entec Consulting & Engineering

gtz

HOW MICRO HYDRO POWER SYSTEMS IMPLEMENTED DURING ENDEV I ARE PERFORMING

EVALUATION OF A MONITORING SURVEY OF 20 MHP SYSTEMS.

November 2010

Hedi Feibel
entec ag Consulting & Engineering
St. Leonhardstr. 59
CH-9000 St. Gallen
Switzerland
Mail: info@entec.ch
Web: www.entec.ch

TABLE OF CONTENTS

Figures

Tables

Abbreviations

A	Ampere
AD / ART	organisational principles (anggaran dasar) / operational regulation (anggaran rumah tangga)
ELC	Electric load control
Endev	Energising Development; a Dutch Government initiative program to promote sustainable access to modern energy services in developing countries
GOI	Government of Indonesia
hh	Household
IDR / Rp	Indonesian Rupiah
IM	Impact monitoring
KDP = PNPM	Kecamatan Development Program (kecamatan = sub district) = Progrm Nasional Pemberdayaan Masyarakat
MCB	Mini Circuit Breaker (kind of a load limiter; 1 A = 220 W)
MHP	mini / micro hydropower system
MHPP	Mini Hydropower Project Indonesia
MoHA	Ministry of Home Affair
NRM	Natural Resource Management
O&M	Operation and management
PERDES	Village regulation (peraturan desa)
PNPM	National Programme for Community Empowerment (Program Nasional Pemberdayaan Masyarakat
RE	Renewable energies
TSU	Technical Support Unit
UPT	Unit Pengelolaan Turbin, O&M unit of the MHP system
V	Volt
WB	World Bank

Exchange rate (Nov 2010): 1 Euro = 12,360 IDR

1 GENERAL INTRODUCTION

Since the 1990s, GTZ was engaged in the Mini Hydro Power Project (MHPP), jointly implemented with the Directorate General for Electricity and Energy Utilization (DitjenLPE) within the Indonesian Ministry of Energy and Mineral Resources. In 2006 under the Dutch-German co-financed "Energising Development" program (EnDev I), the project directed its attention towards a systematic upscale of rural electrification through MHP project implementation. Between 2006 and 2009, over 90 MHP schemes went into operation. Under **EnDev I**, a number of MHP systems were implemented in cooperation with the Indonesian National Community Empowerment Program for rural areas (PNPM Rural). PNPM – Rural is a community-driven development program implemented by the Directorate General of Village Community Empowerment (PMD) under the Ministry of Home Affairs (MoHA). PNPM-Rural disburses block grants to sub district administrations (kecamatan) to fund small scale rural infrastructure projects identified and prioritized by village representatives through a gender-inclusive, participatory approach. The program first began as the Kecamatan Development Program (KDP) in 1998 – and since this time the majority of participating kecamatans have opted to fund development activities which effect an immediate and tangible impact on their welfare and household incomes. This approach to prioritization has seldom resulted in investments in Natural Resource Management (NRM) projects - as these are typically longer-term initiatives, with benefits and linkages to income generation unknown and/or less immediate to the participating communities. This situation together with budget limitations resulted in:

a) Relatively few MHP systems being built under PNPM
b) Relatively low technical standard of the implemented MHP systems due to the mentioned budget limitations and lack of MHP specific technical know how.

To promote and enable "green" investment opportunities, meaning to develop potential investment opportunities for communities through which they can realize economic benefits while conserving Indonesia's natural resources, the Government of Indonesia (GOI) in 2007 launched a pilot project called "Green PNPM" that provides block grants to communities to be used for sustainable NRM and renewable energy (RE) activities.

Under **EnDev 2**, which started in May 2009, the Micro Hydro Power TSU (Technical Support Unit) was established in order to support the implementation of MHP systems implemented under the Green PNPM.

It is expected that the establishment of TSU will significantly contribute to improve the sustainability of MHP systems, both, from a technical point of view as well as from a management point of view. To facilitate the comparison of results between EnDev I and EnDev II projects and to continuously learn from past experience, the MHP projects are periodically monitored.

This report outlines major findings, observations and recommendations to GTZ pertaining to the quality of MHP installations, the extent of community involvement and technical & financial viability of the installations. This includes suggestions for further actions to be taken by GTZ where appropriate.

2 OBJECTIVE OF THE MONITORING AND METHODOLOGICAL APPROACH

In the context of the present monitoring activities, **20 MHP projects** were visited. 10 of these located in Sulawesi (monitored between 29 Sept 10 and 21 Oct 2010) and 10 in Sumatra (monitored between 6 Oct and 27 Oct 2010). To collect the required information and to provide a maximum of benefit for the concerned village, in each case a hydropower specialist together with the representatives of the operation and management unit (UPT) inspected the MHP site (from intake to powerhouse), checked the book keeping and accounting and discussed all problems related to the hydropower system. Thus, the monitoring approach allowed for a **mutual learning process**, meaning that the UPT received recommendations on how to handle difficulties and the hydropower specialist acquired important input on how future MHP design and implementation as well as training activities can be improved.

13 of the 20 MHP sites had already been previously monitored (most of them in 2009, mainly in Sulawesi), meaning that results of two different monitoring missions can be compared.

The **monitoring questionnaire** (see Annex 2) which was used during the survey is the result of a lengthy iterative development process. Experience gained with the current version of the questionnaire proved it to be an extremely useful instrument which addresses comprehensively all aspects crucial for the sustainability of an MHP system.

Based on this questionnaire, all technical issues, the supply situation, tariff and sanction system, cash flow, O&M and the development of productive use of energy were analysed for each site.

3 BASIC INFORMATION ON THE SELECTED SITES

The following table gives a general overview on the location, monitoring date and surveyor of the selected sites. For sites where this was the second monitoring, the date of the first monitoring visit is mentioned beneath the second monitoring date (e.g. Batang Uru / Ratte) has already been visited on April 20, 2009.

No	Village	province	surveyor	monitoring date	Sub-district	regency
1	Batang Uru/Ratte	West Sulawesi	Abraham	18-Oct-10	Sumarorong	Mamasa
				20-Apr-09		
2	Sipai	West Sulawesi	Abraham	21-Oct-10	Messawa	Mamasa
				19-Apr-09		
3	Rippung	West Sulawesi	Abraham	20-Oct-10	Messawa	Mamasa
				15-Jun-08		
4	Batang Uru / Minanga	West Sulawesi	Abraham	19-Oct-10	Sumarorong	Mamasa
				26-Apr-09		
5	Rantetangnga	West Sulawesi	Abraham	14-Oct-10	Tawalian	Mamasa
6	Lisuan Ada (I) / Tandiallo	West Sulawesi	Abraham	29-Sep-10	Sesenapadang	Mamasa
				29-Apr-09		

7	Paladan	West Sulawesi	Abraham	3-Oct-10	Sesenapadang	Mamasa
				30-Apr-09		
8	Satanetean	West Sulawesi	Abraham	16-Oct-10	Sesenapadang	Mamasa
				29-Apr-09		
9	Rante Puang	West Sulawesi	Abraham	4-Oct-10	Sesenapadang	Mamasa
10	Lisuan Ada (II) / Sepang	West Sulawesi	Abraham	30-Sep-10	Sesenapadang	Mamasa
				22-Apr-09		
11	Sapan Salak	West Sumatera	Suharman	13-Oct-10	Koto Parik Gadang Diateh	Solok Selatan
				1-Jul-09		
12	Limau-Limau	West Sumatera	Suharman	6-Oct-10	Ampat Nagari Bayang Utara	Pesisir Selatan
				28-Feb-08		
13	Wonorejo	West Sumatera	Suharman	21-Oct-10	Sangir	Solok Selatan
				2-Jul-09		
14	Muara Air	West Sumatera	Suharman	3-Oct-10	Ampat Nagari bayang utara	Pesisir Selatan
				9-Jul-09		
15	Sungai Kalu I	West Sumatera	Suharman	12-Oct-10	Koto Parik Gadang Diaten	Solok Selatan
				22-Jan-09		
16	Kubang Gajah	West Sumatera	Zamzam	2-Jul-09	Sangir	Solok Selatan
	Teluk Air Putih	West Sumatera	Suharman	22-Oct-10	Sangir	Solok Selatan
17	Lambah saiyo / Paninggiran Bawah	West Sumatera	Suharman	27-Oct-10	Palupuh	Agam
18	Jorong Pidang	West Sumatera	Suharman	23-Oct-10	Sangir Jujuan	Solok Selatan
19	Kampung nan Limo	West Sumatera	Suharman	18-Oct-10	Sungai Pagu	Solok Selatan
20	Jorong Karang Putih	West Sumatera	Suharman	20-Oct-10	Sangir	Solok Selatan

Table 1: Basic information on 20 selected MHP sites

Kubang Gajah and **Teluk Air Putih** are considered as one single MHP system and as “one site” because of the following reason: Kubang Gajah applied for the implementation of an MHP system but the proposal was postponed / rejected (no clear information given). Among the villages an agreement was made to connect the households of Kubang Gajah to the existing MHP system of Teluk Air Putih. The transmission / distribution line subsequently had a length of 9 km resulting in extremely high losses and a very low voltage level in the most distant households. In the following the supply system of the two villages is considered as one single site.

The following table lists the estimated output capacity of the sites, since how many months the systems are operating and how many households they supply.

MHP site / village	estimated output capacity [kW]	operating since… months	number of hh's supplied	Watt per household
Batang Uru/Ratte	15	24	90	167
Sipai	11	51	71	155
Rippung	5	51	25	200
Batang Uru/Minanga	10	51	46	217
Rantetangnga	5	(48)	50	100

Lisuan Ada (I) / Tandiallo	8	49	90	89
Paladan	9	39	85	106
Satanetean	12	39	62	194
Rante Puang	6	14	89	67
Lisuan Ada (II) / Sepang	10	32	61	164
Sapan Salak	30	32	124	242
Limau-Limau	60	42	106	566
Wonorejo	40	44	115	348
Muara Air	35	14	75	467
Sungai Kalu I	30	35	104	288
Kubang Gajah / TAP	50	36	254	197
Lambah saiyo / PB	20	18	28	714
Jorong Pidang	6	18	25	240
Kampung nan Limo	8	15	34	235
Jorong Karang Putih	25	15	154	162
average	**20**	**33**	**84**	**246**

Table 2: available capacity, operation period, supplied households and wattage per household for the 20 sites

The overall average **output capacity** of all sites is about 20 kW, whereby the average of the systems monitored in Sumatra (on average 30 kW) is three times higher than for the systems monitored in Sulawesi (on average 9 kW).

Although the number of **supplied households** for the Sumatra-sites is on average 100 hh and for Sulawesi only 67 hh, this difference alone would not explain a threefold higher capacity on an average. It must be considered that the **general living standard in Sumatra is significantly higher** than in Sulawesi and therefore people use more electricity at home and thus the MHP systems are designed for higher consumption and higher peak load. Consequently also from a general **technical standard** the MHP systems in Sumatra (mostly concrete channels, often metal gates instead of wooden stop logs, better house installation etc.) can not directly be compared with the more simple, but mostly still properly working, systems in Sulawesi (often earth channels, manual control etc.). In addition, the systems in Sulawesi were mostly built on much lower budgets (per kW installed capacity).

