Report

Sumba
Iconic Island Project

Scoping Mission on Off-Grid Electrification

02/2011

Roman Ritter
Energy & Development
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on behalf of HIVOS

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1. Background of this Report

Hivos has developed an Iconic Island project at Sumba, Indonesia, to showcase the possibilities of renewable energy. This project has been described in general terms in a brochure[1]. The long term objective of this Multi Actor Initiative (MAI) is to provide renewable energy to people of Sumba, a medium sized island in Indonesia, and by that demonstrate a replicable model that addresses both climate change and poverty alleviation.

The long term objectives include a shift to 100% renewable energy (grid and non grid), increase access to energy, an increase in the electrification rate, the start of production and use of bio fuels (for transport and power generation), an increase in economic development and an improvement in the gender situation.

Hivos has commissioned feasibility reports on different parts of the project. One study, focussing on grid extension and power production, is already in progress. This report is based on a field mission to Sumba from 22nd to 25th February 2011 and is focussing on non grid access to energy.

The actual situation and potential for renewable energy has been documented by Winrock[2]. At Sumba the electrification rate is very low (24.55%). People living at remote rural areas are poor and have no access to energy. Settlements in rural areas seem to be small and people living very dispersed. Connection to the grid does not seem affordable for many people within a decade. Non grid access to energy should be stimulated to reach the goals of the Iconic Island.

This non grid feasibility report delivers more detailed information on RE potential for off grid use. Proposed technologies should be well proven in conditions comparable with Sumba. The study should also include proposals and a feasibility judgement of financing models, e.g. micro finance, fee for service, government support programmes etc. Preferably the study includes a judgement of the possible improvement of the socio economic position of women. Finally, improvements for existing SHS need to part of this study.

The field mission to Sumba was supported by the German International Cooperation (GIZ) who – on behalf of the Dutch-German partnership 'Energising Development' – jointly implements the Mini Hydro Power Project for Capacity Development (MHPP[2]) together with the Ministry of Energy and Mineral Resources (MEMR) in Indonesia.

[1] "Sumba: An Iconic Island to demonstrate the potential of renewable energy" Hivos 2010.
[2] Fuel independent renewable energy "Iconic Island", Winrock August 2010.

2. Socio-Economic Situation in Rural Sumba

Sumba – especially its rural areas which are in the focus for off-grid electrification – is among the poorest regions in Indonesia.

Although no statistical valid research on households' financial means and expenditures could be carried out during the limited time of the mission, respondents in several interviews provided the following proxies:

- In general, villagers are considered poor and living in a non-monetarized self subsistence farming economy
- Approx. 90% of the communities work in agriculture
- Villagers mostly rely on mono culture agriculture which involves high risks. Therefore harvest failures create additional poverty (very little income or even no income at all)
- Agricultural income in a traditional village's household: there are 4 corn harvest per year (3 x during dry season / 1 x during rainy season) of which approx. 80% is sold and 20% are self consumed with each harvest bringing approx. 300,000 – 500,000 IDR [24,75 – 41,24 EUR[3]]
- More than 50% of villagers are considered to be poor; when support arrives, almost all villagers state that they are poor
- Children eat only once a day (especially in Kecamatan Kodi)
- Micro credit scheme SPP is facing severe difficulties due to very low repayment rate
- Expenditures of rural household with ProAir water supply = 1,000 – 2,000 IDR [0.08 – 0.16 EUR] per month (as flat rate) with a payment quota of only 50%
- Some non physical projects of PNPM cover the procurement of school uniform set for children (this kind of project is quite dominating the proposals)
- The phenomenon of having noble families with property-less farm labourers is only to be found in East Sumba not in the Western parts
- A big share of economic power is spent on traditional ceremonies
- Some houses which are considered as `uninhabitable´ have a satellite dish on top as status symbol. The same applies for mobile phones: some poor people who assumedly cannot afford a mobile phone do have one in order to show status
- Due to specific cultural aspects of doing things the traditional way and a conservative approach towards new developments, it is assumed that the process towards using energy in a productive, income generating manner would take rather long and go on slow speed
- Besides firewood, rural household mainly use kerosene for lighting which costs in average around 6,000 IDR [0.49 EUR] per litre. Figures for households' expenditures on kerosene reported during the mission show a big variance from 12,000 IDR [0.99 EUR] per month to more than 40,000 IDR [3.30 EUR] per month[4]
- Rural households' expenditures for electricity provided by a diesel gen-set (usually from 18:00-06:00) in East Sumba look the following:
  - 87 hh have a 450 VA connection and pay 8,000 – 15,000 IDR [0.66 – 1.24 EUR] per month
  - 11 hh have a 900 VA connection and pay 30,000 IDR [2.47 EUR] per month
  - 4 hh have a 1,300 VA connection and pay 70,000 – 90,000 IDR [5.77 – 7.42 EUR] per month
  - 1 hh has a 2,200 VA connection and pays >130,000 IDR [10.72 EUR] per month

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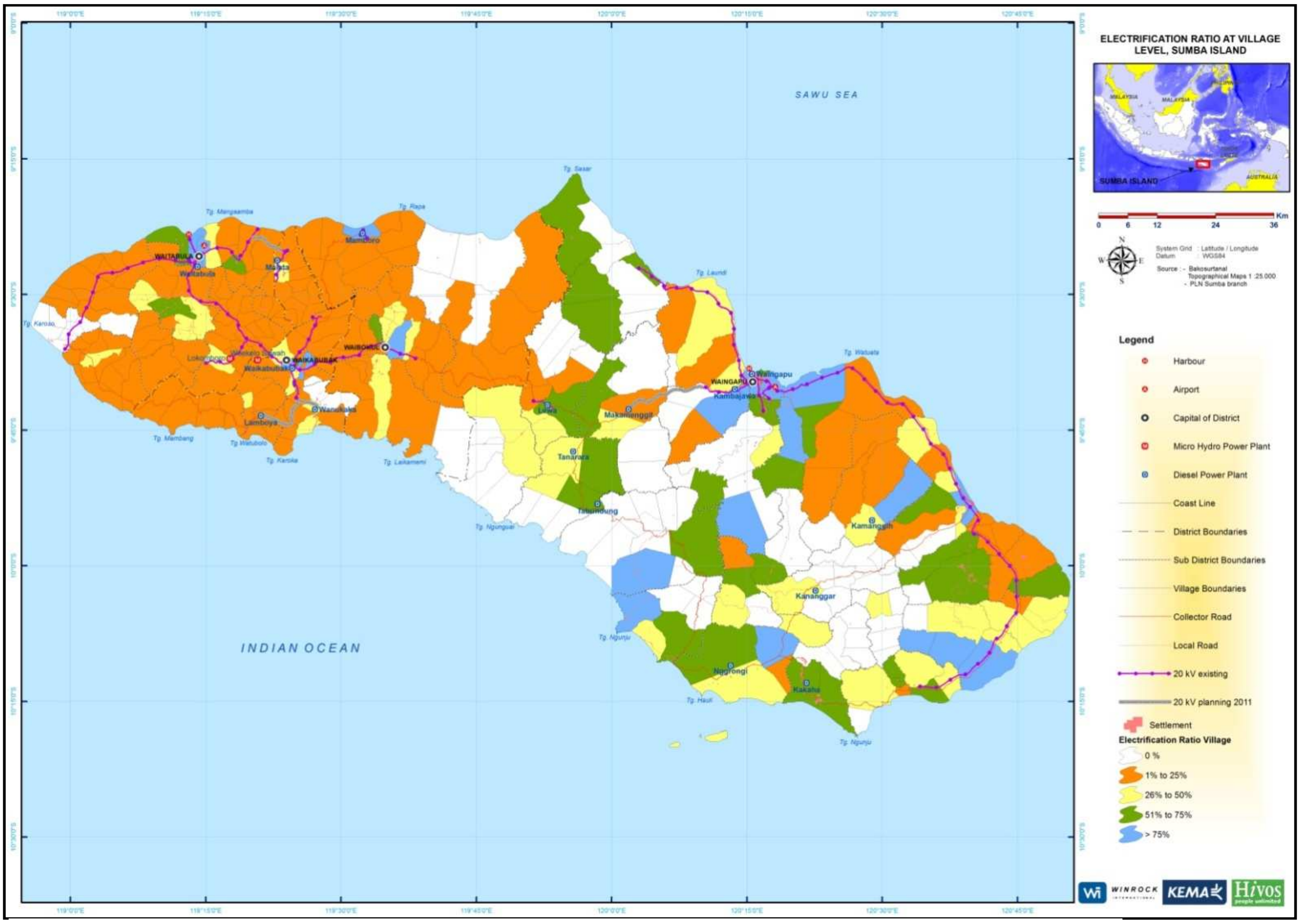
[3] The conversion between Indonesian Rupiah (IDR) and Euro (EUR) made throughout this report is based on the exchange rate 12,123.50 IDR/EUR as of 25 February 2011 as long as not stated differently.

[4] Partly this big variance can be explained by different consumption patterns between poor and less poor households. However, with having received only 6 replies on this topic during the mission, further investigation is recommended to broaden the data base.

- ➢ Sumba's electrification ratio (at household level) is stated at approx. 31% based on PLN's household data (i.e. total number of households in Sumba = 97,523) respectively at 24% based on the BPS 2010 statistics (i.e. total number of households in Sumba = 126,444)
- ➢ Sumba's electrification ratios at commune level are mapped below



Sumba's electrification ratios at commune level.

3. Current Electrification Activities

3.1 Overview

The following table shows the major current electrification activities and related actors in Sumba as reported by various respondents. Since electrification in Sumba has become increasingly dynamic, this information is subject to changes and thus represents only a snapshot picture taken at the time of the mission.

