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Baseline Report on Micro Hydro Power sites selected for EnDev II in Indonesia

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Contents

- Executive Summary 1
- 1. Introduction..... 5
 - 1.1 Project description: Micro Hydro Projects Indonesia 5
 - 1.2 The Green PNPM project and MHP TSU 6
 - 1.3 Country’s State of Affairs 7
 - 1.4 Energy Sector 8
- 2. Evaluation Approach 9
 - 2.1 Evaluation Objective 9
 - 2.2 Strategy to identify impacts 9
 - 2.3 Survey Implementation and Sampling 11
- 3. Results from structured household interviews 12
 - 3.1 Household Structure 12
 - 3.2 Household Economy 13
 - 3.2.1 Housing Conditions and Assets 13
 - 3.2.2 Income..... 14
 - Main Occupation and Wage Income 15
 - Cultivation and Animal Husbandry 17
 - Migration and Remittances 19
 - 3.2.3 Expenditures and Financial Situation 19
 - 3.3 Education, Health and Infrastructure 21
 - 3.3.1 Education..... 21
 - 3.3.2 Health 21
 - 3.3.3 Infrastructure 22
 - 3.4 Energy Usage and Potential Impacts 23
 - 3.4.1 Energy sources and uses 23
 - Lighting 30
 - Crop transformation 32
 - Productive Electricity Use..... 34
 - 3.4.2 Energy expenditures..... 35
 - 3.4.3 Activity Profile 36
 - Time for Studying 37
 - Television and mobile phones usage..... 38
 - Social Commitment and Sense of Security 39
 - 3.4.4 Attitude towards Electricity 41
- 4. Conclusion 43
- References..... 45
- Annex 1..... 47
 - Survey site profiles Sulawesi 47
 - Survey site profiles Sumatra 49
- Annex 2..... 52
 - Survey Tools 52

List of Tables

Table 1: Indonesia at a glance	7
Table 2: Household Characteristics	12
Table 3: Housing Conditions	13
Table 4: The Wealth Indicator	14
Table 5: Subjective Rating of Household Income	15
Table 6: Agricultural activity	17
Table 7: Most important animals	18
Table 8: Financial Situation	20
Table 9: Health	22
Table 10: Diseases suffered by household members in the last six months.....	22
Table 11: Usage and Consumption of different energy sources	24
Table 12: Electricity Sources in EnDev 2 villages	25
Table 13: Expenditures on electricity sources per household and month (in IDR)	28
Table 14: Average number of years households have been using current electricity source	28
Table 15: Appliance usage (electric appliances and <i>non-electric counterparts</i>)	28
Table 16: Appliances that would be purchased in case of electrification / higher capacity	29
Table 17: Lighting devices and consumption	30
Table 19: Lumen per lighting device	31
Table 20: Crop Transformation	33
Table 21: Businesses in EnDev2 villages.....	34
Table 22: Activity profile.....	37
Table 23: Time for studying.....	37
Table 25: Membership in groups.....	40
Table 26: Fear of going out after nightfall (in %).....	40
Table 27: Purpose of electricity usage from MHP (in %).....	41
Table 28: Willingness to pay for electricity services (in IDR).....	41
Table 29: Highest affordable price for connection fee	42
Table 30: How are you planning to pay for the MHP connection?	42
Table 31: Priority concerning lighting and electric appliances (in %).....	42
Table 32: Importance of electricity provision in social infrastructure in the village (in %).....	43

List of Charts

Chart 1: Micro Hydro Project activities of GTZ Indonesia, 2006-2012 (Endev 1 / EnDev 2)	5
Chart 2: Impact assessment: The difference in difference estimator	10
Chart 3: Assets and wealth indicator in Sulawesi and Sumatra	13
Chart 4: Composition of Annual Household Income Sumatra and Sulawesi	15
Chart 5: Main occupation of population able to work distinguished by region and sex	16
Chart 6: Most common crop and dimension of cultivated land	17
Chart 8: Highest level of education	21
Chart 9: Energy Sources	23
Chart 10: Electricity Sources in EnDev 2 villages (in %).....	24
Chart 11: Electricity Sources per village	27
Chart 12: Usage of different lighting devices	31
Chart 12: Satisfaction with lighting quality of different lighting devices	32
Chart 13: Energy expenditures by category	36
Chart 14: Composition of expenditure on traditional energy sources.....	36
Chart 15: Purpose of TV usage	39

Abbreviations

Endev	Engersing Development; a Dutch-German Energy Partnership to promote sustainable access to modern energy services in developing countries
HH	Household
HoH	Head of Household
GDP	Gross Domestic Product
GIZ	Gesellschaft für Internationale Zusammenarbeit
GTZ	Gesellschaft für Technische Zusammenarbeit
IDR / Rp	Indonesian Rupiah
ILO	International Labour Organization
KDP	PNPM Kecamatan Development Program (kecamatan = sub district)
LPG	Liquefied Petroleum Gas
MHP	Mini / micro hydropower system
MHPP/ MHPP ²	Mini Hydropower Project Indonesia
NGO	Non-Governmental Organization
PLN	Perusahaan Listrik Negara, the Indonesian National electricity utility
PNPM	National Programme for Community Empowerment (Program Nasional Pemberdayaan Masyarakat)
TSU	Technical Support Unit
TV	Television Set
VCD	Video Compact Disc

Exchange rate as of 30th of September 2010: 10,000 IDR = 0.81597 EUR

Executive Summary

This report provides baseline data for the micro-hydro rural electrification intervention TSU MHP implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and its subcontractor Entec in Sumatra and Sulawesi. The analysis relies on approximately 400 household interviews conducted between September and November 2010 by RWI, Entec, and local organizations. Additionally, qualitative interviews with key informants provide for background information.

The Technical Support Unit micro-hydro project (TSU MHP) that operates under the umbrella of the German-Dutch Energy Partnership *Energising Development* helps ensuring quality and sustainability of micro-hydro mini-grids built under the so called “Green PNPM” program. The program, which administers money from a World Bank Trust Fund, implements projects for community development. Communities can apply for funding for self-defined community development projects. While in principle also other projects are possible, a focus is on MHP mini-grids.

TSU supports the communities in the application process: villages have to establish own management structures, it has to be verified if sites qualify technically for MHP electrification and, for this purpose, feasibility studies have to be conducted. Main criteria for the feasibility are the distance to the national grid, possible plant capacity and the number of inhabitants. TSU also supervises the implementation of MHP schemes including equipment procurement, civil construction, and construction of transmission and distribution lines as well as the commissioning. In doing so, TSU envisages to build up capacities of PNPM field staff, local MHP hardware providers, and local MHP scheme operators.

The final decision on which sites to be supported is taken every year by PNPM. In 2009, funding was assigned to 26 MHP sites that are all located in Sulawesi. They were under construction at the time of the survey in late 2010. Concerning the decision on 2010 funding, ten sites had already been identified in Sulawesi at that time, while the process was still underway in Sumatra. In West-Sumatra, 35 of the proposed sites had been deemed feasible, out of which 15-20 sites were granted budget in 2010.

Against this background, the present report shows results of a baseline survey conducted in 20 TSU MHP target villages – ten in Sulawesi and ten in Sumatra. The collected data serves the following purposes: First, portray the socio-economic situation with a focus on energy consumption patterns in the project region. Second, provide for baseline data to be used in an ex-post evaluation in 2012. In addition, the households surveyed for this baseline study will serve as a yet non-electrified comparison group for a cross-sectional impact evaluation of villages that already had been electrified in 2008 by EnDev 1. The results of this impact evaluation are presented in a separate report.

The data reveal substantial differences between Sulawesi and Sumatra. Generally, infrastructure in Sulawesi is less developed and the villages are more difficult to access than in Sumatra. In line with this, the annual income per households is 3 times higher in Sumatra than in Sulawesi. Nevertheless, both in Sulawesi and Sumatra, subsistence farming provides the basic livelihood of most households.

While more than 90 % of households in both regions pursue agricultural activities, almost 50% of the household members between 14 and 66 years that do not study work as subsistence farmers. Roughly one third engages in household duties and child care, whereas only 13 % exercises other occupations such as paid farm work (especially Sumatra), public services (especially Sulawesi), or dependent or independent commerce activities.

The main crops in Sulawesi are rice (70%), coffee (52%), banana (42%), cacao (38%), cassava (36%), and sweet potato (21%). In Sumatra the most popular crop is also rice (61%), but followed by the cash crops rubber (52%), coffee (20%), and palm oil (9%). The cultivation of cash crops in Sumatra, obviously, is the major reason for substantially higher incomes than in Sulawesi. The revenues from selling these non-transformed crops amount to more than 50% of the total household income in Sumatra against 2% in Sulawesi.

The transformation of agricultural products is higher in Sulawesi: (87% of households do so, against 53% in Sumatra. Yet, people in Sulawesi transform crops for their own needs. Accordingly, the revenues from selling transformed goods are significantly higher in Sumatra than in Sulawesi. In Sumatra, they amount to approximately 2 Mio IDR (163 EUR) per year whereas they amount to only 0.3 Mio IDR (25 EUR) in Sulawesi. In this regard, the transformation of certain cash crops like coffee and cocoa bears potentials to use electric applications and, thereby, increase the value added in the region.

The non-agricultural sector generally appears to be weak in the regions. In particular in Sulawesi, the potentials to expand production beyond the local demand are limited due to difficult access to markets. Local demand, in turn, can be expected to be low in the light of a dominating agricultural sector, low transit traffic and, consequently, low external cash incomes. The only enterprises in the villages both in Sumatra and Sulawesi are kiosks, carpenters, mills, hullers, and in Sulawesi some weavers. In most cases, though, these businesses do not serve as the primary income source for their owners and are run more on demand basis. Virtually all produced goods are sold and consumed locally.

The most common energy sources both in Sumatra and Sulawesi are kerosene and firewood. Almost all households use them. Whereas kerosene is mostly used for lighting, firewood serves for cooking. Besides these traditional energy sources, almost 50% of the households already use some electricity source. In Sulawesi, the most common electricity sources are traditional waterwheels, so called *kincir*, that supply various households in one village with electricity. In Sumatra, the most important sources are individual gensets. Both sources exhibit substantial drawbacks compared to MHP electricity. The *kincirs*, used by 29% of households in Sulawesi, often only operate a few dim lighting devices and the service provided is mostly poor (voltage fluctuations and generally low voltage levels). The main disadvantage of gensets, mostly used in Sumatra, are high fuel costs. Solar panels also have a low capacity. In some of the villages, even electricity from the national grid ("PLN-grid") is available. These grid connections that approximately 4% of the households have are normally not official connections but illegal extensions of the nearby grid.

The low quality of some of the existing electricity sources, mainly the *Kincir*, is also reflected in the households' subjective assessment of electric lighting quality, where only 5% in Sulawesi and 32% in Sumatra are always satisfied with the quality of lighting provided by electric lighting sources. If

compared to traditional lighting sources, though, the electric lighting sources are consistently ranked higher.

Also electricity using households still consume high amounts of kerosene and other traditional energy sources, which underpins the observation on the sometimes low quality of these electricity sources. Households with and without electricity spend roughly the same for traditional energy sources. This indicates that the electricity usage does not replace traditional energy usage but rather complements traditional sources. In addition, it might as well reflect that “richer” households are more likely to use electricity. At the same time, these richer households use more energy in general – including traditional sources. To this extent, electricity has replaced traditional energy sources – it is only that the expenditures were higher prior to the connection than those of electricity non-users.

The most common electric appliances are lighting devices, mobile phones, and TV including satellite receivers. Whereas mobile phones are more common in Sumatra, generally information technology like TV, CD and VCD, and radio are slightly more widespread in Sulawesi. Further electric devices are only used sporadically. Irons, for example, are in most cases non-electric. Radios are not widely used and also mostly run on dry cell batteries. In both regions there are some households with rice cooker and magic jars, an electronic appliance that cooks rice and keeps it warm. While rice cookers bears potentials to decrease the fuel wood dependency and related risks and burdens, the capacity of the MHP plants in most cases will not allow for the widespread usage of cookers, which require 500-1000 Watts. This observation might be taken into account for the design of future MHP schemes: On the one hand, the target group could be sensitized for advantages of electric cookers, on the other hand the technical capacities have to be made available.

Even if only 27% of the households have a TV set, the usage of TV is widespread. Those households without TV watch with neighbors or friends. The average time household members watch TV is substantially higher in Sulawesi. Mobiles phones are owned by 35% of the households, whereof 60% charge it at home. The households without electricity have been asked which electronic appliance they would like to buy most in case of electrification. 53% like to buy a TV, followed by lighting devices. Households that already have electricity were asked, which appliances they would like to use, but the capacity of the current electricity source does not allow to. They also give priority to TV, followed by rice cookers and refrigerators.

Generally, there is a high demand for electricity in the surveyed regions: Virtually all households are eager to get a connection to the MHP – including households that already use another electricity source. Only few households in Sulawesi (4%) state that they do not want to get connected, mostly for financial reasons. One household prefers its PLN connection. This clearly reflects the superiority of MHP electricity compared to other electricity sources. The advantages are straightforward: For generator users lower costs are the major advantage; waterwheel and Solar Panel users want higher power electricity.

The maybe most striking result of this baseline study are the high pre-electrification rates in the surveyed villages. This has implications on different levels: From the future MHP operator’s perspective, the high pre-electrification rates have advantages, because future customers already have electric appliances and are generally used to electricity. The implication for the monitoring of the TSU project is that data on electricity usage should be collected also in other target villages of the

project that were not included in the survey, since pre-electrification rates might differ there. Accurate numbers are necessary to report reliable figures to the overall Energizing Development monitoring system. The implication for the impacts to be expected for this intervention is that the electrification “treatment” will be less accentuated for the households already using electricity (around half the population in the surveyed villages). As a matter of course, an electricity connection is a more revolutionizing change for someone who has never used electricity than for someone who has been using an electricity source for years – even if the new source is clearly of higher quality. Nevertheless, perceptive questions in the baseline survey suggest that people see many benefits in switching from their current electricity sources to the MHP mini-grid.

