MOPRECO and KAELCO shared that transmission lines cost PhP 450,000 per km. This highlighted the need for a decentralized power scheme.

In response to the church's request, SIBAT visited Tulgao and Dananao to conduct a PFS in the early part of 1997. The pre-feasibility study aimed mainly into assessing the source's potential for hydropower generation. Initial socio-economic survey was also conducted to look into the potential end-uses that the community wants aside for household lighting. The first visit also incorporates an orientation on the nature of the visit and presentation of the result of the technical survey. After seeing the potential of the proposed site a detailed feasibility study was scheduled and carried out in October 1997. The FS contained a detailed engineering design of the MHP scheme, an end-use plan including load management, a financial study, a project implementation work plan developed with the community and a project budget. After the study was completed, a proposal was drawn up and given to EDNP for their endorsement to the Kyosato Experimental Educational Program or KEEP, who had been involved with other projects in Tulgao.

Planning was undertaken through a number of community consultations where the community's consensus was sought on the work schedule and scheme considering their farm activities and other community celebrations. It was the community who provided the details of their work schedule including the number of household representatives that would work per day. SIBAT, EDNP, the Barangay Council and community representatives finalized the plan. SIBAT guided the whole planning exercise of this formative management committee. The minutes of the planning consisted the terms of agreement with the community, which were periodically reviewed during the implementation process.

Multi-stakeholder Partnership

A multi-stakeholder partnership between SIBAT, the villages of Tulgao East, Tulgao West and Dananao, EDNP and the LGU, was formed to implement the project. These stakeholders contributed in the various stages of projects development.

Table 75. *Main Tasks of the Project Stakeholders*

Stakeholder	Tasks in the Partnership
Community entrusting the authority on the elders within the Barangay Council	Took the active role in project development
Local Church - EDNP	Supported SIBAT and the PO in various responsibilities
SIBAT	Provided the technical works and technical management, and fun ding facilitation
Barangay Development Council through the barangay chairman, officers, etc.	Supported through community mobilization

Church and LGU participation was notable in Tulgao, where the assigned priest with the help of the Barangay Officials actively aided in facilitating the community meetings and consultations, in the discussions to crucial issues such as on labour contributions and community mobilization. This participation was appraised as valuable to the projects' take-off and completion.

Social Preparation Phase

The project's social preparation phase consisted of numerous consultations discussing the CBRES concept and the role of the community. The community that was being addressed then was yet without a single association or group undertaking the leadership – but an aggregation of households led by the church representing as well as the traditional authority of elders, and the barangay council. While without an organization, willingness to contribute labor of all able-bodied villagers was expressed during these consultations. Aside form labor, the villagers also committed participation in the entire project process together with the other sectors (church and the LGU) such as in the formulation of policies and managing and sustaining the project after installation.

Energy Demand Study

The needs of the people were investigated during the feasibility study stage (FS) where the households expressed their priorities. They wanted to reduce their reliance on kerosene and to reduce time spent gathering pine pith, locally known as *saleng*, which was used for lighting. Saleng leaves black soot inside the house.

Previous to the MHP scheme an average of PhP 94 per month was spent on kerosene by 40% of households who use kerosene regularly. The majority spent less as kerosene was rarely bought due to cash unavailability. Pine pith was mainly used for lighting a walk along the narrow footpaths that criss-cross the community. Streetlights were also discussed as a potential use of the MHP scheme

In addition there was a need to reduce manual labor such as pounding rice, thus freeing up time and creating additional opportunities to augment income. It was then concluded that rice mills and sugar cane press were potential end-uses of the MHP. The rice mill was expected to ease the manual labour of women and children who are normally tasked to do manual rice pounding and the sugar cane press was intended to support the traditional wine making practice in the community.

From the feasibility study survey, the 312 households of the three barangays wanted an average of 3 lighting fixtures per household. Using 10W lamps, a household would need 30W for lighting totaling to 9.4 kW.

Table 76. *Energy Demand*

Load	Wattage	No of users / units	Energy Demand (kW)
Household lighting	30	312	9.4
Appliances	Variable	Undetermined	15
Rice Mill	5000	1	5
Sugar cane press	3000	1	3
		Peak Demand	**24.5**

From a predicted load curve, the highest of the two peak demands for the daytime and nighttime load was chosen as the basis for designing system capacity. A 1.25 factor was used for future growth to come up with the design capacity of 30.5 kW. At this capacity, the design discharge was determined. After actual site survey and hydrology study, it was concluded that the source can provide for the design discharge for the whole year.

Implementation

Prior to project implementation, a Memorandum of Agreement between SIBAT and the EDNP was forged. In January 1998 the groundbreaking which marks the official project start-up, happened. One of the SIBAT Engineers was assigned to supervise construction of the system.

The construction took 18 months, passing through periods of disruptive typhoons, tribal wars and lean months.

SIBAT was responsible for the supervision, ensuring that designs for the civil, mechanical and electrical works were followed. EDNL, through its priests, together with the Barangay Council, was in-charge of community mobilization and organization for the project.

The construction of the 500 m concrete canal alone took 14 months due to the slope in which the canal was built on and difficulty in hauling of sand and aggregates. These materials were provided by the community as their counterpart and were gathered from the river 300 m from the construction site passing a steep footpath. Several sections need to be blasted and bringing in the dynamite takes time. The village's tribal war culture made acquiring permit to bring in the dynamites difficult.

Figure 43. *Women hauling sand and aggregates from the River*

Table 77. *The Major Technical tasks of SIBAT in Project Implementation*

Tasks	Description
Technical supervision	Supervision and directing of the major works (civil, electro-mechanical, electrical)
Purchase of major components	In-charge of major purchases especially those not available on the site
Turbine fabrication	Supervision of turbine fabrication according to the design
Technical and management training	Conduct of technical trainings while the project is in construction to give the trainees hands-on exercise and management training after the project commissioning
Coordination with PO and local NGO	Conducts necessary coordination and community meetings

Table 78. *The major tasks of the EDNP in project implementation*

Tasks	Description
Overall local supervision	Supervision and directing of all local activities (transport, hauling) ensuring the compliance to schedule and local assignments
Coordination with the community	Consults with the PO in all matters pertaining to the project
Purchase of local components	In-charge of purchases of construction materials

The cooperation of Tulgao and Dananao tribes made the 18-month construction of the Tulgao MHP scheme possible. The Barangay council, with help from the local EDNP priest identified the skilled workers in their barangay to act as foremen. Fr Buyagan initiated the organization of the people into 6 work teams of approximately 20 people each, both men and women. Each team was scheduled to work on the construction one day each week and work paused on Sunday. For the canal construction the community decided to divide the length of the canal into three sections and each section was assigned to each barangay. The community provided food and snacks for the workers, and even the children helped where they could, hauling sand and gravel to the site. In rare occasions when the church were able to solicit food for work, which are in most instance canned sardines, the workers bring with them their rice and cook the sardines with whatever vegetable they could find near the construction site. During the harvest season, when there was abundant supply of food, the residents donated whatever was available from their household for the snacks of the workers.

Figure 44. *Hauling of Tulgao Transformer.*

Peoples Participation

Fr. Buyagan and the Barangay Councils organized the people into several groups to carry out the community counterpart effectively. All families were involved with the project, with the women and children providing food for work and hauling sand and gravel from the river and surrounding areas. The men from both barangays carried out the construction and haulage of the generating equipment, such as the generator and turbine that had to be carried by hand from the road head 1-2hrs away from the site. With the help of SIBAT's electrical engineer, the community laid the transmission line and installed household wirings. Aside from the provision of free labor, they also provided local materials for construction such as lumber, sand and gravel. The lumber was used in the construction of the powerhouse and sand and gravel were used to make concrete to build the canal, forebay and powerhouse.

Figure 45. *Manual hauling from the road head*

Commissioning and Post-Installation Trainings

Tulgao was a pilot project and faced several critical deviations from design including turbine replacement. The installation was completed in March 1999 but was not commissioned to the community until November due to the problems with the first turbine. After the installation of the second turbine unit, commissioning was again delayed as it almost took two months to locate the short circuit in one of the houses in Tulgao. Commissioning and inauguration was then celebrated in November 1999 when KEEP representatives were available.

SIBAT provided technical training for operators during the installation phase. This was done such that the operators would better understand the concepts behind the operation of the MHP. The technical training consisted of modules on: MHP operation and maintenance; household wiring; and practical electricity theory. Project management trainings were given after commissioning. SIBAT gave a follow-up training for all MHP operators from different project sites in February 2005 in Tulgao. Retraining of the operators was conducted due to the replacement of operators in most of SIBAT installed MHP systems.

Figure 46.. *View of the Powerhouse and Buneg Creek from above*

Project Management

Description of the Management System

The work committees formed during the implementation phase evolved into the Tulgao-Dananao Micro Hydro Power Co-operative (TDMHPC). The purpose of this organization was to deal with the day-to-day management of the project.

Fr. Buyagan is the manager of the MHP scheme assisted by a cashier and bookkeeper, operators and collectors he appointed. The Board of Directors (BoD) set the policy and presents it to the community for approval. The BoD includes a Chairman and secretary, but no treasurer. Though Fr. Buyagan originally appointed the members of the BoD, he does not attend the meetings of the BoD, but lets them come up with their own agenda, which he is in charge of implementing. Seven people sit on the BoD, with terms ranging from 3-5 years. Since the inauguration only one position on the board has been changed. The appointment was made through the BoD and Fr. Buyagan rather than through a public election to avoid a predicted popularity contest. There are 5 Anglican members, and 2 Catholics. Only one representative is from Dananao. Political issues are strong, and suspicions high between different groups. The board was expected to meet once a month, though these were suspended for the most parts of year 2003 when the MHP scheme was not operating.

According to the policy agreed between the BoD and the community, all the members of the board would receive an honorarium of PhP 50 per meeting; operators PhP 1,000 per month and PhP 500-600 per month for the collectors. However, due to poor collection, the board and managers are rarely paid. The projects organizational structure is shown below.

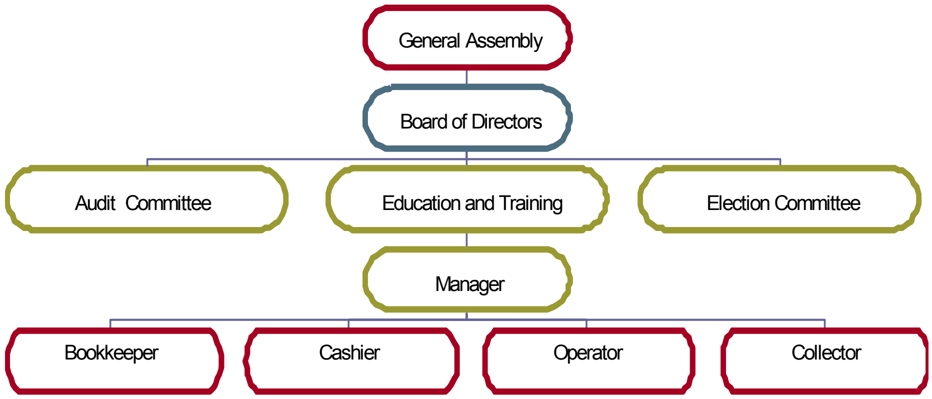


Figure 47. *Organizational Structure*

The Chairman of the committee stated that at present, the church looks after the funds; a claim verified by Fr. Buyagan. He thinks that the funds raised may be misappropriated if left to the community. While this may be true, it is preventing the project from being truly owned and managed by the people of Tulgao and Dananao.

It seems that Fr. Buyagan has inadvertently put himself in sole responsibility for the management of the MHP scheme. If ever there was a problem, he is the only person capable, at present, of resolving the situation. In rare occasions when SIBAT visits the area for monitoring, Fr. Buyagan expressed his recognition for the need to find his replacement but has not done so.

Project Operation

The system operates for an average of 14.5 hours per day with an average of 7.7 hours for household lighting and 4 hours for the operation of the rice mill. During the interviews, there was an expressed desire to use the system longer in the daytime for lighting the rather dark school building.

There are two operators who took turns in going to the powerhouse to start and monitor the system. They are also responsible for day-to-day upkeep of the system such as cleaning the forebay of silt, stones and debris.

Load Allocation and Management

Load allocation was based on household demand data yielded by the feasibility study. SIBAT together with the community fixed the maximum load for lighting per household to 60W, which was adopted by the community as their policy.

The survey of the actual household load (lighting and appliances) shows that the total load were well below the installed capacity of the system. This indicates that the design capacity of the Tulgao MHP has made good allocation for household needs and other end-uses and still has allowances for major applications.

System Downtime

In its almost 9 years of operation, the Tulgao MHP had experienced a total of 11 months of downtime periods. It took a while to attend to the repair of the burnt dump load mainly due to the lack of any ready mechanism or funds to respond to such.

Table 79. *Repairs for Tulgao MHP*

Repairs Required	Who conducted the repairs?
Canal repairs	Villagers
Blockage in the turbine	Villagers
Dump load	PETCO – local supplier of electro-mechanical equipments

Tariff and Collection Rate

The monthly tariff is P25 per month for one 10W bulb, with additional P5 for each additional bulb. The households were not charged for connection but new houses wanting connection must pay a P200 membership fee to substitute for the labor counterpart. With the current average lighting load of 30W per household, and usage hours for lighting, the set tariff is equivalent to P5/kWhr. This rate is lower by P1 to P2/kWh than the current selling rate of the electric cooperatives in rural communities.

The MHP policy includes different charges for different types of appliances but a uniform P15 tariff per appliance was applied. As the community agreed that the use of electricity would not be metered, individual ownership of high-powered appliances was not allowed. This however was not followed. SIBAT then recommended that the villagers should adopt a load management scheme that was best suited in their condition and power requirement since the acquisition of appliances cannot be controlled.

Some residents viewed the policy on appliance use as biased towards the appliance owners who are mostly sitting as the project's BoD. Feelings were shared that policies regarding appliances use and tariff setting should be instigated without bias. This was aired by some of the residents as the BoD felt that increasing the tariff for appliance use was unnecessary when the majority of users struggle to pay for a simple bulb.

At the set tariff, the community was expecting to earn P74,700/yr from lighting alone and an additional P26,800/yr from rice mill and sugar cane press. However, the community had only 31% collection rate from lighting. The milling collection had an option of paying in kind. This made it easier to collect the tariff from the residents who were most of the times cash-strapped.

The recorded collection rate during the evaluation was found lower than the recorded rate (41%) in 2001. Interestingly, during 2001 survey collection varied greatly between the 3 communities. Dananao had a collection rate of 61%, Tulgao West, where the Anglican Church is based, has a rate of 29%, and Tulgao East has 32%.

Although there was an unofficial provision for payment in kind for those who do not have cash, some people express that they would rather keep their food than use it to pay for electricity. This discrepancy in the payment system caused ill feeling between members of the community who pay and those who did not.

Different methods of collection were used to see what is best to get people to pay. Originally there were 2 collectors, one responsible for Tulgao and one for Dananao. Then a system was devised of having a collector in each purok[40]. The collectors were paid P46/month when all revenues from their purok were collected. The households would take turns to be collector. Currently, the purok collectors submit the collection to the treasurer who is responsible for all collections. The treasurers are paid P600 and 500 in Tulgao and Dananao respectively. However, it seems that this policy failed to lessen delinquent users.

Additionally, the current policy relied on collectors monitoring the number of lamps used. This was difficult to implement properly since it is easy for users to remove a bulb from its socket when the collector comes around, and claim fewer bulbs were used.

It is unclear whose responsibility it was to disconnect delinquent beneficiaries. The policy on hiring and firing states that, "*collectors, operators and electricians must be willing and without fear to disconnect delinquent members*". The policy however remained on paper. There was the opinion that disconnecting a household is offensive and the MHP scheme may be sabotaged. Without a strong policy on disciplining defaulters the trend is likely to continue.