	DINAS P&E	PLN	Others
East Sumba (Waingapu)	- 85 diesel gensets in last 4 yrs. provided to groups of 40 hh each in average - In 2011, all NTT will get 13,500 SHS [allocation for (East) Sumba not yet known] - 302 SHS are expected from 2011 Special Allocation Fund (DAK)*) - No proposal for funding MHP yet due to lack of funds for preparing P/FS as part of the proposal	- PLN plans to increase Sumba's electr. ratio (hh-level) from 32% to 70% in 2011 - PLN for 2011 has the Pulau Bebas Asap – Island Free of Smoke Program - Within PLN's SEHEN program (i.e. 24,000 SHS for Sumba in 2011) 11,600 SHS are targeted for E-Sumba - 19 km MV interconnection Lewa-Makamenggit (in 2011) - 21 km MV interconnection RTG.ST-Makamenggit (in 2011) - PLN intends to do a 5 kW pilot on a vertical axis wind turbine in the Waingapu area	- MIN for Underdev. Regions provided 100 SHS in 2010 & did wind power survey (data n/a) - PNPM Mandiri 12/2010 reports 13 activities on village electr. (PV, gensets, MHP rehab.) - Pt. HENINDO Power has a permit to construct the 850 kW Harunda MHP (Desa Bidihunga, Kec. Lewa) - IBEKA is implementing a 37 kW village MHP scheme in Bakahau - Multitron lost its permit for MHP development after not using it - Merukh Iron & Stell/SMS/ Siemag/Paul Wurth: steel plant & power supply & CSR programs
Central Sumba (Waibokul)	- In 2008-10, 526 hh got a SHS - Program "kampung bercahaya" or bright hamlets program targeting economic improvements through provision of energy - Approx. 16,000 hh remain w/o electricity (i.e. PLN or PV or diesel) - LIPI in partnership with DINAS assessed 9 potential MHP sites of which 3 were recommended - Out of these, 2011 DAK-funding for the Harangi site is requested	- PLN plans to increase Sumba's electr. ratio (hh-level) from 32% to 70% in 2011 - PLN for 2011 has the Pulau Bebas Asap - Island Free of Smoke Program - 1,225 hh connected to PLN in 2008-10 - Within PLN's SEHEN program 8,300 SHS are targeted for C&W-Sumba together - In 2011: construction of Malata-Mamboro interconnection (17 km)	- In 2010, MIN for Underdev. Regionspromised 100 SHS
South-West Sumba (Waitabula/ Tambolaka)	- 15 diesel gen-sets provided in past - Govt' subisdy + micro credit for PLN initial connection fee to 500 hh provided in 2010 - 1,044 SHS for 2011 (by central & district govt' funds) - 320 SHS requested from 2011 DAK*) - 380 SHS to be procured from district budget - DINAS started with innovative allocation model for SHS in 11/2010 - DINAS plans to engage consultant for surveying off-grid hydro potential	- PLN plans to increase Sumba's electr. ratio (hh-level) from 32% to 70% in 2011 - PLN for 2011 has the Pulau Bebas Asap – Island Free of Smoke Program - In 2011: installation of a 500 kWp PV-system w/o battery storage to substitute and add to diesel generated power in the grid during daylight - Within PLN's SEHEN program 4,100 SHS targeted for SW-Sumba; as of 01/2011 240 units were distributed - In 2011: construction of Sumba Baya Darat-Malata interconnection (8 km)	- Various IPPs are supposed to start development of 6 grid-connected MHP sites mainly in West & South-West Sumba in 2011 (together with 3 planned PLN MHP sites adding 11 MW)
West Sumba (Waikabubak)	- General policy is to increase electrification ratio but not much specific information available (yet) - Target for 2011: 440 SHS for 22 villages financed by district & central government budgets	- PLN plans to increase Sumba's electr. ratio (hh-level) from 32% to 70% in 2011 - PLN for 2011 has the Pulau Bebas Asap – Island Free of Smoke Program - Within PLN's SEHEN program 8,300 SHS are targeted for Central & West-Sumba together - In 2011: construction of Malata-Mamboro interconnection (17 km) - In 2011: construction of Sumba Baya Darat-Malata interconnection (8 km)	- Various IPPs are supposed to start development of 6 grid-connected MHP sites mainly in West & South-West Sumba in 2011 (together with 3 planned PLN MHP sites adding 11 MW) - Merukh Iron & Stell/SMS/ Siemag/Paul Wurth: steel plant & power supply & CSR programs

*) This needs revision since MEMR Jakarta supports only MHP and centralized PV systems within DAK 2011.

Overview on current electrification activities as reported in 02/2011.

Based on the above shown table, it can be noticed that the majority of off-grid electricity development is based on individual PV systems – in the recent past in the form of conventional Solar Home Systems and from 2011 onwards also with PV lighting kits as disseminated via the SEHEN program of PLN.

Whilst PLN intends to disseminate 24,000 PV lighting systems in 2011, the planning figure for conventional SHS is below 2,500. However, since conventional SHS are excluded from the DAK 2011, the figure might have to be reduced to about 1,900 SHS.

Moreover, in 2011, there are only 2 off-grid / mini-grid Micro Hydro Power (MHP) schemes under development respectively planned: one 37 kW-scheme in Bakahau/East Sumba implemented by IBEKA with support from HIVOS and one in Harangi/Central Sumba for which support from the DAK 2011 is requested by DINAS.

3.2 PLN Grid Extension Planning 2011-2016

In 2011, PLN plans to increase Sumba's electrification ratio from around 32% to 70% of the households. As the map and the corresponding table below show, the focus of PLN's grid extension activities in 2011 is put on establishing interconnection lines between existing grid-networks.

Map of grid-extension and interconnection planning until 2016; provided by PLN Sumba.

DISTRIBUTION GRID DEVELOPMENT PLANNING UP TO 2016
PT. PLN (PERSERO) CABANG SUMBA

NO	DETAIL WORK	VOLUME	UNITS	STAGES											
				2011		2012		2013		2014		2015		2016	
				VOL	UNITS	VOL	UNITS	VOL	UNITS	VOL	UNITS	VOL	UNITS	VOL	UNITS
1	INTERKONEKSI SBD - SR. MALATA	8	Kms	8	Kms										
2	RENC. INTERKONEKSI SR. MALATA - SR. MAMBORO	17	Kms	17	Kms										
3	RENC. INTERKONEKSI RTG.WKB - SR. LAMBOYA	9	Kms	9	Kms										
4	RENC. INTERKONEKSI SR. LEWA - SR. MAKAMENGGIT	19	Kms	19	Kms										
5	RENC. INTERKONEKSI RTG.ST - SR. MAKAMENGGIT	21	Kms	21	Kms										
6	RENC. INTERKONEKSI MAMBORO - RTG. S. TIMUR														
	- Renc. Pengemb. Jardist 20 KV Ds. Ngadubolu	16	Kms					16	Kms						
	- Renc. Pengemb. Jardist 20 KV Ds. Lendiwacu	27	Kms			27	Kms								
	- Renc. Pengemb. Jardist 20 KV Ds. Nappu	12	Kms			12	Kms								
	- Renc. Pengemb. Jardist 20 KV Ds. Kadahang	9	Kms			9	Kms								
	- Renc. Pengemb. Jardist 20 KV Ds. Tanabanas	18	Kms					18	Kms						
	- Renc. Pengemb. Jardist 20 KV Ds. Soru	13	Kms					13	Kms						
	- Renc. Pengemb. Jardist 20 KV Ds. Lenang	17	Kms							17	Kms				
	- Renc. Interkoneksi SR. Kamanggih - Melolo	29	Kms									29	Kms		
	- Renc. Pengemb. Jardist 20 KV Ds. Kahiri	16	Kms					16	Kms						
	- Renc. Pengemb. Jardist 20 KV Ds. Tandulanjanga	0	Kms												
	- Renc. Pengemb. Jardist 20 KV Ds. Kombapari	9	Kms							9	Kms				
	Ds. Lailara	24	Kms											24	Kms
	INTERKONEKSI Lewa - Tabundung	19	Kms											19	Kms
7	Renc. Pengembangan JarDist 20 KV Ds. Rekawatu	10	Kms			10	Kms								
8	Renc. Pengembangan JarDist 20 KV Ds. Kangeli	12	Kms					12	Kms						
9	Renc. Pengembangan JarDist 20 KV Ds. Hanggaroru	16	Kms							16	Kms				
10	Renc. Pengembangan JarDist 20 KV Ds. Praibokul	5	Kms			5	Kms								
11	Renc. Pengembangan JarDist 20 KV Ds. Kadahang	9	Kms			9	Kms								
12	Renc. Pengembangan JarDist 20 KV Ds. Wunga	13	Kms							13	Kms				
	JUMLAH	348	Kms	74	Kms	48	Kms	63	Kms	26	Kms	29	Kms	43	Kms

Catatan :

ST	: Sumba Timur	SBD	: Sumba Barat Daya	DS	: Desa
WKB	: Waikabubak (Sumba Barat)	SR	: Sub Ranting	JarDist	: Jaringan Distribusi

Table of grid-extension and interconnection planning until 2016; provided by PLN Sumba.

As PLN informed, the interconnection of existing grids allows the inclusion of a high share of electricity from the hydropower stations which are expected to be built in 2011.

The actual extension of the distribution network in the villages is planned to start only in 2012. At first glance, this might look somewhat contradictory to PLN's plan of increasing the electrification ratio from around 32%-70% in 2011.
However, when taking the 24,000 PV lighting system plus the approx. 1,900 non-DAK-financed units of SHS which were stated by the 4 DINAS' into account, the electrification ratio increases significantly. From around 31% to 57% based on PLN's household data (i.e. total number of households in Sumba = 97,523). Or from around 24% to 44% based on the BPS 2010 statistics (i.e. total number of households in Sumba = 126,444).

Before this study is addressing off-grid and mini-grid issues in detail, an interesting approach on dealing with PLN initial connection fees shall be reported here that was found in South West-Sumba:

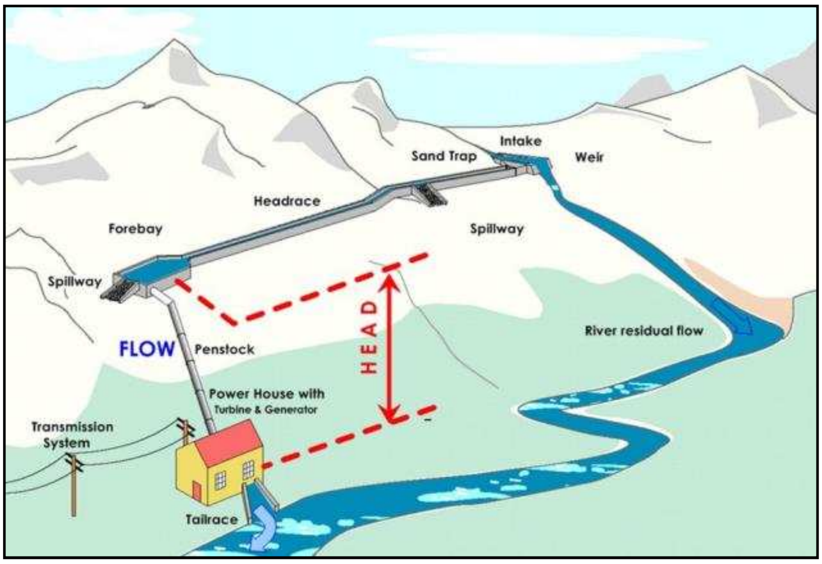
A common problem for poor households in many countries is the affordability of the fee for the initial connection to the national utility's grid. In Sumba the smallest connection (450 VA) costs 346,500 IDR [28.58 EUR] and it can be observed that numerous houses just next to the PLN grid are not connected; likely because they cannot afford the fee.