For the future ex-post evaluation of the EnDev 2 project it is recommended to intensify the examination of productive use activities and the importance that electricity could have to them. While home businesses and home based appliance usage are covered by the structured questionnaire also used for the present survey, in addition a more qualitative approach could focus on micro-enterprises. In-depth interviews could be conducted to explore why micro-enterprises connect or not and invest in machinery or abstain from doing so.

1. Introduction

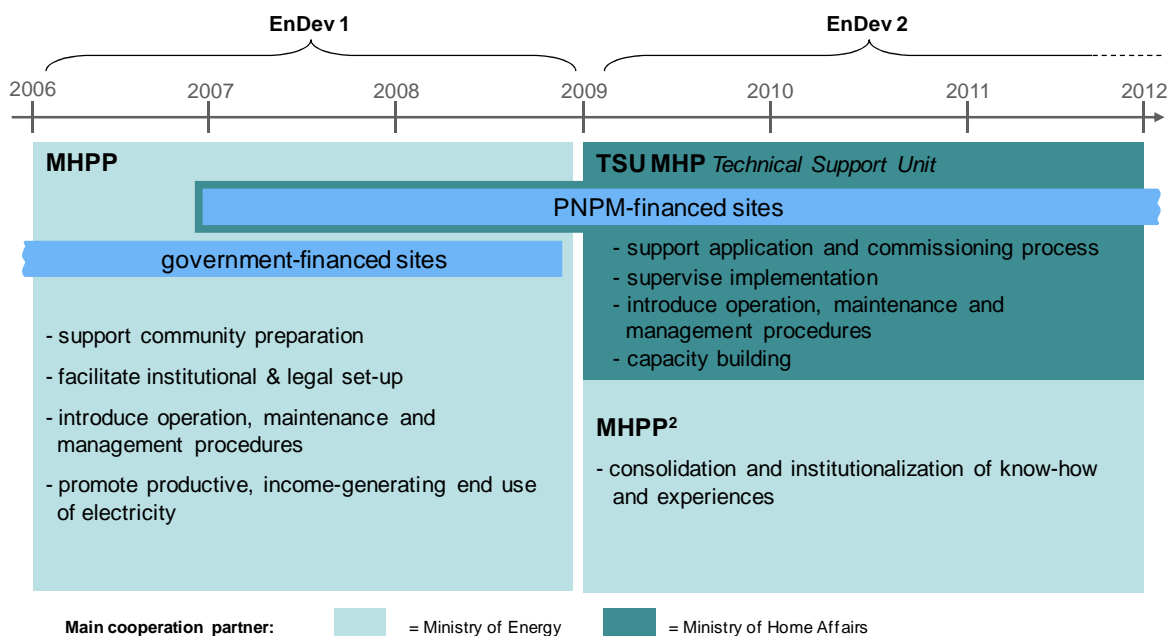
1.1 Project description: Micro Hydro Projects Indonesia

Since the end of dictatorship in 1998 Indonesia's economy has been growing on a persistently high rate of 4.6 %. Nevertheless, almost a third of its 240 million inhabitants is living in poverty (UNDP 2010). In particular, in rural areas people are dependent on biomass and other traditional energy sources to meet their daily energy demands. The electrification rate is at 64.5 % - still leaving some 70 m people without access to electricity who mainly live outside of the main island, Java.

Indonesia is well endowed with natural resources including both renewable and non-renewable energy sources like hard coal or geothermal energy. In particular in remote rural areas the water abundant and mountainous country bears huge potential for micro-hydro power (MHP). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has been active in this field for the last 20 years. Between 2006 and 2009, GIZ has supported the implementation of 96 MHP sites in Sulawesi and Sumatra. These activities have been funded as part of the first phase of the Dutch-German Energy Partnership *Energising Development* (EnDev), an output oriented program that aims at providing modern energy to 6.1 million people in 21 countries.

The activities have been followed up in the second phase of EnDev (EnDev 2) and are implemented via two complementary actors: The Micro Hydro Power Technical Support Unit (TSU) and the Mini Hydro Power Project Indonesia (MHPP²).

Chart 1: Micro Hydro Project activities of GTZ Indonesia, 2006-2012 (EnDev 1 / EnDev 2)



Established in 2009, TSU helps ensuring quality and sustainability of hydro schemes built under the so called "Green PNPM" program. The program, which administers money from a World Bank Trust Fund, implements projects for community development. Communities can apply for funding for self-defined community development projects. While in principle also other projects are possible, a focus is on MHP mini-grids.

MHPP² aims at the institutionalization of know-how and experiences in MHP implementation at the level of the Energy Ministry. Building on achieved successes in the sector the current focus is to disseminate and exchange know-how and experience throughout the country and to consolidate best practices in implementing sustainable hydro power plants.

Against this background, the present report presents results of a baseline survey conducted between September and November 2010 in 20 target villages of MHP projects financed by the Green PNPM and technically supported by TSU. Basically, the collected data serves the following purposes: First, portray the situation in the project region and provide for insights into the socio-economic situation of the households. Second, provide for baseline data to be used in an ex-post evaluation. In addition, the data collected in the Green PNPM villages will serve as a yet non-electrified comparison group in a cross-sectional impact evaluation of villages that had already been electrified by EnDev 1. The results of this impact evaluation are presented in a separated report.

1. 2 The Green PNPM project and MHP TSU

Projects under the Green PNPM are assigned on a competitive basis: Communities that want to receive funds for a MHP scheme have to submit a proposal to PNPM. TSU supports the communities in the application process: villages have to establish own management structures, it has to be verified if sites qualify technically for MHP electrification and feasibility studies have to be conducted. Main criteria for the feasibility are the distance to the national grid, possible plant capacity and the number of inhabitants. TSU also supervises the implementation of MHP schemes including equipment procurement, civil construction, and erection of transmission and distribution lines as well as the commissioning. In doing so, TSU envisages to build up capacities of PNPM field staff, local MHP hardware providers, and local MHP scheme operators.

The objective of the TSU is to ensure that MHP schemes financed with Green PNPM grants fulfil a number of minimum requirements that are crucial for their implementation and subsequent sustainable operation. The target regions of the MHP projects are defined by the Green PNPM program and are generally focused on 8 provinces in total (4 provinces in Sumatra and 4 provinces Sulawesi). Projects proposed and existing so far only target 3 provinces: Sumatera Barat, Sulawesi Barat, and Sulawesi Selatan.

The final decision on sites to be supported is taken by PNPM by budget year. In 2009, funding was assigned to 26 MHP sites that are all located in Sulawesi. They were under construction at the time of the survey end 2010. Concerning the decision on 2010 funding, ten sites have already been identified in Sulawesi at that time, while the process was still underway in Sumatra. In West-Sumatra, 35 of the proposed sites have been deemed to be feasible whereof 15-20 sites will be granted budget in 2010. In total, it can be expected that PNPM assigns funding for 40 sites in Sumatra in 2010. For the coming years, further 80 sites per budget year in both Sulawesi and Sumatra are planned.

1.3 Country's State of Affairs

The Republic of Indonesia comprises more than 17,000 islands and is – with a population of around 240 million people – the world's fourth most populous country. As a former Dutch colony, Indonesia was granted independence in 1945. From 1967 to 1998 Indonesia was ruled by dictator Haji Mohamed Soeharto. The years after his fall were characterized by civil unrest and frequent changes of leadership. Meanwhile, continuity has returned under the current president, Susilo Bambang Yudhoyono, who came to power in 2004 and was comfortably re-elected in 2009 to continue his reformist policy agenda (EIU 2008).

Indonesia achieved an average annual GDP growth rate of 5.2% between 2001 and 2008 (AfDB 2010). Furthermore, Indonesia's economy is not dominated by one sector only. While the industry sector is the largest contributor to GDP, services have expanded rapidly in recent years (being most notably driven by the tourism industry) with agriculture remaining an important employer. Thanks to its lower export dependency, Indonesia was less affected by the 2008-09 global recession than many of its neighbours. With a real GDP growth rate of 4.5%, Indonesia actually was one of the world's best-performing major economies in 2009. Export growth will be strong in 2010, mainly triggered by demand from China for Indonesian commodities like gas, oil and mineral resources (EIU 2010).

The agricultural sector is of vital importance to the Indonesian economy. Being the world's third-largest rice and the largest palm oil producer this sector is a source of export earnings and employment on which the majority of the rural population subsists.

Table 1: Indonesia at a glance

Year	2000	2005	2006	2007	2008	2009
Land Surface (km ²)	1,904,443					
Population (millions)	205.1	228.9	231.8	234.7	237.5	240.3
Population Density (per km ²)	108				123	126
Ann. Pop. Growth Rate (%)		1.3	1.3	1.2	1.2	1.2
Urban Population (%)	42.0	48.1			51.5	
Real GDP Growth Rate (%)		5.7	5.5	6.3	6.0	4.5
Life Expectancy at Birth (y.)		70			70.5	
Net Enrolment in 1 st Schools (%)	92.6	94.5		94.8		
HDI* Rank among 173 (177) (182) countries in 2000 (2005) (2007)	110	107		111	n/k	n/k

Sources: EIU 2008, EIU 2010, UN 2009, OECD 2010, UNDP 2002, 2008, 2009

In early 2010, the overall unemployment rate was at 7.1 percent, while 23.5 percent among the youth are unemployed according to the ILO Department of Statistics (ILO 2010). In spite of ongoing economic growth 29.4% of the population was living below the poverty line of 1.25 US\$ per day in 2007 (UNDP 2010). Poverty in Indonesia is marked by a significant difference between east and west. In several regions of eastern Indonesia the number of people living below the national poverty line of affording a diet of 2,100 calories a day exceeds 20%. In the three project provinces Sulawesi Barat, Sulawesi Selatan and Sumatera Barat 13.6, 11.6, and 9.5% respectively are declared as poor, explicitly higher rates can be found in rural areas. Distinctly lower poverty rates can be observed in Bali (4.9%) and Jakarta (3.5%) (BPS 2009).

1. 4 Energy Sector

The state electricity company Perusahaan Listrik Negara (PLN) is responsible for the national provision of electricity. Legal and contractual uncertainties as well as low power tariffs have led to an underinvestment in power generation capacities. Due to rising oil prices and financial mismanagement the company is forced to reduce its heavy dependence on oil based fuels. The share of oil in electricity generation amounting to 24 percent in 2006 is planned to be reduced to 3 percent in 2010 and replaced by hard coal and natural gas from domestic sources (EIU 2008). In 2008, the installed capacity in Indonesia was 29.5 GW (U.S. Department of Commerce 2010). Total electricity consumption was at 112.6 GWh, of which 86% was derived from conventional sources (oil, natural gas, hard coal), 8% from hydroelectric sources and 5% from geothermal and other renewable sources (UNDP 2009b).

In 2008, the electrification rate was at 64.5 percent. While urban Indonesia is almost completely electrified (94 percent), in rural areas only 32 % have access to electricity (UNDP/WHO 2009). In particular the mountainous rural areas are in many cases difficult to access implying high investment costs for grid or road infrastructure extension. The bad financial situation of PLN aggravates the situation. Nevertheless, the Indonesian government has set the target of 95% electrified households in 2025 (DESDM 2005). This will certainly further contribute to growing electricity consumption – between 2002 and 2006 it has increased by 11 percent annually.

To satisfy this growing demand Indonesia has abundant renewable energy resources. Beyond extraordinary geothermal sources the country can count on considerable hydro power potentials estimated to have a volume of 75 GW for large-scale hydro plants and 500 MW for mini- and micro hydro schemes. Up to date, only 17% of this micro hydro potential has been realized (U.S. Department of Commerce 2010).

Due to various reasons, the abundant potential of small and micro hydro plants is largely untapped. One of the major barriers are the fixed electricity tariffs that are even below the average production costs of PLN. Especially for commercial independent power producers or off-grid projects this poses a market entry barrier. Moreover, subsidies for diesel fuel provide competitive advantages for diesel generators in contrast to non-subsidized hydro energy (YBUL 2002).

2. Evaluation Approach

2.1 Evaluation Objective

The baseline study presented in this report is part of a broader evaluation effort. The evaluation objectives that were taken into account when the household survey was designed are the following:

Portray the socio-economic conditions in the project regions.

The accountability of socio-economic change to an electrification intervention is a matter of complex investigation. The documentation of living conditions is necessary in order to get acquainted with the environment in which these changes take place and to determine potential favourable and adverse factors. The two intervention areas, Sulawesi and Sumatra are quite distinct in their economic, geographic, cultural and political characteristics and will therefore be considered separately.

Provide benchmark data for a potential Ex-Post Impact Evaluation of EnDev 2 activities

The survey in the EnDev 2 villages provides for baseline data before the electrification intervention. It will be used after a follow-up survey in 2012 to compare the households after the electrification (in 2012) to the situation before electrification (in 2010). The difference in outcome variables (e.g. reading hours, income) will approximate the impact of electrification. In order to account for changes in the environment that cannot be ascribed to the electrification but that also affect the outcome variables a control region was and will be surveyed as well. The already electrified EnDev 1 villages were selected to serve as a comparison benchmark (see section 2.2 and IMPACT REPORT).