On average the systems which were analysed had been **operating for 2.75 years**, whereby the average operation time of the Sulawesi-sites is 3.3 years (four MHP systems started operation even more than 4 years ago) and 2.2 years. for those in Sumatra.

For **Rantetangga** the operation time is put in parentheses because in that village a land conflict arose and therefore the operation of the MHP was interrupted. Although an agreement with the landowner of the powerhouse area was found even long before the start of construction, the person finally prevented the system from running. After a visit of representatives from the World Bank who investigated the case, these representatives announced that the village would not receive any further support from WB through the PNPM mechanism as long as this conflict was not solved. After lengthy discussions an agreement was reached with the land owner allowing the re-erection of the power house on its original location. At the time of the monitoring visit the re-construction of the MHP system was ongoing. All finances for the re-construction are being covered by the community.

4 MONITORING RESULTS

4.1 Technical aspects

From the 20 sites analysed, only one MHP system was not operating (see explanation on Rantetangga above). All others, i.e. **95 % of the investigated MHP systems are operational**.

The following diagram gives an overview on the **scores (in good / fair / bad condition)** awarded by the surveying hydropower specialists. E.g. weir and intake are considered to be in a good or fair condition for 9 sites respectively, and for the remaining 2 sites the score "bad" was given (in Minanga the gabion weir was destroyed by a flood, see photos 1 and 2 below; and the intake in Kampung non Limo has neither gate nor spillway).

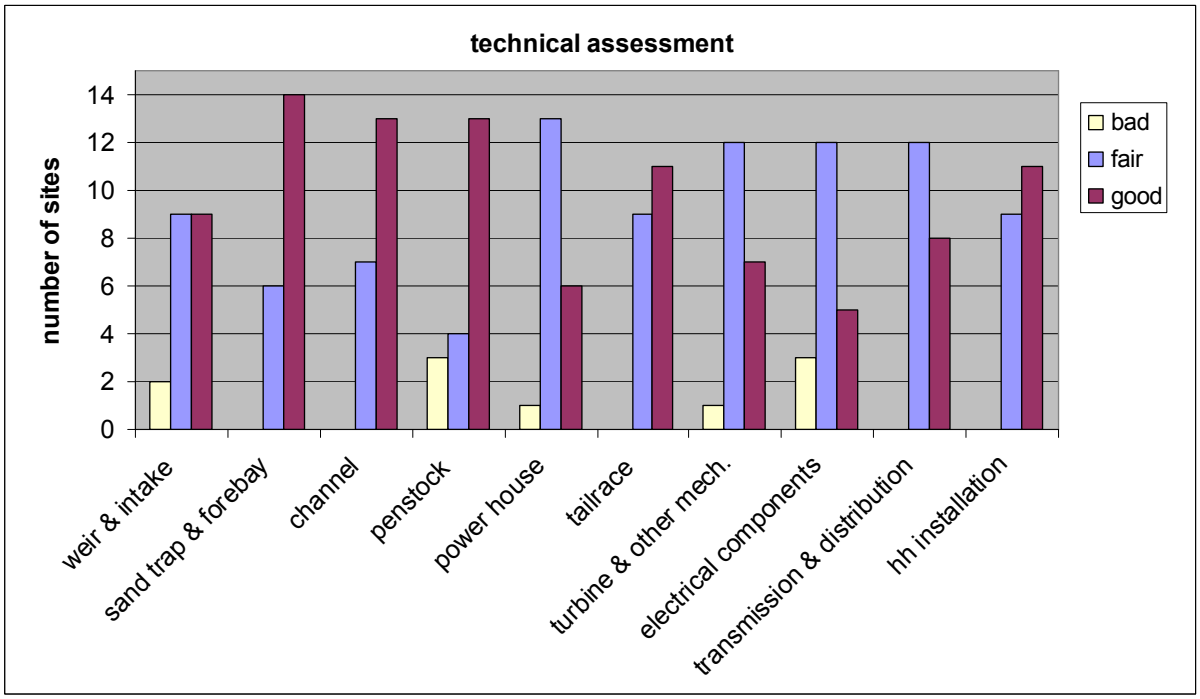


Figure 1: overview on the results of the technical assessment

The "bad" scores for penstocks were given in cases were corrosion (see photo 3 below) or even leakages were visible or where the strength of the thrust block was not sufficient. The "bad" score for "turbine & other mechanical equipment" was given for the turbine in Wonorejo, which can not be closed anymore (problem with guide vane, see photo 4 below).

Photo 1: Weir in Minangga in Nov 07

Photo 2: Same weir in Oct 10

Photo 3: Corrosion at penstock in Wonorejo, Oct 10

Photo 4: Turbine Wonorejo, wooden stick to keep system stopped, Oct 10

Photo 5: Old broken generator in Jorong Karang Putih, Oct 10

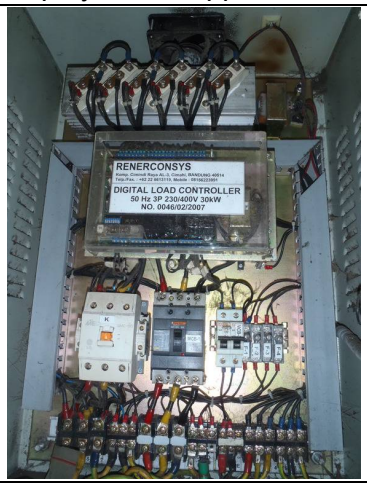


Photo 6: Properly operating ELC in Sapan Salak, Oct 10

"Bad" score for electrical components was awarded for Satanetean were the electric load control is not functioning, for Wonorejo where no ELC is installed and high frequency fluctuations happen and in Sungai Kalu where the voltage is as low as 160 V (frequency meter not working, manual control). Several smaller MHP systems in Sulawesi work properly with **manual control**, however bigger systems with more consumers, who often switch on

and off their appliances, experience difficulties when being controlled manually. This might also be the reason for the fact that in some cases generators had to be replaced even before reaching the end of their service life (see photo 5 above, Jorong Karang Putih).

Some remarks given on the technical issues are as follows:

- Lisuan Ada/Tandiallo: bamboo poles are replaced about every 5 months
- Limau-Limau: already several landslides at channel, continuous repair ongoing
- Teluk Air Putih / Kubang Gajah: due to large number of consumers and high line losses low voltage (150 V) between 7 and 9.30 pm (peak load)
- Lambah Saiyo / PB: operation would be much easier with load control system; manual control difficult for operator (complaining about his difficult task)

Overall the **technical status** of the civil structures, mechanical and electrical equipment is relatively good, because **apart from the above mentioned exceptions all scores given are "good" or "fair"**.

Especially in Sulawesi, it was positive to see how the relatively small and simple systems are properly maintained and partly even systematically improved, as in the case of Sipai. The community of Sipai is presently improving the channel (see Photo 9) and increasing the size and quality of the weir (see photo 7 and 8).

Photo 7: Weir in Sipai in July 06

Photo 8: Weir improvement in Sipai in Oct 10

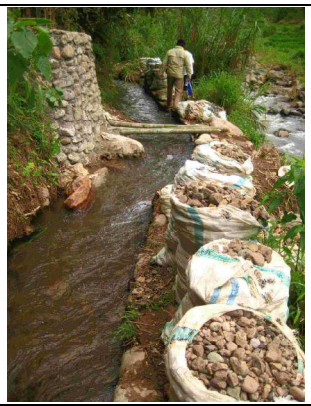


Photo 9: Improvement of channel in Sipai, Oct 10

Photo 10: Well maintained turbine in Batang Uru / Ratte, Oct 10

In the following some good (left column) and bad examples (right column) are presented:

Photo 11: Weir with intake in Sapan Salak, Oct 10

Photo 12: Temporary, instable weir in Wonorejo, Oct 10

Photo 13: Channel in Sapan Salak, Oct 10

Photo 14: Instable earth channel in Satanetean, Oct 10

Photo 15: Clean forebay in Rante Puang, Oct 10

Photo 16: Forebay with inappropriate trashrack in Kampung nan Limo, Oct 10

Photo 17: Penstock in Limau Limau, Oct 10

Photo 18: Anchor block broken due to earthquake, Sungai Kalu Oct 10

Photo 19: Properly operating turbine with generator and protection on belt, Oct 20

Photo 20: Turbine with leakage and too much grease in Sungai Kalu, Oct 10

Photo 21: Concrete pole with well fixed cables in Sungai Kalu, Oct 10

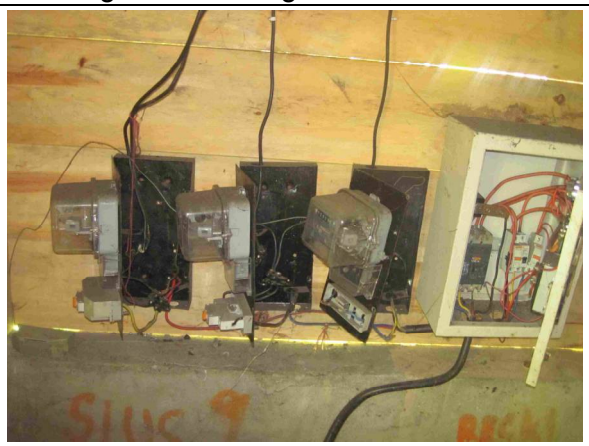


Photo 22: Not well maintained electrical installations in powerhouse in Minangga, Oct 10

4.2 General supply situation

As mentioned previously the general supply situation is assessed as very satisfactory due to all MHP systems apart from one being operational. Currently a total of **1,638 households**

are supplied by the 19 operating MHP systems, corresponding to a **97 % supply of the connected households**.

Interruptions of the operation are often a result of natural disasters like earthquakes (a very frequent reason in Sumatra), landslides and floods. These reasons are often inter related, e.g. a landslide induced by an earthquake. Among the 20 MHP systems, 6 reported interruptions of a few days (maximum 3 weeks for repair work). Regular interruptions due to low flow in dry season were not mentioned in any location. However, the monitoring results on "customer satisfaction" (see also paragraph 4.8) indicates that low voltage in dry season is a problem in some cases.

As shown in the last column of Table 2, on average a capacity of about **240 W is available per household** (minimum 90 W, maximum 710 W). For the sites analysed in Sulawesi the average is around 145 W whereas in Sumatra it is around 345 W. Obviously, the MHP systems in Sumatra, as already explained above, are designed for a bigger load per household.

The consequence of having **more capacity per household available in communities in Sumatra** is that they can also use more different appliances apart from lighting. Based on average household consumption of 145 W for the households in Sulwesi and 345 W for households in Sumatra, Table 3 shows the appliances which can be used (during peak hours). Assuming that not all houses use the full capacity simultaneously the maximum available capacity in a household (off peak times) rather depends on the installed MCB (see also paragraph 4.4).

appliance	wattage
Mixer	100 W
refrigerator	50 – 100 W
Sewing machine (dynamo)	120 kW
Metal grinder	120 W
blender	180 W
Electric blower (2 inch, 3,600 rpm)	250 W
Rice cooker	300-400 W
Drilling machine	350 W
planer	450 W
Coconut rasping machine	500 – 1,000 W
Coffee huller	1,000 W
Coffee grinder	2,000 W
Circular saw	1,500 W

Table 3: examples of appliances and their respective wattages

The **number of households in a "supplied village" which have no electricity** is very limited, on average between 5 (Sulawesi) and 7 (Sumatra) households. The reasons for so few households not being connected are e.g. that they are too remote or that the houses are not used regularly. Affordability of electricity is seldom a reason.