The only report of disciplinary action taken was in the case of commercial VHS user. Films were shown for a fee of PhP 5 per film, but children resorted to petty thievery to afford to watch a film. Also, concerns were expressed over the suitability of the films watched. To avoid a public confrontation, the operator was advised to limit the inflow of water to the turbine. This caused a flicker in the TV making the videos difficult to watch. Thus commercial VHS use was stopped and was no longer a problem. Incidentally, the FS foresee some problems with the introduction of TV, along the lines of its effect on cultural and social norms if not properly handled. The concerns aired about children copying what they saw on TV such as kung fu and karate moves reflect this issue.

Willingness and Capacity to Pay

Reasons for the low collection rate seen are the household's willingness and capacity to pay. A reason cited by some of the interviewed households for non-payment was suspicions over what happens to the monthly tariff. Some believed it goes to the Episcopal Church, and some hinted at corruption. This suspicion was slightly alleviated by a general assembly held in November 2003. A summary of the accounts was presented, and the ledgers were opened for anyone to inspect. However while the project was seen to be under the management of the Episcopal Church these suspicions remained and affected the people's willingness to pay.

On the villagers' capacity to pay, there is a need to adjust this. The set tariff was based on the amount of money spent by users on kerosene. Although the tariff was set lower than this value, it was later discovered that this was an inaccurate way of measuring actual expenditure on fuel as fewer than 40% of households regularly bought kerosene.

---

[40] Small cluster of households usually, equivalent to a sitio

Effect of Poor Collection Rate

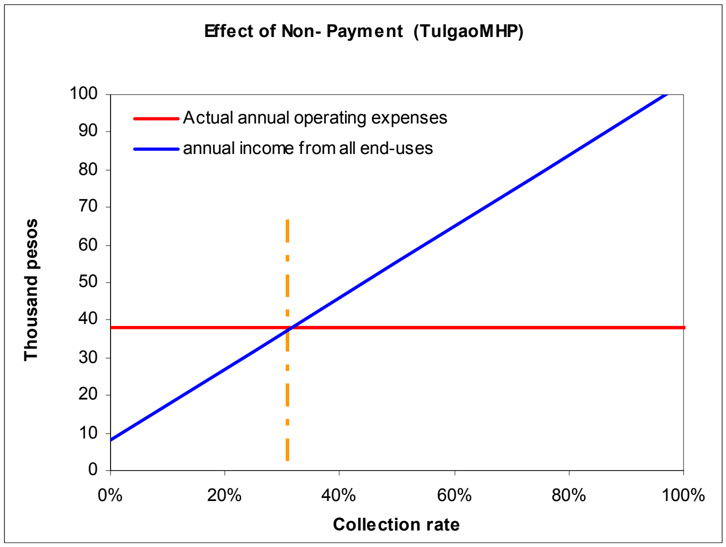


Figure 48. *Effect of Collection Rate in Tulgao*

With its 31% collection rate for lighting and appliance use among its beneficiaries, Tulgao MHP was running on deficit, which amounted to P870/yr. The income from the mills provided some amount in the operational expenses of the MHP.

The low collection rate led to EDNP's stepping in to provide funds when repairs were required or the community to solicit funds elsewhere (e.g., LGU). Often times too, local operators gripe about meager salaries because of poor collection.

The community could look into possible energy uses that could generate additional income for the scheme such that they would not have to pay for the operating expenses nor source this out from other donor.

Tariff Structure

Shown on the table below is the price a household pays for its energy consumption. The income level was assumed to be their ability to acquire appliances and the need for more lighting fixtures in their houses. The table shows that the policy was to the disadvantage of the households belonging to the low income class as they pay more on their energy consumption.

Table 80. ***Energy Cost at Different Income level***

Tariff rate	P25/mo for the first lamp plus P5/mo for additional lamp		
Tariff for appliances	P15/mo for appliances		
Income level of HH	**Equipment Installed**	**Cost of the Services (P/W per month)**	**Cost of the Energy (P/kWh)**
low	1 CFL	2.5	10.82
	2 CFL	1.5	6.49
	4 CFL	1.0	4.33
	2 CFL and radio cassette	0.60	5.91
	2 CFL and Stereo	0.27	3.16
	2 CFL and TV + VCD	0.39	2.89
	4 CFL and stereo	0.30	2.06
	4 CFL and TV + VCD	0.34	2.33
high	4 CFL and TV + VCD + stereo	0.23	1.71

The cost of energy per kWh was computed at the average lighting hours of 7.7hours/day and the corresponding wattages of 10W/lamp. The appliances consumption (kWh/mo) meanwhile was computed based on the surveyed number of hours each appliance was used per day and the corresponding wattage of each. The tariff set for Tulgao considers TV and VCD players as one appliance.

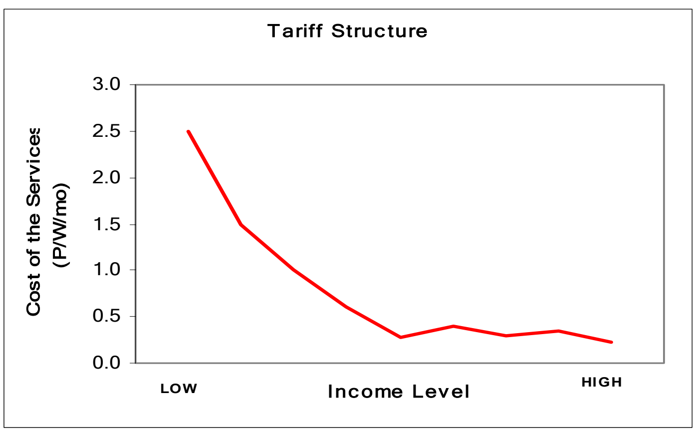


Figure 49. *Tariff Structure*

This data showed that the users do not pay what they are actually consuming. As it should be, defaulters should be penalized or to prevent future injustice, the tariff structure should be adjusted. Should the community agree, a flat tariff for the installed capacity (P/W/mo) could be adopted but a prepaid load limiting device should be installed per household to control the consumption. In this manner, defaulters could be avoided.

Techncial Description

The 30-kW Tulgao-Dananao MHP is an off-grid barangay electrification scheme for household lighting and livelihood-support end-uses.

The system is primarily used for lighting and powering small household appliances. Household lighting consist a minimum of 3 lighting fixtures per household and household appliances which are mostly colored television sets, video players and radio cassettes. There was also a recoded rice cooker and washing machine users in the area.

The system is able to provide electrification to 3 barangays, up to 2.3 kilometers from the powerhouse. Aside from provision of lighting to most households, the energy generated from the MHP is also able to provide electrification to school buildings, churches, barangay halls, multi-purpose buildings and clinics.

Two community–owned rice mills, one for Tulgao and Dananao and sugar cane press are other end-uses supported by the MHP.

In Tulgao, a wife used the MHP power for a sewing machine which she used to augment the cash needs of the household. Other uses of energy in Tulgao include powering small carpentry tools such as planers. These are privately owned and are used for additional cash source of the family.

Technical Design

Tulgao MHP follows the run-off-the-river scheme. Water is diverted by a 20m-wide weir of rubble masonry with side intake along Bunog Creek. It is then conveyed through a 500m long concrete canal to a 44.85m^3 forebay. The intake is located at 873.5 meters above sea level (masl) while the forebay is situated at 871 masl. Water then passes down a penstock made of high-density polyethylene pipe (HDPE), which is attached to the gate valve and then to the turbine located inside the powerhouse.

The cross-flow turbine is a variation from the SKAT T-12 design fabricated locally by the Pangasinan State University (PSU). As the moving water turns the turbine shaft, it harnesses electricity by driving the synchronous generator. An electronic load controller (ELC) from China balances the power produced before sending it to the communities where transformers lower the voltage to 220 V.

Civil Works Component

Table 81. *Description of Civil Works Components*

Weir	Material	Rubble masonry
	Width	20m
Canal	Type	Concrete
	Length	500m
	Width	0.75m
	Depth	0.6m
Forebay	Size	44.85m^3
Penstock	Material	HDPE
	Length	50m
	Diameter	10 inches
	Gross head	40m

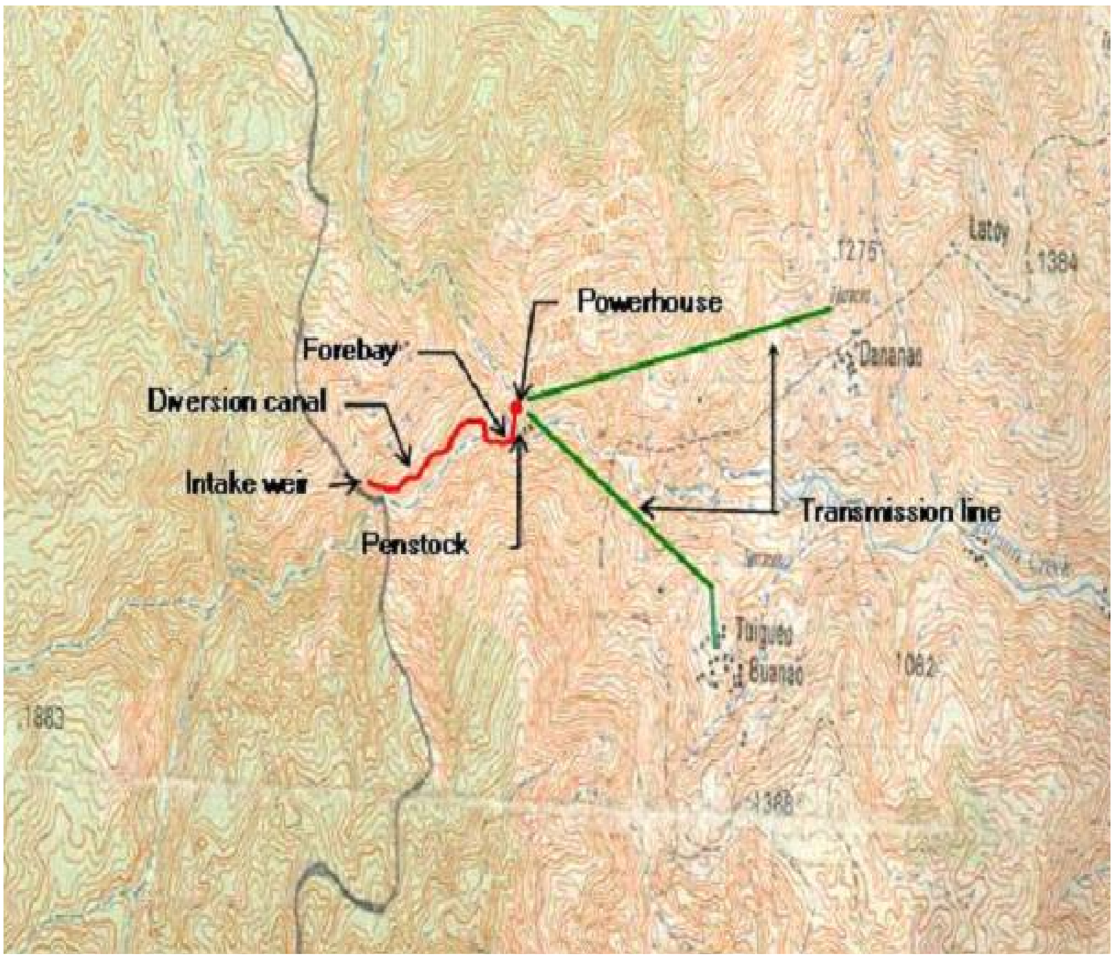


Figure 50. *Project Layout*

Powerhouse Equipment and Transmission and Distribution System

Table 82. *Description of Mechanical and Electrical Components*

Component	Description	
Turbine	Type	Cross-flow
	Manufacturer	Pangasinan State University
	Width	110mm
	Diameter	300mm
	Design power	33 kW
	Design flow	140 l/s
	Turbine efficiency	60%
Generator	Ballast	30 kW
	Type	Synchronous
	Manufacturer	Stamford
	Rated power	40 KVA
	Voltage	480 V
Drive System	Type	Belt-drive
	Turbine Pulley size	24”
	Speed ratio	2.4
Load control	Type	Electronic Load Controller
	Manufacturer	Machinery Research and Design Institute, China
Transformers	Size	Three 10 kVA 440v/220v
Transmission Line		3 wire 440 V
Distribution Line		3 wire 220 V

The community though is in an upland settlement has few trees that can be used for transmission posts thereby 6-m high 3 inch diameter BI pipe were used. The transmission posts height was designed in conformation with the PEC Art. 2.30.2.4(b) which states that the vertical clearance from the ground should be not less than 5.5 m over public streets, alleys, roads and areas subject to truck traffic and not less than 4.6 m for lines not crossing the road such as in the case of Tulgao.

Load

The power produced by the MHP are used both for consumptive and productive uses. As discussed in the energy demand section each household was allocated 60W for lighting during the feasibility study as per desired use of the residents. However the recently concluded evaluation found that on the average, each household is using 30W for their lighting and 21 households are using appliances the majority of which are television sets and video players.

Figure 51. *Children ogle at a public television spectacle in Tulgao*

Productive use of energy includes two rice mills, one for Tulgao and one for Dananao, and a sugar cane press in Tulgao.

Tulgao Rice mill

The rice mill in Tulgao West was installed in 2002, funded by the Episcopal Church. It currently operates twice a week for 9 months for an average of 4 hours each day. The rice mill does not operate for the whole 12 months as the households has 2 to 4 months of rice shortage. The fee to mill a 12kg can of rice is either PhP 15, or one small can of rice (230g). Interestingly, the value of one small can of rice is PhP 4.60, so it is much cheaper to pay in kind than it is to pay in cash. The rice mill operator collects the tariff for milling who then remits to the MHP manager. This money is split equally between the operators, the MHP fund, and the church.

Figure 52. *Tulgao West rice mill*

The rice mill in Dananao, also installed by the Episcopal Church in 2002, has not been fully used by the residents. Instead, they opt to use a diesel-powered rice mill donated by the mayor, which is ran and managed by the barangay captain.

Sugarcane Press

The sugar cane presses (juice extractor), also funded and installed by the Episcopal Church, has been operating since November 2003. Sugarcane is harvested only once a year, in this site most often on March. This limits the time the sugarcane press is used. The sugar cane press operates an average of 3 hours per day during this season. Although the community aspires to produce quality sugar someday, lack of technology limited them to *basi* production. Basi is sugar cane wine, which had become lucrative additional livelihood source for some enterprising residents.

Table 83. *Total Load of Tulgao MHP Scheme*

Load	Description	Wattage	No of users or units	Hours used per day	Total Load (kW)
Household lighting	CFL and Fluorescent tube lamps	30	264	7.7	7.9
Appliances	14 TV and video players, 4 radio cassettes, 2 washing machine, 1 flat iron, 1 sewing machine	Variable	21	Variable	8
Rice Mill		5500	1	4	5.5
Sugar Cane Press		1500	1		1.5
				TOTAL	22.9
				Peak Load	12

Contrary to the predicted peak load in the FS, the system's peak occurs during the day when the rice mills, sugarcane press, washing machine, rice cooker and flat iron are used at the same time.

Technology Appropriateness

With some short-term technical difficulties the system ran satisfactorily until early 2003, when it was shut down for 8 months due to the prolonged unavailability of funds and turbine manufacturer for the repair of the turbine. The turbine runner was jammed due to a large snake that made its way into the turbine. Since restarting in October 2003 the system has been working satisfactorily.

Civil Structures

Since the scheme's power canal was made of concrete, maintenance of the system was easy and only required cleaning once a week. During one of the typhoons that visited the area, a small portion of the canal foundation caved in but did not cause a major problem as the community promptly repaired the damage.

Mechnanical Components

Tulgao was a pilot project and involved several critical deviations from design.

The Tulgao MHP was originally fitted with a locally-fabricated pelton turbine. During testing, it was recommended that the turbine had to be replaced due to poor efficiency. The observed inefficiency of the pelton turbine was caused by inaccurate manufacture of the buckets. The pelton turbine was then replaced with a cross-flow turbine, at the expense of SIBAT.

