Contributing to poverty Alleviation through Regional Energy Planning in Indonesia (CAREPI)

Deliverable No. 15:
Report on projects identified/developed in four selected regions

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Acknowledgements/Preface

This report is deliverable No. 15 of the COOPENER project 'Contributing to poverty Alleviation through Regional Energy Planning in Indonesia (CAREPI)'. The CAREPI project aims to develop institutional and technical capacity in selected regions in Indonesia for conducting energy policy analysis and providing improved energy services to poor communities, in order to alleviate poverty and contribute to sustainable development.

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Abstract

This report presents an overview on the process from site identification to implementation as well as related capacity building activities for a concrete energy supply scheme in the selected CAREPI regions. The approach applied to develop a micro hydro scheme involved an identification of a suitable location, conducting a feasibility study, securing the necessary investments as well as providing technical assistance for the construction of the scheme.

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1. Introduction

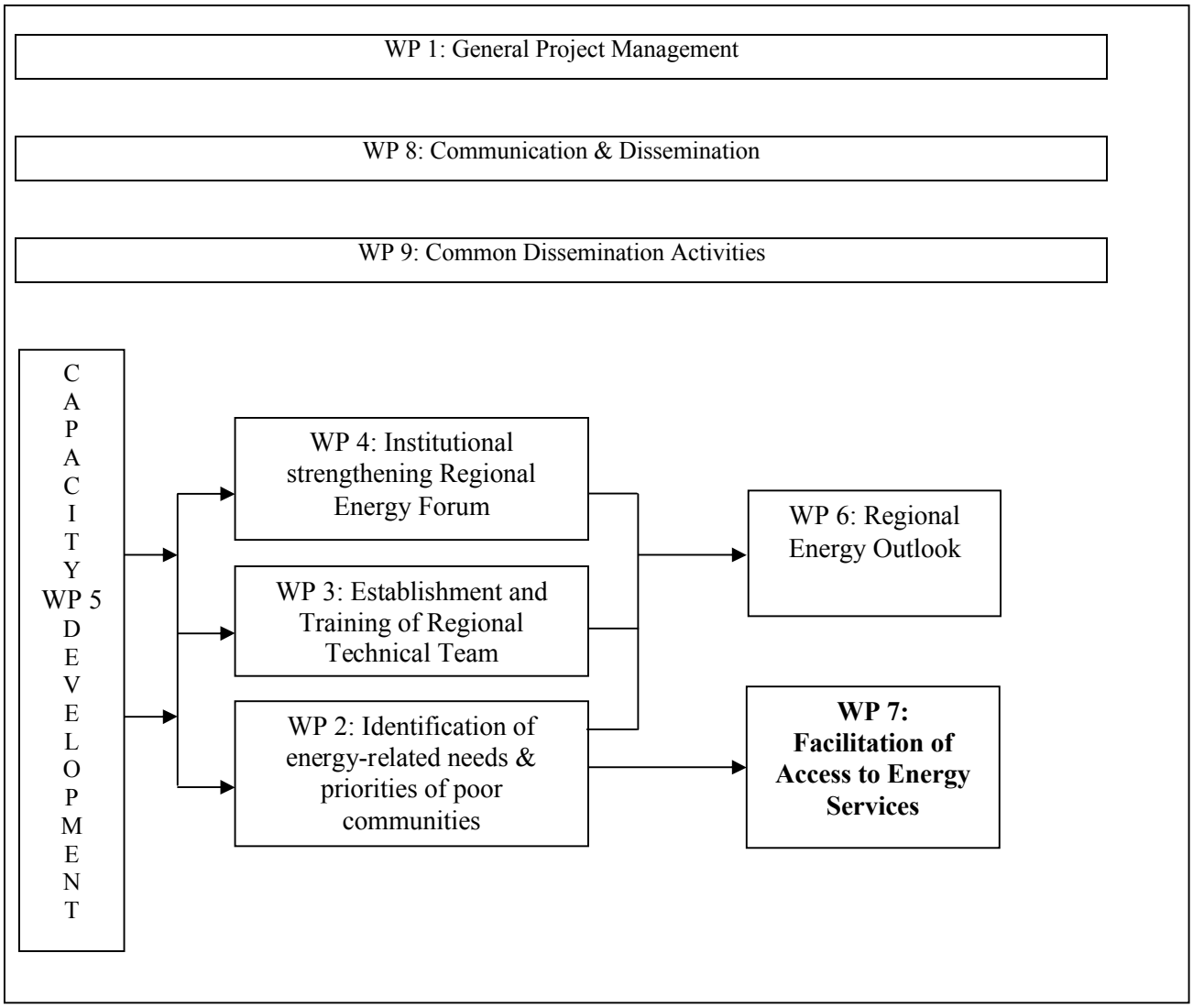
The CAREPI project's main objective is to develop capacity in a number of selected regions for formulating sound regional energy policies, with a clear emphasis on strategies that address the energy needs of poor people. However, it is considered as very important to not only develop capacity for formulating strategies and plans on paper, but to also train local people on how to develop concrete energy projects by which these plans can be realized and which improve the energy provision to the poor. This is especially important in the light of Indonesia's energy crises which results in frequent blackouts in many regions.