4.3 Social infrastructure

Apart from the normal households, many social infrastructure buildings are supplied with electricity from the MHP systems. Referring to the existing infrastructure in the respective villages,

- 86 % of the existing schools (lighting, sound system, computer, etc.)
- 83 % of the existing health infrastructure (mainly for lighting for evening activity)
- 75 % of the existing community centres and (mainly for lighting)
- 95 % of the religious houses which are churches, mosques, temples (mainly for loudspeaker, sound system, keyboard, lighting, water pump, etc.)

are supplied. This corresponds to an average of **88 % supply of social infrastructure buildings**.

In many cases, electricity is used in schools for the sound system. That means that before starting lessons the pupils do some sports whereby music is played or loudspeakers are used for announcements. It was reported in several cases that the operation time of the MHP system was adapted in a way which allows for these school activities, meaning that switching off in the morning is slightly postponed. The fact that even operational hours of the MHP system are adapted in order to allow the use of sound systems (not only in schools but also in churches and mosques) shows the importance which is attributed to the use of sound systems. They seem to be a symbol of progress and modern lifestyle, as it can also be perceived in many other occasions in Indonesia (marriages, jubilees etc.).

As far as health centres are concerned, it was reported in several cases that having electricity during evening hours allows for extended opening and treatment hours. Especially for midwifes who can not postpone their work and often have to work during night time, lighting and thus electricity very much facilitates their work.

The project strongly recommended introducing a specific tariff for social infrastructure and since state owned schools in general have their own budget, they could certainly afford to pay for electricity. Whether finally a community decides to let schools pay or not is their own decision. In many cases social infrastructure is considered to be useful for everybody and should therefore receive electricity for free.

4.4 Tariff and sanctions

Past experience shows that MHP systems often operate without a proper management system and without having any functioning tariff and sanction system. In this respect, the 20 monitored sites show a significant improvement. **All of them are operated by elected operators who receive a salary and the customers pay a regular tariff.** These two issues are considered as the “basics” for a sustainable operation of an MHP scheme. The crucial disadvantage of the “old system” which implies that households only (!) contribute financially and with manpower in case of a breakdown is that when funds are required to finance repair the funds are not immediately available. Independent of a detailed analysis of the management systems and tariff levels etc., it is clear that **all 20 villages had established a technical and financial management** system. This included regular tariff payment enabling the schemes to pay the operators and management a monthly wage. Subsequently the communities were able to operate the MHP systems **without further external support** therefore being financially self sufficient, except the case of Lambah Saiyoh who received an additional 7 million Rp, about 570 Euro, to repair the channel which was seriously damaged by an earthquake; this amount is not taken into consideration in the column “present savings”

in Table 7. Another exception is Muara Air where money had to be borrowed to pay the salaries, because the collected money from tariff payment was not enough.

All communities properly defined a **tariff system**, whereby

- In 6 cases the tariff was defined according to the number and kind of appliances
- In 1 case (Batang Uru / Ratte) kWh-meters are in use
- In 11 cases the tariff depends on the size of the installed load limiter (amperage of the MCB)
- In 2 cases different systems were applied.

In 11 villages a so-called **"social tariff"** was applied in order not to exclude the very poor households from electricity access. In three cases, the poorest households get electricity for free and in other cases tariffs of up to 10,000 Rp/month (for Sulawesi) and of up to 20,000 Rp/months (for Sumatra) were introduced which are in each case a bit lower than the normal tariff.

In 4 communities a special **tariff for social infrastructure** buildings was defined which varies between "electricity for free" and 15,000 Rp/month.

5 communities have introduced a special **tariff for productive use** of electricity, varying between amounts of 5,000 Rp/hour, 30,000 Rp/day, 50,000 Rp/day etc. In Ratte, the kWh for productive use are read from the electricity meter. These kinds of tariff systems for productive use seem to be still a bit improvised. In between, more specific examples and appropriate methods on how to fix such a "productive use tariff" have been included in the trainings and the new media (films, posters etc.) applied during the training sessions.

All communities use so-called **Mini Circuit Breakers (MCB)**. These have the dual function of providing safety and also limit the maximum load per household. This limitation is important to avoid overload of the whole electricity system and can at the same time also be used as a means of defining tariff classes. However, it has to be mentioned that **the smaller the MCB, the less sensitive they are**. An MCB of 0.5 A which should switch off at a load of 110 W, in reality might switch off at any level between 80 W - 130 W. The size of this sensitivity range depends on the quality of the product and thus also the price of the MCB. To use MCB's to define the tariff system is consequently mainly practiced in villages where bigger size MCB's (1 A and more) are in use.

For the communities monitored in Sulawesi, where on an average 145 W are available per household, mainly MCB's of 0.5 and 1 Ampere (corresponding to 110 and 220 W) are in use, whereas in Sumatra (except Sapan Salak and Muara Air where also 1 A is in use), all other households use MCB's of 2 or even 4 A (corresponding to 440 and 880 W). Thus, the mentioned 50 % of the incidents where the size of the MCB determines the tariff are mainly communities in Sumatra. Communities in Sulawesi, where less capacity per household is available and therefore smaller MCB's are in use, prefer to define the tariff classes as a function of the number of appliances (number of bulbs, TV, radio etc.).

The various **tariff systems** applied by the communities are presented in the Table 4. The calculation of a weighted average results in an overall average of about **18,900 Rp/month**, 13,800 Rp/month for Sulawesi and 22,140 Rp/month for Sumatra. Despite the recommendations given by the project, there is a general tendency for villages to **fix relatively low tariffs**. In addition, **the recommended yearly tariff increases were in most cases not applied**. These two factors may eventually lead to problems. The civil structures and equipment, with increasing age, require more maintenance, meaning that the operational budget will continuously increase. In view of this during the monitoring mission it was made

very clear by the surveyor that a continuous increase of the tariffs is a very crucial issue in order to offset the general price inflation and to be prepared for higher maintenance costs in the future. This issue is also taken into account in the improved training material. E.g. on the poster on tariff system a regular yearly increase of 10 % is recommended.

	tariff 1 [Rp/month]		no of hh	tariff 2 [Rp/month]		no of hh	tariff 3 [Rp/month]		no of hh	tariff 4 [Rp/month]		no of hh	tariff 5 [Rp/month]		no of hh	calculated average tariff [Rp/month]
Batang Uru/Ratte	on average	10'000	90													10'000
Sipai	cat. A	10'000	22	cat. B	15'000	44										13'333
Rippung	cat. A	10'000	19	cat. B	15'000	6										11'200
Batang Uru/Minanga	1 A	10'000	20	2 A	10'000	26										10'000
Rantetangnga	cat. A	10'000	2	cat. B	15'000	37	cat. C	25'000	11							17'000
Lisuan Ada (I) / Tandiallo	cat. A	10'000	72	cat. B	20'000	9	cat. C	25'000	9							12'500
Paladan	0.5 A	15'000	61	1 Amp	30'000	18	6A	180'000	1							20'438
Satanetean	cat. A	10'000	9	cat. B	12'000	3	cat. C	15'000	42	cat. D	17'000	8				14'387
Rante Puang	cat. A	15'000	65	cat. B	25'000	24										17'697
Lisuan Ada (II) / Sepang	cat. A	10'000	47	cat. B	15'000	8	cat. C	20'000	5							11'500
Sapan Salak	2A & 1A	15'000	36	2A+TV & 1A+TV	20'000	88										18'548
Limau-Limau	2 A	25'000	106													25'000
Wonorejo	3 bulbs	27'500	18	3 bulbs & TV	29'500	36	4 bulbs, TV	31'500	33	3 bulbs, TV, fridge	33'500	24	5 bulbs, TV, fridge	35'000	4	30'787
Muara Air	1 A	20'000	9	2 A	30'000	56	4 A	40'000	11							30'263
Sungai Kalu I	2 A	20'000	44	with TV	25'000	60										22'885
Teluk Air Putih + KB	3 lamps	15'000	190	3 lamps, TV	27'500	44	3 lamps, TV, fridge	40'000	20							19'134
Lambah saiyo / PB	2 A	25'000	26	4 A	50'000	2										26'786
Jorong Pidang	social tariff	-	4	2 A	25'000	20										20'833
Kampung nan Limo	social tariff	-	4	2 A	20'000	2	2 A	30'000	32							26'316
Jorong Karang Putih	2 A for poor hh	10'000	10	2 A normal hh	20'000	144										19'351

Table 4: Different tariff systems at the 20 MHP sites

The most frequent **procedure of tariff collection** is customers coming to the management staff to pay their electricity bills. It is applied in 16 cases whereas in the remaining 4 cases the management goes from house to house to collect the tariff. Visiting people at their home allows to put more pressure on them to pay in due time but it is much more time consuming for the book keeper or secretary.

In general, the households had to pay a **connection fee** in order to be connected to the village grid. However in 4 villages people did not pay such a fee. This connection fee in some cases included the household installation and in others not. In many cases it was possible to contribute in labour during construction works in order to work off this contribution. For the monitored sites in Sulawesi the connection fee was in the range of 50,000 to 300,000 Rp and in Sumatra between 25,000 and 1,300,000 Rp per household. This very high amount of 1.3 million Rp was fixed in Teluk Air Putih where it was probably intended to prevent too many households from connecting to a grid which is already overloaded.

In all cases, a connection fee is defined for houses who want to be connected later on. In most cases this connection fee for “newcomers” is higher than the original fee because those connected from the start had mostly participated in the construction works.

All communities, without any exception, have defined a clear and transparent sanction system. In almost all cases this system defines that a customer who does not pay for 3 consecutive months will be disconnected. Late payment normally results in an additional charge or fee. This is usually 10 % of the tariff, 2,000 or 5,000 Rp/month. There was one example where the community applied a charge of 2,000 Rp/day for late payment. In all cases, a disconnected household can only be reconnected if all fines and sometimes also a re-connection fee are paid. In Sungai Kalu, a disconnected household would have to pay one bag of cement and 100 Rp per day (of delay). The definition and strict application of a sanction system is a very useful means to ensure tariff payments are made on time. Only Lisuan Ada / Sepang reported that they had not introduced a proper sanction system. The community had properly defined and agreed that 10 % of the tariff have to be paid for 1 month delay and 20% for 2 months etc.; after 3 months delay the house is disconnected and re-connection costs 350,000 Rp. During the first monitoring carried out in April 2009 the management stated that although some consumers were late in paying, they had not imposed any penalty charge. However, in Sept 2010 they reported a consumer who hadn’t paid for 6 months and was still not disconnected. If the management is not strict enough and such a bad example is given, others might also cease to rely on the sanction system. It must be highlighted that in 9 cases or approximately **50 % of the communities which were monitored, no sanction at all had been applied because so far all people paid their bills**. A total of 7 households in only 4 villages, (all in Sulawesi), have been disconnected due to non-payment of their electricity bill.