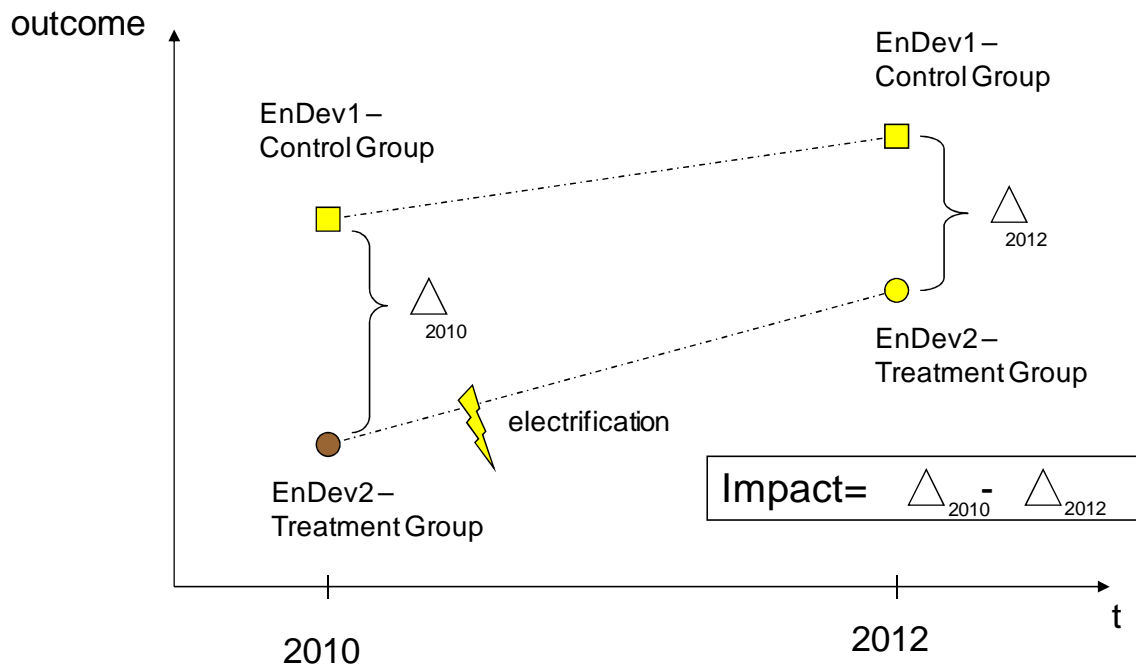
2.2 Strategy to identify impacts

The aim of the impact assessment component of this evaluation is to determine the effect of the electrification intervention – the “treatment” – on the outcome and impact indicators. For the purpose of determining the true effect, one would have to compare the impact variable after having received the treatment to the *counterfactual situation* of not having received it. Obviously, this is impossible, since we can never observe both situations: The household is either connected or not. To address this fundamental evaluation problem, we have to replace the unobservable and, hence, non-computable counterfactual situation. Approaches to do so are called *identification strategies*.

The identification strategy of the present evaluation effort will be to compare households after electrification through MHP to the same households before electrification through MHP. The baseline survey presented in this report delivers the data for the *before* situation. At the time of the survey, none of the EnDev 2 households was connected to an MHP.¹ The same households will be visited again during an end-line survey two years after the baseline survey, when EnDev 2 households will have received the treatment.

¹ As the baseline surveys have shown, around 50% of the households were using already electricity, for example from generators or pico hydro power installations.

Chart 2: Impact assessment: The difference in difference estimator



The households are compared at these two points of time and the difference in a certain outcome variable (e.g. reading hours, income) is assigned to the electrification. The underlying assumption is that the households' outcome would not have changed from 2010 to 2012 if it had not been electrified. This assumption might be violated if external factors (improvements of general economic conditions, rice price changes, etc.) affect the households' behavior with respect to the outcome over time. A growing economy, for example, might affect the household's income. One would then falsely ascribe an increase in income to electrification although this increase would have taken anyhow due to economic growth. Such external influences can be accounted for by including a control group that simulates how the households would behave without the electrification treatment.

As control group, the already electrified EnDev 1 villages in Sulawesi and Sumatra were surveyed. The underlying assumption of this approach is that the already connected EnDev 1 households behave like the households in the EnDev 2 villages would do if they were not electrified – with respect to the external factors that might affect the outcome variables. Taking the example of a growing economy from above, we assume that the income of EnDev 1 villages is affected in the same way by the general economic growth as the EnDev 2 villages would be without electricity.

In practice, the change in the outcome variable in the EnDev 1 villages is subtracted from the “gross” change in income in the EnDev 2 villages. This difference of differences yields the net effect of electrification. This will be done when end-line data in 2012 is available. In the present report, only descriptive statistics on the baseline data of non-electrified EnDev 2 households are presented. For the survey results in the EnDev 1 villages see the EnDev 1 Impact Report.

2.3 Survey Implementation and Sampling

While in total approximately 240 villages will be electrified in the course of the EnDev 2 project, 20 of them were selected by the project for the baseline survey. In total, 392 households were interviewed, 198 in Sumatra and 194 in Sulawesi. The selection of villages – ten in Sulawesi and ten in Sumatra – was driven by comparability considerations – in order to use the collected data for an impact assessment of the EnDev 1 intervention the surveyed EnDev 2 and EnDev 1 villages have to be comparable – and logistical considerations; in addition preference was given to EnDev 2 sites that were likely to be electrified in the near future. The surveyed villages are concentrated in four *kabupaten* (regions): Mamasa in Sulawesi and Pesisir Selatan, Solok Selatan, and Agam in Sumatra. In Mamasa in Sulawesi, all eight EnDev 2 sites already under construction had been intended to be surveyed. However, two of them were not accessible due to heavy rains and subsequent road conditions. Thus, six of them were visited. Additionally, four villages were surveyed for which the MHP scheme will be installed in 2011. In Sumatra, out of in total 13 possible EnDev2 sites, those 10 sites were selected for the survey that were considered most probable to be electrified in 2011.

During a preparatory mission, the methodology including the questionnaire was finalized. For data collection in Sulawesi, 4 enumerators were recruited from the University of Makassar. All of the enumerators had recently graduated from the Faculty of Social and Political Sciences. Enumerators for Sumatra were recruited from RAGOM, an NGO based in Lampung, Sumatra, that is also contracted to support the institutional setup of MHP sites. The enumerators were trained by the RWI evaluation team in two four days courses, one in Sulawesi, one in Sumatra. Pre-tests were conducted to verify the feasibility of the questionnaire.

Two RWI researchers stayed on the ground to supervise the implementation of the survey between September and October 2010 with two survey teams working at the same time in Sumatra and Sulawesi. In each village, only those hamlets (*dusun*) that are to be connected to the planned MHP have been surveyed. In none of the villages the grids have been constructed yet. Accordingly, the hamlets to be connected were identified during a short interview with, preferably, the village chief or, if s/he was not available, with the PNPM facilitator and, subsequently, an ad-hoc simple random sample of households in these hamlets was carried out. Based on the information of the village chiefs only households in hamlets to be covered by the planned MHP grid were included. Based on the data collected in the already electrified EnDev 1 villages, all households covered by the grid also get connected. A comprehensive list of households was obtained from the village chief and 20 households per village were selected randomly. The four enumerators per team were subsequently assigned to the different hamlets.

The major survey tool is a structured questionnaire covering virtually all socio-economic dimensions that characterize the household's living conditions (see Annex 2). A particular focus of the questionnaire is on energy and electricity usage. In addition, income sources, time use, and gender related issues are extensively covered. The household questionnaires have been checked every night for consistency and completeness by the two RWI researchers in the field. Semi-structured interviews with other beneficiaries like schools, health huts, administrative institutions, and micro-enterprises have been conducted. Qualitative interviews with other key informants complement the quantitative approach. This qualitative information provides for context that cannot always be

captured in more structured interviews, not least to cross-check the household statements in the structured questionnaire.

3. Results from structured household interviews

3.1 Household Structure

The average number of people living in a household in the surveyed area is 4.3 persons. This number is slightly higher in Sumatra (see Table 2). The number of children per household amounts to 1.5 in Sumatra and 1.6 in Sulawesi. The share of households where at least one woman is pregnant is around three percent and higher in Sulawesi.

Table 2: Household Characteristics

	Sumatra	Sulawesi
Number of HH Member	4.4	4.3
Number of Children under 15	1.6	1.5
Number of Children under 11	1.3	1.05
Number of Children under 6	0.7	0.5
Share of HH with pregnant women	2.5%	4.1%
One parent is absent	11.1%	10.3%
Distribution of power		
Father is head of HH	90.9%	91.8%
Female is responsible for HH budget (together with male)	50.5% (13.3%)	84.5% (0.5%)
Female is responsible for buying fuel	28.9%	96.4%
Characteristics of Head of HH		
HoH finished primary school	71.7%	46.4%
HoH finished junior high school	15.6%	18%
HoH finished senior high school	7.1%	21.6%
HoH went to university	0	8.7%
Age of Hoh	45.7	45.2

Also the distribution of power between man and women within the household is alike if we look at the sex of the head of household. Both in Sumatra and in Sulawesi, in around 91% of the households the father is the head of household. The rest of the households is headed by the mother. This astonishes, as the prevailing ethnicity in West-Sumatra, the Minang, follow a matrilineal tradition. Looking at the responsibility for the household budget and for buying fuel, women are even more dominant in Sulawesi (see Table 2). In basically all female headed households, the father is not living there. Generally, 11% of households lack one parent.

The educational level of the head of household varies notably between Sumatra and Sulawesi and is generally higher in Sulawesi. In Sumatra, 72 % of the head of households only finished primary school. In Sulawesi, almost half of the head of households received higher education than primary school and even 8 % went to university. These highly educated persons mainly work as teacher. In Sumatra, the teachers often do not live in the surveyed villages because there are more attractive, bigger villages nearby.

54% of the interviews in Sumatra and 64% of interviews in Sulawesi were conducted with the father of the family, 46% and 35% with the mother of the family.

3.2 Household Economy

3.2.1 Housing Conditions and Assets

The housing conditions reflect a different level of wealth in Sumatra and Sulawesi. Compared to Sulawesi, a clearly bigger share of households in Sumatra lives in buildings with higher quality building materials (see Table 3). The buildings are slightly bigger in Sumatra with 3.5 rooms per household compared to 3.2 rooms per household in Sulawesi. On average, people have been living since 14.8 years in their homes in Sumatra and since 12.6 years in Sulawesi.

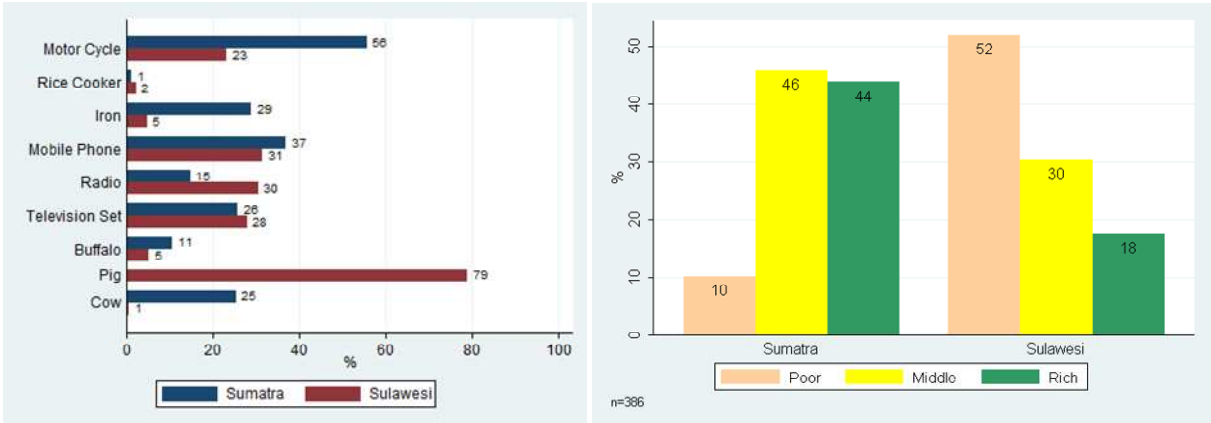
Table 3: Housing Conditions

	Number of rooms	Windows are fitted with glass	Roofing is palm leaves, ijuk ¹ or wood	Building is plastered	Outside wall is stone, brick or zinc	Flooring material is...		
						soil only	bamboo or wood	concrete, bricks, ceramics
Sumatra	3.5	27.3%	7.1%	20.7%	32%	4.6%	41.1%	54.3%
Sulawesi	3.1	11.9%	19.1%	5.2%	7%	8.3%	69.1%	22.7%

¹ Palm fiber

Also concerning the assets of the household, there is a difference between Sumatra and Sulawesi (see Chart 3). A good indicator of wealth is possession of a motorcycle, which is the typical dream of an average Indonesian family. The number of households possessing a motorcycle is clearly higher in Sumatra. Also mobile phones and irons are more common. 72 % of the irons are charcoal irons, with the rest running on electricity. The electric irons are used despite one exception only in Sumatra and driven by individual generators or current from PLN. More details on transportation, communication and entertainment will be provided in Section 3.3.

Chart 3: Assets and wealth indicator in Sulawesi and Sumatra



For the poverty analysis, a wealth indicator originally developed in Bensch and Peters (2010) is applied. Household data typically suffers from sporadic inaccuracies due to, for example, recall errors

– in particular in rural areas of developing countries. Data on income and wealth is further biased, because people tend to state lower values in order not to give rise to jealousy. Therefore, a combined indicator has been created to reduce biases inherent in single variables and to incorporate different facets and proxies of wealth. These comprise assets, expenditure and income elements (see Table 4). Income has been defined following the definition of the World Bank Living Standard Studies (WB 1992). The indicator takes on values between 0 and 24, which are categorized into “poor”, “middle” and “rich”.

Chart 3 shows that the percentage of poor households is clearly lower among Sumatra households. The share of rich households is, as expected, higher.

Table 4: The Wealth Indicator

Criterion	Subindicator
ASSETS	
Dwelling Conditions	Construction Material of Outside Walls Flooring Material Roofing Material
Cattle	Quantity of Buffalos Owned
Savings	Ownership of a Bank Account Saving of Money
Mobility	Type of Means of Transportation
Education	Education Level of Head of Household
EXPENDITURE	
Nutrition	Food Expenditure per Adult Equivalent
Energy	Expenditure on Energy Sources per LogCapita
Health	Entitlement to governmental pro-poor health insurance
INCOME	
Income	HH Income per HH Member Able to Work excl. Consumption of Home Production

3. 2. 2 Income

Both in Sumatra and Sulawesi the households are mainly subsistence farmer. But while in Sumatra at least parts of the population succeed to generate also monetary income with agriculture, this income source is only marginal in Sulawesi. Here, the low monetary income derives primarily from wages from dependent employment, especially teachers and other civil servants.

The monetary household income comprises five different income sources: Revenues from transformed agricultural products, from non-transformed crops, animal husbandry, wage income (from paid dependent employment), and remittances. These values vary substantially between Sumatra and Sulawesi. Whereas in Sumatra there are 3% of households that do not have any monetary income at all, the share amounts to 24% in Sulawesi. As many of these 24% of households in Sulawesi nevertheless have monetary expenditures, there are doubts concerning the reliability of

the income data. The unreliability of income values have been discussed extensively among survey practitioners and scientist. It is mainly ascribed to the unwillingness of households to disclose their real income in order to avoid envy or mockery. In order to cope with this, it is advised to rely instead on values on expenditures and to use these as a proxy for the households' income (Deaton 1997). In our case, we elicited extensive information on different expenditure categories to be able to correct for this drawback.