Work Package 7 (WP 7) therefore consequently aimed at the support for implementation of concrete energy supply schemes in the selected CAREPI regions by training the local teams in identifying and assisting the development of small scale renewable energy projects which are intended to serve as examples of how improved access to energy services can contribute to poverty alleviation.

Due to the limited resources available for this activity, it was decided during the inception phase to focus solely on the development of micro hydro schemes. Over the past 15 years, GTZ together with its sub-contractor Entec has supported the development of a large number of micro hydro power (MHP) schemes in Indonesia within the scope of the Mini Hydro Power Project (MHPP).
Given this experience in combination with the local knowledge of the regional teams, the development of a micro hydro scheme in each of the four target regions was considered to be possible – even with very limited budget and time. GTZ/Entec, as the coordinator of WP 7, has conducted the training courses in the target regions and has supported the regional teams in developing the feasibility studies (FS). MHPP provided the necessary co-funding for the capacity development activities related to WP 7 of CAREPI.

This report presents an overview on the process from site identification to implementation of a scheme as well as related capacity building activities. The approach applied to develop a micro hydro scheme involved an identification of a suitable location, conducting a feasibility study, securing the necessary investments as well as the construction of the scheme. WP 7 therefore comprised of data & information collection, analysis and evaluation related to the micro hydropower (MHP) sites proposed by the four regional teams.

The relation between WP 7 and the other work packages in the CAREPI project is shown below:



2. Identification of Sites

This chapter provides an overview on the information collected by the four regional teams during the process of preliminary site identification for MHP in North Sumatera, Central Java, Yogyakarta and West Nusa Tenggara. These data also served as 'real life examples' in the subsequent trainings for feasibility study elaboration ('FS-training') which were implemented in each of the four regions in April-May 2007 (see next chapter).

A number of initial meetings between the GTZ/Entec-Team and the regional teams were held during the first quarter of 2007 as follows:

- Visit to three potential locations for MHP Pre/FS in Yogyakarta
- Meeting with regional team of West Nusa Tenggara at Mataram University (UNRAM)
- Participate in the seminar on Regional Energy Planning in Mataram
- Meeting with regional team of Yogyakarta at Muhammadiyah University of Yogyakarta (UMY)
- Participation in the seminar on Regional Energy Planning in Yogyakarta
- Discussion with Mr. Joko (member of regional team of Central Java) of Diponegoro University (UNDIP)

Discussions with the regional teams were mainly to learn more about the site identification progress and selection criteria applied by the regional teams. Selection criteria for suitable sites such accessibility of the sites, quality of current electricity and energy services, estimation of energy supply and demand as well as potential for utilizing MHP for productive or income generating purposes were emphasized and further elaborated.

In the following sub-chapters, the data on preliminary identified sites are present according to CAREPI's four geographic areas of intervention.

2.1 North Sumatera

The GTZ/Entec-Team received the site proposal for MHP development from the Regional Team of North Sumatera, as follows:

No	Name	Flow rate (l/s)	Gross Head (m)	Hydraulic Pot. (kW)	No. of Houses
1	Aek Bontar, Tapanuli Tengah	1000	20	196	55
2	Mburidi, Tanah Karo	280	10	27	130

Subsequently, the Regional Team of North Sumatera was requested to describe in more detail the logistics of the sites (e.g. means of transportation, time required to reach the site, and on-site accommodation) as a consideration in the final selection of the site as location for the FS-training and intended follow up. In order to optimize the time and outputs of the MHP training as well as the demonstration effects of the site, the GTZ/Entec-Team advised the Regional Team to propose a more accessible site.