It has to be considered that the sanction system can not in all cases be applied too strictly. In many villages (e.g. Batang Uru) people are solvent after harvesting, meaning about every 2 or 3 months and therefore rather pay their tariff 2 or 3 months in advance or subsequently. Without having fixed it in the official rules and regulations this habit is accepted in several villages.

4.5 Operation and management

On an average the MHP systems which were analysed operated **15 hours/day**. Normally, electricity is switched on between 3 and 6 pm and switched off between 7 and 9 am. Batang Uru / Ratte is the only case where the MHP system is operated 24 hours / day. This is because the electricity is used to supply a manufacturing workshop for turbines and accessories which needs electricity during daytime. In several cases, water is also needed for irrigation and thus not available to produce electricity during daylight hours. However, most communities have defined special days (Sunday, market day or Friday) on which the MHP system operates 24 hours.

Table 5 provides a comprehensive overview of the number of **operation and management staff** and their income for each project.

		head of manage-ment		**operator**		**book keeper**		**secretary**		**other staff**		**TOTAL salaries**
	salary system	no	salary [Rp/mo]	no	salary [Rp/mo]	no	salary [Rp/mo]	no	salary [Rp/mo]	no	salary [Rp/mo]	**[Rp/mo]**
Batang Uru / Ratte	fixed	1	50'000	2	150'000	1	50'000	1	50'000	2	50'000	**550'000**
Sipai	fixed	1	30'000	2	100'000	1	40'000	1	30'000			**300'000**
Rippung	fixed	1	-	2	75'000	1	-	1	-			**150'000**
Batang Uru / Minanga	fixed	1	10'000	2	85'000	1	10'000	1	35'000			**225'000**
Rantetangnga	%	1	-	2	297'500	1	-	1	-			**595'000**
Lisuan Ada (I) / Tandiallo	%	1	93'750	2	140'625	1	93'750	1	93'750			**562'500**
Paladan	fixed	1	100'000	2	180'000	1	100'000	1	100'000			**660'000**
Satanetean	fixed	2	30'000	2	150'000	1	30'000	1	30'000	1	60'000	**480'000**
Rante Puang	%	1	80'040	2	180'000	1	80'040	1	80'040			**600'120**
Lisuan Ada (II) / Sepang	%	1	43'022	2	64'500	1	43'022	1	43'022			**258'065**
Sapan Salak	fixed	1	100'000	2	150'000	1	100'000					**500'000**
Limau-Limau	fixed	1	-	1	700'000	1	-	1	-			**700'000**
Wonorejo	fixed	1	100'000	1	600'000	1	100'000	1	100'000			**900'000**
Muara Air	fixed	1	100'000	3	200'000	1	100'000					**800'000**
Sungai Kalu I	%	1	80'000	2	320'000	1	80'000	1	80'000			**880'000**
Teluk Air Putih	fixed	1	250'000	2	625'000	1	250'000	1	250'000			**2'000'000**
Lambah saiyo / PB	fixed	1	25'000	2	65'000	1	25'000					**180'000**
Jorong Pidang	fixed	1	50'000	1	150'000	1	-	1	50'000			**250'000**
Kampung nan Limo	fixed	1	-	2	200'000 400'000	1	0	1	130'000			**730'000**
Jorong Karang Putih	fixed	1	150'000	2	300'000	1	150'000	1	150'000			**1'050'000**
TOTAL		**21**		**38**		**20**		**17**		**3**		**99 persons**

Table 5: O&M staff and their salaries at the 20 MHP sites

As can be seen in the table, many communities followed the project's approved recommendation to nominate **one head of management, one book keeper and one secretary** and for the technical tasks **two operators**.

The **payment system** is either fixed (in 75 % of the cases) or the salaries are calculated as a percentage from the revenues of the respective month. The system based on percentages is applied in 25 % of the cases. Those calculating the salaries as percentage of the income are:

- Rantetangnga: only operators are paid, receive **70 %** of income (!)
- Rante Puang: **50 %** of revenues used for salaries → Head of management, book keeper, secretary get 20 % of the revenues (6.6 % for each) and 2 operators get 30 % (15 % each).
- Lisuan Ada/Sepang: similar to Rante Puang, but only **40 %** distributed as salaries, meaning same payment for the management but only 10 % for each of the operators.
- Sungai Kalu: **40 %** of the total revenues is distributed for salaries

Altogether, 99 persons are involved in the operation and management of the 20 MHP systems of which 11 are working voluntarily without payment. Consequently, for the monitored sites, **88 persons earn an income from the presence of the hydropower scheme, at an average of 4 per site**.

In order to avoid political conflict situations, it was recommended to assign a purely **advisory role to the head of the village**. This recommendation was followed by all communities.

In 12 villages, the **meeting of the general assembly for the MHP system** is held on a regular basis (often once in 3 months) and in 8 villages it is held as required. Typical subjects which are discussed in such meetings are: tariff and tariff increase, reminder of timely payment of electricity bills, financial status report, rules and regulations, operational time, management problems, changes in O&M team, salaries, community work for repair, measures to be taken to protect against natural disasters, technical issues (replacement of poles, generator,…), customer complaints, long term perspectives, etc.

In 9 villages or almost 50 % of the monitored villages, **part or all of the O&M team had already been replaced** by new staff. In some cases where people are not motivated or capable or where even real mismanagement had occurred such a change is unavoidable. However, the discussions with the responsible persons in the villages also show that such changes in O&M staff can seriously jeopardize the effective functioning of a management system. An important shortcoming is the fact that new people did not participate in any of the training programs provided as part of the project implementation. Also if the old staff leave as a result of a conflict situation they might not be willing to hand over the documents, to provide the required information or to even transfer their know how to the their replacements. For example in one case it was stated that the new management did not get the rules and regulations (AD/ART and Perdes) from the former one and the bank account was not transferred. In general, 2 members of the management have the right to sign for withdrawals from the bank account and they have to sign together as a means of mutual control. If one or both of them resign, they should go to the bank together with the new staff members and change the names of the signing persons so that the new staff members get the right to withdraw money from the account (however the rule that 2 signatures are required for withdrawal should be kept).

In **70 % of the cases** the so-called **AD/ART and Perdes** were properly established. In the remaining 30 % of the cases at least a tariff and sanction system was fixed so that basic rules for proper operation and management were agreed upon by the community. However, as soon as serious problems arise as for example the case referred to earlier in Rantetangnga, clear rules and regulations which allow the community to execute its control function are indispensable. If the management would present clear figures (including the

consequence of using 70 % of the income for salaries) most probably more clever people from the community would intervene. Often the combination of more than one shortcoming will lead to difficulties. E.g. Paladan has neither an AD/ART nor a Perdes and also no bank account. Satanetean did not open a bank account because they did not accumulate enough savings. When they had to buy a new generator for 6 million Rp, they took 3 million Rp from the savings and the remaining 3 million Rp were collected from people. Given the fact that Satanetean in the past already experienced many problems as due to mismanagement, it would be important for them to establish a proper management structure. One reason for neglecting these “formal” aspects may again be the fact that the new management staff never received a proper training and preparation.

Unfortunately **only 45 % of the villages use a bank account** for their savings. In this respect, **Lisuan Ada Tandiallo** is a very special case: after a period of putting revenue on the bank account, it was decided to keep the savings in the village and use it as a **kind of micro finance / revolving fund** based on an interest rate of 5 %. Provided the borrowers pay back their loan in time, this is an example of how the revenue from the scheme can be effectively used.

In 70 % of the cases the **blue booklets** provided by the project to facilitate the administration and book keeping procedures were in use. In 20 % of the cases these booklets were lost when the new management took over. In 10 % of the cases the booklets are perceived to be too complicated, whereby one of the persons who gave that answer did not participate in the training. The most frequently used booklets are the ones for tariff registration (70 %), for cash flow (45 %) and debt registration (45 %). In general it can be stated that the book keeping is done properly, meaning that expenditures and revenues are written down in a traceable and comprehensible way.

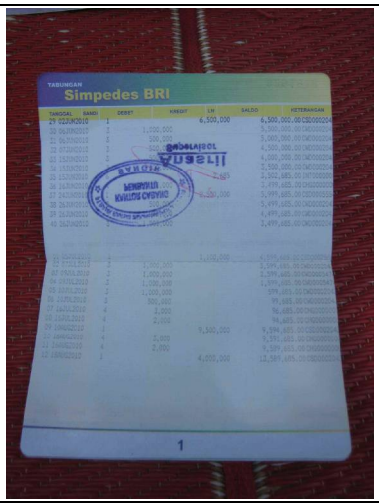


Photo 23: Bank account book of Lambah Saiyo, Oct 10

Photo 24: Blue booklets as used by Lambah Saiyo, Oct 10

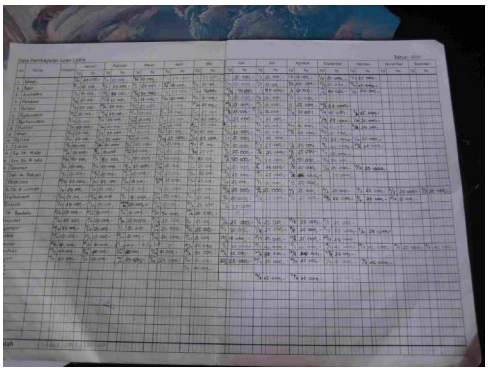
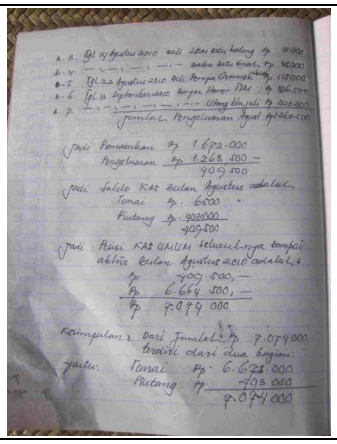
	

Photo 25: tariff payments registered in blue booklet, Lambah Saiyo, Oct 10	Photo 26: book keeping documents from Pante Puang, Oct 10

Changes regarding management issues which happened since start of operation are as follows:

- In 9 villages change of staff
- In 7 villages modification of salaries
- In 4 cases change of tariff and
- In 1 case the content of the AD/ART was changed

In most of the cases (except 2) these changes were decided by the general assembly.

As an example, Rippung, a relatively poor village started with a tariff of 7,500 Rp and then increased it to 10,000 Rp/month. The staff in Rippung first worked voluntarily, then received a salary of 50,000 which was afterwards increased to 75,000 Rp/month. Despite the very limited means of the people, the community tries hard to properly operate and manage the system with low tariffs but also low salaries (see also Table 7).

4.6 Cash flow

Tariff payments as income items and salaries and repair works as expenditure items are the main influencing factors for the cash flow. The following table provides an overview on the **expenditures** as specified by the MHP management staff for the respective villages.