West-Sumba's district government therefore established a scheme (for so far 500 households) which subsidises a part of the connection fee and pre-finances the remaining part as a sort of repayable micro credit. It might be worthwhile to adapt this approach also to other electrification efforts from which often the extreme poor are either excluded completely or provided with an economically inefficient 100%-subsidy.

4. Off-grid Micro Hydropower (MHP)

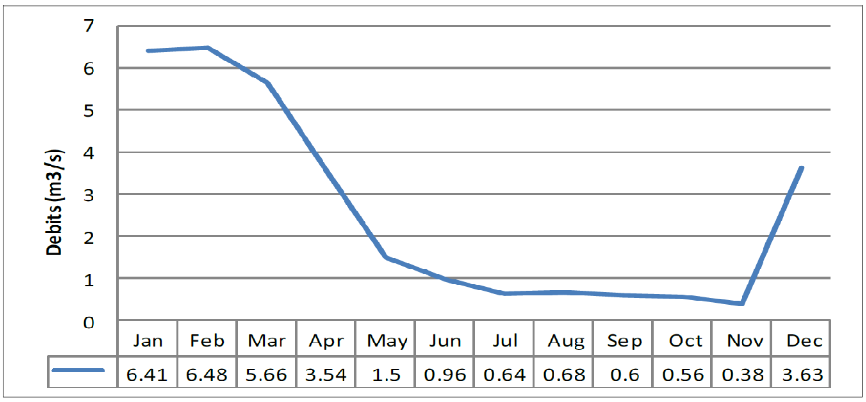
4.1 Background

Micro hydropower (MHP, here defined as 5-100 kW) is typically used to supply a village or several hamlets via a mini-grid. Since in most remote places such a mini-grid is not interconnected with the national utility's grid, it is also referred to as 'off-grid MHP'.
As illustrated below, the crucial parameters for the electric capacity of a hydropower scheme are the difference in height (head) and the amount of water which is available for the turbine (flow):



Schematic layout of a MHP-scheme according to GTZ/ACE.

In a MHP-based mini grid which is neither connected to the national utility's grid network nor has other sources of electric power (e.g. diesel gen-set) in place, it is crucial to have a year round flow of water in the respective stream. Otherwise, its users would have no power during the dry season which can cause frustration and stranded investments for their electric appliances.
Therefore, an isolated MHP-scheme is typically designed to make use of a water flow which is not far above the stream's minimum flow. In contrary to a grid connected hydropower plant which can basically sell every kWh to the national utility, additional water during the wet season remains unused in an off-grid MHP-design.[5]



Example of seasonal flow pattern in Sumba: Luku Mareha / Kalada river.

[5] In some places of Indonesia, one can also find a combination of these two approaches: electricity from a MHP-based mini grid is sold to PLN only in times of excess power respectively bought from PLN only in times of power shortage. Whether this is an economically and financially viable option for harnessing a community's water resources depends on the specific side conditions (e.g. head, flow, and distance to the PLN grid). Since it might create an interesting source of rural income, also an *off-grid* hydro assessment should look into this interconnection-option when being on site.

In Sumba, unlike at other islands of Indonesia further to the West, there are very distinct seasonal differences in water availability (see below graph of river flow). For small streams which are typically used for MHP this implies that they can even fall dry during the dry-season.

During the mission in 02/2011, a detailed on-site assessment of off-grid MHP-potential was not foreseen for two reasons: 1st, there was limited time available for visiting remote places and 2nd, assessing river flow during the rainy season would not make much sense since the crucial parameter of minimum flow can only be assessed at site during the dry season. In such cases, usually a rough estimate on the hydropower potential can be done based on historically recorded seasonal flow data which is typically available from public administration authorities.

4.2 Availability of Hydro Data

During the mission it turned out that seasonal flow data of streams which are geographically close to communities is either not available for Sumba or needs further assessment (see Chapter 4.4 on the study done for Central Sumba by LIPI).
What is available is data of rivers which are shown with year round flow. However, in these cases, there is unfortunately no indication on the distance of these streams to the next communities. On the other hand, there are tables which indicate waterfalls with year round flow and the approximate distance of these waterfalls to the closest communities. However, there is no indication on the debit. As a third category, there was data obtained on the number of streams crossing a village and the number of springs in the area of the respective village.

4.3 Hydro Scouting

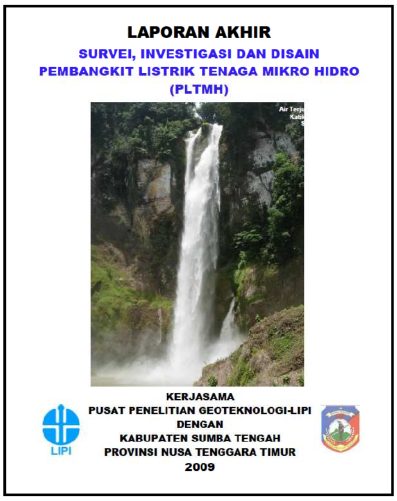
Due to the insufficient data basis, a realistic estimate of the MHP potential for village mini grid supply in Sumba can only be given after some ‘hydro scouting’ has taken place towards the end of the dry season (around September/October).
The data collected during this mission provides a number of valuable hints on where to start with the scouting. During the mission, GIZ’s newly produced `MHP Scout Guidebook´[6] was handed over to the 4 DINAS P&E. At a later stage of the Iconic Island Project it might make sense to distribute a bigger quantity of these books as extension material and input for the required hydro data gathering.

Example of a technicians’ field training on hydro scouting.

[6] Panduan Singkat – Pengembangan PLTMHP (GIZ/ESDM, 2011).

4.4 Existing Hydro Study

In 2009, the Indonesian Institute of Science LIPI in cooperation with the DINAS P&E produced study on survey, evaluation and design of MHP in Central Sumba (for reference: see cover sheet below):


LAPORAN AKHIR
SURVEI, INVESTIGASI DAN DISAIN
PEMBANGKIT LISTRIK TENAGA MIKRO HIDRO
(PLTMH)
KERJASAMA
PUSAT PENELITIAN GEOTEKNOLOGI-LIPI
DENGAN
KABUPATEN SUMBA TENGAH
PROVINSI NUSA TENGGARA TIMUR
2009
LIPI

A closer look was taken into the document since this was the only detailed hydro study which could be obtained from the respective DINAS in the 4 districts during the mission.
LIPI investigated 9 potential MHP sites. As informed by DINAS, 3 out of these 9 sites (Harangi, Lapopu, and Upper+Lower Wangga) are recommended by LIPI as worthwhile for being developed. DINAS put forward a proposal to MEMR in Jakarta requesting funding from the DAK 2011 for the implementation of the Harangi site. The DINAS P&E Central Sumba also expressed their hope that HIVOS would be willing to support the implementation of one of the studied MHP-schemes.

The study provides indication on potential MHP sites and can be appreciated as a good starting point for further MHP assessment in Central Sumba. For the 9 sites and in particular for the 3 recommended ones, head & flow should be measured in further details since it is not sufficiently clear how these crucial parameters were measured or on what assumptions they were based upon in the existing study.
Based on a further detailed measurement, the technical design and the corresponding Bill of Quantity (BoQ) should then be updated.
A rough calculation which was exemplarily done for the site Lower Wangga shows that even within the current design, a potential for cost reduction of at least 25% can be harnessed. Nevertheless, the resulting investment costs would still be extraordinary high with 267m IDR [22,023 EUR] per kW installed capacity.[7] Therefore, reducing the investment costs by further adjusting and optimising the engineering design is strongly recommended.

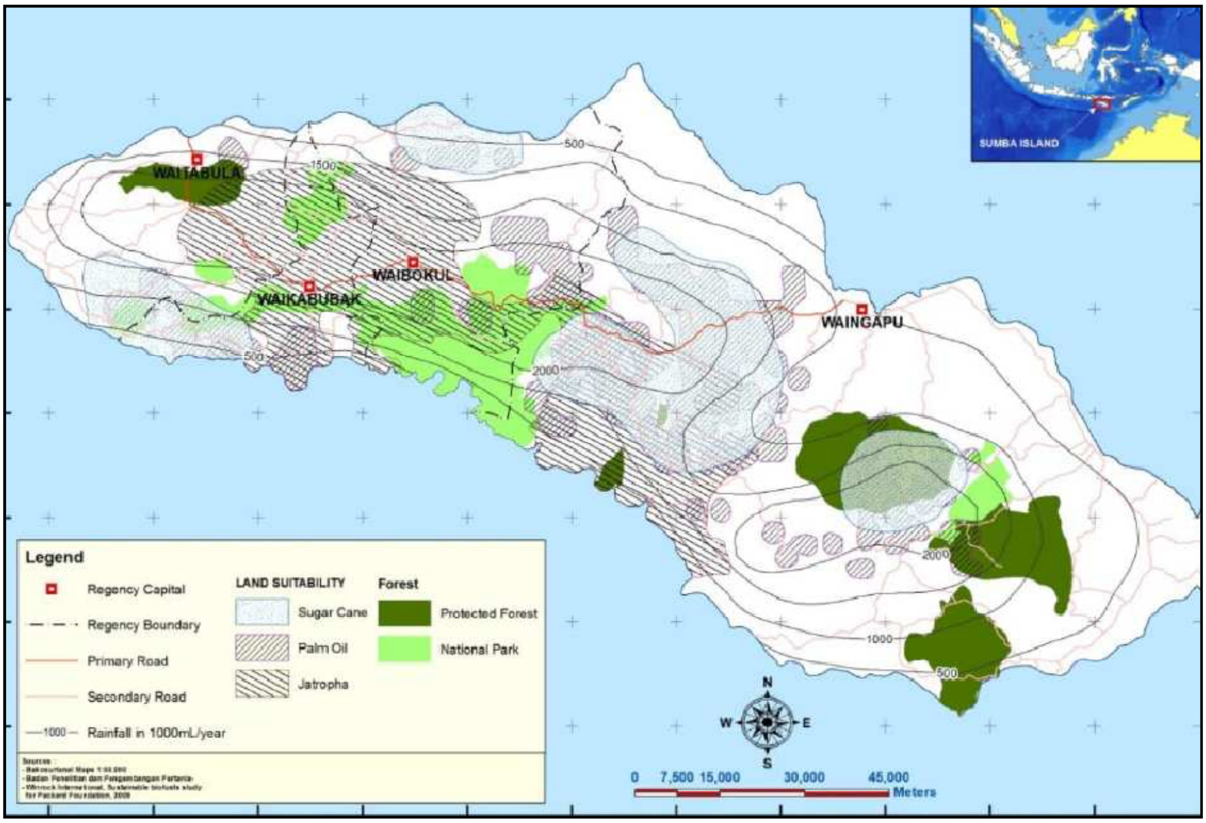
From the assessment of the LIPI-study, it can be concluded that a closer look needs to be done at the potential MHP-sites which are proposed for funding. This could be done by experienced Indonesian hydropower engineers who can be hired e.g. from Java. When an engineer comes to Sumba for a respective assessment (e.g. on behalf of HIVOS within the Iconic Island Project), s/he should team-up with suitable local people who would thereby be trained `hands-on´ on crucial issues of MHP development which they could subsequently apply in a systematic hydro scouting (see Chapter 4.3).