The Regional Team therefore decided to select a more accessible location and choose the Borus mini hydro site in Tanjung Merawa village. The main characteristics of this location are presented in the following table:

No	Name	Flow rate (l/s)	Gross Head (m)	Hydraulic Pot. (kW)	No. of Houses
1	Borus, Tanjung Merawai	1130	25	184	not applicable

Since this proposed site is in the vicinity of an already existing grid-line of the national electricity utility PLN, the least-cost approach for developing the site consists of interconnecting it to PLN's existing network instead of setting-up a stand-alone village mini-grid. By doing so, the load factor of a MHP-scheme typically gets significantly higher than in stand-alone village grids in which electricity is in demand often almost exclusively during evenings and night time. Although the village population can strongly benefit from harnessing their available hydro resources via the implementation of a respective on-grid scheme, no specific number of households can be mentioned as direct beneficiaries since the electricity generated from the MHP-scheme would be mixed with power from other sources feeding into the national utility's grid-network. Therefore the number of households is mentioned as being "not applicable".

In comparison to off-grid sites, grid-interconnected schemes are more likely to be commercially viable. In these cases, the GTZ/Entec-Team's approach typically rather consists of supporting the identification of a professional investor and advising for a business set-up that turns the villagers into co-beneficiaries instead of training selected villagers for setting-up, managing and operating their stand-alone village utility by themselves as is the case for off-grid applications.

2.2 Yogyakarta

A total of 27 sites were identified by the Regional Team Yogyakarta. Together with the regional team, the GTZ/Entec-Team visited the most promising of these sites, namely: Banjar Arum, Sorotanan 1 and Sorotanan 2. A brief profile of these sites looks as follows:

No	Name	Flow rate (l/s)	Gross Head (m)	Hydraulic Pot. (kW)	No. of Houses
1	Banjar Arum	4000	10	392	not applicable
2	Semawung 1	3000	6	176	not applicable
3	Semawung 2	3000	7	206	not applicable

All the above proposed sites would exploit drops in existing irrigation channels and, therefore, the water flow remains relatively stable throughout the year. Moreover, all the sites can easily be accessed from Yogyakarta within approximately 1 hour.

Based on discussions with the regional team of Yogyakarta and the findings of the sites visited it became apparent that all the proposed locations already had access to the electricity grid of the national utility PLN.

Considering this, it has been deemed that the most appropriate approach to sustainably harness the region's water resources for income generating purposes is through the development of grid connected (on-grid) MHP's. Based on this, it was decided that the development of the Banjar Arum site was the most attractive as this possesses the highest hydraulic potential and would likely be financially viable to be developed.

The front view of MHP site of Banjar Arum

The back/top view of MHP site of Banjar Arum

2.3 Central Java

The Regional Team Central Java initially indicated only one potential site which is located a short drive from Banjarnegara in the district of Banjarnegara. The District Banjarnegara can be reached within approximately 3-4 hours drive from Semarang. The proposed site which would be incorporated into an existing irrigation scheme has the following basic characteristics:

No	Name	Flow rate (l/s)	Gross Head (m)	Hydraulic Pot. (kW)	No. of Houses
1	Banjarnegara	11,000	4	431	not applicable

These basic characteristics (4 m head and 11 m^3/s flow) appear problematic, as this type of "large-flow / low-head" schemes usually involve large and complicated components, which are relatively costly in terms of cost per installed capacity. Nevertheless, with regard to the short time period between the belated submission of site-data and the already scheduled training it was recommended to the Regional Team Central Java to conduct the field-component of the FS-training at this site first and then – based on what they learned during the training – to continue their efforts for identifying (a) more suitable site(s) after the training.

Following the training (see Chapter 3.3) the Regional Team Central Java identified and examined two more locations with higher probability of implementation.

Location no. 2 for developing a MHP-scheme was in the hamlet of Pakuluran in the Sidoharjo village. After the feasibility study was completed it turned out that no budget was available with the regional government for the construction of the proposed scheme because they already decided to rehabilitate an already existing but broken down micro hydro scheme in its vicinity.