MHP site	**expenditures**				**total**
Batang Uru / Ratte	salaries	550'000	contribution to village budget	50'000	600'000
Sipai	salaries	300'000			300'000
Rippung	salaries	150'000			150'000
Batang Uru / Minanga	salaries	225'000			225'000
Rantetangnga	salaries (70 % of revenues)	595'000			595'000
Lisuan Ada (I) / Tandiallo	salaries	562'500	operational	280'000	842'500
Paladan	salaries	660'000	operational	50'000	710'000
Satanetean	salaries	300'000			300'000
Rante Puang	salaries (50 % of net income)	600'000	operational	100'000	700'000
Lisuan Ada (II) / Sepang	salaries	258'000	administration	70'000	328'000
Sapan Salak	salaries	500'000			500'000

Limau-Limau	salaries	700'000			700'000
Wonorejo	salaries, main-tenance, transport	900'000			900'000
Muara Air	salaries	800'000			800'000
Sungai Kalu I	salaries	880'000			880'000
Teluk Air Putih / KG	salaries (2 operators)	1'250'000	salaries 3 pers. management	750'000	2'000'000
Lambah saiyo / PB	salaries	180'000			180'000
Jorong Pidang	salaries (4 persons)	250'000			250'000
Kampung nan Limo	total operational cost	730'000			730'000
Jorong Karang Putih	salaries (2 operators)	600'000	salaries (3 pers management)	450'000	1'050'000

Table 6: Expenditures at the 20 MHP sites

In some cases the expenditures column already includes the average regular monthly maintenance costs. However, in general the **expenditures can significantly vary** depending on the sporadic maintenance costs which are difficult to predict.

Again, the higher living standard in Sumatra is reflected by the higher amount of salaries paid.

Based on the revenues (calculated from tariff payments) and the expenditures as specified in Table 6 a **(theoretical) monthly balance** can be estimated as presented in Table 7.

	based on information from community		**calculated**	**information from community**	
	total monthly revenues from tariff payment [Rp]	**total monthly expenditures [Rp]**	**"theoretical" monthly balance [Rp]**	**monthly balance as specified by the community (last month) [Rp]**	**present savings (at bank or saved as cash) [Rp]**
Batang Uru/Ratte	900'000	600'000	300'000	600'000	3'200'000
Sipai	880'000	300'000	580'000	315'000	8'204'500
Rippung	280'000	150'000	130'000	-	3'500'000
Batang Uru/Minanga	460'000	225'000	235'000	235'000	561'980
Rantetangnga	850'000	595'000	255'000	150'000	
Lisuan Ada (I) / Tandiallo	1'125'000	842'500	282'500	412'500	3'613'000
Paladan	1'635'000	710'000	925'000	-	
Satanetean	892'000	300'000	592'000	-	
Rante Puang	1'575'000	700'000	875'000	600'000	7'000'000
Lisuan Ada (II) / Sepang	690'000	328'000	362'000	317'000	
Sapan Salak	2'300'000	500'000	1'800'000	1'076'000	
Limau-Limau	2'650'000	700'000	1'950'000	1'950'000	
Wonorejo	3'540'500	900'000	2'640'500	2'489'000	6'000'000
Muara Air	2'300'000	800'000	1'500'000	-	
Sungai Kalu I	2'380'000	880'000	1'500'000	2'080'000	
Teluk Air Putih + KB	4'860'000	2'000'000	2'860'000	2'300'000	13'590'000

Lambah saiyo / PB	750'000	180'000	570'000	570'000	6'000'000
Jorong Pidang	500'000	250'000	250'000	250'000	1'500'000
Kampung nan Limo	1'000'000	730'000	270'000	270'000	
Jorong Karang Putih	2'980'000	1'050'000	1'930'000	950'000	

Table 7: balance resulting from revenues and expenditures and present savings for the 20 MHP sites

The table should be considered as a **rough estimation** since, as mentioned above, the monthly expenditures can vary significantly. To a lesser degree monthly revenues can also fluctuate. If tariff payments are delayed or people pay fines the revenues can be lower in one month and higher in another. This variability of the input parameters is the reason why the "theoretical" monthly balance differs in some cases from the monthly balance which was specified by the management during the monitoring. E.g. in Ratte the paid staff (2 operators) receive only 300,000 Rp and the remaining amount for salaries is earmarked for unskilled workers / assistants, hired on demand. In Sipai, Rante Puang and Sapan Salak the management probably also considered important repair costs besides salaries.

Minangga originally started with a tariff of 15,000 Rp/month (→ monitoring Nov 07) but after requests from some of the consumers it was decided to reduce (!) the tariff to 10,000 Rp/month, which is insufficient to maintain the system on the long run. Up until Sept 2010 Minangga had accumulated savings of 4.86 million Rp (on bank account) of which 4.3 million were withdrawn (most probably for the repair works, necessary after a flood had damaged the gabion weir).

For Rantetangnga, Lisuan Ada / Tandiallo and Kampung nan Limo the **expenditures exceed 70 % of the revenues** which is far too high. Consequently the management needs to either reduce the salaries which will certainly discourage the staff and lead to a deterioration of the performance or increase the tariffs which would be the most obvious solution.

The fundamental advantage of Sapan Salak, Limau Limau, Wonorejo, Sungai Kalu and Teluk Air Putih (together with Kubang Gajah) is that they have more than 100 customers who contribute to a very positive cash flow.

Besides providing an overview on the (possible) cash flow for each MHP system, Table 7 shows that **almost all villages produce a certain surplus** which they (can) save at the bank account. Presently two MHP systems, namely **Kampung nan Limo and Jorong Karang Putih seem to be already in the red**.

Although the cash flow situation can give an indication on the quality of management, a temporary lack of savings or even borrowing money like in the case of Muara Air, does not necessarily mean that the management will soon totally fail. According to tariff payments (a bit more than 2 million Rp) and the amount of salaries (a bit less than 1 million Rp) the UPT of Muara Air should in general be in a position to save money at the bank account. However, it seems that important repair works brought them into the red. Looking at income and expenditures in January 2010 it can be seen that 1.4 million Rp had to be paid for the December deficit so that for January finally the revenues 2.16 million Rp are lower than the expenditures of 3.28 million Rp (of which 1.4 million Rp debt redemption). On the other hand all other expenditures in January are for grease, for employment of labor to repair the damage caused by a landslide, for generator spare parts etc. This shows that the management is still maintaining the MHP in order to facilitate efficient and proper operation. It can be assumed that the management and the community are perfectly aware of the present difficulties, because of the interest payment for the loan which was raised. Thus, it can be expected that such difficulties will help them to learn a lesson. As mentioned under

paragraph 5 a kind of “refresher training” would certainly help the management to put the problems on the table discuss it with others and get input on how to get out of the misery.

In general, the idea of Table 7 to contrast the “present cash flow situation” with a “cash flow situation as it should be” is quite critical because real revenues and expenditures are difficult to predict. During the very first monitoring mission the whole cash flow was still more or less easy to track. However, after more than 2 years of operation it gets very difficult to follow-up, because the expenditures vary significantly. If a landslide destroyed the channel, some cement has to be bought, workers are paid, or if a new generator had to be bought etc. then too many different expenditures, even relatively big ones, happened and the “theoretical cash flow” is quite different from the real one.

Looking at Table 7 and dividing the figure in the last column (present savings) by the figure in the forth column (“theoretical monthly balance”), it can theoretically be calculated in how many months these savings could be accumulated. However, this calculation might be very misleading. Villages which properly maintain their system and always make all necessary repair might have less money on the bank account than those who keep the money without spending, even if repair would be necessary (to avoid bigger disaster later on). Even during the first monitoring it became already obvious that in villages where the MHP system was very well maintained, the current amount of savings was relatively low, simply because the money was spent for useful repair.

In some cases, the **reasons for management problems** are not very obvious. Some observations such as change of management staff, bank account not existing, no clear regulations etc. indicate potential mismanagement. In Table 8 villages are marked in red where a management change already happened and where no bank account existed (or is presently in use). In the case of Satanetean for example, a bank account had already been opened when operation started. When the first monitoring (November 2007) was carried out they had a bank balance of 7 million Rp. Following the change of management the bank account is no longer in use. In Limau Limau and Jorong Karang Putih the situation is similar.

It can certainly not be denied that **staff continuity** is an important success factor for the financial management as well as for the technical operation. The longer a person fulfills certain tasks the more experience is accumulated which can not easily be transferred to different person. It might turn out, already during the first few weeks or months of operation, that the originally elected staff are not appropriate for their tasks, in which case it is certainly advisable to quickly replace the respective persons. Again, however, the problem arises that this replacement staff have not had the benefit of the preparatory training provided as an integral part of the initial project implementation.

	change in staff	bank account	important comments (on changes)
Batang Uru/Ratte	yes	no	
Sipai	no	yes	tariff increase from 7'500 > 10'000>15'000 and from 25'000>30'000
Rippung	no	yes	increase operator salary from 50'000 to 75'000; increase tariff from 7'500 to 10'000
Batang Uru/Minanga	yes	yes	once tariff increased to 15'000, then the people asked and agreed to decrease to 10'000
Rantetangnga	?	no	interruption of operation due to land conflict
Lisuan Ada (I) / Tandiallo	yes	no	money not saved in bank anymore, but revolving in the village as (kind of) a credit with the interest 5%

Paladan	no	no	(have no AD/ART and Perdes)
Satanetean	yes	no	at the beginning had a bank account at BPD at about 30 km distance, transport cost 50,000 Rp, went there every month (Nov 07: 7 million savings), but due to mismanagement new management elected in April10
Rante Puang	no	yes	
Lisuan Ada (II) / Sepang	no	no	management is too neglectful to open bank account
Sapan Salak	yes	no	
Limau-Limau	yes	no	old management had bank account; new management intends to open a new one; with old management operator got Rp 500'000, with new one he will get Rp 700'000 (only 1 operator, no other staff)
Wonorejo	yes	yes	management was changed just one year ago
Muara Air	no	no	no change since start of operation
Sungai Kalu I	yes	no	replacement of old management by new one; total of salaries should be 40 % of revenues; monthly tariff same for all but for additional electric device + Rp 5000.
Teluk Air Putih / KG	yes	yes	two of the staffs were replaced (head and book keeper)
Lambah saiyo / PB	?	yes	
Jorong Pidang	yes	yes	2009: change of head of management, secretary and book keeper
Kampung nan Limo	?	no	2 months ago: tariff increased by 2'000 Rp/month, operator salary also increased from 450'000 to 600'000 Rp; **BALANCE PRESENTLY NOT SUFFICIENT**
Jorong Karang Putih	yes	no	after short time management already changed! **PRESENTLY NEGATIVE BALANCE**

Table 8: Juxtaposing of different weak points like change in management and existence of a bank account; with comments (from the surveyor and the management)

Looking at the case of **Kampung nan Limo** where the management obviously noticed that the “saldo is presently not sufficient”, the proposed changes in tariff and of the salary levels will certainly not lead to any improvement of the situation. If the salary of the operator is increased by 150,000 Rp and the tariff is increased by 2,000 Rp/months, a number of 75 paying households would be required to compensate for this salary increase. However, Kampung nan Limo has only 34 customers.

Although the situation in a number of villages may soon become critical, some obviously already understood the problem and have initiated the necessary measures to overcome the problems. Sipai for example has applied a tariff increase. The **monitoring mission itself** where discussions were held on cash flow situation, lack of savings, tariff and salary levels etc. will certainly have a **positive impact and provoke further discussions amongst management and community** and thus (hopefully) induce changes. In Annex 1 the recommendations as discussed and agreed upon between the surveyor and the respective management unit are exemplified for Sulawesi.