[7] Compared with e.g. a low cost village self-help MHP approach within Green PNPM in South and West Sulawesi where the cost averages at 16m IDR [1,320 EUR] per kW for schemes below 10 kW capacity (figures from budget years 2009, 2010).

4.5 National Park and MHP

Before visiting Sumba, there was the rumour that more or less the whole island might be turned into a national park. As this might seriously limit the possibilities for MHP development, the mission team asked representatives from BAPPEDA and DINAS P&E in East Sumba about the issue.

They clarified that the national park areas actually only cover parts of Sumba (for details, see map below) and expect that MHP development would not be completely forbidden in the National Park. However, a permit from the Ministry of Forestry will be required in the future. According to a DINAS representative, it is expected that permits will be granted as long as there is no major change of landscape required for the MHP construction.



National park areas according to mapping agency.

4.6 MHP and Productive Use of Energy

Hydropower is often considered to be the least-cost option among all renewable energy technologies for electricity generation. However, this is only true when looking at the cost per kWh which can be generated.

In remote rural areas of Indonesia, electricity is often used solely in the evening hours when farm workers return home from the fields and switch on their lights and TV-sets. This means that during daytime the MHP-scheme is often not utilized which results in relatively high investment costs for only a few actually consumed and paid kWh.

In order to increase the power plants load factor it is therefore important to identify activities which utilize energy productively during the day time when energy is available in abundance. Thereby not only the income situation of villagers can be improved but also higher financial revenues can be obtained with the operation of the MHP-scheme which ultimately contributes to its economical and technical sustainability.

In many rural areas of Indonesia with a high potential for MHP (e.g. Sulawesi and Sumatra), the energy is used for post harvest processes of agricultural products, such as threshing, hulling, and milling. Investment costs for the required machineries can be kept relatively low when they are not operated electrically but instead are powered with a direct mechanical drive at the powerhouse as pictured here:

Productive Use of MHP by mechanically direct driven milling machines in Sulawesi and Java.

When comparing with Indonesian islands further to the West where rice growing is the major agricultural activity, there seems to be significantly less potential for using MHP productively in Sumba. Pumping water from rivers for irrigation might be interesting but whether there is need and technical potential for doing so at the same location needs to be assessed in detail in the field.

Communities where an assessment indicates no potential for productive end-use activities of a size that would require the large power capacity of a MHP-scheme, the electric power will likely be for lighting, TV and mobile phone charging only. For this type of communities, it is worthwhile to consider alternatives to MHP (see following Chapters) which require less maintenance and neither substantial civil works constructions nor expensive electricity lines from the sometimes distant powerhouse location to the scattered houses.

5. Pico Hydropower

In places which have no demand for powering machines for productive, income generating use of energy but only need electricity for lighting, TV and mobile phone charging pico hydro can be an interesting option.

In China, Vietnam and Laos smallest systems with often less than 150 W and at a price of 440,000 – 880,000 IDR [36 – 72 EUR] are widely applied to supply 1-2 households which are nearby a water stream. These systems, however, are of low quality, not very reliable and often electrically hazardous.
Therefore, the GTZ supported Mini Hydro Power Project (MHPP) developed electrically safe and reliable systems with a capacity of up to 2 kW (for several households located close to each other) that can be seen here:

Low-cost pico hydropower as installed in Sulawesi.

These systems are designed in a way that allows manufacturing in basically every standard metal workshop of vocational schools throughout Indonesia. For more details see ANNEX 2.

Most hamlets seen whilst visiting Sumba are located on hilltops which seems to be the traditional settling-pattern. For pico hydro, unfortunately, these hamlets are too far away from the respective water streams. Transporting the electric power over long distances requires high voltage with step-up and step-down transformers at the beginning and the end of the transmission line. When implementing such a complex setting for pico hydro, its cost advantage would be gone.

Whether there are more suitable locations in Sumba than those seen by the mission team can be assessed when going further into remote areas during future hydro-scouting and site assessment activities.

6. Photovoltaic Systems (PV)

6.1 Overview

Sumba has a fairly high solar irradiation.[8] Since people settle rather dispersed and alternatives such as MHP might face difficulties during the dry-season in many places, PV is certainly a highly important energy option for off-grid electrification in Sumba. Also with regard to the relatively easy engineering and maintenance requirements, PV is deemed as first off-grid electrification choice for the remote Sumba Island.

Before going into details of PV in Sumba, the following chart provides a condensed overview on some typical PV system concepts:

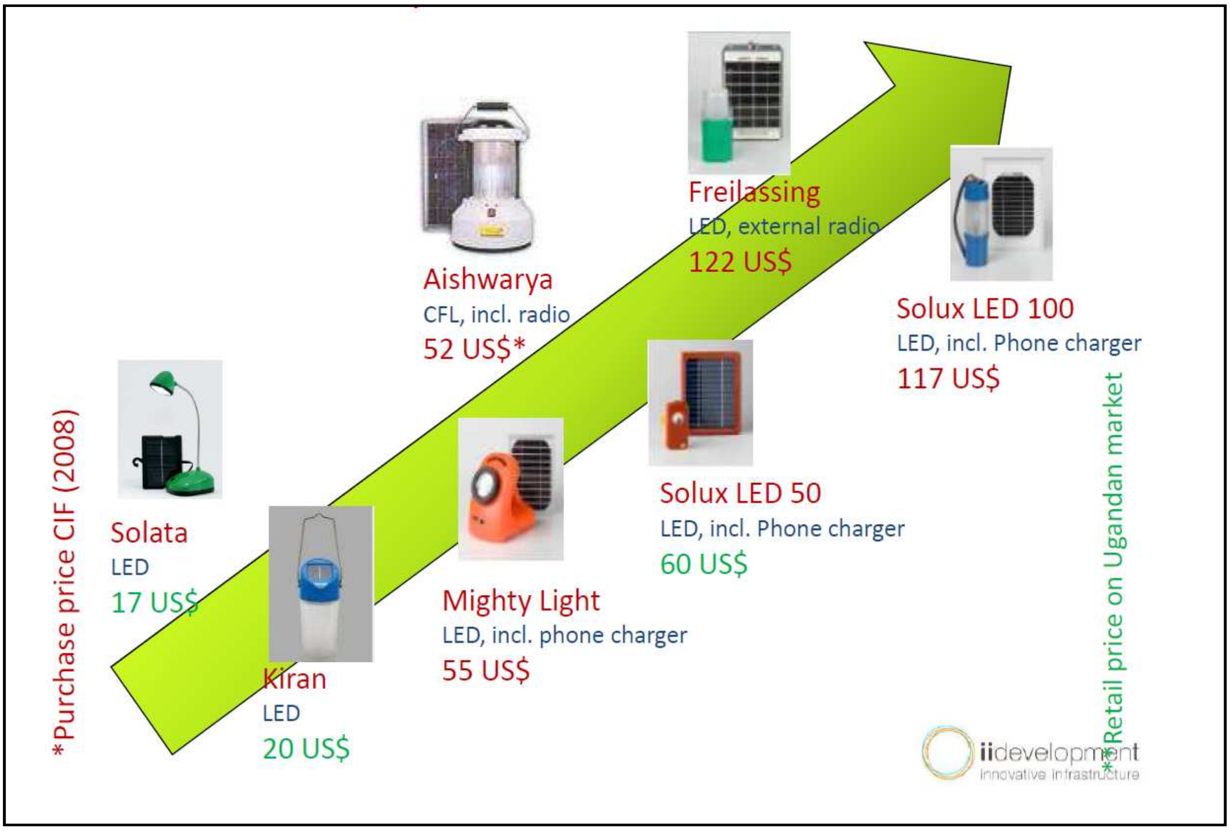
Technology	Description	Typical daily Energy Available	Appliances that may be powered
Solar Lantern	Light, battery and electronics integrated in one unit. One light of typical 3W-9W. Battery typical 4Ah-7Ah. Solar panel typical 3Wp-10Wp.	12Wh to 40Wh	1 light
Portable Solar System	Battery and electronics are integrated in one unit. Often possibility for radio/hifi connection. Two lights of typical 3W-9W each. Battery typical 5Ah-12Ah. Solar panel typical 5Wp-15Wp.	20Wh to 60Wh	1 to 2 lights radio/hifi
Small to Medium SHS DC System	Often individual components. 2 to 6 lights typical 7W-13W each. One to three batteries of typical 100Ah each. One to three solar panels of typical 50Wp each.	200Wh to 600Wh	2-6 lights, radio/hifi
Large SHS AC System	Often individual components. 6 to 12 lights typical 7W-13W each. Four to ten batteries of typical 100Ah each. Four to twelve solar panels of typical 50Wp each.	800Wh to 2.4 kWh	6-12 lights, radio/hifi, VRC, TV, fan, sewing machine and other small power appliances, small fridge for largest systems
Battery Charging Station	Typical central PV system of 250Wp-1kWp for 10 to 50 users. Users have batteries ranging from 20Ah-50Ah. Users connect 1 or 2 lights to the battery and radio/hifi.	50Wh to 150Wh per user	1 to 2 lights radio/hifi
PV minigrid	Central PV system. Systems are sized for a particular application. Typical system sizes of 1kWp-20kWp. Typical 10 to 50 users.	4kWh-80kWh	6-12 lights, radio/hifi, VRC, TV, fan, sewing machine and other small power appliances, small fridge for largest systems
PV-LPG Hybrid System	Central hybrid systems powered by PV and LPG. Systems are sized for a particular application. Typical generator sizes of 10kW-50kW. Typical 20 to 100 users.	Mainly depends on the size and running time of the generator	Lights and most domestic appliances.

Overview on typical PV system concepts according to ETC /CASINDO.

[8] For details on long-year average monthly irradiation displayed graphically at a map of Indonesia, see here: http://www.casindo.info/fileadmin/casindo/Training/Solar_resources_in_Indonesia.pdf.

6.2 Solar Lanterns / PicoPV

The smallest and thus also most affordable PV systems for lighting are solar lanterns, also called PicoPV systems. With LED technology advancing and also small LEDs being meanwhile available in reliable quality (i.e. facing almost no degradation of light output over time) numerous small systems either with an integrated or a separate PV-panel have come on the market- especially in Africa.
With a price range of approx. 150,000 – 1m IDR [12,37 – 82,48 EUR], many of them cost far less than most conventional Solar Home Systems (SHS, price range approx. 4m – 8m IDR [330 – 660 EUR]) and therefore are affordable for a far bigger number of users. Some examples (which have been laboratory and field tested in a GIZ supported initiative) can be seen here:



Examples of PicoPV lighting systems according to iiDevelopment/GIZ.