The current turbine performed without major problems observed since its installation except for frequent belt replacement due to misaligned turbine and generator shafts. The bearing was also replaced earlier than its expected lifetime as a consequence of this.

The actual performance of the unit at 100% turbine opening was measured by reading the meter of the ballast load. Instead of the design capacity it produced only 22 KW i.e. 73% of what it was designed for.

Table 84. *Performance of Tulgao MHP*

Design Capacity, kW	30
Measured Output, kW	22
Ratio of Design Capacity / Measured Output, %	73%

The observed significant shortfall of output can be attributed to a number of factors such as losses in the penstock due to poor butt welds, but the biggest factor was probably poor design and low quality in manufacturing of the turbine. This indicated that the manufacturers needed more support to produce more predictable and reliable equipment.

Generator and Control

A problem met related to generator and control was burning of the dump load due to the blockage of water supply pipe and the operator failed to notice the low water level in the dump load tank. A snail that crawled inside the pipe and blocks it caused this. This could have been avoided with improved design on the intake of the water supply for the dump load, i.e. putting screen filter. To reduce the chance of the dump load burning in the future, an innovation was made where water supply for the dump load was directly drawn from the penstock so that the dump load is always full of water.

After the repair, the operators reported that the axle of the generator was overheating, causing the belts to snap frequently. This was suspected to be caused by misaligned belts; over-stressed bearings or the generator may have been affected by the dump load's failure. In early 2003 the system was shut down. Later inspection revealed a decomposed snake inside the turbine, which was jamming the runners. Despite removing the obstruction, the drive belts still needed to be replaced approximately every quarter.

Transmission and Distribution System

This installation had not experienced problem in their transmission system so far. However, on the transmission and distribution systems an earth-leakage circuit breaker must be installed to avoid lethal shocks. This device trips if a person comes in contact with bare wires.

Lessons Learned

Looking at current evidence and at reports made by previous documentations, there are some lessons that can be carried through from the experience in Tulgao for smoother and more efficient implementation and operation of MHP projects elsewhere.

First, technical problems should not have taken 8 months to resolve. Though communication within the management of the project was difficult, the problem could have been highlighted earlier and a quicker response made. Perhaps for future projects a policy could be in place allowing a channel for communication between SIBAT and the management so that when problems arise that is outside the capacity of the management group, then help can immediately be sought.

Figure 53. *Installation of the sugar cane press*

Second, technical failures of the MHP scheme could be attributed to operator negligence, despite the training on operation and maintenance given by SIBAT to the identified operators at the project onset. There were reports that the operators sometimes sent down children to carry out their duties, rather than make the long and steep journey themselves. Given the nature of the system, it is inappropriate for anyone other than trained operators to start up and shut down the system. On four separate occasions technical monitoring and evaluation was carried out by SIBAT, revealing many indications that the operators were not competent, thorough or diligent at their job.

Technical failures can also be mitigated with proper system designing such that the operators can take advantage of the system's ability to control it.

Figure 54. *View of Tulgao West from the balcony of the multi-purpose building.*

Thirdly, design by which the water supply for the dump loads was tapped somewhere along the penstock could be revised by putting the dump load into the tailrace such that it is always immersed in water when the system is running. This should be done with proper considerations on safety. Another way is by taking advantage of the cold climate in the area and use an air-cooled dump load instead.

Project Effects

The most recent formal research into Tulgao MHP's project effects was in January 2005, the RE and Gender Research. Its results, plus the insights from previous project monitoring and documentation by SIBAT were collated to present these perceived project effects.

Socio-Economic

Basket weavers (mostly men) can now work longer hours due to the availability of electric light in the evenings, allowing them to contribute more to household income. Through focus group discussions (FGDs) and key informant interviews women respondents mentioned that it was the men who have directly benefited from the MHP, because of more time for basket weaving that men typically do in the evening. One respondent said that his winnower products increased from 15 to 20 pieces per month since the introduction of the MHP scheme. This gave the household an additional income of PhP 250 per month.

Other male residents occasionally engaged in blacksmith or farm tool making with the use of electric tools to augment income. But this is an occasional activity, and so it is difficult to generate a clear idea of the effect on income.

Before the installation of the rice mill, manual rice pounding was a daily, year-round activity carried out mostly by women and children. On average, about an hour a day was spent on pounding rice to produce 2.5kg of milled rice. The rice mill can mill 150kg of rice in the same amount of time.

It was thought that women's workload would be lessened through the introduction of the MHP scheme, but it seems that this was not the case; in fact they have the same workload and a longer time to work in. This was especially useful for the majority of women who have babies and young children to look after. Some women used the saved time to work in the fields and then complete housework in the evening.

By and large, women respondents have attributed the extra time and ease in doing house chores (e.g. chopping firewood, cooking, washing clothes at night, house cleaning, etc) to the available electricity. Most claimed that their houses were a lot cleaner and have less soot from burning pine pithwood since the installation of the MHP scheme.

Employment

The project employed two operators providing cash income to otherwise cash poor households.

Environment

Residents no longer needed to collect large quantities of pine pithwood. One person stated that an amount that could have been consumed in 2 weeks could now last around 3 months. This has resulted in a reduction in deforestation in the area.

Similarly, the local residents have upheld the watershed protection scheme initiated by EDNP that involved planting of endemic forest species. Although the expected effects may take sometime to monitor, the community was now aware on the protection of the watershed and its link or importance to the MHP scheme's sustainability.

Health and Education

Other benefits derived from the introduction of the MHP scheme, though less quantifiable, were in terms of the health and well being of the family, particularly children. It was mentioned that children could now read and study at night as well as get access to news and information through radio and television, which before the introduction MHP were totally unheard of in the community.

Many women mentioned that their families have more time to sit and talk in the evening. Thus, bonding of the family members increases with availability of the electricity. The women also revealed that their family can "breathe" better because there is no soot coming from pine pithwood any more. It is also healthier for the members of the family as it reduces the risk of respiratory and eye diseases.

The women cited that child delivery is much easier now. The provision of electricity has facilitated childbirth especially so that most local women give birth alone or with minimal assistance.

Tribal Unity and Governance

The MHP project in Tulgao-Dananao secured a big improvement – and hopefully, a lasting peace and order condition in the area by mitigating the prolonged tribal conflict between the two tribes.

Initially, SIBAT's impression was that the people of Tulgao lack experience in organizing and leading community projects. Problems in community mobilization such as disagreements on labor counterpart were encountered during the project implementation; but through time and series of consultations, these were resolved. The MHP project was the first time that the people of Tulgao organized themselves and act together as a community for the benefit of all. This is manifested in the development of the PO running the MHP scheme.

The installation of the MHP along the Bunog Creek situated between the disputed boundaries of Tulgao and Dananao tribes, gave the formerly warring tribes the opportunity to set aside their differences and work together on a community undertaking. From the project planning, mobilization and through the course of project implementation, the two tribes learned the value of collective resolve and strong cooperation. This has immensely lessened the threat of potential tribal conflicts and emphasized the need for continuing unity and cooperation. Hence, community solidarity was enhanced by the community-based project.

Problems and Issues

Labor Counterpart

In previous projects undertaken in the community, members of the community were paid for their labor, either by the LGU or other funding agency. For the MHP project, the concept of community counterpart was introduced. Fr. Buyagan and the barangay captain organized the people into work parties but not everybody worked, as they should have. The confusion surrounding the community counterpart was compounded by the fact that carpenters were paid for their labor, but unskilled laborers were not. All members of the communities were asked for assistance with the development of the project.

Problems with community counterpart work could be hard to deal with. It was important that during the feasibility study development, the project partner's capability in resolving this issue was assessed. The study also established that the partner organization (church) was respected within the community.

Land Ownership

The son of the landowner who donated a portion of his field for the MHP scheme asserted his rights to the land and insisted that he should be designated as operator, despite being unsuitable for the job. The land was given over to the project prior to groundbreaking, and it was understood at the time that the land that the powerhouse, penstock and canal are located on would be given over as communal land for the benefit of all. The son did not respect the earlier agreement and this created tension. In order to resolve this issue, the organization planned to buy the powerhouse site from the owner but was not carried through due to lack of funds.

Other Issues

Given that Tulgao was in such physical proximity to Ngibat, where a MHP project was installed in 1994, some sharing of experiences and lessons would have been valuable both at an early stage and now. It could be inspiring to see how a project nearby has been successful, and give a different aspect of social preparation which SIBAT, coming from a base in Manila, was not able to completely provide. The Tulgao-Dananao community might have seen the project in a different light. This was suggested many times, but the concepts of 'tribal pride' and 'loss of face' hinder fruitful exchange of ideas and experience.

Some of the problems experienced in Tulgao may have been exacerbated by the fact that no official and proper project turnover from SIBAT was given. Issues and problems on project management; technical operation and maintenance should have been identified early on and addressed by trainings and efficient system designing. With no funding available for regular project monitoring and no easy communication channel some problems were addressed after a while.

Financial Analysis

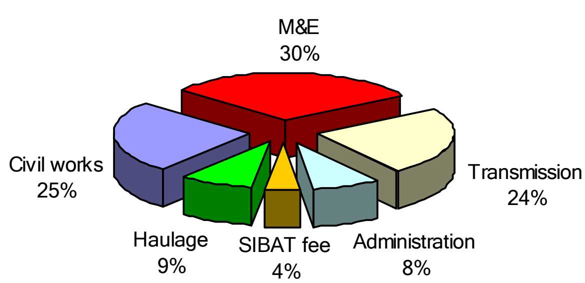
System Cost

The total capital cost of the Tulgao MHP scheme, was PhP 2,781,064. This figure covered material costs (79%), haulage (9%), administration (8%) including community organization and the SIBAT fees (4%) for surveys, design work and supervision of construction.

The actual cost of the installation reached PhP 2,834,565, which was PhP 50,500 over budget. SIBAT covered this deficit out of institutional funds. Pre-feasibility and feasibility studies conducted by SIBAT, as well as post-installation expenses -- were not included in the project cost.

Table 85. ***Breakdown of Capital Costs***

Civil works	P	739,964
M&E	P	841,190
Transmission	P	679,180
Administration	P	219,705
SIBAT fee	P	100,000
Haulage	P	251,525
Total	**P**	**2,831,565**
	US$	56,631
Total grant	P	2,781,064
Cost per Household	$/hh[41]	215
Cost per kW Installed	$/kW	1,888



[41] Computed at P50/$

Mode of Financing

Kyosato Experimental Educational Program (KEEP), that has had a long history of involvement with the people of Tulgao, provided the grant fund for the project. Originally the program was set up by the Episcopal Church in the US to help the Japanese town of Kyosato to develop after the WWII. The program was a success, and now the organization funds similar projects in Tulgao through the Episcopal Church.

The funds contributed by KEEP were for the materials and did not include labor cost. This was provided by the community as their contribution. The owners donated land directly used by the project also as their contribution to the project.

The community provided free labor and materials as their contribution. Their work included construction of the canal and powerhouse, hauling of materials and clearing the areas to be built upon. Community labor was valued at P678, 000 using the standard 30% of the material cost to be allotted as labor cost. The villagers' contribution on local materials including lumber, sand and gravel were valued at PhP 94,667. These values were based on local prices.

The grant funds fell within the concept of one-time enabling capital costs which included materials and equipment, supervision and training and all that were necessary to install the plant. Said upfront costs install the project which the community operates and sustains, through returns from the project itself. Hence, operation and maintenance costs, and costs to replace major parts and equipment will be the responsibility of the community.

Operation and Repair Cost

The P38,240 annual operating expenses of the Tulgao-Dananao MHP annual expense is about 1.8% of the total project cost. The bulk of the project's annual cost was for the salaries and honorarium of operators. The repair cost incurred was from the repair of the dump load while maintenance cost was mostly for belt replacements.

Table 86. *Annual Operational Cost of Tulgao MHP*

Cost Item	Amount (PHP)	% of Total
Personnel	24,000	72
Maintenance	2,040	4
Repairs	12,200	24
Annual Operational costs	38,240	
Expected Operational costs[42]	28,316	

The repair cost is shared between the civil, electro-mechanical and transmission components as follows:

[42] Based on 1% of the total material cost of the project per year.

Table 87. *Breakdown of Repair Costs*

MHP Component	Annual Cost (P)	% of Total
Civils	1,000	8
Electro-mechanical	11,200	92
Transmission	0	0
TOTAL Repair Cost	12,200	

Financial Sustainability

Income from lighting and rice milling tariff are the sources for financial sustainability of the system. The actual tariff for lighting of P35/W/mo for lighting (3 lamps), supposing a 7.7 hours usage results in an energy cost of 5.05 P/kWh.

A study of its income-expense records indicate that Tulgao-Dananao MHP is running on deficit but were able to sustain the operation. As discussed in the load section, only 1/3 of the rice mill's income goes to the MHP thereby reducing the expected income of P18, 900 to P6, 300. The deficit was shouldered by the operators as they were not paid when the collections are too low to provide for their salaries. The operators were in effect paid P900 per month instead of P1, 000 that was stated in the policy.

Table 88. *Annual Income-Expense for Tulgao MHP*

Cost Item	Amount (P/yr)
Annual Operational Cost	38,240
Annual Income	
Household lighting and appliance	29,462
Rice mill	6,300
Sugar cane press	1,612
Total actual annual income	37,374
Net profit	(866)

Quality of Lighting and Replacement Cost

The community is presently using different lamp types which have a significant influence on the amount a household spends on lighting. This is shown in the table below.

Table 89. *Annual Expense for Lighting for Different Lamp Types*

Lamp type	Wattage	Price (P)	Lifetime (H)	Annual replacement cost (P/yr)	Tariff (P/W/mo)	Annual Energy cost (P)	Annual expense for lighting (P)
Chinese SL-CFL	11	90	765	331	5.05	156	487
Fluorescent lamps	10	110	1275	242	5.05	142	384
Philips PL-CFL	18	200	5000	112	5.05	256	368
Philips incandescent bulb	40	25	1020	69	5.05	568	637

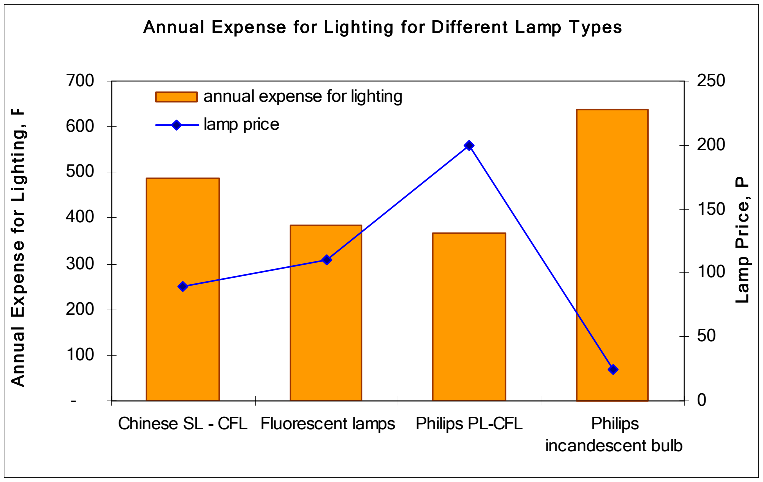


Figure 55. *Comparison of Annual Expense for lighting for Different Lamp Types*

The graph above shows that the cheaper the lamp, the higher the annual expense. The household would be better off to purchase the lamp with the lowest annual cost, which is the more expensive Philips CFL lamps.

Savings with Electric Light

A household spent PhP 1,128[43]/ yr on kerosene. To determine the savings the household achieved with substituting kerosene with hydropower, the annual equivalent cost of wiring, replacement cost of lamp and energy cost was computed:

Table 90 *Annual Cash Savings per HH with the Electric Light*

Cost Item	Calculation	Annual Cost (P)
Cost of wiring	P1,200 / 20 yrs	60
Lamp replacement (for 2 fluorescent lamps)	P267 *2	534
Energy Cost for two lamps	P 160 * 2	320
TOTAL Annual Lighting Cost		914
Saving on Kerosene		1,128
Annual Net Saving		214

The savings was small, but could be further improved by increasing the utilization rate of the plant, which would allow lowering the monthly tariff as will be discussed in the next section. A non cash savings was the time saved by not needing to collect pine pithwood. The small savings impacts on a much-improved standard of household lighting which the villagers appreciate.