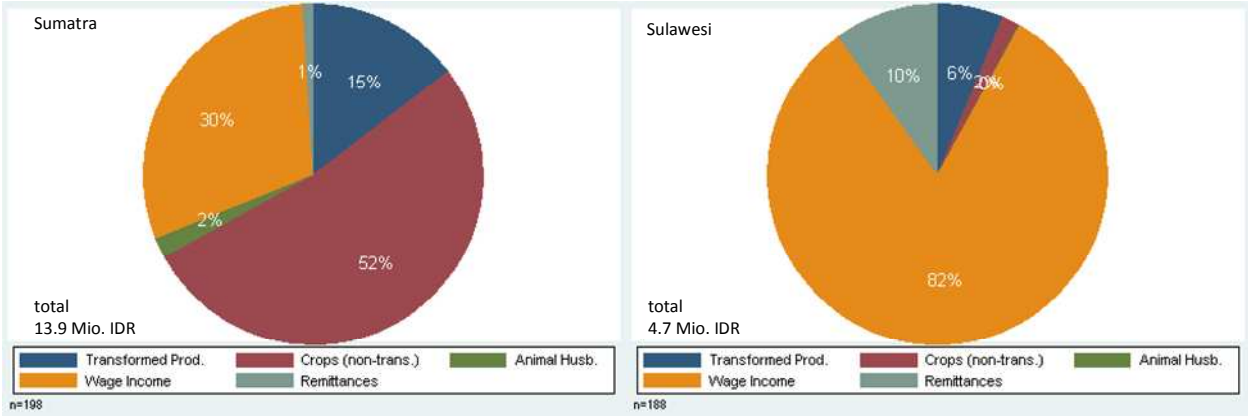
Table 5: Subjective Rating of Household Income

	Mean Annual Income	Household budget is...		
		sufficient	Tight	not sufficient
Sumatra	13,900,000 IDR	31.8	35.9	31.8
Sulawesi	4,703,288 IDR	16.5	43.3	39.7

The mean annual income amounts to 13.9 Mio IDR (ca. 1,120 EUR²) in Sumatra and to around only 4.7 Mio IDR (378 EUR) in Sulawesi. The lower income figures in Sulawesi are also reflected in the households' perception if the household budget is sufficient. As depicted in Table 5, only 17 % of the households in Sulawesi think that their budget is sufficient whereas this share amounts to 32 % in Sumatra.

The different sources of income are depicted in Chart 4. The astonishingly high income from crops in Sumatra derives mainly from rubber and palm oil cultivation. In Sulawesi, the most important monetary income is generated through paid dependent employment. Its relative importance is significantly higher than in Sumatra, even if the absolute wage income in Sumatra and Sulawesi is similar (28 EUR per month in Sumatra and versus 26 EUR in Sulawesi).

Chart 4: Composition of Annual Household Income Sumatra and Sulawesi



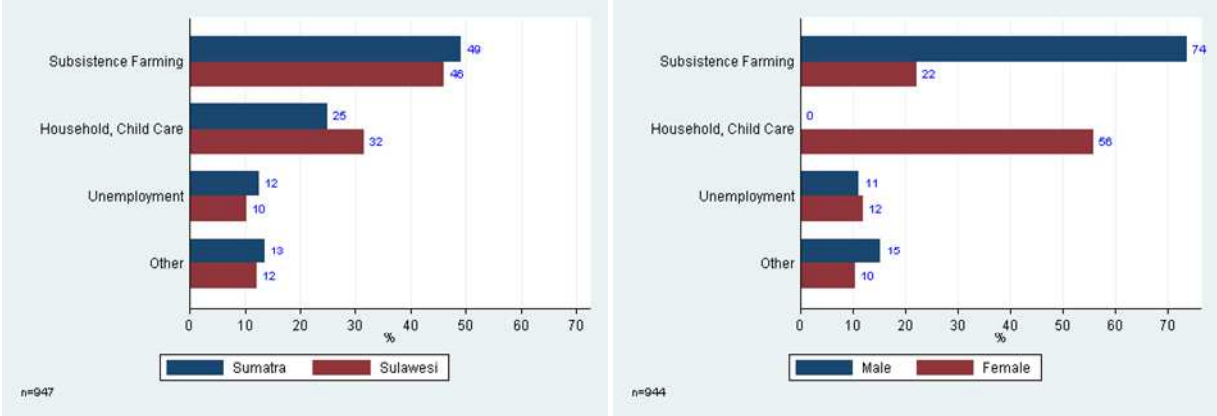
Main Occupation and Wage Income

The vast majority of household members work as subsistence farmers. If we look at the population able to work (older than 14 and younger than 66, neither studying nor being retired), 49 % in Sumatra and 46 % in Sulawesi of the population is working as subsistence farmers. Further 25 % in Sumatra and 32 % in Sumatra - unanimously women - care for the household and children.

² Exchange rate as of 30th of September 2010: 10,000 IDR = 0.81597 EUR

In Sumatra, 13 % of the population looked at works in other jobs than subsistence farming and household duties. In Sulawesi, the share amounts to 12 %. Unemployment amounts to 12 % in Sumatra and 10 % in Sulawesi. The gender-specific distribution of employment is depicted in Chart 5.

Chart 5: Main occupation of population able to work distinguished by region and sex



In Sumatra, the occupations subsumed as other occupations are mainly farm workers (51 %), traders (12 %) and other independent salespersons such as kiosk owners (12 %). In Sulawesi, the majority of other occupations are public services like teachers, nurses, policemen and administrative employees (29 %). Another 20 % are so called honor teacher, who are not government employees, but directly hired by the school. Independent salespersons are as common as dependent salespersons (both 8 %).

While in Sumatra there are more men executing more than one activity (22 % of male versus 10 % of female), in Sulawesi the share of women with second occupation is higher (15 % of male versus 27 % of female).

Fathers who work primarily as subsistence farmers work on average approximately 7h 30min per day in farming and other income generating occupations, excluding breaks. Those who work primarily in other occupations work on average 8h 15min per day. These values do not differ very much between Sumatra and Sulawesi. For mothers, there is a difference between the two regions and generally they work longer in Sumatra. In Sumatra, female subsistence farmers work on average 7h, whereas in Sulawesi they work 6h. Mothers primarily occupied with housework work approximately 5h 30min in Sumatra and 6h in Sulawesi in income generating activities. Those with other occupations than housework work 8h in Sumatra and 6h in Sulawesi.

Women who are primarily housewives approximately work 6h per day on housework duties. But also women primarily occupied in subsistence farming work approximately 3h20min in the household and those with other occupations for 4h20min each day. These numbers for mothers who are subsistence farmers or with another occupation are slightly higher in Sulawesi than in Sumatra.

Fathers work much less in the household. Those who are subsistence farmers work only five minutes in Sumatra and at least 30 minutes in Sulawesi. Those with another occupation spend approximately 25 minutes with housework each day.

The wage income (from paid dependent employment) amounts to approximately 348,000 IDR (28 EUR) per month in Sumatra and approx. 327,000 IDR (26 EUR) in Sulawesi.

Cultivation and Animal Husbandry

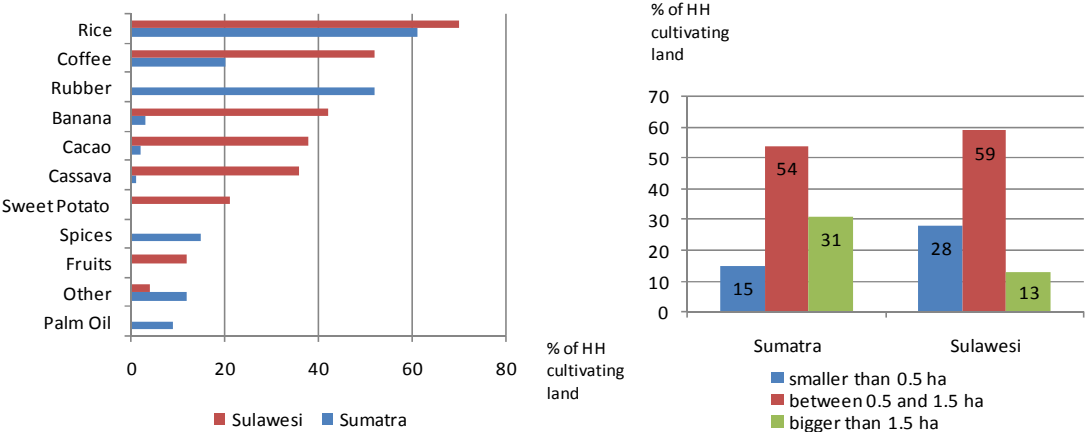
92% of the households in Sumatra and Sulawesi cultivate farming land. In 92% of the cases, the land is the households’ own property and in 8% the land is cultivated under the *bagi hasil* system. This means that the land does not belong to the farmer but, instead of paying a rent to the owner, the agricultural production is shared between the owner and the farmer. In most cases half of the production has to be delivered to the owner, but these shares can be negotiated. In Sumatra there are 2 % who cultivate partly their own land and partly under *bagi hasil*. In contrast to the similar property structure in Sumatra and Sulawesi, the dimension of the cultivated land differs notably between the islands. It is on average 1.2 ha in Sumatra and 0.8 ha in Sulawesi. The dimensions of the fields vary between 0.1 ha in Sulawesi and 7 ha in Sumatra (see Chart 6).

Table 6: Agricultural activity

	Sumatra	Sulawesi
Share of HH cultivating land	92.9%	89.7%
Share of HH who sell non-transformed crops	57.6%	21.7%
Share of HH who transform crops	52.5%	86.6%
Share of HH who sell transformed crops	44.4%	50.5%
Land is own property	91.3%	90.8%
Land is cultivated under bagi hasil	7.1%	8.1%
Dimension of cultivated land (in ha)	1.24	0.77

In Sulawesi, rice is most frequently cultivated (70%), followed by coffee (52%), banana (42%), cacao (38%), cassava (36%), and sweet potato (21%). 12% of farmers cultivate fruits (pineapple, papaya, mangosteen) and 4% other agricultural products.

Chart 6: Most common crop and dimension of cultivated land



The most important agricultural products in Sumatra are rice, rubber, and coffee. 61% of the households in Sumatra cultivate rice, 52% rubber and 20% coffee. 15% grow spices (cardamom, cinnamon and hot pepper) and 9% palm oil. However, palm oil is only cultivated in three villages in Sumatra, in Sungai Sirah (47%), Sungai Keruh (41%), and Taratak Paneh (12%). Sungai Keruh is a

special case because it is located within a huge, commercial palm oil plantation. 12% of households grow other agricultural products (maize, peanut, pumpkin, durian and jengkol, a legume of the pea family) are cultivated. In contrast to Sulawesi, just 2% of farmers cultivate cacao and 3% banana.

In Sulawesi, 22 % of all households sell agricultural products in a non-transformed way. In Sumatra, this share is much higher and amounts 58 %. The reason is that many farmers in Sumatra grow rubber basically only for selling it. The latex from the rubber trees has to be collected and stuffed for a while in wooden boxes before it is sold to traders. As this is a passive process, it is not considered a transformation process. Besides rubber, for example palm oil, peanut, hot peppers, banana, durian, or jengkol are sold in a non-transformed way. In Sulawesi some farmers sell non-transformed cassava, cocoa, coffee, banana, or pumpkin.

The share of households who transform agricultural products and sell them is higher in Sulawesi (see Table 6). Details on the transformation process and transformed products can be found in Section 3.4.1.

The revenues from selling non-transformed agricultural products amount to 5,800,000 IDR³ (470 EUR) in Sumatra and 81,000 IDR (7 EUR) in Sulawesi. The substantially higher revenues in Sumatra derive especially from the cultivation of rubber and palm oil. Further important sources are selling green pepper, jengkol, and durian. In Sulawesi the revenues mainly originate from selling cocoa and coffee.

Selling transformed goods also produces higher revenues in Sumatra than in Sulawesi. In Sumatra households earn on average 2,000,000 IDR (166 EUR) and households in Sulawesi 300,000 IDR (25 EUR).

Table 7: Most important animals

	Sumatra			Sulawesi		
	Animal	share of HH	average number	Animal	share of HH	average number
1.	Poultry	67%	8.8	Pigs	90%	2.5
2.	Cows	42%	2.4	Poultry	62%	6.6
3.	Buffalo	18%	1.7	Buffalo	6%	1.3

61% of households in Sumatra and 88% of households in Sulawesi possess domestic animals. The main domestic animals in Sulawesi are pigs and poultry (see Table 7). 3% of households have other animals (mainly goats, horses, or cows). In comparison to Sulawesi, households in Sumatra do not have pigs, because the majority of surveyed households in Sumatra are Muslim, whereas in the survey region in Sulawesi the majority is Christian. The main domestic animals in Sumatra are poultry and cows. 8% of households possess goats.

Buffalos are very important both in Sulawesi and Sumatra, even if due to different reasons. In Sulawesi they play an important role in traditional death ceremonies. In Sumatra they are rather used for working and breeding.

³ Selling prices of transformed and non-transformed agricultural products have been elicited at the household level, which accounts for regional differences between villages as well as between Sulawesi and Sumatra.

Most households keep their livestock exclusively for home consumption. Only in Sumatra there are approximately 20 % of the households selling animals or their products. The revenue from animal husbandry totals on average 267,000 IDR (22 EUR) in Sumatra and stems primarily from cows, poultry and buffalos.

Migration and Remittances

Migration of household members is very common in both Sulawesi and Sumatra. In Sumatra, in 32 % of the households one or more household member migrated. In Sulawesi, the share amounts to even 48 %.

The most important reasons for migration are marriage and work. In Sumatra there are more people migrating due to marriage (51 %) than due to work (29 %). In Sulawesi, both reasons are equally important (36 %). The third reason which is especially important in Sulawesi (24 %) is studying. In Sumatra, only 15 % gave this reason.