Unlike in many areas of Sub-Sahara Africa, no PicoPV lighting systems were seen during the mission in Sumba. However, for households which just want to convert from kerosene lighting to LED and at the same time cannot afford to subscribe to the better (in terms of quality and light output) SEHEN lamp rental program of PLN, introducing low-cost LED lanterns might be an interesting alternative.

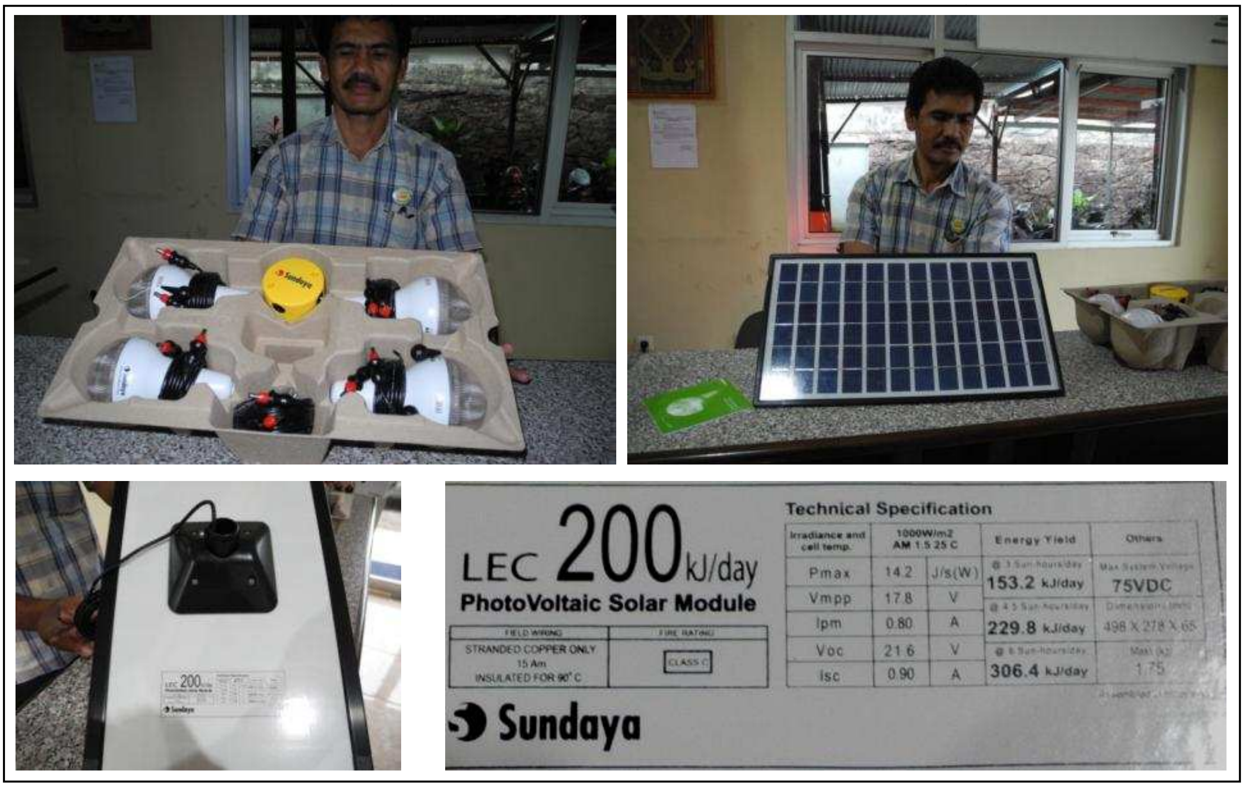
The experience in Sub-Sahara Africa so far is that the technical quality of the systems varies very much whilst common buyers cannot assess upfront whether they buy a good or a crappy product. Therefore, Lighting Africa, a joint IFC and World Bank program, developed a quality assurance program which supports market development, provides technical advisory services to quality oriented companies, and protects the interests of low-income consumers.[9]
When promoting PicoPV within the Iconic Island Project in Sumba, linkages with the Lighting Africa Initiative should be established for sharing concepts and product information.

[9] For 'Lighting Africa certified' products see http://www.lightingafrica.org/our-associates.html?layout=item. Additional information on PicoPV is provided here: http://www.gtz.de/de/dokumente/gtz2009-en-solar-lanterns-screen.pdf and here: http://www.gtz.de/de/dokumente/gtz2010-en-picopv-booklet.pdf.

6.3 Solar Lighting Systems SEHEN by PLN

In an effort to rapidly increase Sumba's electrification ratio, PLN has put in place the SEHEN program (Sangat Extra Hemat ENergi – Very Extra Energy Efficient) for PV powered lighting based on the high quality, easy to install Sundaya Ulitium 4 light kit (10 W_p PV panel, 3 respectively 4 LED lamps with integrated Li-Ion battery).[10]

In 2011, the target is to distribute 24,000 systems in Sumba with 8,300 units for West and Central Sumba together, 4,100 units for South-West Sumba and 11,600 for East Sumba. The total target for NTT is approx. 110,000 units.



Pictured at PLN's warehouse in Waingapu: Sundaya Ulitium lighting kit used in PLN's SEHEN program.

The dissemination mechanism for SEHEN is designed the following:

- SEHEN customers have to put a IDR 500,000 [41.24 EUR] deposit in Bank NTT to get the system
- A monthly fee of 35,000 IDR [2.89 EUR] will be deducted from this deposit account
- In case of technical failure, replacement (PV panel or lamp) can be requested from PLN
- PLN therefore procures the modular 4 light kit and hands out 3 lights only to the customers whilst 1 light is kept back for replacement
- When the deposit has depleted, the customer has to make a new deposit of at least IDR 35,000 [2.89 EUR] per month

[10] For details, see: http://www.sundaya.com/daftarprodukEN.php?Kat=Ulitium. Whilst compiling this report, it turned out that a Germany based PV-system engineer who currently is probably the most informed person when it comes to PicoPV-systems has tested the Sundaya Ulitium light kit and considers it as one of the 2 best systems presently at the market worldwide. All individual components are of high end quality and match well. Its plug and play approach is very user friendly. With a separately available cable, the Ulitium can also charge mobile phones. When bought in bigger quantities the system is available even without the PV panel so that it can be charged with a common 12V layout in a centralized battery charging station, i.e. in an energy kiosk.

- When PLN's grid gets extended to a SEHEN customer's home, the customer will automatically be converted into a conventional PLN customers without any connection fee payment
- PLN has set-up a team for marketing/awareness creation for the SEHEN program and works closely with village leaders in order to identify potential SEHEN customers

With the SEHEN program, PLN follows a 'fee for service' approach which follows the concept that customers do not want to buy power plants but need electricity or ultimately energy services such as lighting, communication, etc. Moreover, this approach matches well with a utility company whose core business consists of (generating and) selling electricity.

The 500,000 IDR [41.24 EUR] upfront deposit requirement and 35,000 IDR [2.89 EUR] monthly fees will likely be difficult to be borne for the income-wise "bottom of the pyramid", low-income households. On the other hand, the SEHEN fees are relatively close to PLN's fee structure for grid-connected households (see table with published rates below) allowing PLN to identify early who financially qualifies as future grid-connected household customers:

PT.PLN (Persero) CABANG SUMBA RANTING SUMBA TIMUR
DATA TDL TAHUN 2011

TARIF		DAYA (VA)	BP (RUPIAH)	MATERAI (RUPIAH)	JUMLAH (RUPIAH)
SOSIAL	S2-TR	450	337.500	9.000	346.500
	S2-TR	900	675.000	9.000	684.000
	S2-TR	1.300	975.000	9.000	984.000
	S2-TR	2.200	1.650.000	12.000	1.662.000
	S2-TR	3.500	2.712.500	12.000	2.724.500
	S2-TR	4.400	3.410.000	12.000	3.422.000
	S2-TR	5.500	4.262.500	12.000	4.274.500
	S2-TR	6.600	5.115.000	12.000	5.127.000
	S2-TR	7.700	5.967.500	12.000	5.979.500
	S2-TR	10.600	8.215.000	12.000	8.227.000
	S2-TR	13.2[illegible]	10.230.000	12.000	10.242.000
RUMAH TANGGA	R1-TR	450	337.500	9.000	346.500
	R1-TR	900	675.000	9.000	684.000
	R1-TR	1.300	975.000	9.000	984.000
	R1-TR	2.200	1.650.000	12.000	1.662.000
	R2-TR	3.500	2.712.500	12.000	2.724.500
	R2-TR	4.400	3.410.000	12.000	3.422.000
	R2-TR	5.500	4.262.500	12.000	4.274.500
	R2-TR	6.600	5.115.000	12.000	5.127.000
	R3-TR	7.700	5.967.500	12.000	5.979.500
	R3-TR	10.600	8.215.000	12.000	8.227.000
	R3-TR	13.200	10.230.000	12.000	10.242.000

PLN's published connection fees in East Sumba for 2011.

If PLN agrees to widen the menu of choice within the SEHEN approach, also Sunday Ulitium light kits with only 2 or 1 lamp could be provided and therefore made affordable for a larger number of customers. To get an idea of how much lower respective hardware costs for the various Sundaya light kits could be, a quotation was requested from Sundaya (originally received in Singapore Dollar for markets outside Indonesia) which looks the following:

Description	IDR[11]	EUR
1 Ulitium200 Lightkit	600,000	50
2 Ulitium200 Lightkit	1,100,000	91
3 Ulitium200 Lightkit	1,600,000	132
4 Ulitium200 Lightkit	2,100,000	173

[11] Rounded price figures in IDR and EUR are provided for reference only based on the Singapore Dollar-exchange rates of the quotation's date (8 March 2011).

6.4 Solar Home Systems (SHS)

Solar Home Systems with PV panels of 50 W_p, storage batteries of 70-100 Ah and several fluorescent tubes can be found in many communities of rural Sumba (see Chapter 3.1 and ANNEX 4). They cost around 10m IDR [825 EUR] each and are provided free of charge to the users from governmental support programs.
Reportedly a substantial share of the SHS is in disrepair due to non-functioning batteries and/or charge controllers often resulting from matching system components which are either of insufficient quality or simply do technically not harmonize with each other. Users pay no fees and repair and maintenance services are not in place.

Typical SHS installation in Sumba. Pictures provided by Zakarias Natara.

Since reliable LED-lighting with far smaller power consumption has become a technically and financially viable option, the only advantage of larger-sized and much more expensive 50W_p SHS can be seen in its capacity to power a black & white TV-set. However, with recent market introduction of DC-powered LCD and LED-TV receivers consuming less than 20 W also this advantage becomes increasingly obsolete.