[43] From the actual expenses on kerosene before the MHP at P94/mo

Utilization Rate

The ratio of the total energy used per year to the potential energy production yields the utilization rate of a scheme, which in the case of Tulgao amounts to 10.7%. This implies that the potential the installation offers is under utilized.

Table 91. *Utilization Rate of Tulgao MHP*

End-Uses	Energy Consumption (kWh/yr)
Lighting Load	22,260
Appliances	3,110
Rice mill	1,390
Sugar cane press	80
Actual Energy Used	26,840
Potential annual production	249,660
Utilization Rate	**10.7%**[44]

The tariff necessary to cover production cost is very dependent on the utilization of the plant in the case of hydropower. This is in contrast to the well known diesel generator set where the production cost per kWh is practically independent on how much it is used. This particularity of a hydro plant needs to be considered when analyzing the financial situation. **Error! Reference source not found.** shows that under certain utilization rate the diesel set can produce cheaper energy than the hydro. To take full advantage of economics of a hydro plant high utilization rates need to be aimed for. The graph also shows that the more energy can be sold the lower the tariff per kWh can be made.

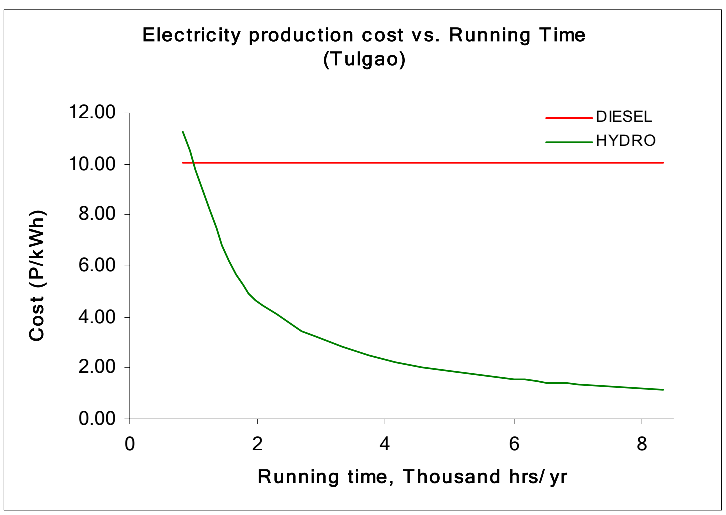


Figure 56. *Production Cost vs Plant Utilization*

Possibilities to Improve Plant Utilization (Rice Mill)

As the Tulgao-Dananao MHP scheme is under-utilized, the community could identify other ways by which the utilization could be increased with the installation of livelihood support end-uses. Possible MHP power user is the 5 kW rice mill in Dananao which

[44] Based on 8300 hr/yr plant operation or pant availability of 95% of the time

remains idle. With the continuing price increase of diesel fuel, it would be more economical if the village use the MHP powered mill instead of the diesel-powered mill. Should Dananao decide to use MHP; the plant will have an increase in utilization from 10.7% to 11%. Presented in the table below is the rice milling data for Dananao.

Table 92. *Energy Consumption of a Rice Mill*

average rice production	kg/yr/hh	300
no of households in Dananao		112
Volume of milled rice annually (assumed 70% of total production)	kg/yr	23,000
milling tariff	P/kg	1.00
milling capacity	kg/hr	150
Operating hours necessary	hrs/yr	154
Energy consumption of a 5 kW rice mill	**kWh**	**770**

On the average, a household in Dananao harvests 300[45] kgs of rice annually which a huller with a capacity of 150 kgs/hour can process in 154 hours. With its 5 kW motor, the huller would consume 770 kWh/yr. As the village already has the motorized and the engine driven mills, the annuity assumed was for the replacement of the system after 15 years at 0% interest rate.

Table 93. *Cost Comparison of Using MHP and Diesel-Powered Mills*

Assumptions	Fuel Consumption, Li/kWh	0.225	
	Diesel cost, PhP/li	39	
	interest rate, %	0	
	project life, yr	15	
Net Profit Computations		**MHP**	**Diesel**
	Investment for rice mill equipment, P	30,000	30,000
	Tariff for Electricity, P/kWh	5.00	
Annual Cost	Energy Cost , P/yr	(4,125)	(7,239)
	Operator salary, P/yr	(12,000)	(12,000)
	Replacement Cost, P/yr	(2,000)	
	Total Annual Cost, P/yr	**(18,125)**	**(19,239)**
Income	Milling Tariff to cover cost, P/kg	0.73	0.78
	Actual Tariff charged, P/kg	1.25	1.25
	Annual volume of rice to be milled, kg/yr	33,000	33,000
	Income w/ present tariff, P/yr	**30,938**	**30,938**
	Net Profit w/ present tariff, P/yr	**12,813**	**11,698**
Community Income	Income generated by the hydro	4,125	
	income generated by the mill	12,813	
	Total Income generated by the community	**8,396**	privately owned
	income generated by the rice mill	8,542[46]	

The village currently uses the engine-driven mill which the barangay captain prefers to operate as a personal income generating project and leave the motorized mill idle.

[45] From SIBAT's Community-Based Resource Management Project Report
[46] Assuming 1/3 of the net profit goes to the MHP for maintenance and operation and 2/3 of the net profit goes to the rice mill

If the Dananao tribe decided to use the motorized rice mill, the hydro scheme would have an additional income of P4,125/yr from the sales of electricity plus P4,270 assuming 1/3 of rice mill income goes to the MHP as set in Tulgao. Dananao can contribute to the amount saved for the MHP's operation assuming they use the MHP-powered rice mill and still have the income from milling for their village.

Therefore, to use the existing motorized rice mills will be of economic advantage to both villages. It is in the interest of the community to explore further productive end uses of the energy and aim for a significantly higher utilization of the installation.

Cost Covering Tariff

The cost covering tariff to cover system replacement was calculated such that the village can save the amount needed after the project's useful life. As the project cost was grant, the total annual cost of P217,000 was used to cover system replacement. This is the project's annual O&M cost at 1% of the investment plus P188,700 which is the annualized cost of the project in its 15-year project life.

The community's expected performance if the project was funded with a loan component was also analyzed. The schemes cost covering tariff to cover loan repayment was determined using three utilization rates and annual cost of P529,458. This is the projects annual O&M cost that is assumed to be 1% of the investment (P28,316) plus the annual repayment of P501,142 for a loan with 10 years repayment period and 12% interest.

Table 94. *Cost Covering Tariff of Tulgao MHP*

Cost Item	tariff to cover system replacement	tariff to cover loan repayment and system replacement
System Replacement	113,263	113,263
Annual O&M	28,316	28,316
Loan Repayment (50% of capital)		250,571
TOTAL Annual Costs	141,578	392,149
tariff at 9.1% utilisation	6.23	17.26
tariff at 30% utilisation (lighting)	1.89	5.24
tariff at 100% utilisation	0.57	1.57

This tariff should be applied by the community in order to be able to replace the system or in future, to service a loan for the capital cost. **Error! Reference source not found.** shows that the community needs to find ways to increase the MHP's utilization in order to afford lower tariffs.

With the community's present tariff on energy, they only need to attain 100% collection to have the amount needed for system replacement after 15 years.

Capability for Loan Servicing

In order to determine the project's capability of servicing a loan, the cost covering tariff was calculated for various levels of loan covering the capital cost of the project. In **Error!**

Reference source not found. the tariff necessary to pay the loan and the annual O&M cost is shown versus the loan percentage. For the loan an interest rate of 12% and 10 year repayment period was assumed.

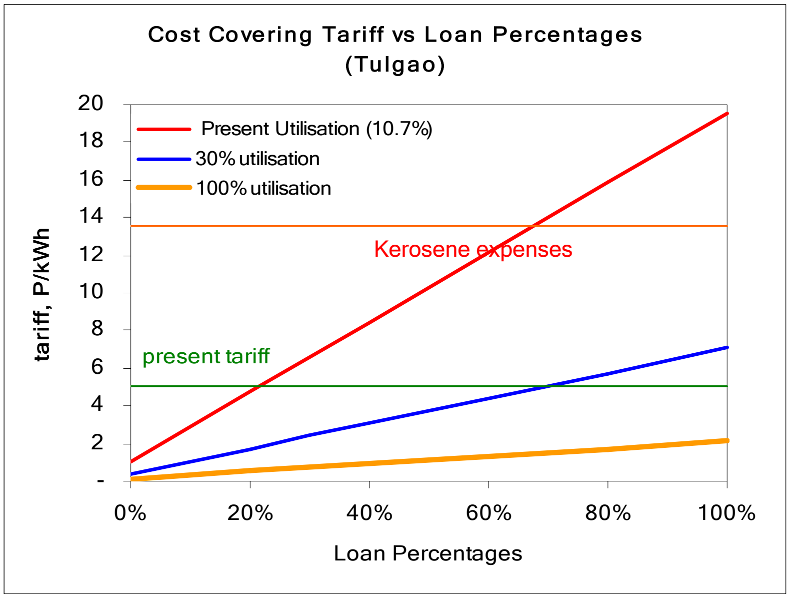


Figure 57. *Cost Covering Tariff w/ Varying Loan Percentages*

The figure above shows that the project can pay for a loan equivalent to 20% of its total project cost at the present plant utilization assuming 100% collection rate. If the kerosene expense was taken as ability to pay, the tariff could be raised up to this level.

With increased utilization meanwhile, the blue line represents the maximum utilization rate of the plant for lighting only. At this utilization level the plant is able to cover a 100% loan assuming 100% collection rate. At a 100% utilization, which would be the case if the plant is connected to the grid and could sell all the energy it produces, the plant could easily serve a 100% loan even at the present tariff.

The analysis shows that a higher utilization will increase the project's ability to service a loan significantly. This higher utilization can be achieved by livelihood or income generating end-uses and no increase of tariff is necessary. Therefore a loan would not result in a higher cost for the beneficiaries.

Table 95. *Potential Profitability w/ Improved Utilization and Collection Rate*

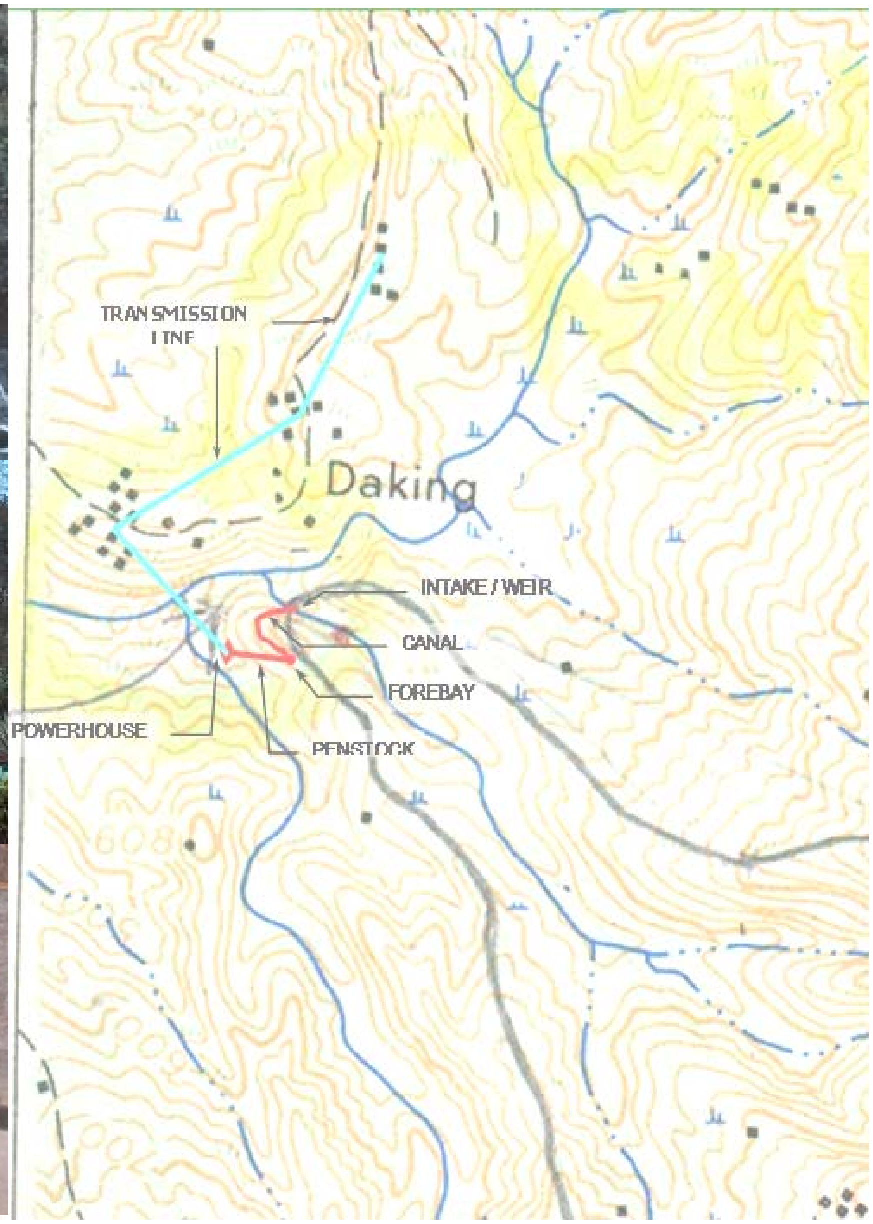
		Actual collection rate	**100% collection**
Annual Expenditures			
O&M costs (1% of the capital cost)	P/yr	28,316	
Total actual annual expenses	**P/yr**	28,316	28,316
Annual Income			
Household tariff (Lighting and appliance)	P/yr	29,462	95,040
Income from sugarcane press		1,612	1,612
Income from rice mill		7,350	16,879
Additional income from sales of electricity to the Dananao rice mill			3,850
Total actual annual income	P/yr	38,424	117,381

Net Profit at 10.7% utilization rate	P/yr	10,109	75,686
Net Profit at 11% utilization rate	P/yr	23,488	89,065

Supposing the community is able to enforce its own policy and obtain 100% collection rate and further supposing that Dananao used the motorized rice mill, the potential income generated by the plant at the present utilization rate could amount to P89,065 annually. This amount is not enough for system replacement as the project has an annualized replacement cost of P188, 700 assuming a project life of 15 years. Therefore, there really is a need for the village to increase the utilization rate to be able to save for the system's replacement.

Lon-oy Micro Hydro Power Scheme

A Case Study of a Community-based Renewable Energy System



LON-OY MICROHYDRO POWER SCHEME

A Case Study of Community-based Renewable Energy System

Name of Project	Lon-oy Micro Hydro Power Scheme
Location	Bgy. Lon-oy, San Gabriel, La Union, Philippines
Project Partners	▪ Sibol ng Agham at Teknolohiya (SIBAT) ▪ Episcopal Diocese of North Central Philippines (EDNCP) ▪ Department of Energy (DoE)
Construction Start Date	December 1999
Project Inauguration	March 2001
Design Power Output	20 kW
Households Connected	78
Total cost	PhP 1,875,253

Introduction

This case study presents an assessment and historical development of a micro-hydro power project in barangay Lon-oy, San Gabriel, La Union. This community-based project was initiated and facilitated by the Episcopal Diocese of North Central Philippines (EDNCP), with technical assistance from Sibol ng Agham at Teknolohiya (SIBAT) and funding from the Department of Energy (DOE). The community was organized and prepared by members of the Episcopal Church's community development personnel. SIBAT provided technical help through its Microhydro Service Center (SECEN), assigning engineers to conduct surveys, design the final system and assist with the construction. The community themselves carried out all the construction work free of charge, including the hauling of aggregates and equipment.