The migrants' destination is normally not far away from their home, especially in Sumatra. Around 70 % of migrants in Sumatra stay in the same *kabupaten* if not in the same *kecamatan*. In Sulawesi this share amounts to around 40 %. The province capital Padang in West Sumatra and Mamuju in West Sulawesi are further popular destinations (11 % and 8 %, respectively). In Sulawesi there are 28 % who went to Makassar, the province capital of the neighboring province South Sulawesi. In both regions there are very few migrants that went to other Indonesian islands. There is no household that reports a former household member having migrated out of Indonesia.

Remittances from migrants are much more common in Sumatra than in Sulawesi. Here, 80 % of the households where some family member migrated receive remittances. In Sulawesi, only 24 % of these households receive money from the migrants. However, the amount of money that migrants send is higher in Sulawesi. The remittances amount to approximately 350,000 IDR (29 EUR), if we exclude those migrants who do not send money. In Sumatra migrants only send on average 250,000 IDR (20 EUR).

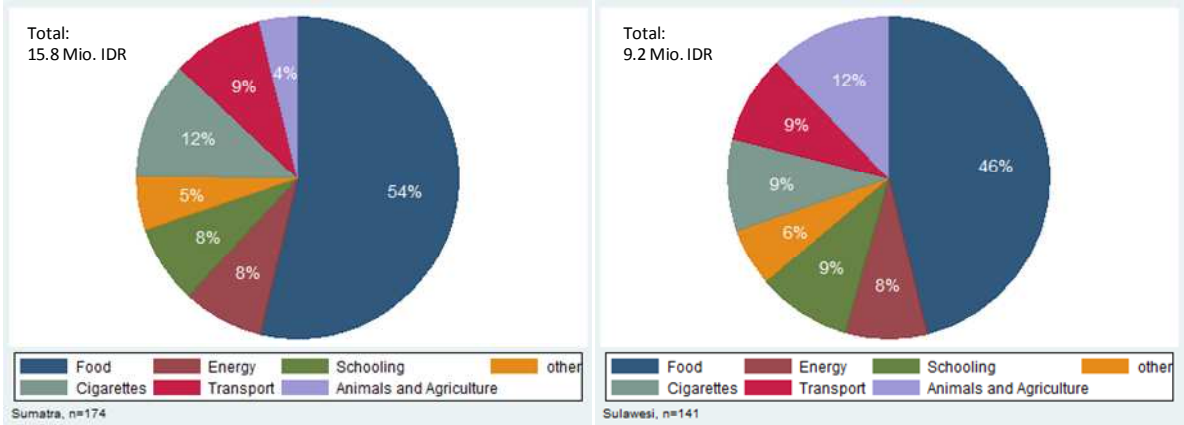
The migrants' education level is higher than among all other household members between 15 and 60 years. 29 % finished secondary high school (22 % among all household members) and 14 % even visited university (4 % among resident household members).

3.2.3 Expenditures and Financial Situation

Households' expenditures are dominated by food and, in total, they are in Sumatra almost twice as high as in Sulawesi (see Chart 7). The share of food expenditures is smaller in Sulawesi but in absolute values still lower than in Sumatra (8.8 Mio IDR (718 EUR) vs. 4.4 Mio IDR (359 EUR) per year). The second most important expenditures in Sulawesi are expenditures for animal husbandry and agricultural activities, which amount to 1.3 Mio IDR (105 EUR). In Sumatra households only spend on average 0.6 Mio IDR (47 EUR). The difference derives particularly from higher expenditures in Sulawesi for animal husbandry. Additionally to monetary expenditures, it is common to pay in kind for agricultural services. Especially for crop milling or deshelling, households normally give away part of the transformed crop in order to pay for the milling service. The third most important

expenditures are expenditures for cigarettes. In Sulawesi, households spend on average 0.8 Mio IDR (65 EUR) per year. In Sumatra these expenditures even amount to 1.8 Mio IDR (147 EUR).

Chart 7: Annual expenditures per household, Sumatra and Sulawesi



Expenditures subsumed as “other” are telecommunications, remittances, and medical expenses. Besides these regular expenditures, households were asked about bigger investments (>200.000 IDR, >16 EUR) they made in the last 12 month. In Sumatra, these include especially expenditures for Idul Fitri, the Muslim celebrations at the end of Ramadan, when households spend much money on food and new clothes. In Sulawesi as well as in Sumatra, households invest in clothes, TV Sets, medicine, children’s education and also investments related to animals or crop cultivation.

Table 8: Financial Situation

Percentage of HH that...	...has a bank account	...saves money at home	...took up a loan last year	Loan was contracted with:			
				relative, friend	commercial bank	cooperative	shop
Sumatra	6.6%	17.7%	15.1%	51.7%	6.9%	20.7%	13.8%
Sulawesi	7.2%	4.6%	21.7%	71.4%	21.4%	2.4%	0

Having a bank account is both in Sumatra and Sulawesi uncommon (7 %, see Table 8). It is more common to save money at home, especially in Sumatra, where 18% of households do this. In Sulawesi the share amounts to 5%. The take up rate of loans during the last year is lower in Sumatra. Here, 15% of households took up a loan in comparison to Sulawesi where 22% of households did. However, most of the loans in Sulawesi have been contracted with a relative or friend. Only 22 % of the credits have been contracted with a commercial bank. In Sumatra the lender structure is more diverse. Again, relatives and friends are the most common lender, followed by different saving and loan cooperative, like micro finance groups or PNPM-cooperatives. The rest of the credits have been contracted with commercial banks, shops, or middlemen.

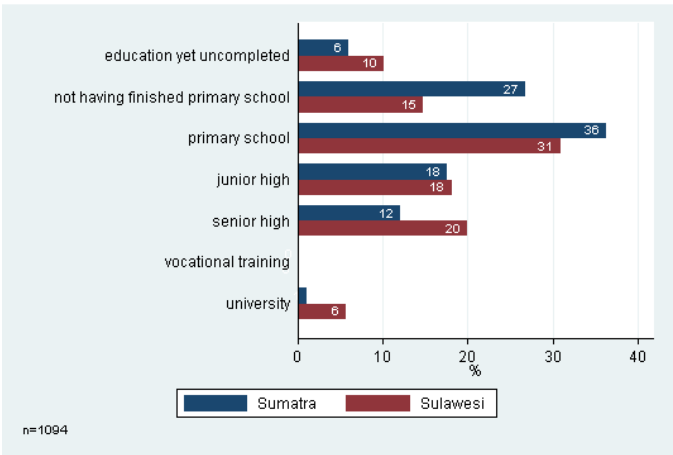
3.3 Education, Health and Infrastructure

3.3.1 Education

The education level is generally higher in Sulawesi than in Sumatra. In Sumatra there are 27 % of the household members older than 15 years who never finished primary school. In Sulawesi the share amount to only 15 %. The difference derives from a high share of people in Sumatra who went to primary school but who have never finished it. The share of people who did not receive any education at all amount to approximately seven percent in both regions.

Whereas the share of people visiting junior high school is similar in Sumatra and Sulawesi, the higher education level strikes again if we look at the share of people with senior high school or university degree. The average years of schooling amount to 6.9 years in Sumatra and 8.6 years in Sulawesi among those persons that have already completed their education.

Chart 8: Highest level of education



3.3.2 Health

In Sulawesi, 76% of surveyed households have a health insurance, whereas just 30% of households in Sumatra have one. The reason is that most people are insured by the governmental health insurance *Jamkesmas*, which is designed to cover the costs of certain health services for the poor. Eligibility for this insurance depends on daily household consumption estimates. Accordingly, the lower number of *Jamkesmas*-recipients in Sumatra is in line with their higher living standard and, consequently, higher expenditures.

However, the amount of money the households spend on medicine and other health expenditures are identical in Sulawesi and Sumatra. In both regions they amount to approximately 134,000 IDR (11 EUR) per year. The subjective rating of the households concerning their ability to pay for necessary medicine depicts a tighter situation in Sulawesi. 41 % of the households state that they are even rarely or never able to pay for necessary medicine. In Sumatra, 63 % state that they are always able.

All households in both Sumatra and Sulawesi boil water before drinking it. Additionally, 13% of households always filter water before drinking it in Sumatra and 39% in Sulawesi. 10% in Sulawesi and 6% in Sumatra filter the water at least sometimes.

Table 9: Health

Percentage of HH that...	HH that have health insurance	Health expenditures per year	Household is able to pay for medicine:			
			always	often	seldom	never
Sumatra	30%	131,535 IDR	63%	15%	22%	0%
Sulawesi	77%	137,236 IDR	4%	55%	27%	14%

It is sometimes argued that electricity might reduce respiratory diseases, headache, and eye problems through a reduction in indoor air pollution that is induced by kerosene lamps and candles. The households have been asked to indicate whether certain household members suffer from one of these diseases. The results are displayed in Table 10.

Table 10: Diseases suffered by household members in the last six months

Disease	Age	Sumatra		Sulawesi	
		male	female	Male	female
Headache	≥18	56%	74%	6%	4%
	<18	20%	14%	2%	2%
Respiratory disease	≥18	6%	9%	2%	1%
	<18	3%	1%	2%	0
Eye disease	≥18	3%	3%	1%	-
	<18	0.5%	0.5%	-	-

The reasons for the substantially higher frequencies of disease symptoms in Sumatra cannot be explained from the data we have at hand. We have no reason to believe that they are somehow related to energy issues, since consumption patterns do not differ that much between the two regions. In order to explain these differences, one would need more information on medically relevant issues. In addition, note that the numbers in Table 10 are based on subjective self-assessments by the households. Hence, a speculative explanation might be that – due to cultural traits – people in Sumatra are more prone to “complain” than in Sulawesi.

3.3.3 Infrastructure

The quality of infrastructure is substantially different in Sumatra and Sulawesi. In Sumatra, most of the project villages can be accessed via at least good quality dirt roads also with a normal car. Only some villages (e.g. Sungai Kaluh, Sungai Sirah, or Limau Limau) are less accessible and require motorcycles or four wheel drive cars. In Sulawesi, basically all villages are only accessible with four wheel drive cars or motorcycles. Even these vehicles sometimes have difficulties during the rainy season when landslides frequently block the roads. Both in Sulawesi and Sumatra the public transport connection to other villages is difficult or non-existent. In most cases, only motorcycles can be hired if people do not have own means of transport.

In Sulawesi, 76% of the households do not have any means of transport. In Sumatra, the share only totals 39%. 56% in Sumatra and 23% in Sulawesi own a motorcycle – the most common private

vehicle. Very few people have bicycles or chariots. Only 6 households in the sample own a cars or a tractor.

Expenditures for transport amount to approximately 1.45 Mio IDR (118 EUR) per year in Sumatra and 0.8 Mio IDR (65 EUR) in Sulawesi.

The mobile network coverage is better in Sumatra. Among the interviewed household, 61 % are covered by the network. In Sulawesi, only 51 % are covered. Whereas some villages have always good reception, most of the surveyed regions only have connection sporadically or only in certain parts of the village. In Sumatra, at least one household per village in the sample has mobile phone connection. In Sulawesi, there are three villages without any reception

Agricultural markets hardly exist in the survey regions – at least not directly in the villages. In Sulawesi, only two villages have a weekly agricultural market. However, at a maximum distance of one hour, the households can reach a village with a weekly market to sell their products. In Sumatra, there are also traders who regularly visit the villages to buy agricultural products. This is especially the case for rubber and palm oil.

3.4 Energy Usage and Potential Impacts

The following section describes the households’ energy usage patterns and those behavioral and socio-economic characteristics that are possibly influenced by a switch from traditional energy sources to electricity from MHPP.

3.4.1 Energy sources and uses

The most common energy sources are kerosene and firewood (see Chart 9). Almost all households both in Sulawesi and Sumatra use these energy sources.