Therefore, when it comes to SHS the questions for the Iconic Island Project should be the following:

- How can already installed and still functioning SHS be better maintained, e.g. by supporting the establishment of small service and repair shops and providing vouchers to SHS owners for making use of respective services?
- How can non-functioning SHS be repaired or be partly converted into more reliable LED-systems by making use of still functioning PV panels?
- How can environmentally hazardous lead-acid batteries from SHS be safely disposed or recycled once they are worn-out?
- How can governmental decision makers be interested to phase-out the sporadic procurement of SHS and instead support the mass-dissemination of more reliable and lower priced LED-systems which would allow a far bigger share of users to get access to electric lighting?
- When substituting bigger SHS by PicoPV-LED systems in individual households, how can the users' demand for TV (i.e. entertainment, information and participation in public & political live beyond their village) still be fulfilled by e.g. publicly accessible village cinema (TV/DVD/Karaoke/etc)?

Whilst reportedly in West Sumba the local parliament refused a proposal to charge user fees in return for post-installation services, the DINAS P&E of South-West Sumba reported that their local government has made an attempt for a better SHS implementation model which shall mitigate potential conflicts in the villages (implementation started in 11/2011):

- The village conducts a village discussion on who's going to get the systems
- The amount of investment contribution (complementing the contribution from the local budget) and also the monthly fee for maintenance and repair is decided in this forum
- The money is managed by a SHS forum at village level
- As soon as the collected money is sufficient, additional SHS systems will be bought and provided to those who do not yet have one
- Whilst everybody has to continue with paying the monthly fee, the new owner of a SHS will have to make his investment contribution

The DINAS P&E of South-West Sumba also designed a concept on improved maintenance and troubleshooting for SHS:

- DINAS employed 2 PV-technicians
- It is planned to institutionalize all SHS users in a community in a forum and direct them to appoint 1 or 2 persons as PV troubleshooting technicians / care takers
- Those technicians / care takers shall be trained by the DINAS' PV technicians and later on be paid from the monthly maintenance and repair fee

6.5 PV Mini Grids

PV mini-grids for the supply of one to several hamlets have so far not been seriously considered as an electrification option in Sumba. Reportedly the reason is that due to Sumba's settling structure the costs for connecting scattered houses are assumed as too expensive.

On the other hand, there are at least 100 diesel gen-sets provided via the DINAS for supplying groups of 40 households in average with electricity during evening hours. The characteristics of the diesel powered electricity supply reportedly look the following:

diesel gen-set with5 kW
on average 40 HH per diesel
18 watts FL, 3 lamps per HH (i.e. 54 Watt/hh)
no other appliances (except maybe handy charger)
TV only for communal use (in average 1 parabolic antenna per hamlet)
operational hours max. 6 pm to 6 am

In the respective communes, the mini grid (i.e. distribution lines and household connections) is assumedly already in place and would cause no additional costs when substituting expensive diesel-fuel by a centralized PV system.

Since the Iconic Island Project aims at a conversion from fossil to renewable energies, a cost estimate (as basis for further considerations) was provided by an experienced Indonesian PV-system integrator company (originally in USD) for:

Option 1) conversion of the purely diesel-powered systems into PV-diesel hybrid systems

Option 2) full replacement of the diesel gen-sets by `pure PV mini-grid systems´

Insolation	:	5	kWh/m2		
System Voltage	:	48	VDC/230 VAC		
Based on	:	100	units purchase	**Option 1**	**Option 2**
	Solar fraction (%)			100	50
	Imported Hardware				
1	-	PV Array (Wp)		5,280	10,560
2	-	Battery Charge Controller (A)		100	200
3	-	Inverter (Watt)		3,500	3,500
4	-	Battery Capacity (Ah)		1,000	3,000
5	-	Transport (ls)		1	1
	Local Hardware				
6	-	Powerhouse		1	1
7	-	Support Structure (unit)		4	8
8	-	Foundation (unit)		4	8
9	-	Combiner & connection panels (ls)		1	1
10	-	Cabling & Grounding (ls)		1	1
11	-	Grounding		1	1
12	-	Installation material (ls)		1	1
	Costs				
12	-	Imported Hardware (CIF Jakarta Port)		246m IDR [20,291 EUR]	539m IDR [44,459 EUR]
13	-	Custom clearance, tax & storage fee		70m IDR [5,774 EUR]	70m IDR [5,774 EUR]
14	-	Local Hardware		108m IDR [8,908 EUR]	165m IDR [13,609 EUR]
15	-	Delivery		40m IDR [3,299 EUR]	40m IDR [3,299 EUR]
16	-	Installation		44m IDR [3,629 EUR]	44m IDR [3,629 EUR]
17	-	Commissioning		17m IDR [1,402 EUR]	17m IDR [1,402 EUR]
		Total Cost		**525m IDR [43,303 EUR]**	**875m IDR [72,172 EUR]**

In a PV-diesel hybrid system (i.e. Option 1), the diesel gen-set can directly cover the demand peaks in the mini-grid whilst the electricity for regular demand is generated by the PV panels. Compared to a pure PV system (i.e. Option 2), this combination allows for smaller PV arrays and battery banks and thus for a far lower investment.

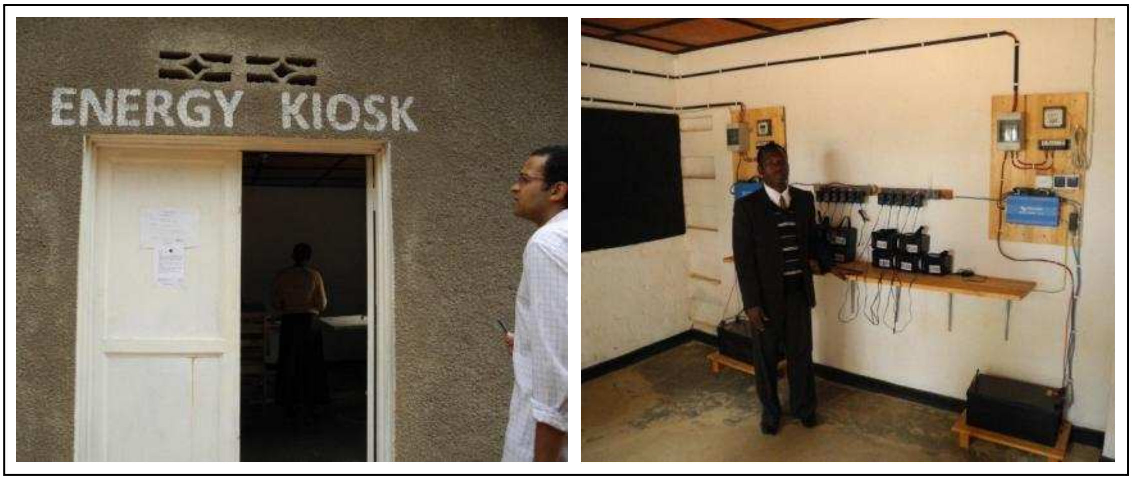
Although having a smaller PV array, the battery bank in a PV-diesel hybrid system can be fully recharged even during longer periods without sufficient sunshine which is crucial for a lead-acid battery's lifetime.

Compared to a pure diesel powered mini grid, the operational expenses of a PV-diesel hybrid system are far lower since most of the time the electricity is provided by PV. When during typically short periods of time PV does not provide sufficient power, the diesel gen-set is switched on and operated at its rated capacity. Running it at rated capacity and feeding the 'excess energy' into a battery can significantly lower the specific fuel consumption per generated kWh compared to part-load operation in a system without battery storage.

Due to these advantages, it is recommended to combine the two technologies for mini-grids. With regard to the aim of 100% renewable energy, it should be assessed to which extend it makes sense to run the gen-sets either by bio-diesel or by plant-oil.

PV Energy Kiosks / Charging Stations

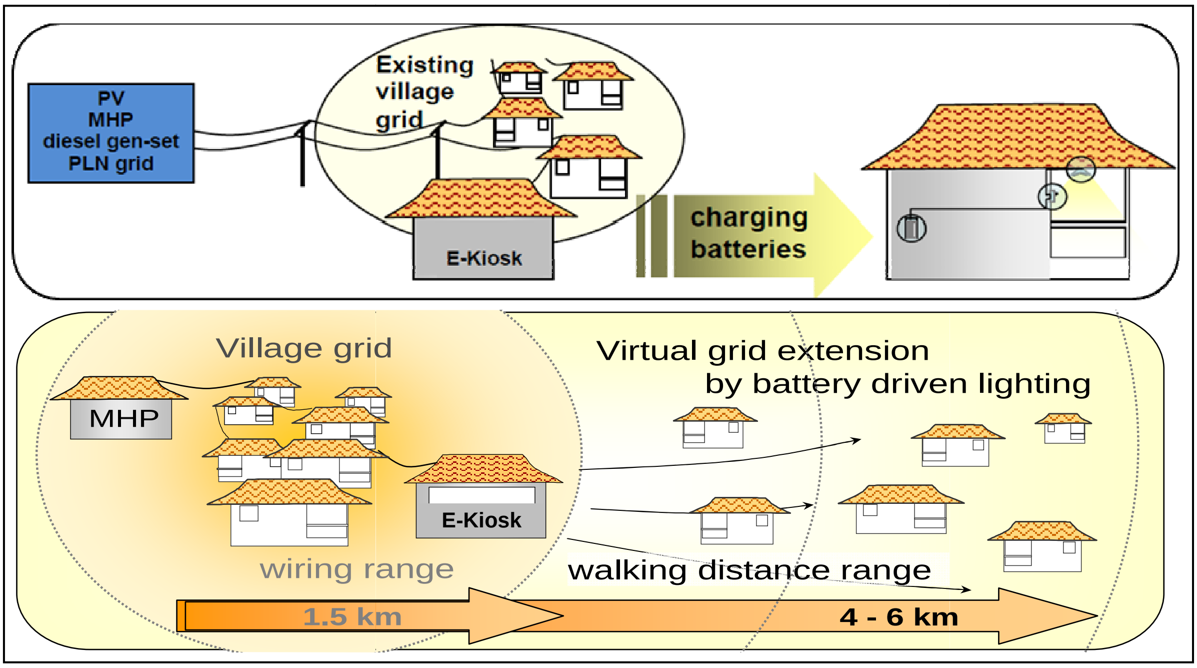
The concept of charging stations or PV powered energy kiosks with portable batteries or small electric lanterns is not yet widely applied in Indonesia and hardly known in Sumba. In the past, batteries had to be big and heavy and thus carrying them was not accepted by the majority of users. With LED lighting systems, however, batteries nowadays can be much smaller and far easier to carry. Therefore, there is an increasing number of battery charging systems implemented, especially in Sub-Sahara Africa (see picture below):



Example of a rural Energy Kiosk in Rwanda with numerous lightweight battery boxes.