The project had its ground breaking in 1999, and one year and 3 months later, in March 31, 2001, the project was formally inaugurated. Since that time, the people of Lon-oy has been provided with a 24-hour supply of electricity for most of the year. The project is managed by the people of Lon-oy through the community organization, and operated by two trained community members.

Land and People

Location and Accessibility

Barangay Lon-oy is part of the municipality of San Gabriel, La Union, close to the border with Benguet. It is bordered to the north by the province of Ilocos Sur, Benguet on the East, Pangasinan on the South and the Luzon Sea on the West. On a NAMRIA map the barangay may be found at 120°29'27" E longitude and 16°40'27"N latitude.

Figure 58. *Location Map of La Union*

Lon-oy is composed of seven (7) sitios, namely, Dayegdeg, Dercas, Dongili, Gawagaw, Genned, Lon-oy proper, and Nakawa. Of these seven sitios, only five are served by the Microhydro Power (MHP) project, as the sitios are spread far apart. Genned and Dayegdeg serve as meeting points in the barangay as most of the stores and other public facilities are located there.

A road connects barangay Lon-oy to the town center of San Gabriel, approximately 23 km away. The road is only partially concreted and vehicles must pass through the river twice along the route; a journey which takes around two (2) hours by jeep. During the rainy season the route can become partially or wholly closed to vehicles. The hike takes around six (6) hours for the local residents, or they can use an alternative footpath which reduces hiking time to 3-4 hours. At times when the river cannot be crossed, the Kapangan route is taken, which is around 12 hours walk from Lon-oy.

The area around Lon-oy is composed of rolling hills and mountains, with an elevation range of 300-700 meters above sea level. The barangay occupies a total land area of 3,004 hectares and is covered with secondary growth forest. Of this, approximately 75 hectares is communal forest. The local residents estimated the agricultural and settlement areas to occupy an approximate size of 750 hectares. These are restricted to the low lying and flat land areas along the mountain range.

The forest surrounding Lon-oy was observed to be composed of dipterocarp tree species and fruit trees. However, within the time frame of the project, it has been noticed that there is denudation of the forest due to expansion of farming areas and the encroachment of *kaingin* farming in the watershed area of the Baroro river system. In general the vegetation within the catchment basin is in relatively good condition, with a watershed protection program recently initiated to help improve the watershed area and reduce soil erosion.

There are several creeks close to Lon-oy, one of which supplies potable water to the barangay and for irrigation of rice fields. The creeks are tributaries of the Baroro River, which provides potable water to nearby barangay Balbalayang, as well as the town center of San Gabriel and San Fernando. The National Power Corporation (NPC) has also identified the river for mini-hydro power development for the year 2011.

Kankana-eys and Bago

The people of Lon-oy trace their ancestry back to the *Kankana-eys* of Kapangan, a municipality of Mountain Province. Prior to them, the area was first inhabited by *Kankana-eys* from Benguet. During the last century, these original settlers sold or bartered their lands when they moved further a field. It is not certain where the name '*Lon-oy*' came from, but some of the people suggested it was the name of an old woman who once lived there.

The ancestors of the current people of Lon-oy moved to the area around 1900s. At present, around 95% of the populations are *Kankana-eys*, with the remainder *Bago-Ilocanos*. Most of the people are farmers. The *search and follow* teaching of the "Sagrada Familia," a religious sect under the Aglipayan or the Philippine Independent Church was believed to have started the migration to Lon-oy. Today, the majority of the population is Anglican, and Lon-oy is under the Episcopal Diocese of North Central Philippines.

The people of Lon-oy retain their cultural identity as *Kankana-eys* most noticeably through their dialect. The older generation and those who have received higher education and training understand Ilocano as well as English, whereas the younger generation can understand more Tagalog, in addition to local dialects.

The main religion within the community is Anglican, with 90% of residents affiliated to the church. The church has provided support for the development of infrastructure and services within the community including the potable water system. Initially the health center in the barangay was paid for and staffed by the church, until the local government provided a separate barangay health center.

Agricultural Condition

Lon-oy is an agricultural area where the majority of the residents rely on rice cultivation as source of livelihood. Rice is generally harvested twice a year. Both men and women carry out planting during July and January. During the summer months, additional irrigation is required, and during the last couple of years, water from upstream of the intake has been diverted for use in irrigation of fields. The farmers use chemical pesticides and fertilizers, with a variety of seeds grown. During the harvesting and planting season, all the farmers help each other with the work, a system known as *bayanihan*. There are 5 privately-owned diesel rice mills in the area.

In addition to rice, some farmers plant glutinous rice for sale outside of the barangay. The amount of rice produced is sufficient for the whole year. There are also *kaingin* activities carried out throughout the year; it was noted by some of the community members that this activity was causing denudation of watershed areas and reducing the forest cover. Most of the farms and residential lands are privately owned.

Other crops include corn, tiger grass, camote and banana. Tiger grass is used to make brooms to sell outside the village. Corn and fruit crops are also sold outside of Lon-oy. An additional source of income is the barangay bakery – a livelihood project set up with funding from Department of Labor and Employment (DOLE) around the same time as the micro-hydro project. Fueled by a liquefied petroleum gas (LPG), the oven is located in the barangay multi-purpose center and the bread is sold within the community and in San Gabriel.

Sources of Cash Income

Aside from the modest volume of fruits and vegetable produced, other sources of cash in the locality are soft broom making, tending consumer stores, working overseas and waged labour. On the average, a family's gross annual income amounts to P49,000 which according to the National Statistics Coordinating Board is below the poverty threshold in the region.

Basic Social Services

Within the community 8-health workers, a nutritionist and a midwife staff the barangay health center. Health programs in the community include immunizations, nutritional education, and the administering of iodine and iron during pregnancy. The nearest hospital is in the town center, and people with more serious conditions must travel to there or to San Fernando for medical assistance.

The community has a year-round supply of potable water, and several other basic services in addition to the barangay rural health unit. These include a barangay hall, multi-purpose playground, post office, and elementary school. The school has grades 1-6, with six teachers providing education in single and combination classes. The nearest high school is 1 km away in barangay Balbalayang. Children must walk either to there or to the town center or San Fernando to pursue higher education.

Those who have college education often seek employment outside of the community. People travel to San Gabriel, San Fernando and Baguio to seek employment, and also to supplement income when there is no work available in Lon-oy.

Project History

The National Power Corporation has identified the Baroro Creek in Lon-oy for possible development prior to the MHP project. In 1997, EDNCP was introduced to SIBAT through the former Microhydro Service Center (SECEN), SIBAT's Renewable Energy Program based in Baguio, and the possibility of MHP development was discussed. EDNCP informed the community of the possibility of electrification through use of their water resource and their reaction was gauged.

Following this, in 1998 the community, acting through EDNCP, formally requested SIBAT to conduct an ocular survey.

SIBAT conducted an ocular inspection in January to assess the resource's suitability for the proposed MHP project. The survey also included an initial socio-economic survey, where findings were presented to the community. It also provided an initial orientation to the community on the potential project, after the technical viability was determined.

Figure 59. *Construction of Lon-oy Powerhouse*

In April 1998, the detailed feasibility study was conducted. It contained: a detailed technical design; an application plan including load management; a financial study; a project work plan developed with the community; and the project budget. During this stage, it was established that an extension of the national grid would be unlikely due to the large cost in extending the transmission lines from San Gabriel town center (around 22 km).

Baroro Creek was deemed most suitable to supply the requirements of the system, and could provide a minimum of 10kW during the dry season, but up to 30kW during the rainy season. This was discussed with the partner and the community, and it was decided that the load would be reduced during the summer to take account of the drop in capacity.

Owing to their distance from the powerhouse, it was agreed that only five of the seven sitios would be electrified under the project.

After the Feasibility Study, funding was sought for the project. SIBAT presented the site to DOE for approval, as a package with four other sites[47].

[47] Balbalasang, Balbalan, Kalinga; Kimbutan, Dupax del Sur and Sitios Nursery and Kapacnaan in Brgy. Oyao, Dupax del Norte, Nueva Vizcaya.

Multi-Stakeholder Partnership in Project development

A multi-stakeholder partnership between SIBAT, Lon-oy community, EDNCP, the barangay officials and DOE, was formed to implement the project. These stakeholders contributed in the various stages of projects development.

Table 96 *Main Tasks of the Project Stakeholders*

Stakeholder	Tasks in the Partnership
Community entrusting the authority on the elders within the Barangay Council	Took the active role in project development
Local Church - EDNCP	Supported SIBAT and the PO in various responsibilities
SIBAT	Provided the technical works and technical management, and fun ding facilitation
Barangay Development Council through the barangay chairman, officers, etc.	Supported through community mobilization

The Episcopal Church has programs to improve the livelihoods of the towns and barangays where it works. The Church has provided the potable water system in the barangay, and runs a money-lending cooperative, not only in this particular area but throughout the Cordillera. The loan is intended to assist farmers in purchasing farm inputs for rice production.

LGU participation was also notable in Lon-oy. The local officials with the help of church leader actively aided in facilitating the community meetings and consultations and in the discussions of crucial issues such as labour contributions. This LGU participation was appraised as valuable to the projects' take-off and completion.

Social Preparation Phase

The project's social preparation phase consisted of numerous consultations discussing the CBRES concept and the role of the community.

Meetings were organized within the community in the elementary school, initially to inform the residents of the proposed project. The importance of attendance by the whole community was expressed, and largely this was achieved. EDNCP's community organizer arranged the meetings, with assistance from the barangay officials of Lon-oy. Willingness to contribute labor of all able-bodied villagers was expressed during these consultations. Aside form labor, the villagers also committed participation in the entire project process together with the other sectors (church and the LGU), formulation of policies, and managing and sustaining the project after installation.

The community has experience of both livelihood projects and counterpart working: this includes a bakery, the ongoing concreting of the road to San Gabriel, and the potable water system. Their experience eases the task of seeking their counterpart and support for the MHP project development.

There are several organizations within the area formed even before the MHP project. These are the women's group (Timpuyog), a youth organization (PCF), and a farmer's group. There is also the Bumikas Multi Purpose Cooperative, a consumer cooperative that owns a store designed to give discounted goods to its members. The people's organization to run the project was formed by EDNCP and the barangay council.

Energy Demand Study

The needs of the people were investigated during the feasibility study stage (FS). The people expressed household lighting as the primary application of the electricity to be generated by the MHP project. They also expressed their need for a post harvest facility particularly a rice mill.

Before the MHP project, the community was reliant upon bamboo and kerosene for lighting. On the average, a household in Lon-oy spent P 65/month on kerosene. Dry cell batteries were used for flashlights, and radios/cassette recorders; and either firewood or LPG for cooking.

Bamboo sticks are mainly used for lighting a walk. Streetlights were also discussed as a potential use of the MHP scheme

Aside from kerosene for lighting, four (4) families owned diesel generator sets for their household energy needs. A solar battery charging station was provided for one of the more remote sitios by the government, but the people no longer use it, as they do not feel confident in using the system.

From the feasibility study survey, the 121 households of the 5 sitios wanted an average of 3 lighting fixtures per household. Using 10W lamps, a household would need 30W for lighting totaling to 3.6 kW. The same survey also came up with the number of households wanting to use appliances. The community's other end-use priorities meanwhile were concluded during the consultations.

Table 97. *Energy Demand*

Load	Wattage	No of users / units	Energy Demand (kW)
Household lighting	30	121	3.6
Appliances			
Stereo	145	27	3.9
Television set	80	31	2.5
Electric stove	1000	2	2.0
Washing machine	600	9	5.4
refrigerator	250	10	2.5
Rice Mill	5000	1	5.0
Planer	1000	1	1.0
		Peak Demand	**13.9**

Normally, the highest of the two peak demands for the daytime and nighttime load is chosen as the basis for designing system capacity. But due to resource's limitation to provide for the peak demand especially during summer, a load management will have to be adopted such that the peak demand will not exceed the MHP supply during this period. A 1.25 factor was used for future growth to come up with the design capacity of 17.5 kW. SIBAT decided to maximize the resource's potential and install 20 kW MHP such that the villagers can have options to add other livelihood end-uses. At this capacity, the design discharge was fixed. This design capacity however will be available only for 80% of the time. This was made clear with the beneficiaries and the villagers agreed to adopt the load management scheme to cope with the system's limitation.

Project Implementation

Prior to project implementation, a Memorandum of Agreement between SIBAT and the EDNCP was forged. Through the MOA, EDNCP agreed to provide community training and social mobilization for the project, and SIBAT would provide the technical support needed for the project. In 1999 groundbreaking, which marks the official project start-up, happened. One of the SIBAT Engineers was assigned to supervise construction of the system. Due to the inaccessibility of the site during the rainy season, hauling of all materials had to be completed during the summertime.

As some portions of the barangay road from San Gabriel are of earth type, it is closed to vehicles during the rainy months, i.e. from September to December. Instead of being idle during this period, community workshops and consultations were conducted to generate and encourage local counterpart while waiting for the road to open. The community also discussed the crucial policies of actual implementation and long-term management.

SIBAT was responsible for the supervision, ensuring that designs for the civil, mechanical and electrical works were rigorously followed. EDNCP, through its priests, together with the Barangay Council, was in-charge of community mobilization and organization for the project.
The construction took 15 months, passing through periods of disruptive typhoons. The construction of the 240 m concrete canal alone took 12 months due to the slope in which the canal was built on and the loose soil structure that erodes when disturbed. Overnight an entire day's work would be buried underneath with more earth. This led to demoralization in few workers but the barangay captain's ever-increasing eagerness and leadership propels the villagers to complete the project.

Table 98. *Major Technical tasks of SIBAT in Project Implementation*

Tasks	Description
Technical supervision	Supervision and directing of the major works (civil, electro-mechanical, electrical)
Purchase of major components	In-charge of major purchases especially those not available on the site
Turbine fabrication	Supervision of turbine fabrication according to the design
Technical and management training	Conduct of technical trainings while the project is in construction to give the trainees hands-on exercise and management training after the project commissioning
Coordination with PO and local NGO	Conducts necessary coordination and community meetings

Table 99. *The Major Tasks of the LGU and EDNCP in Project Implementation*

Tasks	Description
Overall local supervision	Supervision and directing of all local activities (transport, hauling) ensuring the compliance to schedule and local assignments
Coordination with the community	Consults with the PO in all matters pertaining to the project
Purchase of local components	In-charge of purchases of construction materials

Figure 60. *Lon-oy Power Canal*

The cooperation of Lon-oy villagers with the leadership of the barangay captain made the 15-month construction of the MHP scheme possible. The barangay council, with help from the local EDNCP priest identified the skilled workers in their barangay to act as foremen. During the construction, people were organized into teams to carry out the work by the Bgy. Captain, EDNCP staff and SIBAT engineer to carry out the community counterpart effectively. Six work teams of approximately10 to 15 people each were formed. Each team was scheduled to work on the construction one day each week and work paused on Sunday. The women and children contributed as well as the men, collecting and hauling sand and aggregates from the river to use in the concrete for canal and the forebay. During the harvest season, when there is abundant supply of food, the residents donate whatever is available from their household for the food of the workers.

People's Participation

The community agreed during a general assembly meeting, that each household would be expected to contribute forty- (40) days of free labor for the construction of the MHP project. An equivalent cash amount (P4000) could be donated instead, or food for work. .

All families were involved with the project, with the women and children providing food for work and hauling sand and gravel from the river and surrounding areas. The men carried out the construction and haulage of the generating equipment, such as the generator and turbine that had to be carried by hand from the road head 30-minute walk from the site. With the help of SIBAT's electrical engineer, the community laid the transmission line and installed household wirings. Aside from the provision of free labor, they also provided local materials for construction such as lumber, sand and gravel. The lumber was used in the construction of the powerhouse and sand and gravel were used to make concrete to build the canal, forebay and powerhouse.

Figure 61. *Hauling the turbine to the powerhouse site*

Commissioning and Post-Installation Trainings

The final commissioning and official project inauguration was held in March 2001.