4.7 Productive use of energy

Although lighting and TV are the most obvious and appreciated changes brought by electricity, a more in-depth analysis proves that many other appliances, also for so-called productive purposes are in use. Table 9 summarises the number and kind of appliances encountered in the villages. It distinguishes between two different cases:

- Due to the availability of energy / electricity from the MHP system, a fossil fuel generator (diesel or petrol) is **replaced**; in this case a **pale blue** marker is applied
- A **new machine** is installed (creation of a new productive use) due to the availability of energy / electricity from the MHP; in that case a **dark blue** marker is applied

Two rice threshers and 4 rice hullers are “directly driven” by the turbine of an MHP system, meaning that they are installed in the powerhouse, beside the turbine. The installation of these machines (as well as the coffee mill, which is electrically driven) was supported by the project itself. For unknown reasons one of the rice hullers (the one in Minangga) is not operational at the moment.

The most impressive example of productive use is certainly **the MHP system in Ratte where three lathe machines, one welding machine and a compressor are supplied with electricity**. The machines belong to a turbine manufacturing workshop, whose owner made a special agreement with the management whereby he receives the electricity for free for his workshop and in return he is responsible for all necessary mechanical and electrical repair work at the MHP system.

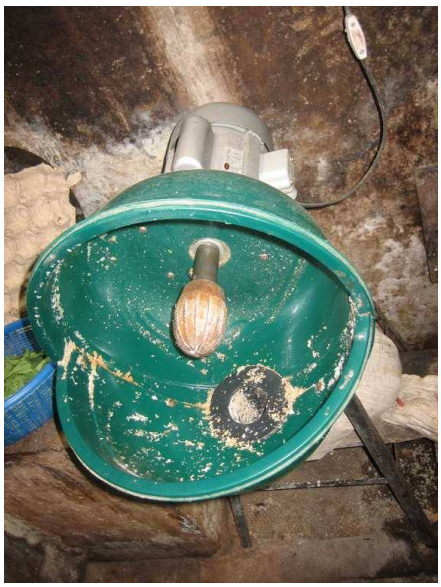
Many carpenters used diesel or petrol gensets prior to the presence of the MHP, for which they incurred relatively high costs as the diesel price has increased significantly over the past 5 years. It seems that many **carpenters now enjoy cheaper electricity from the MHP systems**. The increase in the total number of carpentry machines is likely due to the switch from manually operated machines to electrical ones and the fact that there is more carpentry work carried out in general than in earlier times.

The use of **coconut rasping** machines also became very popular as can be seen with a tenfold increase in their number following the presence of the MHP (all in Sumatra).

kind of machine / appliance	before MHP existed		after MHP was installed	
	no	energy source	no	energy source
rice thresher	5	diesel	5	diesel
			2	MHP
rice huller	19	diesel	19	diesel
			4	MHP
rice mill (for rice flour)	6	diesel/petrol	6	diesel/petrol
coffee huller	14	diesel/petrol	17	diesel/petrol
			2	manual
coffee mill (for coffee powder)	1	diesel	2	diesel/petrol
			1	MHP
coconut rasping machine	15	petrol	278	MHP
lathe machine			3	MHP
welding machine	1	diesel	1	diesel
			1	MHP

compressor	3	petrol	3	petrol
			1	MHP
angle grinder	9	diesel	6	diesel
			1	MHP
planer	32	diesel/petrol	20	diesel/petrol
	6	manual	42	MHP
	20	PLN		
circular saw	5	diesel	7	diesel
			1	MHP
drilling machine	8	diesel/petrol	4	diesel/petrol
			38	MHP

Table 9: machines in use before and after MHP started operation and their respective energy source



Coconut rasping in Muara Air, Oct 10

Directly driven rice huller (left) and thresher (right) in Lisuan Ada Tandiallo, Oct 10

Productive use not only happens in workshops but also in a **household environment.** Ice, juice and cookie production are examples of small scale income generation. Sewing and ironing can also create additional income. Given this backdrop questions relevant to these initiatives were raised during the monitoring. Table 10 provides an overview on the results.

Overall at least 2 more persons are now using their sewing machine for income generation, one person uses a blender to sell fruit juice and 11 more fridges are now in use for income generating purposes.

If we look at the enormous increase of appliances for private use, including blender, mixer, fridge, rice cooker and magic jar, it **can be concluded that women's workload is significantly reduced**. Before electrification all these activities, like rasping coconuts, chopping chilli etc. had to be done manually. Now they can easily be done by means of electric appliances. From other surveys, we know that women before having electricity cooked everything (also the rice) with firewood. Their irons also worked with firewood. Using electricity for these appliances reduces their workload because they have to collect and carry less fire wood. Consequently they save a lot of time and enjoy a more comfortable life.

The **massive increase of battery and mobile phone chargers** provides a number of "secondary" positive impacts: less problematic battery waste due to use of rechargeable batteries, better communication facilities due to the possibility to recharge mobile phones and various other downstream impacts related to improved communication. It must be stressed that especially in Sulawesi where access is often a problem, communication with mobile phones is deemed by the communities as a major factor contributing to improved welfare (health, business, etc.).

kind of machine / appliance	before MHP existed		after MHP was installed	
	income generating	not income generating	income generating	not income generating
sewing machine	3	28	5	27
ironing		617		642
	of which min 40 with coal		of which min 100 with MHP	
blender		12	1	281
mixer	1	5	1	206
fridge	3	5	14	43
rice cooker		24	2	622
magic jar (keeps rice warm)				150
battery charger				686
mobile phone charger		25		1'131
electric water dispenser				10

Table 10: kitchen and household appliances in use before and after MHP started operation and their respective energy source

4.8 General changes and customer satisfaction

When asked whether any **change in income** happened due to the availability of electricity from the MHP system, the changes mentioned by the respondents are as listed below. If aspects are mentioned more than once the number is given in brackets:

- lamp warmer for chicken breeding (2)
- palm broom maker, craft from bamboo etc.
- change in income due to extension of work until late evening (4)
- harvest from fields and forest can be processed during evening hours (3)
- activities during evening hours: processing of cinnamon, coffee, forest products (usually pines gum)
- sewing machines for productive use at home
- better harvest since rice fields are protected from wild pigs with low voltage fence
- the livestock are saver because of light during the night
- change in income due to better business of small kiosks (ice, coffee...)
- selling ice
- embroidery business grew after MHP operation
- awareness of community on information
- more carpentry activities / industry

Changes related to expenditures mentioned by the respondents are:

- expenditures for kerosene consumption reduced (9)
- Before MHP expenditures for kerosene for lamps and stove around 50'000 to 100'000 Rp/month! Now expenditures significantly reduced
- now only rarely buy battery for torch (2)
- people buy more electric appliances
- live style changed, more consumptive (5)

Changes related to "spending time" mentioned by the respondents are:

- children can study in the evening (10)
- children can make handicraft in the evening
- go to bed at 11 pm instead of 7 pm
- go to bed at 11 pm instead of 8 pm (3)
- more activities during evening hours
- go to bed late because of watching TV (2)

Under the category "other changes", the easier access to information through TV was mentioned 3 times.

Table 12 lists the customer complaints and the "unsolved problems" as they were mentioned by the management staff.

	customer complaints	**unsolved problems**
Batang Uru/Ratte		
Sipai	**tariff** a bit too high	
Rippung	for some people it is difficult to pay **tariff**	difficulty to **convince people** to pay the tariff
Batang Uru/Minanga		
Rantetangnga	electricity sometimes **unstable**	fixing the **generator**
Lisuan Ada (I) / Tandiallo	during dry season **quality of electricity** sometimes decreases	
Paladan		management has difficulties to **execute decisions** that were agreed in the assembly meeting
Satanetean	community wanted to change **management staff;** management is still **not sufficiently transparent** to customers	**ELC** broken, they do not know whom to contact
Rante Puang	during dry season **quality of electricity** sometimes decreases	
Lisuan Ada (II) / Sepang	comment November 07: Customers are very satisfied with affordable electricity. The PLN line reached the village in 1995, but only 2 hh are connected to PLN because so far no other hh could afford the connection fee of 3 million Rp!	

Sapan Salak	**low voltage** between 7 and 9 pm (180 V), then normal again	
Limau-Limau	sometimes **unstable voltage** (destroys electronic appliances, also bulbs)	difficulty to replace 200 m **transmission line** and how to make **concrete poles** (to replace wooden ones)
Wonorejo	**low voltage** (160 V) especially in remote locations; bulbs broken	
Muara Air		**runner** already 2 times broken, **bearings** already changed 2 times, bearing of generator changed once
Sungai Kalu I	at low flow in river only electricity for lighting, then other appliances have to be switched off	
Teluk Air Putih / KG		
Lambah saiyo / PB		
Jorong Pidang		
Kampung nan Limo		
Jorong Karang Putih	sometimes electricity interrupted, electronic appliances break down fast, bulbs quickly broken due to **low voltage**	

Table 11: customer complaints and "unsolved problems" as reported by the management staff

5 CONCLUSIONS

Conclusion 1:

Setting very clear rules for financial management including use of generated revenue is extremely important. Although a specific cash flow calculation for each site is necessary to accurately project cash flow, it seems more viable to provide clear guidelines to the management personnel on how to calculate operating costs and suitable tariff conservatively (i.e. on the "safe side" - see posters in Annex 3). Firstly, a **tariff of 35,000 Rp/month** is generally recommended as reasonable. Secondly, as far as the allocation of the budget is concerned it is recommended to assign **5-10 % for "daily routine"** (small spare parts, tools, grease etc.), **20 % for the salaries** and **70 % should be saved at the bank**. Although it is unlikely the guidelines will be followed entirely, experience indicates a significant increase in awareness of the management personnel can be achieved.

Conclusion 2:

There are two main reasons, why **the concept of providing one single training session before the start of operation of an MHP system should be reconsidered**:

1. the monitoring allows for the conclusion that, especially with management problems, the communities are a bit left alone, once the MHP system has started operation. Although O&M staff participates in a comprehensive and professional training adapted to their needs, the participants will only encounter their specific problems once they started to apply what they learned. If the staff would get the opportunity, after e.g. the first year of operation, to participate in a **short refresher course whose main topic would be to answer questions which have arisen so far and to facilitate the exchange of experience between different villages** this would decisively contribute to the long term sustainability of MHP systems

2. The monitoring clearly shows that often management problems arise as soon as the O&M team is replaced and new staff which is too inexperienced and who never participated in any training takes over. The short refresher course would give these communities a kind of a **"second chance" to get some motivated new staff trained** and at the same time they could also benefit from other participants' experience.

Conclusion 3:

As far as technical issues are concerned, the monitoring showed again that a proper and easy to handle **load control system** plays an important role in the efficient and proper operation of a MHP scheme. The questions on customers' satisfaction revealed that voltage fluctuations in many schemes causes damage to electrical appliances and sometimes even the generator which is then even more expensive to replace. With a properly functioning load controller, there is much less likelihood of damage to electrical appliances. The downside of load controllers is that during periods of low flow and reduced output, supply will be switched off. Although manually controlled schemes can continue to operate albeit at a lower voltage, electronically controlled schemes will normally switch off when the voltage drops below a certain level. .