Chart 9: Energy Sources

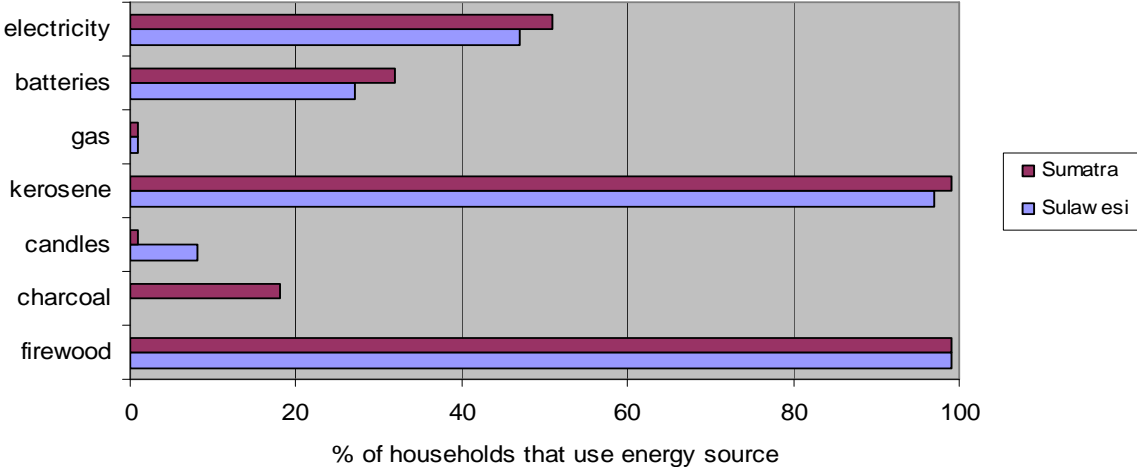


Table 11: Usage and Consumption of different energy sources

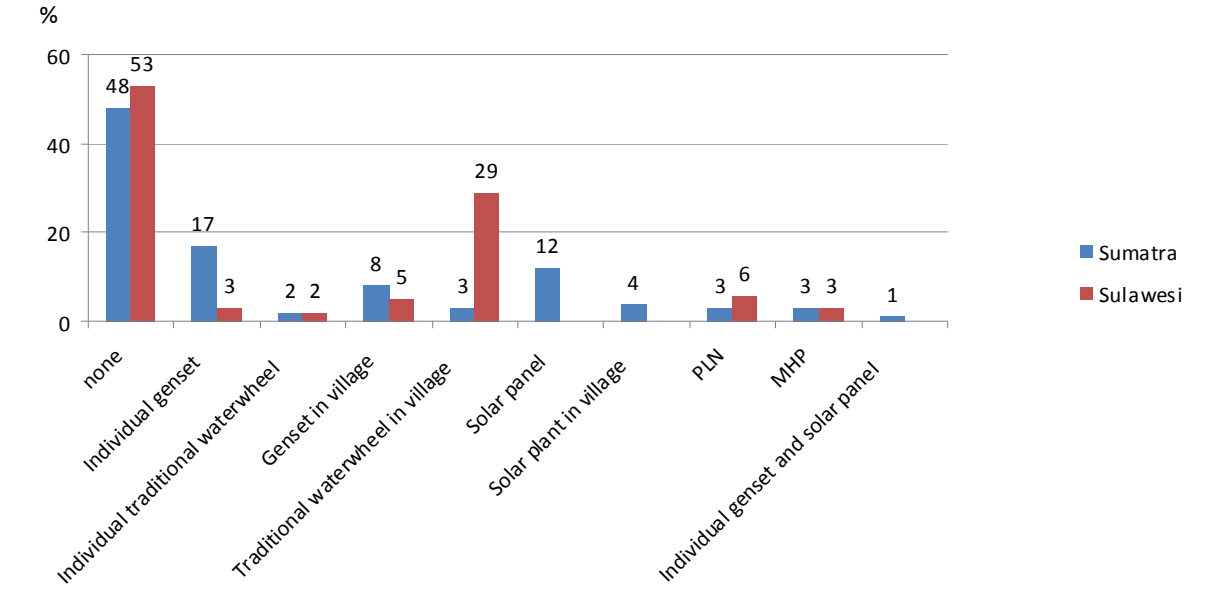
Percentage of HH that uses... (quantity)	electricity	batteries (pieces)	gas (kg)	kerosene (liter)	candles (pieces)	charcoal (kg)	firewood (bundles)
Sumatra	52%	32% (1.3)	1% (0.01)	99% (7.4)	1% (0.2)	18% (0.4)	99% (11.1)
Sulawesi	47%	27% (0.8)	1% (0.01)	97% (5.3)	8% (0.3)	0%	99% (33.8)

Firewood is used for cooking – in virtually all cases it is collected. Only 15 households buy firewood. The consumption of firewood is higher in Sulawesi amounting to 34 bundles per month compared to 11 bundles in Sumatra. The difference is likely due to different sizes of firewood bundles in the two regions.

Kerosene is primarily used for lighting: 80 % in Sumatra and 91 % in Sulawesi. The rest is used for cooking. Charcoal is also used for cooking, but in most cases for ironing. LPG for cooking is used by only one percent of households. Candle usage is very rare: Both in Sumatra and Sulawesi candles are only used in case of blackouts or fuel shortages.

Batteries are mainly used for lighting with torches (60 % of consumption in Sumatra and 40 % in Sulawesi). The rest of the consumption is almost solely for radio usage.

Chart 10: Electricity Sources in EnDev 2 villages (in %)



Most of the surveyed EnDev 2 villages exhibit astonishingly high pre-electrification rates. Only 51 percent of the households do not have any electricity source at all. The information of the household interviews have been substantiated by qualitative interviews with village chiefs, key informants like PNPM facilitators, and generally verified by inspection walks in the villages. In Sulawesi, the most common electricity sources are traditional waterwheels, so called *kincir*, that supply various

households in one village with electricity. In Sumatra, the most important sources are individual gensets.

In addition, some households are even connected to the national electricity grid from PLN. This illustrates that many of the villages are located in immediate vicinity of the national grid. Not all of these households are officially connected, but have simply extended the grid from their neighbor. Table 12 gives an overview on the distance from the village to the electricity grid. TSU considers a village that applies for a micro hydro scheme as viable if it is at least 2.5 km away from the PLN grid. It can be seen that 7 of the 10 surveyed villages in Sumatra and 5 villages in Sulawesi are closer to the grid.⁴

This leads to the question why the villages did nevertheless apply for an MHP instead of applying for a PLN connection. First, the PNPM competition to obtain financing for an MHP is much more accessible for the villages than the PLN grid extension process. Second, qualitative information gathered from interviews with village chiefs, PNPM facilitators, or villagers shows that the villages also do not want to connect to PLN because of much higher connection fees for households. Those EnDev 2 villages that tried to get PLN connections report connection fees that range between 2.1 Mio IDR (171 EUR) and 15 Mio IDR (1,244 EUR). Reliability problems and blackouts of the PLN grid are rarely named as a reason by the village chiefs.

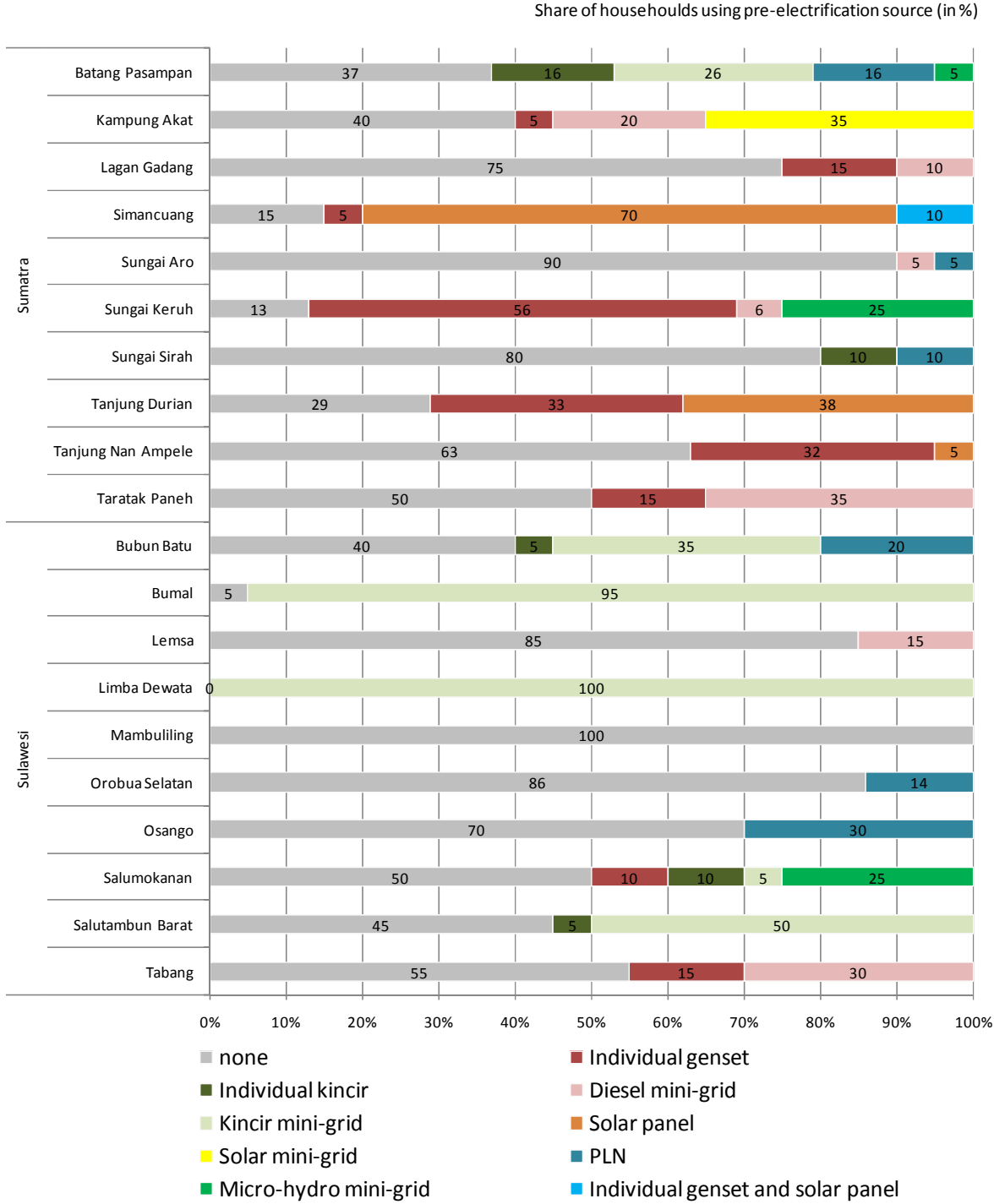
Table 12: Electricity Sources in EnDev 2 villages

Region	Site	Estimated distance to PLN grid	(Pre-)Electrification Status
Sumatra	Batang Pasampan	1.2 km	Village applied for connection to PLN grid. The connection fee for each household has been estimated to amount 15 Mio IDR. There are two traditional waterwheels in the village with 52 households connected.
	Kampung Akat	not in immediate vicinity	About 30 households are connected to a solar power plant that has been financed in 2008 by the Ministry of Energy and Mineral Resources. Each household pays 20.000 IDR per month. This electricity is only used for lighting (175 W per household). Additionally, 10 households use electricity from gensets.
	Lagan Gadang	0 km	Other hamlets of Nagari Punggasan have already been connected to PLN for 10 years. It does not seem to be a legal connection though (bamboo poles, etc.).
	Simancuang	6 km	Applied for PLN connection but connection cost would have been prohibitive, according to PLN. Instead, the government distributed 110 solar panels in 2009.
	Sungai Aro	0 km	Other dusuns are already connected to PLN. The grid also reaches the first households of Sungai Aro.
	Sungai Keruh	not in immediate vicinity	Village is surrounded by a huge private palm oil plantation that operates a mini grid driven by a diesel generator.

⁴ A cost analysis for different rural electrification options has been carried out on behalf of World Bank for different Indonesian provinces in March 2009 (Maunsell and AECOM 2009). This study concludes that grid expansion is the least-cost means of electrification up to distances of even 7 km if compared to micro hydro isolated grid options.

Region	Site	Estimated distance to PLN grid	(Pre-)Electrification Status
	Sungai Sirah	0 km	Other dusuns are already connected to PLN since 1994. The grid also reaches the first households of Sungai Sirah.
	Taratak Paneh	0 km	The PLN grid reaches the entrance of the village. It has been installed there already 17 years ago. Furthermore, they have 2 gensets where approximately 20 households are connected.
	Tanjung Durian	1 km	Widespread usage of solar panels, distributed by the government, and individual gensets.
	Tanjung Nan Ampele	1 km	Village applied for connection to PLN grid. The connection fee for each household has been estimated to amount 2.1 Mio IDR. The neighboring village has been electrified ten years ago and each households paid 400.000 IDR. There are two shared generators in the village with 16 households connected. Each HH pays 11,000 IDR per week for electricity from 6 to 12pm.
Sulawesi	Bumal	>30 km	6 traditional waterwheels available in villages. Basically all households are connected, but the supply is not stable. 4 gensets for carpenter work are also available.
	Bubun Batu	0 km	25% of households connected to PLN, some to a traditional waterwheel
	Lemsa	2km	There is one MHP in the village, nearly 50% of the population is connected.
	Limba Dewata	>3 km	Since 2005 the village has 9 traditional waterwheels, the majority of the population is connected (lighting, radio and for 15 HH also TV)
	Mambuliling	5 km	One genset available
	Orobua Selatan	0 km	In one hamlet some households are connected to PLN, either officially or through the neighbor. The other hamlets are 500m-1km away.
	Osango	0 km	80% of HH in village are connected to PLN. The village is dispersed, the remaining 20% of HH to be connected to a MHP are farer away from the main road than hamlets connected to PLN
	Salumokanan	0,5 km	There are 6 gensets with 2-3 households per genset connected.
	Salutambun Barat	>3 km	4-7 traditional waterwheels in village, but they do not seem to work well.
	Tabang	>3km	1 village genset and approx. 6 individual gensets

Chart 11: Electricity Sources per village



The individual gensets are powered by petrol (68%) or diesel (32%). In Sulawesi, there are only few households using a generator. The generators have an average capacity of 1.5 kW and consume 52 liters per month.

Compared to other electricity sources, the individual gensets induce the highest generation costs (see Table 13). But also some genset minigrids are extremely costly for the user: For example in

Taratak Paneh, the households that are connected to a shared generator pay 25,000 IDR per week for using a TV and 2 lamps or 20,000 IDR for using 3 lamps. The system runs from 6pm to 12pm.

Table 13: Monthly expenditures on electricity sources per household (in IDR)

	MHP	individual traditional waterwheel	traditional waterwheel minigrid	individual genset	genset minigrid	solar minigrid	individual solar panel	PLN
Sumatra	24,000	-	10,000	307,443	38,077	20,000	-	21,667
Sulawesi	-	-	6,420	214,000	32,889		-	40,500

Most households are using the current electricity source for already some years (see Table 14). This information, though, does not refer to the year when households started to use electricity for the first time.

Table 14: Years households have been using current electricity source

	MHP	individual traditional waterwheel	traditional waterwheel minigrid	individual gensets	genset minigrid	solar minigrid	indiv. solar panel	PLN
Sumatra	2.5 (n=5)	4.5 (n=3)	4.5 (n=5)	3.3 (n=37)	2.7 (n=14)	1.4 (n=7)	1.2 (n=24)	0.8 (n=6)
Sulawesi	2.5 (n=5)	4.3 (n=4)	3.1 (n=57)	3.4 (n=5)	1.9 (n=9)		-	2.4 (n=12)

The most common electronic appliances are electric lighting, mobile phones, and TV with satellite receiver (see Table 15). Whereas mobile phones are more common in Sumatra, generally information technology like TV, CD and VCD, and radio are slightly more widespread in Sulawesi. Beyond television sets electronic devices are only used sporadically. Irons, for example, are in most cases non-electric. Radios are not widely used and also mostly run on dry cell batteries. In both regions there are some households with rice cooker and magic jars, an electronic appliance that cooks rice and keeps it warm.