SIBAT provided technical training for operators during the installation phase. This was so done such that the operators will better understand the concepts behind the operation of the MHP. The technical training consisted of modules on: MHP operation and maintenance; household wiring; and practical electricity theory. The MHP operators received their training on general electricity from the Technical Education and Skills Development Authority (TESDA) in 2000. In addition, project management trainings were given after commissioning.

SIBAT gave a follow-up training for all MHP operators from different project sites in February 2005 in Tulgao where Lon-oy operators actively participated. Meant not only as review course, the 3-day training basically provided the operators with appropriate inputs in civil works, electro-mechanical and electrical maintenance of the system. Retraining of the operators was conducted due to the replacement of operators in most of SIBAT installed MHP systems.

Project Management

Description of the Management System

During implementation, EDNCP set up a provisional project structure, which was largely church appointed. A democratically elected committee, with the barangay Captain as president, then succeeded this group, following elections in 2002. This new management group, known as the Lon-oy Community Development Association, Inc. (LCDAI) was led mostly by Lon-oy's barangay officials. The church still has a role in the management group, acting as an adviser.

The project's organizational structure is shown below.

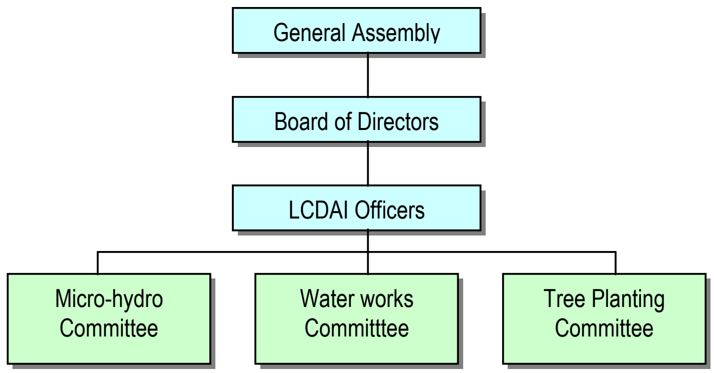


Figure 62. *Organizational Structure*

The structure has a General Assembly of members that elect the officers and formulate the policies. As per by-laws, the BOD as the policy-making body is required to meet monthly to draft, review and amend policies to guide household load management, tariff formulation and daily operation and maintenance activities of the MHP. Though these were clearly stated in their policy, there was an observed laxity in the enforcement. Community consultation remains as the accepted practice for resolving issues and arriving at policy consensus.

By and large, LCDAI has positively asserted their lead role in project management with a fairly efficient system of technical system's operation and maintenance, load management, policy enforcement, and tariff collection system.

Essential skills and information on financial and project management though has yet to be provided by SIBAT. An appropriate project monitoring and technical response system also needs to be adapted.

Conflict with the Priest

There were conflicts at the onset between the assigned priest in Lon-oy and the people about the management of the project; the Episcopal priest thought the church should be in charge of the project. The people of Lon-oy however wanted the project to be community-ran. This created friction in the community, which resulted in periods when the people carried out little or no work to express their dissatisfaction with the priest's management. Eventually the matter was sorted out among the project partners resolving that the community should primarily run the project.

Project Operation

The system operates for 24 hours per day with an average of 5.7 hours used effectively for household lighting. During the day, when lighting load are not in use, small household appliances such as radio cassettes are used.

Two trained operators man the powerhouse and run the system daily. They alternate monthly with 3 other pairs of operators who were chosen from a group of local volunteers trained by SIBAT's engineers in technical operation and maintenance and practical household electrification. The operators are responsible for day-to-day upkeep of the system such as cleaning the forebay of silt, stones and debris.

They each receive an honorarium of P1000 per month during their turn.

Load Allocation and Management

Originally, the policy formulated by the management committee stipulated that power use should be limited to 100W, and that high-powered appliances was not to be permitted due to the limited capacity of the system, particularly during the dry season.

During the months of March towards April, which is the on-set of dry season in the country, the community adopts a load management scheme to cope with the system's limitation. It was agreed that only half of the number of household beneficiaries use electricity on a set day and the other half the next day. This is put into practice by switching the power off at the transformer, which allows either half of the community to be switched on or off.

Knowing the resources' limitation the power allocation per household during summer is restricted to 70W to be able to supply power enough for lighting and operation of small household appliances.

Although the La Union Electric Cooperative (LUELCO), had waived plans for electrification of the area in 1998, lines were extended in Lon-oy, and Balbalayang in 2000. Power has been supplied in late 2003. Thirty-six households have applied for grid connections (mostly in Sitios Genned and Dayegdeg), while maintaining simultaneous MHP subscriptions. When questioned, respondents stated that they would prefer to use the cheaper hydropower for household lighting. Those households requiring additional power obtain it from the grid to power appliances such as refrigerators, washing machines, video and stereo appliances and flat irons, which the hydro policy restricts.

Thus, given the availability of both MHP and grid connection, 36 residents now have a choice of availing both services while the rest are solely with the MHP. The grid also serves as a back-up supply for power limitations of the MHP during summer. While the MHP serves as the back up power typhoon months when the electric cooperative's power supply is cut.

To prevent the households with appliances to use the MHP for their appliances use, a fine of P500 for each household caught using MHP was adopted as policy. Members of the organization are tasked to monitor their neighbors with appliances. To date, there has been no reported case of MHP use for appliance.

System Downtime

The system in Lon-oy experiences 2 months of downtime periods every April and May annually when the flow recedes.

In its 4 years of operation the Lon-oy MHP had experienced only one month of downtime due to repair. This happened in 2001 when the powerhouse was submerged in floodwater. This does not cause a major problem in the system but the people are not confident at that time to operate the MHP after the incident. They waited for the technician to test and switch the system back on.

Tariff and Collection Rate

Upon project commissioning, the community decided that a uniform fee of P 40 per month would be paid by all users. In 2001, this increased to P50, to make sure enough money was collected to provide for maintenance of the system. This flat rate for all consumers is still enforced and there have been no complaints, or problems with non-payment. The organization claims to have 100% payment among its beneficiaries. A closer look into the records however reveals that the expected income is lower than the actual collection. The organization has an annual income from lighting tariff of PhP 40,480 from all beneficiaries when the expected annual income should have been PhP 46,800 giving a collection rate of only 86%. This is the highest collection attained by the evaluated SIBAT MHP schemes.

The present monthly tariff is a flat rate for any number of lamps used. At present, a household in Lon-oy has an average of 6 lighting fixtures totaling to 100 W. The households who do not complete the agreed 40-day labor contribution paid an equivalent amount of P100/day for the days they did not work as their connection fee. Those who contributed more than 40 days of free labor however are paid back from the collection.

With the current average lighting load of 100W per household, and usage hours for lighting, the set tariff is equivalent to P 3/kWhr. This rate is lower by half of the current selling rate of the electric cooperative in the area.

The community has no policy yet on the tariff for appliance use. As stated above, the MHP restricts the use of high-powered appliances and the households with dual connection use the grid power for these. The current policy relies on collectors monitoring the households with appliances. This is difficult to implement properly since it is easy for users to draw the plug of their appliances from the socket when the collector comes around, and claim to use grid power for their appliances.

The monthly tariff is collected by a designated person per sitio, and remitted directly to the treasurer. As there has been no non-payment yet, there has been no need to enforce the cut off policy.

Effect of Collection Rate

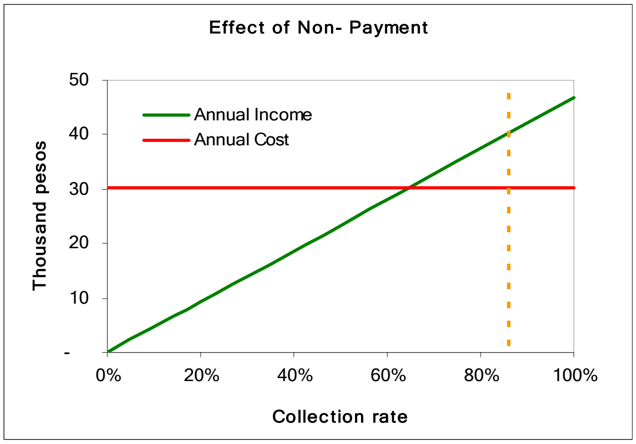


Figure 63. *Effect of Collection Rate in Lon-oy*

With its 86% collection rate for lighting use among its beneficiaries, Lon-oy MHP was able to sustain its operation and have an annual net profit of P 9,900.

The low annual cost incurred by repairs helped the project to have saving.

Tariff Structure

Shown on the table below is the price a household pays for its energy consumption. The income level was assumed to be their ability to acquire appliances and the need for more lighting fixtures in their houses. The table shows that the policy is to the disadvantage of the households belonging to the low income class as they pay more on their energy consumption.

Table 100. *Energy Cost at Different Income Level*

Tariff rate P50/mo
Tariff for appliances: non yet

Income level of HH	Equipment Installed	Cost of the Services (P/W per month)	Cost of the Energy (per kWh)
low	3 CFL	1.52	8.86
	4 CFL	1.14	6.65
	6 CFL	0.76	4.43
	8 CFL	0.57	3.32
high	4 CFL and radio cassette	0.51	3.54

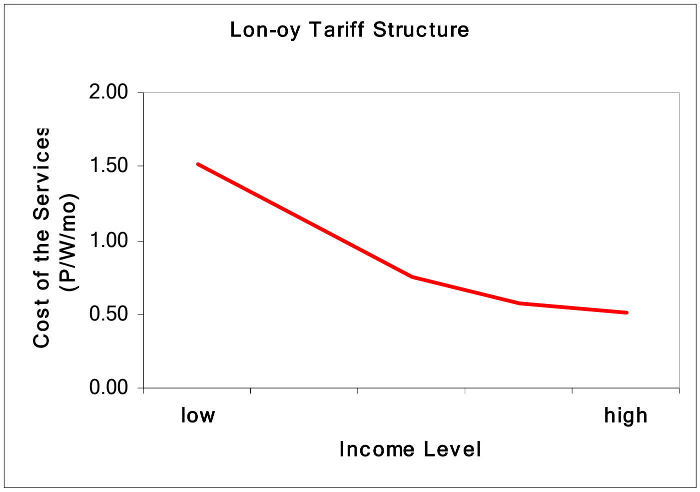


Figure 64. *Tariff Structure*

As there are no means by which appliance use could be monitored, Table 62 and **Error! Reference source not found.** were generated assuming the appliances are not drawing power from the MHP.

Even with lighting alone, the data shows that the users do not pay what they are actually consuming. As it should be, the tariff structure should be adjusted. Should the community agree, a flat tariff for the installed capacity (P/W/mo) could be adopted but a prepaid load limiting device should be installed per household to control the consumption. In this manner, defaulters can be avoided.

Technical Description

The 20-kW Lon-oy MHP is an off-grid barangay electrification scheme for household lighting and livelihood-support end-uses.

The system is primarily used for household energy consumption though it was originally intended to power small post-harvest facilities. Household lighting consist an average of 6 lighting fixtures per household. It is still yet to be verified whether the 36 households with dual connections: one form the grid and one from the MHP, do not use the MHP power for their appliances.

The system is able to provide electrification to 5 out of the 7 sitios of Lon-oy. Aside from provision of lighting to most households, the energy generated from the MHP is also able to provide electrification to school buildings, church, barangay hall, multi-purpose building and street lighting.

Technical Design

Lon-oy MHP follows the run-off-the-river scheme. Water is diverted by a 15–m wide weir of rubble masonry with side intake along the Baroro River. It is then conveyed through a 240m long concrete canal to a 9.4 m^3 forebay. Water then passes down a penstock made of high-density polyethylene pipe (HDPE), which is attached to the gate valve and then to the turbine located inside the powerhouse.

The cross-flow turbine is a variation from the SKAT T-12 design fabricated locally by the Pangasinan State University (PSU). As the moving water turns the turbine shaft, it harnesses electricity by driving the synchronous generator. An electronic load controller (ELC) from China balances the power produced before sending it to the communities where transformers lower the voltage to 220 V.

Civil Works Components

Table 101. *Description of the Civil Work Components*

Component	Description	
Weir	Material	Rubble masonry
	Width	15m
Canal	Type	Concrete
	Length	239m
	Width	0.60m
	Depth	0.45m
Forebay	Size	$9.41m^3$
Penstock	Material	HDPE
	Length	36 m
	Diameter	8 inches
Gross Head		28 m
Inlet Valve	Type	Gate valve

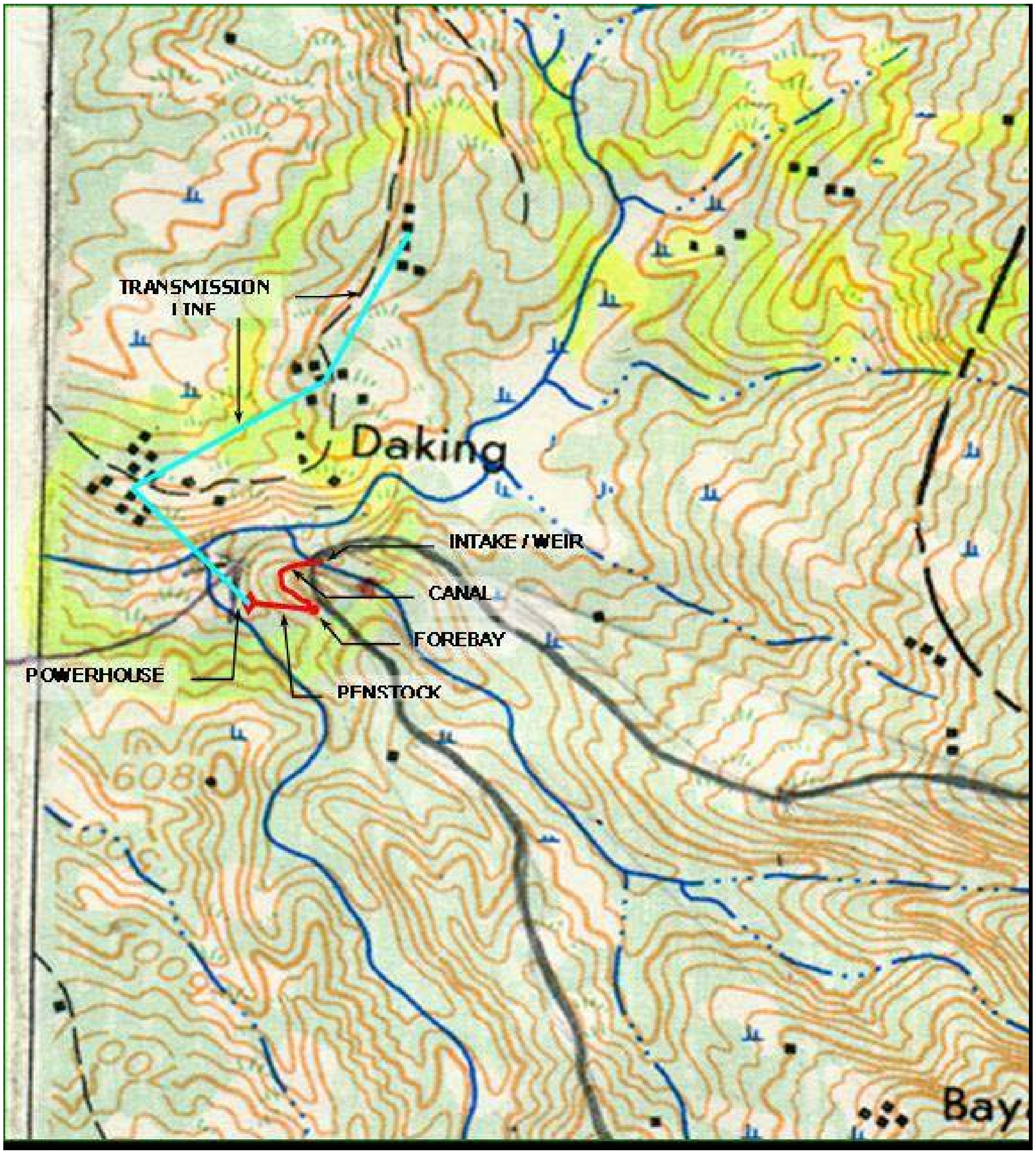


Figure 65. *Lon-oy MHP Project Lay-out*

Powerhouse Equipment and Transmission/ Distribution System

Table 102. *Description of Mechanical and Electrical Components*

Component	Description	
Turbine	Type	Cross-flow
	Manufacturer	Pangasinan State University
	Width	95mm
	Diameter	300mm
	Design power	20 kW
	Design flow	110 l/s
Drive System	Type	Belt Drive
	Type belt	V-belt
	Generator Pulley rpm	1800 rpm
Generator	Type	Synchronous brushed
	Manufacturer	Stamford (UK)
	Rated power	25 KVA
	Voltage	416 V
Load control	Type	ELC
	Ballast	20kW
Transformers	Size	25 KVA 416/220
Transmission Line		3 wire 440 V
Distribution Line		3 wire 220 V

Load

The people of Lon-oy claim that the MHP is exclusively used for household lighting. Though the organization tasked its members to monitor the households with appliances, it is very easy for the households with dual connection to unplug the appliance from the MHP grid if the monitoring team comes.