Conclusion 4:

As illustrated on the following two photos, **training of turbine manufacturers** in Sulawesi has had a major impact:

turbine from Endev I phase

turbines of the same manufacturer, today

Turbine manufacturers in Sumatra would definitely also benefit from trainings on certain technical details:

Conclusion 5:

Floods and landslides are important cost factors. The can result in enormous repair costs. The impact of a flood on the MHP system can be minimised by a proper design of the weir and intake, Enhanced measures for **erosion protection and control** should also be given more attention during the design and construction of schemes.

One of the general dilemmas of the project is that the main focus of TSU and thus the assignment of its resources are very much focused on electrifying as many villages as possible. Additional trainings or “refresher courses” would be extremely useful but would require additional resources. An upcoming question would also be whether Endev I sites can still receive additional support. Currently, once an MHP system starts operation apart from selective monitoring no further (regular) activities from TSU side are scheduled. Thus, the project has no more real “access” to these operating sites. Therefore, a “refresher meeting” would be a very efficient way of addressing these communities. Management staff could bring their blue booklets, sit together with UPT staff from other villages and check who follows the rules and who does not, why not and what are the problems, how can they be solved. During the monitoring visit many issues have already been discussed (too low tariffs, no regular tariff increase, no bank account etc.). It is also part of the monitoring guideline to make a kind of “to do list” together with the management staff at the end of the interview. However, during a monitoring visit so many questions have to be considered that time is not sufficient to go into all details of book keeping and very specific details. Such issues could easily be solved in a kind of a workshop where management staff with all there experience can come together to compare and discuss their problems.

Another idea would be to establish a kind of MHP association e.g. in Mamassa area which would need some support at the beginning but which could become a permanent institution. Such an association could besides implementing trainings also offer a stock of spare parts provide technical support for more difficult issues which can not be solved by operators. Communities could become member of the association and pay a certain contribution/membership fee.

The training material which was significantly improved based on the outcome of former monitoring missions can be used but for refresher trainings. It would probably even be sufficient to facilitate the gathering of people provide them one or two resource persons and then work on the problems which they bring forward. Even a re-definition of the “institutional set-up” could be considered in a sense that not only the MHP unit on village level is in the focus of interest but also higher levels (e.g. regency) where other MHP stakeholders could also be included (manufacturers, NGOs, MHP developers etc.). An organization on a higher level could accommodate various needs of its members, knowledge exchange etc.

ANNEX 1: RECOMMENDATIONS AS DISCUSSED AND AGREED BETWEEN SURVEYOR AND MANAGEMENT UNITS

Batang Uru / Ratte	**Sipai**	**Rippung**	**Batang Uru / Minangga**	**Rantetangnga**
• prepare AD/ART and perdes • improve the tariff record • plaster the power house wall • buy toolkit • provide belt protector • repair the flushing gate • change poles where necessary • repair the tailrace • prepare access bridge to power house • obey the regulation	• change poles where necessary • weld the leaking turbine housing • clean the channel at least 4 times/year • forceful to comply the regulation • use the administration book properly • discuss tariff increase of 5-10% per year	• convince people about importance of tariff payment • clean the cable network from branches & twigs • re-align the poles upright • tighten the distribution cable • clean up bush along the channel • remove sediment • clean power house • prepare documentation for every activity	• separate the customer and tariff data into 2 books • implement AD/ART • repair gabions • repair poles and align them upright • keep the power house clean	• improve the book keeping • apply the regulation
Lisuan Ada / Tandiallo	**Paladan**	**Satanetean**	**Rante Puang**	**Lisuan Ada / Sepang**
• penstock repair • upgrade administration • remove sediment • clean the cable network • re-align the poles upright • conduct general assembly to discuss tariff increase every year	• collect the unpaid tariff ASAP • improve the administration • open a bank account	• repair floor and wall of power house • buy toolkit • install belt protector • fit one lamp in power house • cleaning the channel • repair ELC • clean the cable • change poles where necessary • re-align the poles upright • tighten loose cables	• open bank account • buy toolkit • clean the cable network from tree branch • prepare to increase the tariff 5-10% per year	• improve the book keeping • management should enforce the rules • cable network and poles should be checked • pay the tariff on time • change the o-ring • protect the penstock adapter from rust

Table 12: recommendations as discussed and agreed with respective management staff as conclusion from monitoring (example: Sulawesi)

ANNEX 2: GUIDELINE-MONITORING

Last Writer:	**Writer:**	Last Date:	**Date:**	**Pages:**

Site data

Village Name		Kecamantan (sub-	
Kabupaten (district):		Province:	
Respondent(s) during main			

I. Technical aspects

take photos !!!		**Condition** Good=1, fair=2, bad=3			**Remarks**
Last result ▼		**1**	**2**	**3**	***Please give tick mark(✓)***
Weir and intake	5				
Headrace channel	5				
Sand trap / desilting Basin	5				
Forebay & Spillway	5				
Penstock	5				
Power house	5				
Tailrace	5				
Turbine & other mechan. components	5				
Electrical components ❑Manual ❑Electronic control	5				
Transmission and distribution lines	5				
HH installations	5				

Further remarks, problems mentioned by operator/s etc.

II. General supply situation:

Output **capacity**	999 kw		**Start** of MHP operation	05/2006	

Interruption in dry	ye s	❑Yes	no.of weeks/months of	99 months	

No. of **connected HH:**		No. of "reachable" HH which are **NOT connected** ?		
999 HH	HH	99 HH		▶why not connected ?

III. Operation and management

the **salaries**	defined as % of the revenues	❑fixed amounts	❑defined as % of the revenues

Operator/s	Number		Salary of each (Rp)	
Men	99		9,999,999	
Woman	99		9,999,999	

Bookkeeper/s				
Men	99		9,999,999	
Woman	99		9,999,999	

Management				
Men	99		9,999,999	
Woman	99		9,999,999	

Has **Kepala Desa** an official role in	Ye s	❑Yes	If so, which	

Any additional	Yes	❑Yes	If so, how	

Problems with staff (someone already replaced since start of	Yes	❑Y	❑No
▶Is there any complaints from customers?			

Village **meetings on MHP**: Number of meetings since start of operation?			
99 times; regular meetings	times	❑regular	❑ on
▶specify which issues were mainly discussed so far !			

Is a **"Perdes" / regulation** established and are all rules	Yes	❑Yes	❑No
▶ If no, why not ?			

Are the **blue template booklets** from MHPP in use ?	Yes	❑Yes	❑No
▶ If no, why not ?			
Suggestions for improvement ?			

IV. Tariffs and sanctions

What kind of **tariff system** is applied	❑ Depending on number of appliances	❑ Per kWh
Depending on number of appliances	❑ According to social status	❑ Other; specify ▼

Special **"social tariff"** for the	Yes	❑Yes ❑No	How	99,999	
Special tariff for **social**	Yes	❑Yes ❑No	How	99,999	
Special tariff for **productive use**	Yes	❑Yes ❑No	How	99,999	

regular **tariff increase** (e.g. 5% per year)	Yes	❑Yes ❑No, if yes, how much ?

Are **MCB's** in use ?	Yes	❑Yes ❑No	size :	❑0.5 A	❑1A	❑2A	❑3A	❑4A	❑No
different size in different hh's ?	Yes	❑Yes ❑No	Do several hh's share an MCB ?	Yes	❑Yes ❑No				
▶ describe the system applied !									

how many hh's pay which tariff per month?					
	No HH		**Tariff (Rp)**		**Total collected amount**
Tariff 1	999		99,999		

Tariff 2	999		99,999		
Tariff 3	999		99,999		
Tariff 4	999		99,999		
Tariff 5	999		99,999		
				Total	

How is the **tariff collected**	❑ Staff walking from house to house	❑ people coming to a specific place to pay
	❑ other method, please specify:	

SANCTIONS				
▶ Which **sanctions** are fixed for late payment				
Had the sanctions	all tariff payments are paid in due time	❑ Already been applied	❑ all tariff payments are paid in due time	
Is already any household disconnected again?	Yes	❑Yes	❑No	How many hh?
After disconnection is there a re-connection fee?	Yes; 999,999	❑Yes, ▶ how much	❑No	

Did people pay a **connection fee**	Yes; 9,999,999	❑Yes, ▶ how much		❑No				
did it include the household installation ?	Yes	❑Yes	❑No	Did people **participate in construction works**?	Yes	❑Yes	❑No	
What connection fee will be applied to people who move to the village today ?								

V. Cash Flow

What are normally the **revenues and expenditures** in a month?	**Revenues (Rp)**		**Expenditures (Rp)**	
	99,999,999		99,999,999	

▶ Which significant **expenditures / repair works** happened so far?

Did the UPT open a **bank account**	Yes	❑Yes,	❑No, why not ?	
▶ if yes, where?	Bank Somewhere		transport cost (return	Rp 99,999
How often is money deposited at	Every three months	❑Month	❑Other ▶	
What is the present **balance of the bank**	Rp 99,999,999			

VI. Electricity usage

what is the **operation time/schedule** of the MHP system ?

which **social infrastructure** in the village is supplied with electricity and for what purposes do they use electricity ?

Social Infrastructure		Purpose	
Religious house		lighting	
Health centre		refrigerator	
School		sound system	
Community centre		lighting	

Are there any social infrastructure that is not supplied by the electricity	Yes	❑Yes,	❑No
▶ which one is not supplied, why not?			

VI. Further remarks / problems

Which **changes** already happened since start of operation			
❑Staff	❑Salaries	❑Tariff	❑Other, ▶ specify

▶ Were those changes decided by the general	Yes	❑Yes,	❑No
▶ Remarks			

Any **complaints** from customers?	Yes	❑Yes,	❑No
▶ If yes, what are their complaints			
Any **complaints** from staff?	Yes	❑Yes,	❑No
▶ If yes, what are their complaints			

Was there already any **problem which staff could not solve** (operators, UPT) ?	Yes	❑Yes	❑No
▶ Please specify !			

VIII. Additional interviews

Customer/s: general satisfaction, experiences, problems, complaints about operator, tariff, bookkeeping, other MHP problems

Teacher/s: changed pupils performance after electrification ? How did availability of electricity change pupils ?

Staff of social infrastructure: change of operational hours of any service (e.g. health centre: increase in treatments during evening hours ?)

Summarise conclusions and make a "to do list" (together with the responsible persons)	
▶ **Summary**	
▶ **To Do List**	
1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

IX. Productive End Use

Please specify in the following table which appliances have already been in use before electrification and are in use since electrification with the MHP system.

Please specify for each appliance the source of energy used before and after electrification:

Example: a rice huller which was in the village before the MHP started operating can still be operated by a diesel engine i.e. before = 1 by diesel; after = 1 by diesel) or was converted to use MHP (i.e. before = 1 by diesel; after = 1 by MHP.