Table 15: Appliance usage (electric appliances and non-electric counterparts)

Percentage of HH that possess...	Sumatra	Sulawesi
Electric lighting	50 %	46%
Mobile phone	37%	32%
TV	26%	28%
Satellite receiver	22%	20%
Charcoal Iron	20%	4%
Electric Iron	9%	1%
CD / VCD	14%	17%
Battery radio	12%	13%
Line powered radio	2%	8%
Bivalent radio	1%	9%
Rice Cooker with warm keeping mode (Magic Jar)	4%	0%
Rice Cooker	1%	2%
Ventilator	3%	1%
Speaker	2%	3%

Percentage of HH that possess...	Sumatra	Sulawesi
Water cooker	2%	1%
Fuel-run refrigerator	2%	0%
<i>Mechanical sewing machine</i>	1%	2%
<i>Fuel-run mill</i>	1%	0
Mixer/Blender	1%	0%
Coconut rasper	1%	0%
Washing machine and pump	1%	0%
Computer	0	1%
Carpentry equipment	0%	1%

The households without electricity have been asked which electronic appliance they would like to buy most in case of electrification. With 53% the majority likes to buy a TV, followed by lighting devices.

Households that already have electricity have been asked, which appliances they would like to use but the capacity of the current electricity source does not allow to. They also give priority to TV, followed by rice cookers and refrigerators.

Table 16: Appliances that would be purchased in case of electrification (for non-electrified) / in case of higher capacity electricity supply (for electrified)

Appliance	HH without electricity (single answers only)	HH with electricity (multiple answers possible)
TV	54%	43%
Lamps	32%	10%
Radio	4%	5%
Rice Cooker	4%	15%
Satellite Receiver	2%	5%
Mobile Phone	1%	-
CD Player	1%	2%
Electric Iron	1%	4%
Refrigerator	1%	12%
Ventilator	1%	1%
Tape Recorder	1%	-
DVD	-	2%
Computer	-	1%
Carpentry machine	-	1%
Water Pump	-	1%

Unlike in African rural areas the potential use of rice cookers ties a linkage between electricity and cooking energy. Today, virtually all households in the survey region cook exclusively with firewood (3% use kerosene or LPG).

Also unlike in Africa the persons responsible for firewood collection are mostly men. Only 25% in Sumatra and even only 7% in Sulawesi are women. In most cases, this work is done by adults and rarely by children, although the youngest firewood collector is 6 years old only. In Sumatra it takes on average 2.5 hours per week to collect the firewood, in Sulawesi around 5.8 hours.

Households hardly use the appliances for home business activities. Only 4 households in Sulawesi offer ironing services with their electric iron.

Lighting

For the analysis of lighting devices we distinguish between the households that use some sort of electricity and those that do not. Within the group of electricity using households there are only 4 households that do not use the electricity for lighting. The rest uses primarily compact fluorescent lamps (see Table 17). Normal incandescent bulbs and fluorescent tubes are also used but to a lower degree. Only 3% of electricity users in Sumatra and 7% in Sulawesi have completely replaced their traditional lighting sources with electric ones. The most commonly used non-electric lamps are hurricane lamps in Sumatra and tin lamps in Sulawesi. Candles are only used in case of blackouts or fuel shortage.

Table 17: Lighting devices and consumption

Lighting devices		HH with electricity		HH without electricity	
		Sumatra n=102	Sulawesi n=92	Sumatra n=96	Sulawesi n=102
Incandescent light bulb ("Normal electric bulb")	% (outside/ inside)	6% / 9%	3% / 12%		
	# (outside/ inside)	1.17 / 1.56	1.00 / 1.64		
	h (outside/ inside)	5.30 / 5.79	13.7 / 12.2		
Neon/fluorescent Tube	% (outside/ inside)	6% / 20%	1% / 1%		
	# (outside/ inside)	1.00 / 2.00	1.00 / 6.00		
	h (outside/ inside)	5.8 / 0.90	12.00 / 2.00		
Compact fluorescent lamp ("Energy saver")	% (outside/ inside)	40% / 79%	28% / 90%		
	# (outside/ inside)	1.00 / 2.38	1.19 / 2.27		
	h (outside/ inside)	5.50 / 5.40	10.40 / 10.40		
Candles	%	2%	9%		
	# (consumption per month)	17.50	4.38	-	3.75
Hurricane Lanterns	%	74%	0%	76%	0%
	#	2.33	-	2.47	-
	h	7.2	-	10.2	-
Tin Lamps	%	23%	95%	22%	100%
	#	2.48	1.85	2.91	2.69
	h	6.5	6.2	11.7	5.4
Gas lamp	%	2%	1%	2%	2%
	#	1.5	1	1.5	1
	h	6	3	12	4

%= percentage of households using the device

= average number of devices per household (only device using households)

h= average lighting hours per lighting device

Chart 12: Usage of different lighting devices

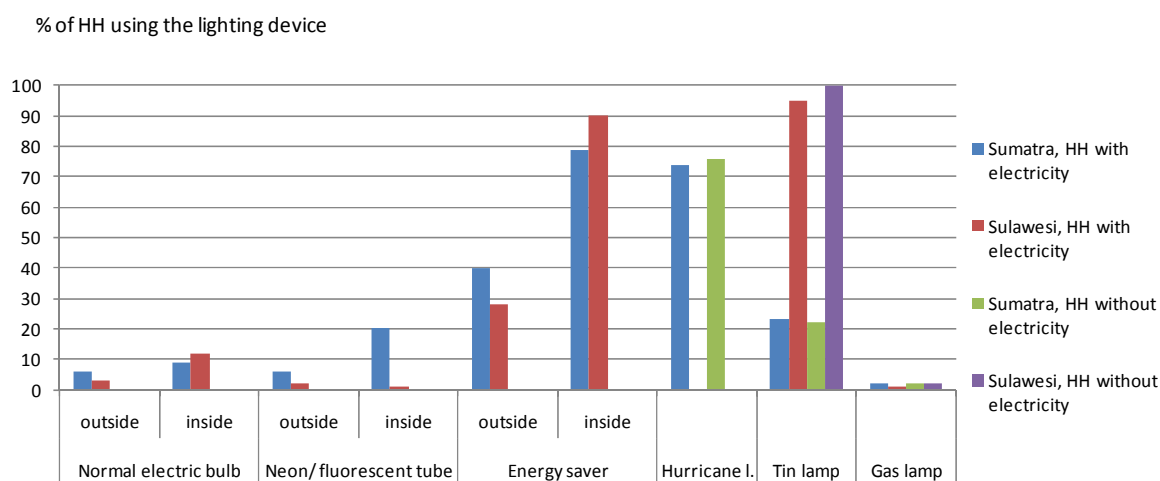


Table 18 shows, first, the total lighting hours consumed by the households; this is, the total time lighting devices are illuminated, summed up over all devices. Electricity users consume considerable more light already in terms of hours. If we furthermore account for the higher quality of electric lighting by looking at the amount of lumen hours consumed per day, this gap becomes substantially wider. As can be seen in Table 18, the electricity users consume between 10 and 50 times more lumen hours than the non-users.

Table 18: Lighting hours and lumen hours consumed per day

Lighting hours and lumen hours consumed per day		lighting hours	lumen hours
Sumatra	n=102 (HH with electricity)	31.21	10,137
Sulawesi	n=92 (HH with electricity)	38.72	17,618
Sumatra	n=96 (HH without electricity)	27.05	1,190
Sulawesi	n=102 (HH without electricity)	14.79	328

Table 19: Lumen per lighting device

	lm
Wick Lamp	11.4
Paraffin Candle	11.8
Hurricane Lamp (kerosene)	32.0
Gas lamp ("kerosene pressure")	2,040.0
Incandescent Light Bulbs (60 W)	730.0
Fluorescent Tubes (40 W)	1,600.0
Compact fluorescent lamps (11 W)	600.0

Source: O'Sullivan and D. Barnes (2006)

This is of course due to the much better lighting quality of electric devices. But also between different electric lighting sources and between different non-electric lighting devices the emitted lumen varies substantially. Table 19 shows the lumen values for different types of lamps. As can be seen, even smaller electric bulbs are much brighter than traditional lamps. One exception are pressurized kerosene lamps that are extremely bright but also consume huge amounts of fuel.

At this point it has also to be emphasized that the light bulbs in many households in Sulawesi connected to a waterwheel are not used at their full capacity. Therefore, the estimation of consumed lumen hours in Table 18 is a rather optimistic one. The extent to which the households are satisfied with their lighting sources was also included in the questionnaire as a softer indicator for lighting quality. While the absolute judgment of respondents has certainly to be interpreted with care (e.g. “often satisfied” vs. “seldom satisfied”), the comparison between groups and regions offers insights.

Chart 13: Satisfaction with lighting quality of different lighting devices

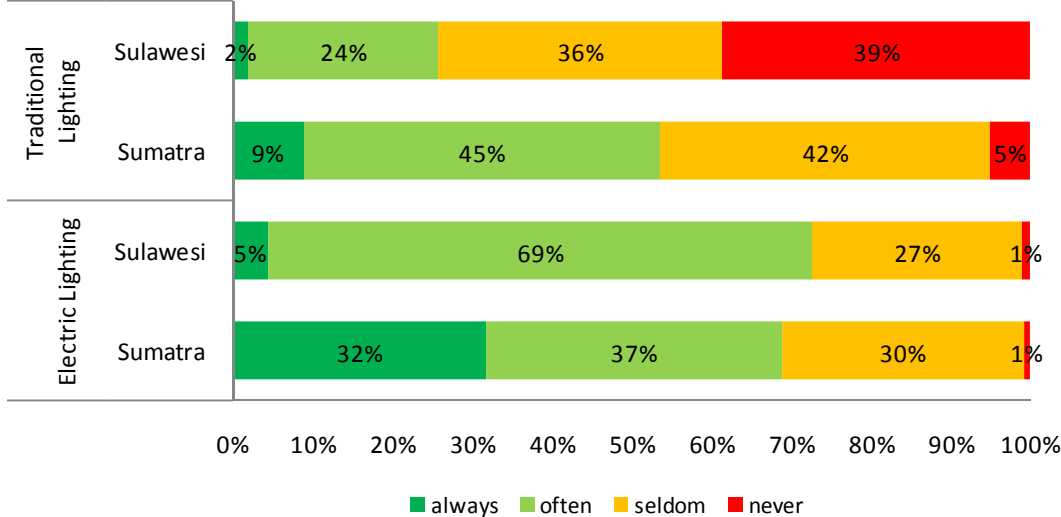


Chart 13 shows that the waterwheel users in Sulawesi only rarely express complete satisfaction with their electric lighting source, whereas electricity users in Sumatra do so more frequently. It can also be seen in this chart that the electricity non-users more frequently report to be “never satisfied” in Sulawesi than in Sumatra, which is due to the prevalent tin lamp usage here and hurricane lantern usage there. Hurricane lanterns are much brighter (see Table 19).

On average, the households illuminate 2.3 rooms with the electrical lighting devices and 2.2 rooms with the traditional lamps.

Crop transformation

Crop transformation is very common in the surveyed regions and done by around 53% in Sumatra and even 85% in Sulawesi. In Sulawesi, the most important basic products are rice, coffee, and cocoa. In Sumatra, the household transform additionally cardamom, and cinnamon. Occasionally, there are also households transforming maize, peanuts, gambir, and nutmeg.

The revenues from selling transformed goods are significantly higher in Sumatra than in Sulawesi. In Sumatra, they amount to approximately 2 Mio IDR (163 EUR) per year whereas they amount to only 0.3 Mio IDR (25 EUR) in Sulawesi. In Sulawesi, 50% of the income derives from selling cocoa, 40% from coffee and 10% from rice. Most of the income in Sumatra derives from selling rice (30%), gambir, a natural dye feedstock (25%), and coffee (20%). The high importance of the revenues from gambir comes as a surprise, as only eight households in Taratak Paneh and Sungai Aro cultivate it. However, the leaves of the gambir shrub can be transformed into valuable dye and tanning agent. The households harvest the leaves each three month, cook and press them, and sell them to traders or to the nearest market. They get 25.000 IDR per kilo (2 EUR) and sell approximately 600 kg per year. If we subtract the revenues from gambir, the households in Sumatra only earn approximately 1.5 Mio IDR (122 EUR) from selling transformed goods, which is still substantially more than in Sulawesi.

Table 20: Crop Transformation

		Number of HH cultivating basic product...	Number of HH transforming product	By which means?			Share of transforming HH that sells transformed product
				by hand / tool	motorized appliance (diesel or petrol)	electric appliance	
deshell rice	Sumatra	120	65	15%	85%		48%
	Sulawesi	138	138	45%	55%		6%
hull coffee	Sumatra	39	15	33%	67%		100%
	Sulawesi	94	61	98%	2%		83%
grind coffee	Sumatra	39	0				-
	Sulawesi	94	26	96%	4%		14%
dry coffee	Sumatra	39	23	87%	13%		100%
	Sulawesi	94	0				-
dry cardamom	Sumatra	26	25	100%			100%
	Sulawesi	0	0				-
hull areca nut	Sumatra	15	10	100%			100%
	Sulawesi	0	0				-
clean cinnemon	Sumatra	13	7	100%			86%
	Sulawesi	0	0				-
dry cocoa	Sumatra	4	2	100%			100%
	Sulawesi	73	58	100%			95%
hull cocoa	Sumatra	4	2	100%			100%
	Sulawesi	73	6	100%			100%
cook and press gambir	Sumatra	8	8	100%			100%
	Sulawesi	0	0				-

Crop transformation is frequently cited as a potential productive application of electricity in order to increase the efficiency of the agricultural sector or, in the case of cash crops, to increase the value added in the region. In fact, most of the transformation processes are done by hand. Motorized appliances are prominently used for milling and hulling activities. These motorized services are offered by commercial millers and hullers (see next section).

Productive Electricity Use

While the focus of the survey was on households as the ultimate beneficiaries of the electrification intervention, in qualitative interviews with village chiefs and other key informants a particular focus was put on enterprises and potential productive electricity uses.

The surveyed villages are clearly dominated by an agricultural economy. The only enterprises are kiosks, carpenters, mills, hullers, and in Sulawesi some weavers. In most cases, though, these businesses do not serve as the primary income source for their owners and are run more on demand basis. Virtually all produced goods are sold and consumed locally.