The five rice mills existing in the village already are still run by diesel engines, but could be converted to electric motors. The bakery oven that uses LPG as fuel could also be converted to utilize the MHP. The total load at present is as follows:

Table 103. *Total Load of the Lon-oy MHP*

Load	Description	Wattage	No of users or units	Hours used per day	Total Load (kW)
Household lighting	CFL and Fluorescent tube lamps	Average 100 W/HH	78	5.7	7.8

Technology Appropriateness

With some short-term technical difficulties the system ran satisfactorily since its installation. The system currently operates whole year, 24-hours daily except during the months of March and April, when there is insufficient water. A 2-hour regular maintenance check (e.g., greasing, bearings check, etc.) of the system is conducted on weekends besides the daily mandatory civil works, powerhouse and transmission monitoring conducted by the operators. The MHP Committee is aware of the need to stock-up on belts, oil and bearings to avoid delay in system's repair should it fail.

Civil Structures

The only major problem that the project has faced rains from super typhoon *Feria* swelled the river and flooded the powerhouse. The system was not operational for 2 weeks. Local operators waited until the floodwaters had receded and it was discovered that some of the meters for monitoring the power output (e.g., ammeter, voltmeter, and kilowatt meter) were damaged.

Figure 66. *Turbine and generator set configuration inside the Lon-oy Powerhouse*

Damaging of power meters was entirely unanticipated but points to a major oversight in the system's technical design. A careful study on hydrology including the prediction of worst flood in 20-50 years, should have taken the safest location for a powerhouse into account.

The powerhouse is located atop a natural solid rock along the converging point of two tributaries of the Baroro River. The powerhouse location was blasted and reinforced with concrete and grouted riprap was added at the base to increase the area available for the powerhouse. The riprap base was washed out during the 2001 typhoon and left a precarious hallowed ground near the entry to the powerhouse. Although, flash flooding has recurred during last year's typhoon season, it caused no damage at all to the MHP scheme.

Electro-Mechanical Components and Control

Aside from the problem discussed above, the system has not experienced any problem in its electro-mechanical component and controls.

Transmission and Distribution System

This installation has not experienced problem in their transmission system so far. However, on the transmission and distribution systems an earth-leakage circuit breaker must be installed to avoid lethal shocks. This device trips if a person comes in contact with bare wires.

Initial Project Effects

From the management interviews and household surveys, early noticeable project effects as articulated by the respondents include the following:

Socio-Cultural

Socially, the electrification scheme has allowed the people of Lon-oy more time to carry out chores and pursue interests. There is more quality time spent with the family as well as socialization with friends and neighbors. Everyone claims a sense of safety in the streets, specially comparing it to the pre-MHP scenario, where people would sleep immediately at nighttime and avoid wandering on the streets. Community issues and projects could easily be resolved and planned-out given the frequency of meetings that can be held and extend even at the wee-hours of the evening.

One negative impact is that the children watch television more, particularly cartoons, which are aired directly after school time. However, one local schoolteacher said that the benefit of having light is now that the children can study later at night if they want to.

Economic

Household income increased by 18% (from P49,000 to P58,000) a year from soft broom making. One particular household attests to the added benefit of having electricity with more income he rakes in from making soft brooms fashioned from the locally grown tiger grass, which he sells in San Gabriel and San Fernando. At nighttime with the help of the children, the family weaves the tiger grass and produces around 6 brooms each night. Before, brooms produced are only 120 each month but with the increased time of weaving, a family can now produce 180 brooms. Sold at P25 per piece, the additional brooms produced translate to an additional P1, 500 per month. Broom making activity however is not a year-round activity as tiger grass can only be harvested once a year and requires drying prior to production. The households engaged in this activity normally makes brooms at least 6 months a year.

There is yet an undetermined number of residents who have ventured into dressmaking and tailoring with the advent of the MHP in the community. The new activities usually done during nighttime and seasonally – depending on outside orders, have thus helped augment family income.

Sectoral Participation

There is a remarkable high regard to the Lon-oy community, through the LCDAI and the barangay officials because of the project. Management attributes this to good leadership and people's participation, which are deemed critical in implementing development projects. Although community participation may not be 100% all throughout, the LCDAI's leadership through astute organizational policies to address this was formulated and applied. Also, noted was the active LGU-participation from the beginning to end of project implementation, and the facilitative role (e.g., organizing, advisory and project coordination) of the church.

This positive character of the people in Lon-oy has reaped them numerous rewards in terms of other community development projects such as waterworks, infrastructural improvements, health and technical services, and even livelihood opportunities (e.g., bakery) mostly from the church and government. The community has consistently topped the cleanest barangay contest in the province for 5 years in a row (since 1999). This is made possible by the village's collective effort that they believe was strengthened by their experience in MHP development.

Financial Analysis

System Cost

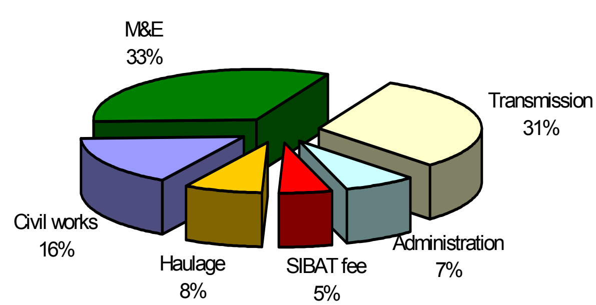
The total capital cost of the Lon-oy MHP scheme, was P1,875,000. The material costs made up 80% of the cost of the scheme in Lon-oy. Haulage, administration (including community organization and training) and the SIBAT fee (including surveys, design and construction supervision) made up the remaining 20%.

The grant amount for the installation was only P 1,595,000. SIBAT covered the deficit amounting to P280,000 out of institutional funds. Pre-feasibility and feasibility studies conducted by SIBAT, as well as post-installation expenses were not included in the project cost. These forms part of the SIBAT counterpart.

The relatively high electro-mechanical costs were mainly due to the 100% import tax charged on the equipment price of the Chinese-built ELCs, i.e. doubling the costs of the imported item.

Table 104. *Breakdown of Capital Costs*

Civil works	P	300,936
M&E	P	616,605
Transmission	P	579,475
Administration	P	131,740
SIBAT fee (supervision)	P	100,000
Haulage	P	146,497
Total		**1,875,253**
	US$	**37,505**
Total grant	P	1,595,000
Cost per Household	**$/hh[48]**	**481**
Cost per kW Installed	**$/kW**	**1,874**



Mode of Financing

The DoE through the O' Ilaw Program for rural electrification contributed the capital cost.

The funds contributed by the DoE were for the materials and does not include labor cost that was provided by the community as their contribution. The owners donated the land

[48] Computed at P50/$

directly used by the project also as their contribution to the project. Rendering material contribution by the community, including free labor, was consistent with the traditional communal practice of ownership and sharing.

For SIBAT, the grant funds fell within the concept of one-time enabling capital costs which included materials and equipment, supervision and training and all that is necessary to install the plant. Said upfront costs install the project which the community will operate and sustain, through returns from the project itself. Hence, operation and maintenance costs, and costs to replace major parts and equipment will be the responsibility of the community.

Operation and Repair Cost

Lon-oy spent less on operation and maintenance, only about 1.6% of the total investment. Of this, 79% has been for the operator's salary and honorarium.

Table 105. *Annual Operational Cost of Lon-oy MHP*

Cost Item	Amount (PHP)	% of Total
Personnel	24,000	79
Maintenance cost	6,040	20
Repairs	250	1
Annual Operational cost	30,290	
Expected Operational cost[49]	18, 750	

Lon-oy's repair cost of P1000 was mainly due the powerhouse repair after a typhoon in 2001. This amount was divided into 4 years to arrive at the annual repair cost of the scheme.

The annual maintenance cost meanwhile was the P4000 annual budget for the belts and bearings and P170/month on grease and lubrication.

Financial Sustainability

Income from lighting is the main source for financial sustainability of the system.

A study of its income-expense records indicated that Lon-oy sustained its operation with an annual net profit of P9,900.

Table 106. Annual Income-Expense for Lon-oy MHP

Cost Item	Amount (P/yr)
Annual Operational Cost	30,290
Annual Income	
Household lighting	40,248

[49] Based on 1% of the total material cost of the project per year.

Household appliances	0
Total actual annual income	40,248
Net profit	9,958

The scheme does not have income from appliance use though there are a number of households with television sets already. The tariff for lighting could be adopted for the utilization of household appliances. It was gathered that the users were not paying for this end use, as the appliance owners' claim that they did not use MHP power for their appliances. This however was difficult to validate.

Quality of Lighting and Replacement Costs

The community is presently using different lamp types that have a significant influence on the amount a household spent on lighting. This is shown in the table below.

Table 107. *Annual Expense for Lighting for Different Lamp Types*

Lamp type	Wattage	Price (P)	Lifetime (H)	Annual replacement cost (P/yr)	Energy Cost (P/kW-hr)	Annual Energy cost (P)	Annual expense for lighting (P)
Chinese SL - CFL[50]	11	90	765	365	2.92	67	432
Fluorescent lamps	10	110	1275	268	2.92	61	329
Philips PL-CFL	18	200	5000	124	2.92	110	234
Philips incandescent bulb	40	25	1020	76	2.92	243	319

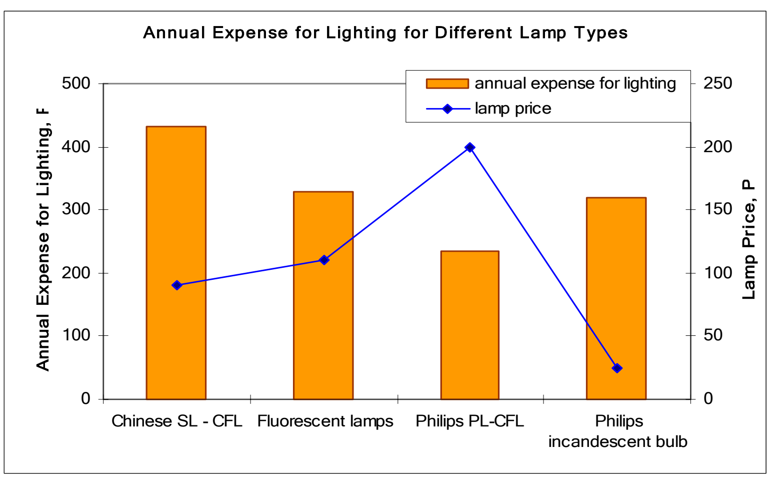


Figure 67. *Comparison of Annual Expense for lighting for Different Lamp Types*

The graph above shows that the households would be better off to purchase the more expensive Philips CFL lamp because this has the lowest annual cost.

[50] Compact fluorescent lamp

Savings with Electric Light

A household spends PhP 780[51]/ yr on kerosene. To determine the savings the household can achieve with substituting kerosene with hydropower, the annual equivalent cost of wiring, replacement cost of lamp and energy cost was computed:

Table 108. ***Annual Cash Savings per HH with the Electric Light***

Cost Item	Calculation	Annual Cost (P)
Cost of wiring	P1,200 / 20 yrs	60
Lamp replacement (for 2 fluorescent lamps)	P268 *2	536
Energy Cost for two lamps	P 61 * 2	122
TOTAL Annual Lighting Cost		718
Saving on Kerosene		780
Annual Net Saving		62

Table 70 above shows that the Lon-oy households saving was small, but could be further improved by increasing the utilization rate of the plant, which would allow to lower the monthly tariff as will be discussed in the next section.

Utilization Rate

The ratio of the total energy used per year to the potential energy production yields the utilization rate of a scheme, which in the case of Lon-oy amounted to 11.4%. This implies that the potential the installation offers was under utilized.

Table 109. *Utilization Rate of Lon-oy MHP*

End-Uses	Energy Consumption (kWh/yr)
Actual Energy Used	16,228
Potential annual production	142,400
Utilization Rate	**11.4%**[52]

The tariff necessary to cover production cost is very dependent on the utilization of the plant in the case of hydropower. This is in contrast to the well known diesel generator set where the production cost per kWh is practically independent on how much it is used. This particularity of a hydro plant needs to be considered when analyzing the financial situation. **Error! Reference source not found.** shows that under certain utilization rate the diesel generator set could produce cheaper energy than the hydro. To take full advantage of economics of a hydro plant high utilization rates needed to be aimed for. The graph also shows that the more energy can be sold the lower the tariff per kWh can be made.

[51] From the actual expenses on kerosene before the MHP of P65/mo
[52] Based on 7300 hr/yr plant operation or plant availability of 83% of the time

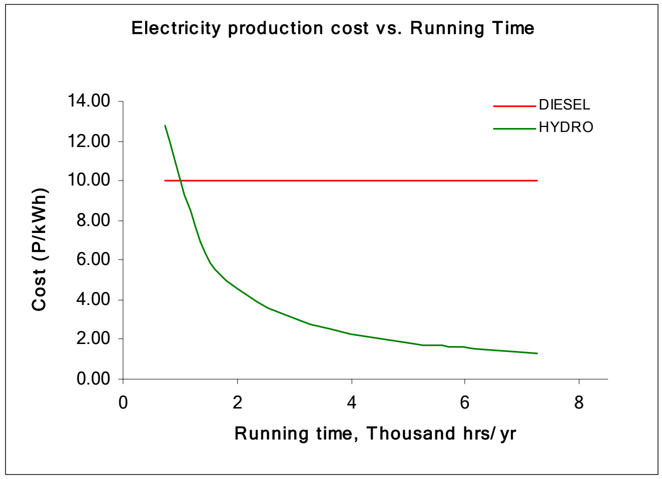


Figure 68. *Production Cost vs Plant Utilization*

Other applications for appropriate end-use or livelihood development could be identified to increase power utilization. Case in point is the gas-fired bakery project by the *Timpuyog* women organization in the community. Producing bread was a seasonal activity, selling mainly during the rainy months where it is difficult for local people to reach the larger bakery in the main town. The feasibility of its conversion to an MHP-powered scheme was examined in this case.

Possibilities to Improve Plant Utilization

As the MHP in Lon-oy is underutilized, it is worth looking into the possibilities of improving the plant utilization given the existing energy end-users that are presently not directly benefiting from the MHP. Possible MHP power user is the bakery and the 5 diesel-powered rice mills in the area. With the continuing price increase of fossil-based fuels, it would be more economical if the women use the MHP power for the bakery instead of using LPG.

Should the women group decide to use MHP and further assuming that the rice mills shift to MHP power; the plant will have an increase in utilization from 11.4% to 15.5%.

Aside from bakery and rice mills, another seen potential to improve plant utilization of Lon-oy MHP is selling power to the local electric cooperative.