A clear advantage of such a concept is that charging batteries can take place centrally. Thus, better quality charge controllers can be put in place and the technical conditions of batteries can be monitored regularly when they are at the charging station. This allows taking necessary measures early for maintaining the system's quality by a trained shopkeeper who runs the energy kiosk. At a well designed energy kiosk, there is also sufficient electric power available to operate bigger electric appliances (e.g. a village cinema or a laptop with internet access) so that respective user demands e.g. for ICT can be fulfilled.

As the graph below shows, an energy kiosk can be powered by different electricity sources and most importantly can be combined also with already existing mini-grids or even PLN grid-electrification in order to scale-up their outreach beyond the actual wiring:



Battery charging: low-cost virtual grid extension. Drawings according to MHPP/GTZ.

6.6 PV and Productive Use of Energy

Although PV is often not considered as a first choice when it comes to productive, income-generating use of energy, there are a number of applications which can well be powered by PV and might be interesting in the context of Sumba:

- Electric sewing and electric (LED) lighting in home industry e.g. for weaving of Sumba's traditional ikat (which is typically done by women and thus could improve their health and economic situation)
- Water pumping (for irrigation and possibly also for household supply) which is reportedly done by diesel pumps in several places in Sumba and could be replaced with a low cost PV system which would not require any battery (i.e. storing water instead electricity)
- Electric fencing for livestock (which would free up time that might be used more productively)

Productive use of energy for income generation is not only a technical issue but also requires a comprehensive addressing of business skills, value chains, marketing possibilities, etc. Therefore, the above listed applications shall only be seen as first ideas which would need further assessment and follow up in the course of implementing the Iconic Island Project.

7. Financing Options for Off-Grid Electrification

Worldwide, there is a big variety of financing options and dissemination models for off-grid electrification available[12]. These days, the prevailing experts opinion suggests that the more commercial and market based a model is the better it is. An introduction to the various financing options models can be found e.g. at the webpage of the Dutch funded renewable energy project in Indonesia CASINDO[13].

Commercial funding of renewable energy systems including a substantial contribution by its customers undoubtedly increases the sense of ownership, thus contributes to increased sustainability. However, throughout the last couple of years, for many reasons it proved to be extremely difficult in rural areas of Indonesia to establish commercially oriented dissemination mechanisms for off-grid electrification. With Sumba being among the poorest areas of Indonesia there is not much hope that at this particular island it would be any easier.

Although a commercial financing mechanism – particularly for the upfront investment of power generation equipment – seems unlikely to be functional at Sumba, it is even more crucial to foster a good sense of ownership so that users take care for their energy sources.

This means that upfront investment costs might well be covered even to a large extend by public funds (as it is also the case for the connection of e.g. a remote farmhouse in German mountains) as long as users contribute by themselves within their limitations (no matter how little this is, as long as it is sufficiently noticeable for the users). This can be in the form of 'sweat equity' (e.g. providing labour free of charge during the construction of an MHP scheme) or by paying a connection fee or by making a small deposit when buying an individual SHS. In order to create a sense for taking care and maintaining an energy system, it is equally important to also charge regular user fees which should be saved to cover major repairs and buying spare parts.

As a consequence of the non-applicability of commercial financing options for rural Sumba, this chapter is dealing almost exclusively with public funds, i.e. governmental programs to support off-grid electrification.

These are however only seen as a starting point for the Iconic Island Project. Starting from here, it is hoped that together with local authorities who proved to be well aware of the shortcomings of existing support programs it will jointly be explored how to improve the sustainability and outreach of respective rural electrification efforts.

7.1 Micro Finance

Information obtained during the mission suggests that due to Sumba's high poverty rate there is no commercial financing available in rural areas of Sumba (i.e. neither banks nor otherwise commercially oriented financiers lending to villagers) and that are only 2 micro finance schemes implemented:

One is the Credit Union, CU, organized by the Catholic Church in West Sumba. They finance family businesses, education, health and the setting-up of small kiosks. Due to time limitations during the mission no information about their mechanism and conditions could be obtained.

The other one is the 'simpan pinjam perempuan' – SPP which is the women's saving and lending scheme supported by the PNPM. Most loans (in average around 1.5m IDR [124 EUR] per credit) are officially requested for investment like setting up small shops, buying raw material for weaving, etc). However, the majority of loans are actually used for non-productive expenditures such as food, clothing, school uniforms and school fees of children or repaying debts. Therefore, repaying rate is low and the aim of creating a revolving fund has not yet succeeded (especially in South West Sumba).

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[12] See for example the information provided by the Enabling Access to Sustainable Energy (EASE) partnership and their compilation of business models for up-scaling processes in the rural energy sector and local energy markets at http://www.ease-web.org/wp-content/uploads/2010/11/EASE-Business-models-for-energy-access-sm.pdf.

[13] See "Delivery Models" at http://www.casindo.info/training-courses/ .

7.2 Special Allocation Fund DAK from MEMR

Dana Alokasi Khusus Listrik Perdesaan (DAK LisDes) is a scheme operated by Ministry of Energy and Mineral Resources. DAK schemes have a standardized administration structure and started more than 8 years ago in other sectors. 2011 is the first year of applying the DAK mechanism in the energy sector. As of 02/2011 this scheme has not been operational yet with the following status:

1. The scheme is only supporting hardware related costs (for rehabilitation and/or extension of existing schemes, and construction of new schemes) up to 90%. It covers MHP (up to 30 kW) and centralized PV system (island mini-grids up to 20 kW_p). No other technology is supported in the DAK trial-year 2011. There is possibility to expand the technological scope of the scheme to biomass and wind in the future.

2. A technical quality guideline is ready and waiting to be officialised as ministerial decision. The guideline consists of a quality standard for MHP and centralized PV systems as well as for feasibility study (FS) reports. As soon as the ministerial decision is out, the program can be implemented.

3. The criteria for Kabupatens receiving DAK LisDes support (inter alia: PLN's generation cost and electrification ratio) are ready and a first batch of Kabupatens are selected. Most of them are in the Eastern region including East Nusa Tenggara (NTT) with all Kabupaten at Sumba being eligible.

The active role of Kabupatens is important. Feasibility study (complete with detailed design especially for MHP) is a must. This actually is posing a risk to the program's implementation since Kabupatens fulfilling afore mentioned criteria usually do not have enough experience in compiling good FS. Moreover, MEMR expects that local Kabupatens will support institutional capacity building for setting-up village utilities and respective trainings by themselves.

In 2011, 150b IDR [12,372,665 EUR] shall be disbursed for a planned number of approximately 40 Kabupatens, thus providing in average 3.75b IDR [309,317 EUR] per Kabupaten. Assuming 40m IDR [3,299 EUR] per kW for MHP, the amount would be enough to build on average 3 MHPs at 30 kW each per Kabupaten.
The respective funds are directly disbursed from central government to Kabupaten government by the Ministry of Finance. The MEMR provides guidance and assesses proposal (including provision of feedback for improvement) but has no power to enforce quality of actual implementation on the ground, since the responsibility for implementation is at Kabupaten level.

7.3 Listrik Perdesaan (LisDes) from MEMR

Within MEMR this program has now been moved from DGEEU to the newly formed Directorate General DGNREEC and it is assumed that within DGNREEC the Directorate of Various Renewable will take care of this program in the future.

In the past, this program financed MHP and PV (both centralized systems and SHS). MEMR is differentiating the target capacity of its programs (DAK and LisDes) with LisDes supporting MHP schemes up to approx. 150 kW with (average size of MHP around 50 kW). In general for 1 kW MHP installation, LisDes provides a rough cost orientation of 30m IDR [2,475 EUR]. This can be adjusted according to the site and geographic area (with far higher accepted specific investment cost for e.g. Papua).
For centralized solar PV system the program usually finances projects with average capacity of 20 kW_p. Compared to MHP, there are fewer implementations of centralized PV systems which do not occur every year.
The usual capacity for Solar Home Systems is 50 W_p with a battery of 70-100 Ah capacity. For SHS, one province might get more than 1,000 systems per year.

However, the recently uncovered financial irregularities in SHS dissemination have led to a decrease of SHS support activities and to a smaller extent seem also having affected the pace of implementation of MHP and centralized PV.
The program is basically covering hardware-related investment costs only. Proposals have to be provided complete with feasibility study by the regional (provincial or kabupaten level) energy office DINAS which poses a big challenge for many DINAS. There is no standard proposal format to be used (and no standard FS format) and the proposals show high variation in quality.

The finance is provided by the central government which also tenders hardware & implementation nationwide. Community facilitation is not part of the contract with the winning contractor. It is expected that local governments will do the community facilitation (trainings, guiding institutional set-up, etc) at their own expenses.
In most cases, the technical quality of LisDes projects is relatively good compared to rural electrification activities supported by other ministries. Relatively good specifications are clearly stated in the tender documents.

7.4 Funds from Ministry for Underdeveloped Regions

The ministry in charge of supporting less developed regions has a particular (but not exclusive) focus on border regions with 199 districts throughout Indonesia defined as underdeveloped areas. The ministry promotes micro hydropower (MHP) and solar home systems (SHS).
It was planned that as soon as the DAK for rural energy (designed by MEMR) is operational, all other ministries would stop their rural electrification activities and respective funds would all be channelled through the DAK. However this concept seems not yet to be implemented with the Ministry for Underdeveloped Regions still being active in rural electrification in 2011.

The capacity of supported MHP systems is not limited but mostly in the range of 30-50 kW. The investment support per kW seems to be more or less fixed at around 30m IDR [2,475 EUR] per kW (probably higher for very remote areas like Kalimantan or Papua). The planning and supervision of implementation and ultimately the technical and socio-economic quality of the MHP schemes usually lags behind those schemes supported by MEMR.
For the SHS, the technical specifications are the same as of the MEMR and also the hardware suppliers are mostly the same. There is no information of average annual volume of SHS distributed throughout Indonesia. Figures for Sumba are shown in the table of Chapter 3.1. For SHS the usual price within this program is 10m IDR [825 EUR] per system (50 W_p PV panel plus battery, charge controller, cables and three lamps).

The ministry finances purely hardware-related expenses but no training for operators, managers or users. Local governments can request the funds from the central government based on relatively unstructured proposals, i.e. no (pre-) feasibility studies are required. A team from Jakarta then verifies the local situation (actual assessment criteria not known) and if the proposal is deemed feasible the project will be tendered nationally. Local contractors are encouraged to apply for implementation whereby in the field it often seems that too little attention is paid to their previous experience with energy projects.

7.5 Funds from Ministry for Cooperatives

The Ministry for Cooperatives is working with the regional office for cooperatives in identifying suitable MHP sites and eligible cooperatives. MHP-promotion seems to be a by-product of fostering the roles of cooperatives. Therefore, no detailed information about recent hydropower activities support by this ministry could have been obtained.