Next, the Regional Team Central Java selected location no. 3 in the Brukah Telaga village of the Banjarnegara district. The key information for both locations is presented in the following table:

No	Name	Flow rate (l/s)	Gross Head (m)	Hydraulic Pot. (kW)	No. of Houses
2	Pakuluran / Sidoharjo	80	25	12	69
3	Brukah Telaga	5,094	11.2	27.4	220

2.4 West Nusa Tenggara

Four sites were visited by the Regional Team West Nusa Tenggara, with the following profiles presented:

No	Name	Flow rate (l/s)	Gross Head (m)	Hydraulic P. (kW)	No. of Houses
1	Teres Genit	190	22	41	200
2	Air Berik	348	7	24	510
3	Tepal	200	20	39	350
4	Kawidatoi	1290	14	175	985

From the discussion with the Regional Team West Nusa Tenggara, the Teres Genit site was proposed as the site for a feasibility study and the related training activities. This decision was based on the following reasons:

- The three hamlets which would benefit from the proposed MHP had no access to electricity;
- The site is located in North Lombok and is relatively well accessible (it takes approximately 2 hours by car from Mataram plus 30 minutes walk);
- The local community showed a high level of commitment to the development of the scheme

Formerly, a MHP scheme was constructed in Teres Genit in 1997 to supply approximately 200 households within the four hamlets of the village. The relatively simple scheme exploited a drop structure of approximately 22 m in height in an irrigation network. Its construction formed a sub-component of the Teres Genit irrigation system, constructed in 1994 and financed by the Ministry of Public Works. With no capacity building for establishing a suitable institutional and management set-up, the scheme operated for only 3 years before it went into disrepair. Only some of the civil structures remained which could be re-used. All electro-mechanical equipment and distribution lines were removed.

The previous MHP scheme was integrated into the Teres Genit irrigation system which was constructed in 1994.

The majority of the civil structure was still in good condition and could be put back into operation for the MHP relatively easily.

3. Trainings

As presented in the previous chapter, preliminary identification of the sites was carried out by the regional teams. A more detailed collection of site data was conducted as "on-the-job" training together with the regional teams during the FS-trainings in April-May 2007.

The training conducted under WP 7, aimed to develop and enhance capacity of local experts for site identification, assessment and preparation of concrete energy supply projects in the field of MHP. For data analysis and evaluation, detailed training modules were prepared and presented to the teams during classroom sessions at the beginning and the end of the field training.

The training approach and basic contents was identical in all four provinces. Training was conducted in the classroom as theoretical lessons (presentations and analyses), complemented with a field session where practical application of the survey and data collection techniques was practiced. This was carried out at the pre-selected site locations. Whilst the training in the field usually took one full day, two days were allocated for the field training in North Sumatra and in Lombok due to the length of travel required to reach the sites.

The summary of the training activities is presented in the following sub-chapters. For more details including the training topics, a list of participants as well as a photo documentation, please refer to deliverable no. 12.

3.1 North Sumatra / Universitas Sumatra Utara

The class room sessions of the training were conducted at the Universitas Sumatra Utara. The training was attended by 18 people from university and other institutions.

The site where the field-training took place was planned to be incorporated in an unused irrigation system (not used due to severe landslides downstream of proposed MHP location). The gross head was approx. 28 m, the approx. design flow possible up to 1 m^3/s. The site was proposed for grid-interconnection (approx 1.2 km to the nearest medium voltage interconnection point). An intake was existing; repairs of headrace channel would have been required as well as a new forebay, penstock and powerhouse needed.

3.2 Yogyakarta / Universitas Muhammadiyah

The class room sessions of the training were conducted at the Universitas Muhammadiyah. The training was attended by 20 people from the university and other institutions.

The site where the field-training took place shall utilize an existing drop of approximately 10 m within the Banjarharjo irrigation system. During the field visit, a flow of approx. 6 m^3/s was measured which would make the site suitable to supply electricity to the national grid.

Additionally to the site visit an existing MHP was visited in the vicinity of Yogyakarta. Despite being much smaller in size (10 kW, utilizing a drop of approx. 5 m in an irrigation system) interesting technical and non-technical aspects could be studied at this plant.

3.3 Central Java / Universitas Diponegoro

The class room sessions of the training were conducted at the Universitas Diponegoro. The training was attended by 12 people from the university and other institutions.

As mentioned in section 2.3, the Banjarnegara site where the field-training took place was rather problematic in terms of cost per installed capacity. Nevertheless, keeping the training purpose of the mission in mind, relevant measurements could be conducted at this site.

After the field training, a visit was made to the local office of Indonesia Power, who at that time placed high priority on developing the relatively large hydraulic potential in the area for energy generation. After an interesting presentation made by the local management, a visit to one of their sites currently under construction was carried out. The site of Siteki is located in Kec. Rakit and was scheduled for commissioning by the end of 2007. Finally, a MHP-scheme close to Wonosobo, the Wangan Aji MHP, was visited for study purposes.