Bakery Change-over

An additional source of income of the women is the bakery – a livelihood project set up in March 2001, with funding from the Department of Labor and Employment (DOLE). It was ran and managed by the women's group *Timpuyog Dagitti Babbai iti Barangay Lon-oy*, selling bread and cakes year-round to both the residents and stores in neighboring villages. The peak season was during the rainy season, when access to the main town was hindered by erosions or landslides along the road. This cuts off the bread supply from competing bakeries in San Gabriel, the municipal center.

Fueled by a liquefied petroleum gas (LPG), the oven is located in a building next to the barangay multi-purpose center, and operates with 5 staff per day for approximately 40 weeks per year. The staffs are all members of the *Timpuyog* and were paid P100 per day (per bake). Working at the bakeshop was in shifts of 5 members per day.

The scheme was running successfully for over 4 years. Since the road to San Gabriel is fairly good, LPG supply is readily available but its price is expected to rise over the short to medium term, making conversion of the oven to electric increasingly desirable.

Presented below is the data on bakery operation in Lon-oy.

Table 110. *Summary of Bakery Operation*

Facts:		Assumptions:	
bakes per week	2	kWH equivalent of LPG	36 kWh
LPG used/bake	2.5 kgs	Heating element req'd	36 kW
time to bake	1 hr	energy consumption of the bakery	2,883 kWh/yr
cost of LPG used per bake	PhP 240	interest rate	12%
income	2000 PhP/bake	Loan repayment period	10 years
staff salary	500 PhP/bake		
ingredients	1000 PhP/bake		
months of operation	10		
energy cost	3 P/kWh		
MHP operation per year	10 months/yr		

Table 111. *Cost Comparison Of Using MHP and LPG for the Bakery*

Net Profit Computation	MHP	LPG
cost of new oven	30,000	
annuity for loan repayment	(5,310)	-
annual O&M		
ingredients	(80,000)	(80,000)
energy cost	(8,648)	(19,200)
staff	(40,000)	(40,000)
Total annual Costs	(133,957)	(139,200)
Income	160,000	160,000
Net profit	**26,043**	**20,800**
MHP Income (change - over)	8,648	
Community Income	**34,690**	

Cost comparison showed that even with a loan for a new oven, the community could gain more with the MHP-powered oven compared to that of their existing LPG oven. Should they use the MHP to power their oven, the community could have additional income of more than PhP 8,000 per year from the electricity tariff of the bakery.

If the women organization decides to change their oven to avail of the cheaper energy cost of the MHP, it is recommended that a stone-oven be used instead of the commercial oven. It is unlikely that the oven could be modified to allow it to be powered by the MHP scheme. This is because of the system's capacity limitations. The stone oven could be heated up during the time the villagers switch their lights off and have it ready for baking the following morning.

As the bakery does not utilize power for 24-hours a day, the community can think of other possible end-uses of energy to increase the system's utilization.

Rice Mill Change-over

Some potential end-use suggested by the community for daytime loads included rice mill and sugarcane press. There were 5 diesel-powered rice mills in the area. Presented below is the data on rice production and the rice mill energy consumption.

Table 112. *Energy Consumption of a rice mill*

average rice production	kg/yr/hh	1,050
no of households		152
annual rice milling volume	kg/yr	159,600
milling cost	P/kg	1.00
% of hh using the mill		80%
% rice recovery		70%
milling capacity	kg/hr	150 [53]
effective rice milling hours	hrs/yr	596
rice mill motor	kW	5.0
energy consumption of the mill	**kWhr/yr**	**2,979**

Table 113. *Cost Comparison of Using MHP and Diesel-Powered Mills*

Assumptions	Fuel Consumption	Li/kWh	0.225
	Diesel cost	P/li	39
	interest rate	12%	
	project life	10	
Net Profit Computations		**MHP**	**Diesel**
	Investment for rice mill equipment	30,000	
	Tariff for Electricity	2.92	
Annual Cost	Energy Cost	(8,711)	(26,142)
	Operator salary	(12,000)	(12,000)
	Loan repayment	(5,310)	
	Total Annual Cost	(26,021)	(38,142)
Income	Milling Tariff to cover cost	0.29	0.43
	Actual Tariff charged	1.00	1.00
	Annual volume of rice to be milled	127,680	127,680
	Income w/ P1/kg milling tariff	89,376	89,376
	Net Profit w/ P1/kg milling tariff	63,355	51,234
Community Income	Income generated by the hydro	8,711	
	income generated by the mill	63,355	
	Total Income generated	72,066	
	Rice Mill Owners Net Savings (Change -Over)	12,122	

[53] Milling capacity is given in kg of milled rice per hour

If a rice mill will be installed in Lon-oy, the community can have an additional income of P 92,000/yr. The rice mill owners would have an annual net savings of P12,000 resulting from the lower energy cost of the MHP plant and the community could realize an additional income of P8,700 from the sales of electricity.

Therefore, to convert existing rice mills from diesel to electric will be of economic advantage to both, the millers and the community. It is in the interest of the community if they could identify productive end uses of the energy and aim for a significantly higher utilization of the installation.

Ability to Supply the Grid

As discussed previously, the grid reached the community which could be seen as another potential to improve plant utilization. The villagers having dual connection sometimes used the MHP power as back-up during typhoon months when power from the grid was cut-off.

Assuming the La Union Electric Cooperative (LUECO) agrees to buy the power produced by the MHP, the scheme could have a net profit of 297,800 annually. The energy selling rate assumed in this case was the effective selling rate of the National Power Corporation to the electric cooperatives. In the Philippine setting, these electric cooperatives are the power distributors in the provinces.

Table 114. *Expected net profit if MHP is supplying power to the grid*

Grid Connection		
energy produced by the MHP	kWh/yr	142,400
energy actually used	kWh/yr	22,090
energy available to the grid	kWh/yr	120,310
energy selling rate	P/kWh	3.5
expected income	P/yr	421,086
annual O&M	P/yr	(18,753)
Capital Recovery	P/yr	(125,017)
TOTAL Annual Costs	P/yr	(143,769)
Net Profit	P/yr	277,317

Cost Covering Tariff

As the project is a grant, the cost covering tariff to cover system replacement was calculated such that the village can save the amount needed to replace the system after the project's useful life. To cover system replacement the annual cost of P143,700 was used. This is the project's annual O&M cost at 1% of the investment and P125,000 which is the annual cost of the project in its 15-year project life.

The community's expected performance if the project was funded with a loan component was also analyzed. The schemes cost covering tariff to cover loan repayment was determined using three utilization rates and annual cost of P350,600. This is the projects annual O&M cost that is assumed to be 1% of the investment (P18,700) plus the annual repayment of P331,900 for a loan with 10 years repayment period and 12% interest.

Table 115. *Cost Covering Tariff of Lon-oy MHP*

Cost Item	tariff to cover system replacement	tariff to cover loan repayment and system replacement
System Replacement	75,010	75,010
Annual O&M	18,753	18,753
Loan Repayment (50% of capital)		165,945
TOTAL Annual Costs	93,763	259,708
tariff at 11% utilization	5.84	16.17
tariff at 30% utilization (lighting)	2.14	5.93
tariff at 100% utilization	0.64	1.78

This tariff should be applied by the community in order to be able to service a loan for the capital cost or to replace the system. **Error! Reference source not found.** shows that the community needs to find ways to increase the MHP's utilization in order to afford lower tariffs.

With the community's present tariff on energy, they need to attain 30% utilization rate and 100% collection to have the amount needed for system replacement after 15 years. They can also opt to convince LUECO to buy their excess power such that they can lower down their tariff.

Capability for Loan Servicing

In order to determine the project's capability of servicing a loan, the cost covering tariff was calculated for various levels of loan covering the capital cost of the project. In **Error! Reference source not found.** the tariff necessary to pay the loan and the annual O&M cost is shown versus the loan percentage. For the loan an interest rate of 12% and 10 year repayment period was assumed.

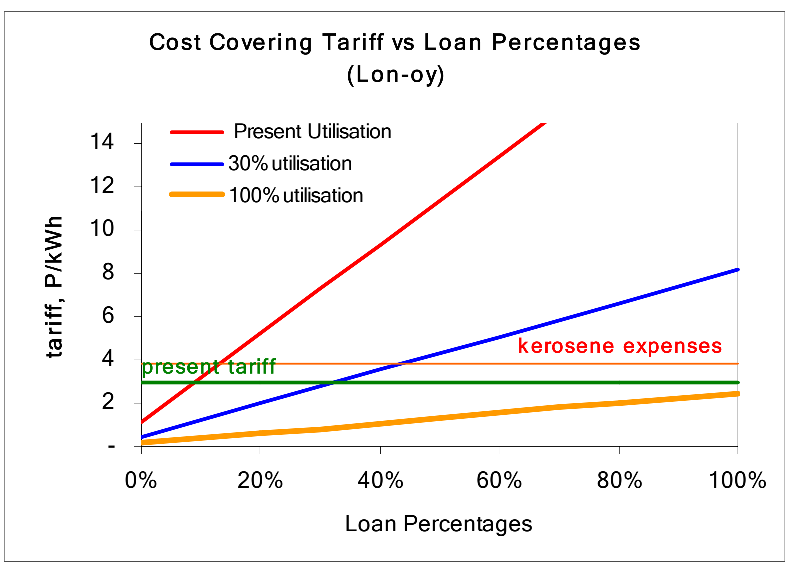


Figure 69. *Cost Covering Tariff w/ Varying Loan Percentages*

The figure above shows that the project can pay for a loan equivalent to 10% of its total project cost at the present plant utilization assuming 100% collection rate.

With increased utilization meanwhile, the blue line represents the maximum utilization rate of the plant for lighting only. At this utilization level the plant is able to cover a 30% loan assuming 100% collection rate. At a 100% utilization, which would be the case if the plant is connected to the grid and could sell all the energy it produces, the plant could easily service a 100% loan even at the present tariff.

The analysis shows that a higher utilization will increase the project's ability to service a loan significantly. This higher utilization can be achieved by livelihood or income generating end-uses and no increase of tariff is necessary. Therefore a loan would not result in a higher cost for the beneficiaries.

Table 116. *Potential Profitability w/ Improved Utilization and Collection Rate*

		Actual Collection Rate	100% collection rate
Annual Expenditures			
Annualized Cost of Replacement		(125,017)	(125,017)
O&M costs (1% of the capital cost)	P/yr	(18,753)	(18,753)
Total actual annual expenses	**P/yr**	(143,769)	(143,769)
Annual Income			
Income from Lighting	P/yr	40,248	46,800
Income from appliances use		0	0
Income from rice mill			72,066
MHP income from Bakery			34,690
Income from LUECO			421,086
Total annual income	P/yr	40,248	574,643
Net Profit at 11.4% utilization	P/yr	(103,521)	(96,969)
Net Profit at 15.5% utilization	P/yr	3,236	9,788
Net Profit at 100% utilisation	P/yr	317,565	324,117

Supposing the community is able to enforce its own policy and obtain 100% collection rate and further supposing that new mill was installed and the bakery used the MHP, the potential income generated by the plant at 15.5 utilization rate could amount to P9,788 annually. The income from the rice mill considered is the net profit of the rice mill (P63,350) plus the income from the sales of electricity to the mill (P8,710). The income considered from the bakery is the income assuming a new oven will be built such that it can be powered by the MHP.

At 100% utilization, i.e. assuming LUECO agrees to buy the unused power from the MHP, the community san have a net profit of P320,000 per year assuming they sell their energy at the prevailing selling rate of NPC to the electric cooperative (P3.5/kWh) and P2.9/kWh to all energy end-users within the community.

As the evaluation already includes the amount to be set aside for the replacement of the equipment after it has reached its lifetime, the savings is available to the people for community development projects.

GLOSSARY OF TERMS

ANEC	Affiliated Non-Conventional Energy Center
Barangay	Officially, the basic local government unit in the Philippines is called barangay. It is referred to here as the main village. It is comprised of several sitios, usually based around a major or strategic settlement called 'sitio proper' which is the main center. A barangay is headed by a village chief or the Barangay Captain.
BMTO	Buneg-Mabaca Tribal Organization
Basi	Local term for fermented sugarcane wine.
Bayanihan	Local common term for a traditional form of community labor practice.
CAR	Cordillera Administrative Region
Cavan	Unit of measure equivalent to 50 kilograms – or traditionally, equivalent to 1 sack.
CBRES	Community-Based Renewable Energy Systems
City/Municipality	A local government unit equivalent of a town comprised of several barangays or villages, headed by the local Mayor. The town center or *Poblacion* serves as the administrative, commercial, economic and socio-political hub of these barangays.
CBO	Community-based Organization (as distinguished from the PO) is a localized association of people or residents belonging to a specific tribe, village or community under a common objective. It is a fundamental requirement for project coordination, implementation, control, management and ownership at the grassroots level.
Currency	The Philippine Peso (PhP) is the monetary unit of the Philippines. Exchange rate used in this document was PhP50 to US1$.
Dapilan	Sugarcane presser or juice extractor machine.
DOE	The Philippine Department of Energy
DSWD	The Philippine Department of Social Work and Development
EDNCP	Episcopal Diocese of North Central Philippines
EDNL	Episcopal Diocese of Northern Luzon
EDNP	Episcopal Diocese of Northern Philippines

FGD	Focused group discussion (FGD) is a data gathering method used in participatory research – done through a meeting of pre-determined set of respondents and conducted with a facilitator, to gather responses from a specific sector or population group represented by said respondents.
GATE	German Appropriate Technology Exchange (GATE), a division of the development cooperation agency of Germany or the *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)*.
KAELCO	Kalinga Electric Cooperative
Kaingin	'Slash-and-burn' cultivation of rice crop commonly practiced in upland areas of the country.
KEEP	Kiyosato Experimental Education Project
kW	kilowatt unit, equivalent to 1,000 watts
kWh	kilowatt – hour
Labor counterpart	This is the provision of unpaid labor by beneficiaries during the construction of a project, as their counterpart investment to the intervention or development scheme.
LGU	The local government unit or LGU is the system or hierarchy of governance in the country. The LGU is responsible for the implementation of national and local government policies at either barangay, municipal or city, provincial and regional levels. It is made up of elected positions (e.g., barangay captains, mayors, governors) who, along with their respective councils, have the power to set local policies or ordinances.
MHP	Microhydro Power Plant having a capacity of not more than 100 kW
MOPRECO	Mountain Province Electric Cooperative
MRDC	Montañosa Research and Development Center
NGO/NGOs	Non-governmental organizations (NGO) are non-stock and non-profit associations, foundations and private organizations which are set up to provide specific development objectives such as reducing poverty, improving healthcare etc. Mostly registered with SEC, their capacities, programs and services vary greatly, mostly working independent of government support and are funded through grant or donations from other funding organizations.
PO/POs	Peoples organization or PO is an association of local people, bonding together under a common set of objectives (e.g., sectoral, political, cultural, etc.). POs may or may not be formally registered with the Securities and Exchange Commission (SEC), Department of Trade and Industry (DTI), or the Cooperative Development Authority (CDA).

Province	The third level of Philippine local government and administrative unit is called province, which is basically a collection of municipalities segregated into districts. The main center seats the *Capitolio* where the political administration, socio-cultural, commercial and major economic activities reside. A governor heads each province.
PVWP	Photovoltaic water pumping
RE	Renewable energy
Region	A region comes next in the level of hierarchy of Philippine local government administrative units. A region is a cluster of provinces usually bonded together not only because of geo-political administration but of socio-cultural relatedness (e.g., language or ethnicity, thus: Ilocos, Bicol, Cagayan Valley, etc.) There are currently 15 political and administrative regions in the country.
Saleng	Local term for pine pithwood, commonly used as source of lighting and fuel in most mountainous communities of the Cordillera region.
SIBAT	Sibol ng Agham at Teknolohiya, Inc.
Sitio	Also called *puroks*, it is the smallest unit of a barangay consisting of clustered settlements of households with a population usually of less than 50 households.
UNDP – GEF SGP	United Nations Development Program – Global Environment Facility – Small Grants Programme