Agro processing machines (100 %) :	**before electrification**		**after electrification**	
	No of appliances	**Source of energy**	**No of appliances**	**Source of energy**
Rice thresher				
Rice huller				
Rice mill (to grind rice to flour)				
Coffee huller				
Coffee mill (to grind coffee to				
Coconut rasping				
Cassava mill				
Oil expeller				
Kapok mill				
……				
……				
……				
……				

Wood and metal working machines (50 %):	**before electrification**		**after electrification**	
	No before electrification	**Source of energy**	**No after electrification**	**Source of energy**
Angle grinder				
Planer				
Circular saw				
Drilling machine				
Lathe machine				
Soldering iron				
Welding equipment				
Compressor				
……				
……				
……				
……				

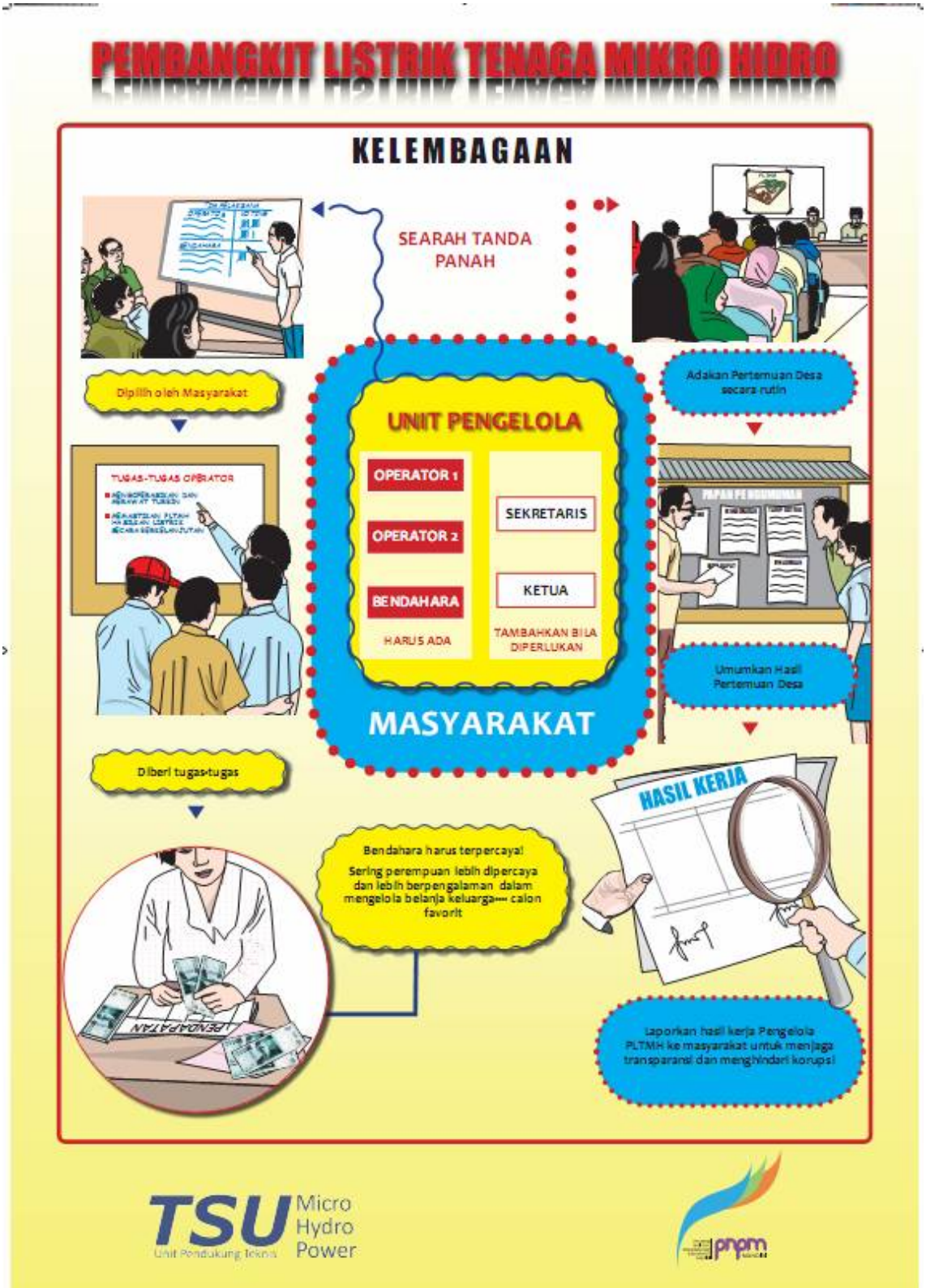
For those households appliances which have been driven and/or are still driven by a diesel genset, please put a "d" in brackets behind the respective number of appliances !

Household appliances: please fill in how many of the identified appliances are used for income generation "ig" and how many do not "nig" (25 % if "ig"):[1]	**Number before/after electrification**			
	before		**after**	
	"ig"	***"nig"***	***"ig"***	***"nig"***
Electric sewing machine				
Ironing				
Blender / juicer				
Mixer				
Freezer				
Refrigerator				
Rice cooker (to cook rice, about 450 W)				
(old) Magic Jar (only to keep rice warm, about 40 W)				
(car) battery charger				
Handphone charger				
……				

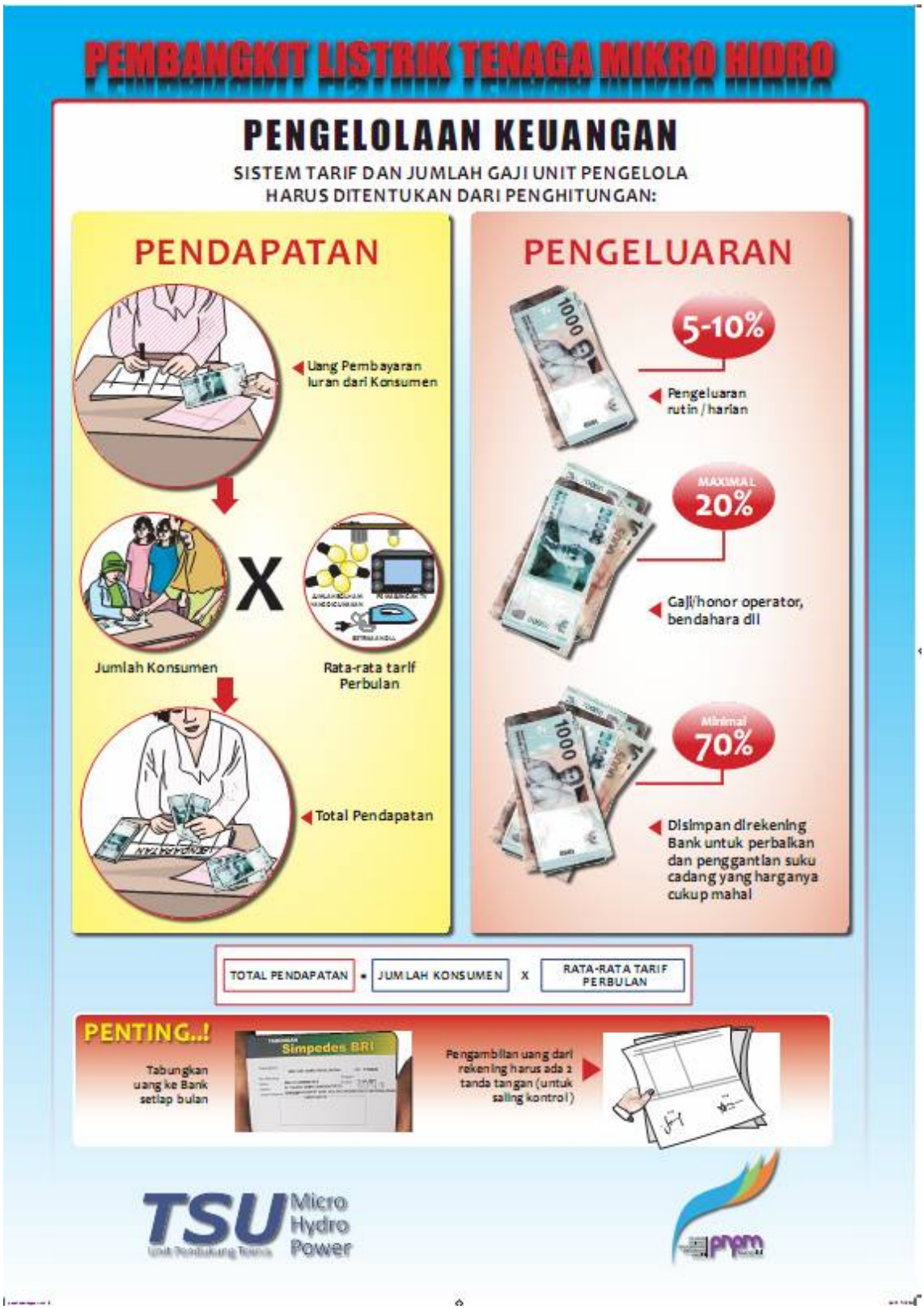
Important findings and additional remarks on productive use of electricity (Note what has changed due to the availability of MHP - e.g. change in income / change in expenses / change in time expenditure / change in types & quality of products / change in number of industry):

[1] E.g. a freezer / refrigerator used in a kiosk to sell cold drinks or a mixer used to produce cakes which are then sold are both „income generating (ig)" appliances, whereas a sewing machine or a blender which are exclusively used for personal need are "NOT generating additional income (nig)".

ANNEX 3: POSTERS




PEMBANGKIT LISTRIK TENAGA MIKRO HIDRO
TARIF LISTRIK
TARIF LISTRIK YANG SESUAI UMUMNYA SEKITAR
RP 35.000 / Bulan
BANDINGKAN DENGAN
= Rp 40.000 /Bulan
1 Bungkus Rokok/ Minggu
ATAU
= Rp 25.000 /Bulan
5 Liter Minyak Tanah/ Bulan
PENTING..!
Naikan tarif listrik setahun sekali (misalnya setiap tanggal 1 Januari) minimal 10%, untuk mengantisipasi kenaikan harga suku cadang untuk perbaikan PLTMH
Tetapkan tarif yang lebih murah (tarif sosial) untuk konsumen yang benar - benar miskin
Tetapkan dan gunakan sistem dan formulir Pembayaran Listrik untuk memonitoring penggunaan dan pembayaran listrik serta menghindari pencurian listrik
TSU Micro Hydro Power
Unit Pendukung Teknis


PEMBANGKIT LISTRIK TENAGA MIKRO HIDRO
PENGELOLAAN KEUANGAN
SISTEM TARIF DAN JUMLAH GAJI UNIT PENGELOLA
HARUS DITENTUKAN DARI PENGHITUNGAN:
PENDAPATAN
Uang Pembayaran Iuran dari Konsumen
X
Jumlah Konsumen
Rata-rata tarif Perbulan
Total Pendapatan
PENGELUARAN
5-10%
Pengeluaran rutin / harian
MAXIMAL 20%
Gaji/honor operator, bendahara dll
Minimal 70%
Disimpan direkening Bank untuk perbaikan dan penggantian suku cadang yang harganya cukup mahal
TOTAL PENDAPATAN = JUMLAH KONSUMEN X RATA-RATA TARIF PERBULAN
PENTING..!
Tabungkan uang ke Bank setiap bulan
Simpedes BRI
Pengambilan uang dari rekening harus ada 2 tanda tangan (untuk saling kontrol)
TSU Micro Hydro Power