3.4 West Nusa Tenggara / Universitas Mataram

The class room sessions of the training were conducted at the Universitas Mataram. The training was attended by 15 people from the university and other institutions.

The site where the field-training took place is located close to Teres Genit Village in North Lombok. The proposed MHP plant was meant to provide 126 households and public and productive uses in four hamlets with electricity. The scheme was planned to be incorporated into an existing irrigation scheme and utilize a drop (gross head) of approximately 23 m. Flow measurements revealed an utilizable flow of approximately 200 l/s.

Funding for the implementation of the scheme had already been allocated by the local government department responsible for rural electrification (Dinas Pertambangan) in their annual budget for the fiscal year 2007.

4. Preparation of Feasibility Studies

Following the completion of the training courses at the 4 universities, efforts during late 2007 and early 2008 were focused on preparing the subsequent feasibility studies for the locations selected by the respective technical teams. Of the 4 locations, 2 off grid or stand alone schemes were selected (Central Java and West Nusa Tenggara) and 2 grid connected (Yogyakarta and North Sumatra). Whilst the intention from the outset was to select locations where development of the scheme was deemed viable, due to the specific site conditions of each site the subsequent steps involved in this process have had to be staggered accordingly.

Specifically for the off grid schemes, before going ahead with the feasibility studies discussions were held with representatives from the local Government to establish whether they would be willing to make the necessary funds available for the subsequent construction of the prepared sites. In the case of Central Java, this was also one of the reasons for doing the feasibility study for the Pakuluran instead of the Banjarnegara site where the training had been conducted but no budget was made available in due course for any subsequent implementation.

Although the training courses were very comprehensive in the material they provided, in order for the technical teams to prepare a fully fledged feasibility study which could be used as the basis for the actual implementation of the schemes, further technical assistance and backstopping was essential. Consequently between June-December 2007, the GTZ/Entec-Team conducted the first follow up site visits to all 4 locations together with representatives from the technical teams. Detailed site surveys were carried out during these visits. During early 2008 further site visits were made where appropriate. After completion of the site visits work on the actual preparation of the studies was initiated.

Selected members of each technical team were invited to attend an additional 1 week “on-the-job” training at the office premises of GTZ/Entec in Indonesia’s ‘MHP-capital’ the city of Bandung where they in cooperation with the GTZ/Entec-staff directly worked on the processing of the respective site data and on the detailed preparation of the studies including detailed designs. The following table presents some of the main findings of the feasibility studies for the four sites. For more details please refer to the feasibility study reports presented in separate reports.

Site	Design Flow (l/s)	Gross Head/ Net Head (m)	Electrical Capacity (kW)	Estimated Investment (US$)	No. of Houses
Tanjung Merawai / North Sumatra	1,130	25.05 / 24.40	184	378,498	not applicable
Banjar Arum / Yogyakarta	6,500	12.34 / 12.20	614	584,898	not applicable
Pakuluran / Central Java	80	25.42 / 22.20	12	72,091	69
Teres Genit / West Nusa Tenggara	200	24.00 / 23.32	26	140,000	350

5. Follow-up / Development of Sites

5.1 North Sumatera

In North Sumatra, the feasibility study has been conducted and the report was submitted to the Dinas Energi. However, this was not followed up; firstly, because the energy forum in this region has not yet been formally established which has hampered an effective cooperation with the Dinas and, secondly, the feasibility showed that given the Indonesian regulatory framework with its high level of uncertainty the identified site (approx. 180 kW) was not sufficiently attractive with its payback period of some 8 years.

5.2 Yogyakarta

In the Yogyakarta province, the feasibility study clearly showed that the scheme can be operated in a commercial way, i.e. by a private investor who is selling the electricity to the public utility company. An interested private investor has been identified and first discussions were very encouraging. With the new Electricity Law dated 23 Sept. 2009 and a Ministerial Regulation defining the purchase price for renewable energy based electricity (to be released in November 2009), it is expected that the scheme becomes sufficiently attractive for the investment actually taking place in 2010.

5.3 Central Java

In Central Java, the feasibility study of the selected Pakuluran/Sidoharjo-site revealed that it would be better to construct a new system next to the existing system rather than to rehabilitate the existing system where an open channel micro hydro scheme was severely damaged due to landslides. Rehabilitation of the existing open channel system would only be a short-term solution, since there is a high probability that another landslide would occur and again damage the system.