7.6 National Community Empowerment Program - PNPM

Under the guidance of the Ministry of Home Affairs, the cross-sectoral National Community Empowerment Program PNPM is active throughout all Indonesia. PNPM which is often labelled as 'the world's biggest community driven development program' empowers communities to identify their own development needs and provides block grants to finance the prioritized activities which have won in an inter-village competition by requesting a substantial contribution by the respective village community.
In Sumba, each Kecamatan receives 3b IDR [247,453 EUR] per year. Per project there are up to 300m IDR [24,745 EUR] with up to 3 projects/village/year. In average there are 2 projects per village whereby 25% of the budget (i.e. 25% of 3b IDR [247,453 EUR] at Kecamatan fund allocation) must be allocated to women's micro credit schemes – the so called simpan pinjam perempuan or SPP.

Villagers are highly motivated to participate in PNPM because the PNPM process steps are very clear, predictable and reliable (e.g. if your proposal wins, you will have to work for it but the implementation will surely take place). At Kecamatan level there is high motivation to allocate at least 1 project activity to every village. Despite competition for the best proposals to be funded, this also leads to cooperation between villages to get supported one project at least in every community.

From an open menu of choice, in Sumba non-physical projects of PNPM are dominated by provision of school uniforms and additional food for school children. Physical implementation projects are dominated by construction of buildings (school, housing for teachers, health centre buildings etc), road improvement, and rain water collection/storage systems.
Rural villages can also opt for 'energy supply' as catalyst for their development. However, standard block grants are often too small for a good quality implementation of energy supply schemes and the standard PNPM facilitators have not sufficient capacities to train the villagers in developing and maintaining dynamic infrastructure assets such as a village based electricity utility. Therefore, in 2009 the Dutch Government provided funds to GIZ for setting up a Technical Support Unit for MHP (MHP-TSU) which provides MHP-specific advise embedded in a so-called PNPM pilot project named Green PNPM or `PNPM Lingkungan Mandiri Perdesaan (PNPM LMP)´. Although the MHP-TSU is not active in NTT, there is conception-wise a lot which can be learned from Green PNPM's approach in Sulawesi and Sumatra – e.g. when looking at opportunities for cooperation between the Iconic Island Project and the standard PNPM in Sumba. [14]

7.7 Local Government Funds

During the mission, no assessment was done of local governments' budget for financing energy related activities. However, as can be seen in the overview table (Chapter 3.1), there is substantial support provided for hardware procurement in off-grid electrification activities by the local governments in Sumba.

Several central government financing schemes expect that feasibility studies, implementation supervision, training and guidance for setting operational, management and maintenance structure is provided from local government funds.

Some local government representatives stated an apparent need to do more on sustainability issues in rural electrification. The Iconic Island Project could therefore jointly explore with the DINAS how local budgets can be used to increase the sustainability of centrally financed energy equipment. This complementary approach might be a better investment than just buying a few more systems which then take the same fate of premature disrepair.

[14] For more details, see: http://tsu.or.id/cms/ or contact TSU's Team Leader mark.hayton@entec.ch.

8. Conclusions & Recommendations

On data management & monitoring...

The Iconic Island Project aims with a long-term perspective at providing the people of Sumba with 100% renewable energy. This shall be achieved by a Multi Actor Initiative (MAI). This goes well beyond the sporadic provision of some additional energy devices and requires a comprehensive programmatic approach which includes substantial coordination and management tasks.

Common management theory states `you cannot manage what you do not measure´. All actors – those already on board but also those joining in the future – therefore have a need for consistent data of all kinds (hydropower potential, number of people not yet having access to electricity, failure and success-rates of specific energy equipment, etc).The district governments of Sumba have understood this already and have shared their data – as far as available –very openly with the mission team.

On the other hand, some data are not up-to-date or inaccurate or simply missing on some issues. Therefore, within the Iconic Island Project it is recommended to set up a data management unit in Sumba which collects, processes, updates and ultimately gives back relevant data to the stakeholders in the MAI.

Moreover, transforming an Island like Sumba to 100% renewable energies is an undertaking for which no blueprint exists. Whilst the end point is clear, the way of how to get there can only be one of `trial and error´ which will ultimately lead to success. Questions like "Where is money spend better? – by setting up battery charging stations or by promoting individual PV systems?" will need to be answered in order to keep errors small and reach success early.

To answer such questions, it is recommended to establish an effective monitoring system (i.e. a systematic observation of causes, results, risks and opportunities) right from the outset of implementing the Iconic Island Project.

On energy-related technical skills...

Outside DINAS and PLN, energy-related technical skills seem to be in short supply. For assessing, designing, installation, operation, management and repair of energy systems, more local expertise is required.

In Waingapu is a vocational school for technical issues whilst the Dutch supported energy program CASINDO has a component for improving technical schools curricula. On this issue, CASINDO is working with the Technical Education Development Centre (TEDC) which trains vocational school teachers from all over Indonesia. Respective contacts could be established by the Iconic Island Project and an assessment be done on how to improve the energy skills development (e.g. for PV technicians) in Sumba.

On supporting commercial energy shops...

Low cost LED-lamps can often be bought (almost) without requiring subsidies. However, at present, there seems to be no retail sellers for this kind of lamps in Sumba. Likely, there is also no provider of maintenance and repair services for e.g. a broken SHS at Sumba.

An additional, commercially oriented path to off-grid electrification might be opened when providing a combination of technical plus business advice. If need be, this could also be combined with providing some start-up capital to promising entrepreneurs (push approach). This could be complemented by providing vouchers for off-grid users in need of the entrepreneurs' products and services (pull approach).

On rehabilitation of broken SHS...

Reportedly a substantial number of SHS are broken in Sumba. It might be more economical to rehabilitate these systems than to replace them by new ones. Typically, the PV panels are still functioning whilst either the battery or the charge controller is in disrepair. It is recommended to carry out a detailed technical assessment in the field in order to determine whether either the broken parts should be replaced or whether the systems could still partly be used when substituting (C)FL lamps by LEDs. If all this does not work, it should be assessed, how at least the PV panels could be used alternatively.

On battery recycling...

During the mission, the opportunity was missed to inquire if/how environmentally hazardous lead-acid batteries from SHS are safely disposed or recycled once they are worn-out. Given the supposedly high numbers of broken batteries, this should be assessed in order to maintain Sumba's iconic character.

On priorities in technology choices...

The mission focused on small-scale hydropower and on PV. As for hydropower, the technical potential is unclear and thus needs to be looked at in the field during the dry season. For PV, the technical potential is established, thus making PV a safer technology choice.

The mission team was continuously told that people settle so scattered that only individual PV systems (i.e. SHS and PicoPV powered LED-lighting) make sense. However, there are also diesel powered mini-grids which could be substituted by PV.

Battery charging in an energy kiosk which is possible from PV but also from hydropower or diesel or even a PLN grid-connection was considered as not attractive by interview partners due to long walking distances. However, there might be a misperception of big heavyweight batteries which actually are not required any longer since low-cost LEDs have matured.

The conclusion at this stage of assessment is to definitely focus on PicoPV LED-lighting systems (not only the high end Sunday Ulitium but also lower priced systems) for a replacement of kerosene lamps.

Beside these individual systems which all come with their own PV-panel, a closely monitored pilot installation of an energy kiosk with centralized battery charging and an affiliated village cinema is also recommended. With a pilot installation, one could find out whether users would accept this concept with its manifold advantages (and the one disadvantage of carrying a battery every 3-5 days).

Whether it is worthwhile going for a diesel gen-set replacement by PV already during an early stage of the Iconic Island Project might depend on an economic and financial analysis of a respective investment project. As long as people still are supplied within their diesel mini-grid, it might be more urgent to focus on those people who have no access to electricity at all yet.

As mentioned above, for MHP and pico hydropower a closer assessment in the field is required during the dry season. Where sufficient hydro potential is identified, MHP becomes an interesting choice – especially at places with a promising potential for productive use of energy.

On hydropower assessment...

During the mission it turned out that seasonal flow data of streams which are geographically close to communities is either not available for Sumba or of doubtful quality. Therefore, it is recommended to conduct some 'hydro scouting' during the dry season (around September / October). The data received during this mission provides a number of valuable hints on where to start with the scouting.

The scouting can be done in a staggered approach: when an experienced Indonesian hydropower engineers who could be hired e.g. on behalf of Hivos comes to Sumba to do an in-depth assessment of a likely suitable site, s/he should team-up with suitable local people who would thereby be trained \`hands-on´ on crucial issues of MHP development which they could subsequently apply when doing on their own the less detailed hydro scouting.

On PLN's SEHEN program...

PLN within its SEHEN program provides a PicoPV LED light kit consisting of 4 lamps of which 3 are given to the customer and 1 is held back as a spare. The customers have to make a substantial deposit upfront and pay a monthly fee later on. Both is probably quite high for the majority of rural households.

Therefore, it could be explored with PLN whether they agree to widen the menu of choice by also providing Sunday Ulitium light kits with only 2 or 1 lamp(s), thus making SEHEN more affordable for a larger number of customers.

Another option for making SEHEN affordable to more users could be to establish a subsidy and/or micro finance scheme along the lines of what the district government of South-West Sumba established for households who otherwise could not afford to pay the initial connection fee.

On how to utilize local government's funds most effectively for rural energy provision...
Since LED based lighting systems have matured in the very recent past, they have become more energy efficient, technically more reliable and economically far more affordable than SHS which were the preferred choice in the past. Now, due to the technological progress of LED, a high share of users could be provided with access to electric lighting. A respective mass-dissemination program for kerosene lamp replacement could be explored jointly between Hivos and governmental decision makers.

Moreover, within several financing schemes provided by the central government (see e.g. Chapter 7.2), it is expected that feasibility studies, implementation supervision, training and guidance for setting operational, management and maintenance structure is covered by funds from local governments.
Some local government representatives stated an apparent need to do more on sustainability issues in rural electrification. It is therefore recommended, to also jointly explore with the DINAS how local budgets can be used in a complementary manner in order to increase the sustainability of energy access activities which are (partly) financed by the central government. This complementary approach might be a better investment than just buying a few more systems which then take the same fate of premature disrepair.

On how to raise user fees in an almost cash-less environment...
The challenge is that for repairs and spare parts and e.g. in the case of a MHP-scheme also for daily operation and management, fees need to be collected from users who do not have money.
Being faced with this challenge, IBEKA developed an interesting approach in Sumba which might be adopted also within the Iconic Island Project:

- Using a 'sticks and carrots' approach whereby providing energy is considered as the carrot that motivates the community to conduct additional development activities
- Insisting that the community establishes as cooperative which is taking care for the energy infrastructure
- Promoting agricultural development (as source of income to pay user fees), i.e. by promoting irrigation / by conducting an award winning competition for harvest yields / etc
- Higher cash-income in the community ultimately allows paying user fees for electricity supply to the cooperative.