The GTZ/Entec-Team visited the location and recommended not to rehabilitate the existing system but to build a new closed pipe system some 20 meters next to the existing system to avoid any future damage from landslides. After conducting the feasibility study for the new scheme (approx. 12 kW), the CAREPI team found out that the Dinas Energi already had allocated funds for the rehabilitation of the existing system. Several meetings were held with the Dinas to try to shift these funds to the construction of the new scheme. Despite the arguments of the CAREPI team this decision could not be reversed.

Therefore, the CAREPI team has identified, in close cooperation with the local energy office, another site in Central Java for developing a micro hydro scheme. The local government has already indicated its willingness to provide (part of) the funding for the construction of this site in the Brukah Telaga village if its feasibility study will show that this is a feasible location.

5.4 West Nusa Tenggara

Following the completion of the feasibility study (see Chapter 4), the rehabilitation of the 32 kW MHP-scheme in West Nusa Tenggara province proved to be highly successful.
After seeing their scheme out of operation for more than one decade, the core actors in the village of Teres Genit stated an unusually high desire for capacity building related to operation, maintenance and management. Upon the first visit, the CAREPI team was told by the village chief: "When the scheme was built the first time, nobody told us how to take care for it. Better do not rehabilitate the scheme at all and spare our village from another round of disappointed hopes if you are not committed to teaching us the skills we need."
Based on such fertile ground, only relatively small technical assistance input was required by the CAREPI-team to bring the scheme back to sustainable operations. After more than a dozen years, the village was brought literally out of the dark when the scheme came back into operation in June 2008.
With approx. 140,000 USD, the majority of investment costs were provided by its owner, the Government of West Nusa Tenggara. By employing a Lombok-based community development NGO which worked sporadically together with CAREPI's West Nusa Tenggara Team on this task, MHPP supported the setting up of a village-based organization for operation, maintenance and management of the MHP-scheme with approx. 4,000 USD.

The village based organization employs (in part time arrangements) 2 operators, 1 head of management, 1 secretary and 1 bookkeeper. The tariff is collected based on metered monthly consumption, whereby typically 3-4 households are connected to one meter and pay their monthly bill collectively ('clustered metering').
After overcoming a number of technical problems, in the 3rd quarter of 2009 the scheme finally has become fully operational and supplies electricity to more than 380 households in the four hamlets of the Teres Genit village.

The reason for the different number of households connected during the different stages of the MHP project in Teres Genit is that at later stages of such projects, often extra funds are made available for extending the village grid to hamlets which were originally not included in the planning. Another reason is that - especially if the supply turns out to be reliable - people convert from gen-sets to the MHP-electricity. Another reason is that villagers who - at the early stage of the project - did not want to advance the connection fees, want to be connected as well at a later stage, when they can see the benefits of electricity

As revealed during a site monitoring visit, the households' monthly energy expenses have decreased from approx. 100,000 IDR to approx. 10,000 IDR due to substitution of kerosene by electricity for lighting purposes. Also transportation expenses for motorbike taxis have significantly decreased since a lot of communication is now be done by mobile phone instead of driving to the neighboring settlements. However, interviewees stated that their expenses for prepaid mobile phone cards have increased.

By now, 10 local families have replaced their petrol gen-sets by hydroelectricity to run their woodworking home industry. Other income generating uses of the hydro electricity comprise of hand phone charging for the neighbors as well as of the electricity supply to a

lodge adjacent to the village. Due to mobile phone availability, farmers' cattle transactions have reportedly become quicker and better informed with regard to respective price levels. Whilst the MHP-scheme's capacity is already well used during the nights, there is still spare capacity left for day time use of energy. However, substantial investments into respective productive machinery typically only occur after more than at least one year of smooth MHP-operation when the local entrepreneurs have become assured that the electricity which their new equipment requires would be reliably available.

To summarize the developments in Teres Genit it is safe to state, that even with only a relatively minor contribution in form of technical assistance, the EC through the COOPENER project CAREPI had a big leverage effect with regard to the sustainable implementation of a concrete energy supply system. With CAREPI's good reputation and high visibility, the development of the Teres Genit scheme enjoys high attention by a big number of sector stakeholders allowing the scheme to serve as good practice example for replication throughout Indonesia. In Teres Genit, electricity supply has become even better than in neighboring settlements which are connected to the national power grid where the utility PLN is conducting rotating black outs to overcome the shortage of power from fossil fuels.