Both in Sumatra and Sulawesi, the most numerous enterprises are kiosks (see Table 21). These are often home businesses, i.e. one room of the house is stocked with non-perishable food, especially chips, instant noodles, and cookies, small sachets of shampoo or instant coffee, beverages, and not least cigarettes, which are sold through a little window to the customers. In some cases these kiosks also sell batteries, kerosene, and bottles of petrol. In Sumatra nearly all, in Sulawesi some of the kiosks have electricity for lighting. Moreover, there are some owners that possess refrigerators or TVs; the latter to attract more consumers to visit their kiosk.

Table 21: Businesses in EnDev2 villages

	Kiosk*	Mill/Huller	Carpenter	Other
Sulawesi				
Bubun Batu	11		10 **	
Bumal	3	3	6	3 photocopiers
Lemsa	7		20 **	
Limba Dewata	3		5	
Mambuliling	5		3	
Orobua Selatan	8		2	5 weaver, 1 blacksmith
Osango	20		2	5 restaurants
Salumokanan	10		4	1 blacksmith
Salutambun Barat	5	5	2	
Tabang	4		6	
Sumatra				
Batang Pasampan	2	3		
Tanjung Nan Ampe	5		saw mill	
Simancuang	8	7	4 **	
Sungai Keruh	3		1	Women's bakery
Tanjung Durian	3	2	2 **	
Taratak Paneh	5			1 brickyard
Kampung Akat	5		1 **	
Lagan Gadang	2			tailor
Sungai Sirah	2			
Sungai Aro	1	1		

* The kiosk numbers for Sulawesi are approximations. **These carpenters work on demand only.

Mills and hullers exist that are used to transform rice and process coffee. These mills are driven by gensets or have diesel engines and are normally in operation only two to three times per week for some hours. In few villages traditional rice mills are driven by a waterwheel, so called *kincir padi*. The waterwheel moves a shaft that raises and lowers wooden mashers to pound rice in small wooden

bowls. In Sungai Aro, there is a soja mill which belongs to a little workshop for tofu production. The workshop owner employs two workers that are producing 10 buckets of tofu each working day. The customers come to the workshop to buy the tofu. On average, they earn 66,000 IDR (5 EUR) per bucket of tofu. The inhabitants of villages without mills normally have to travel to neighboring villages to transform their rice. It is also common that after the harvesting period there are itinerant diesel mills that travel from village to village offering milling services for rice and coffee.

As most of the houses and furniture are made of wood, many carpenters exist in the villages. Metal-processing workshops are virtually inexistent. There is only one blacksmith in Orobua Selatan. He only works manually and does not have any electricity source. By contrast, in basically all villages there are carpenter workshops or carpenters that occasionally exercise their profession. Also carpenters work mostly as farmers and only if there is demand for constructing a house, furniture, or repair work, they take up their carpentry work. The majority of them work with gensets. Approximately one third of the carpenter only works manually and does not use any non-human energy source.

In Sungai Keruh, there is a bakery driven by a women's association. They use firewood and kerosene for the operation of their ovens. In the Mamassa region in Sulawesi there is a tradition of manually weaving blankets that are sold to local customers; either directly from the workshop or sometimes also at local markets.

3.4.2 Energy expenditures

The energy expenditures for traditional energy sources are quite similar in both regions (see Chart 14). Furthermore, those households that use an electricity source spend a similar amount on traditional energy sources like their non-electrified counterparts. This indicates that the electricity usage does not replace traditional energy usage but rather complements traditional sources. This can as well reflect the fact that "richer" households are more likely to use electricity. At the same time these richer households use more energy in general – including traditional sources. To this extent electricity has replaced traditional energy sources – it is only that the expenditures were higher prior to the connection than those of electricity non-users.

Chart 13 additionally shows that the electricity expenditures are dominated by fuel costs of generators. In Sumatra the household with generators have extremely high expenditures. About 20% of the generator using households in Sumatra use between 90 and 300 liters per month. One might also conclude from Chart 13 that energy expenditures are not elastic with respect to income: Households in richer Sumatra do not differ from the poorer households in Sulawesi. As can be seen in Chart 15, expenditures on traditional energy sources are clearly dominated by kerosene for lighting.

Chart 14: Energy expenditures by category

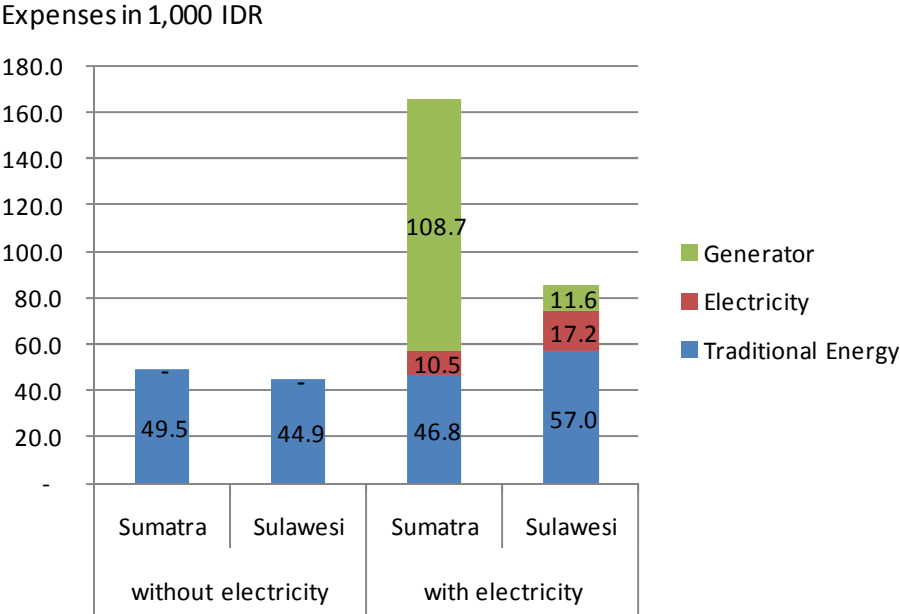
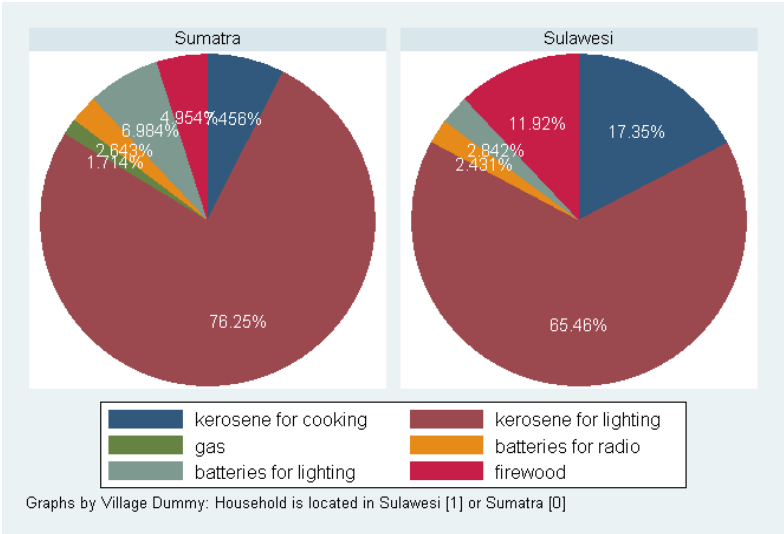


Chart 15: Composition of expenditure on traditional energy sources



3.4.3 Activity Profile

The increased and improved usage of artificial lighting can translate into different day- and nighttime activities of households. Additionally, electricity fuelled activities like television can change people’s behavior. Therefore, we look into the activity profile of households in the survey region.

Generally, both in Sulawesi and Sumatra, adults get up between 5h and 5.30h in the morning. The mother gets up slightly earlier and generally also goes to bed earlier than the father. Children get up later than their mothers and at least small children between 6 and 11 stay awake less time than the

adults. All household members go to bed between 20h and 22h. Among electricity using households in Sulawesi, all household member go to bed later than their non-electrified counterparts. In Sumatra, this relationship only holds for adults. It might reflect a higher dependency on daylight or more expensive traditional lighting. As Table 22 shows, there is, however, no clear indication for electricity using households staying up later than non-using households. At this point, it has to be taken into account that the electricity sources are quite heterogeneous. The waterwheel users have rather low quality lighting, whereas gensets produce bright lighting – but at high costs. The activity profile and its responsiveness to electrification has to be reassessed as soon as the high quality electricity from the MHP is available.

Table 22: Activity profile

Activity Profile	father		mother		children 6-11		male children 12-17		female children 12-17	
	get up	go to bed	get up	go to bed	get up	go to bed	get up	go to bed	get up	go to bed
	hours awake		hours awake		hours awake		hours awake		hours awake	
Sumatra n=102 (with electricity)	5.25	21.34	5.20	21.07	6.02	20.26	6.08	21.06	6.08	21.06
	16.11		15.47		14.25		14.58		14.13	
Sumatra n=96 (without electricity)	5.17	21.11	5.13	20.49	6.01	20.44	6.11	21.28	6.11	21.16
	15.53		15.35		14.43		15.05		14.41	
Sulawesi n=92 (with electricity)	5.23	21.44	5.01	21.14	5.38	20.58	5.16	21.24	5.14	21.26
	15.35		16.13		15.20		16.11		16.11	
Sulawesi n=102 (with electricity)	5.26	21.06	5.05	20.46	5.46	20.26	5.15	21.01	5.46	20.44
	15.37		15.41		14.41		15.46		14.58	

Time for Studying

Electricity usage might transfer into impacts on educational outcomes because studying conditions are improved. It is often argued that particularly improved lighting leads to increased study activities of children after school. The questionnaire therefore dedicated some effort to grasp the studying behavior of children after school: Children between 12 and 17 years study on average much more time than their younger brothers and sisters. Whereas the mean amounts to 107 minutes among households without electric lighting and 114 minutes among households with electric lighting, it only totals approximately 77 minutes and 94 minutes, respectively, for children under 12 years. There is no clear tendency for differences between the sexes of the older children.

Astonishingly, children in households without electric lighting study by and large more time after sunset than their electrified counterparts. Only in Sumatra among female children between 12 and 17 years those children living in non-electrified households study slightly more time after sunset. Apart from the result for male children between 12 and 17 in Sumatra, though, the differences in study time are not statistically significant. So, one must not conclude that non-electrified kids study more.

Table 23: Time for studying

Studying time (in min/day)		children 6-11			male children 12- 17			female children 12-17		
		# of obs.	total	night	# of obs.	total	night	# of obs.	total	night
Sumatra	without elec. lighting	30	83	56	17	119	80	15	100	59
	with elec. lighting	39	98	49	22	109	52	23	116	64
Difference nighttime studies				-7			-29**			4
Sulawesi	without elec. lighting	33	70	40	30	106	58	25	104	49
	with elec. lighting	32	89	35	14	102	51	23	127	44
Difference nighttime studies				-4			-7			

** Statistically significant at the 5 percent level

Television and mobile phones usage

Access to electricity might as well improve access to information and communication. For example, people in non-electrified areas who use mobile phones have to spend time or money on getting their phones recharged. 37% of the households in Sumatra and 32% of the households in Sulawesi own a mobile phone. 59% of these household in Sumatra and 59% in Sulawesi charge their mobile phone at home. The rest has to walk a distance of on average 1.7 km in Sumatra and 2.6 km in Sulawesi to charge the mobile phone. Only four households in Sumatra and two households in Sulawesi pay for charging the battery (1,250 IDR/0.1 EUR in Sumatra and 6,000 IDR/0.5 EUR in Sulawesi). On average, the respondents use their mobile phone around 4.6 times per week.

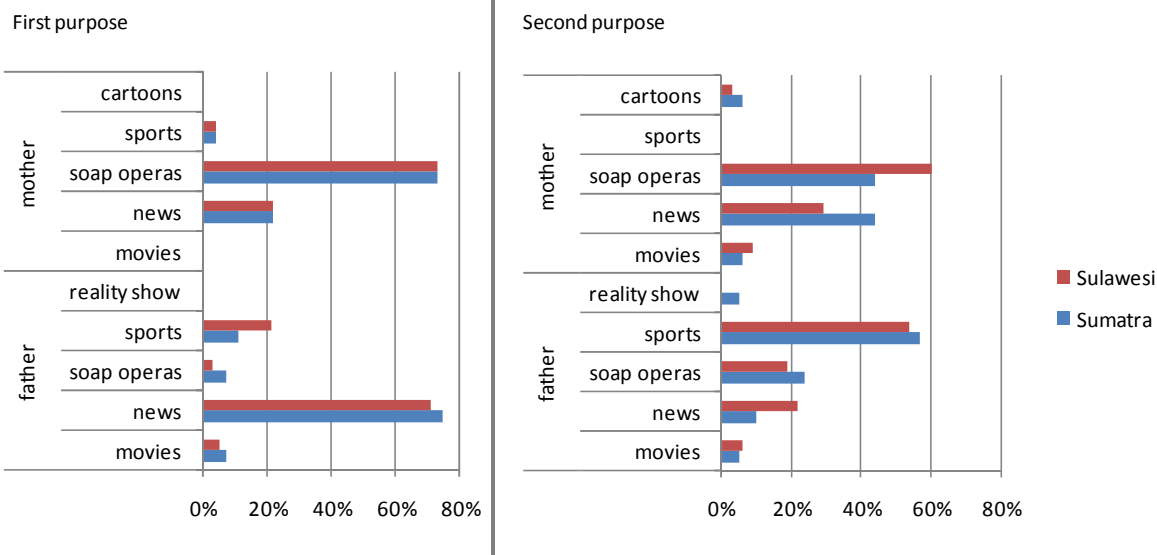
Table 24: TV usage in minutes per day

TV Usage (in min/day)		father	mother	children 6-11	male children 12- 17	female children 12-17
TV owner	Sumatra (N= 50)	31	55	35	28	37
	Sulawesi (N=42)	106	127	40	106	106
no TV	Sumatra (N=148)	4	4	3	4	2
	Sulawesi (N=142)	53	35	27	43	35

While the usage of TV following to electrification is sometimes considered as an inferior or even harmful application of electricity, more and more evidence can be found supporting the contrary view: TV provides access to information – not only in the form of news broadcasts, but also by communicating a more emancipated cognition – not least (but also not only) with regards to gender

aspects.⁵ In the survey regions, the usage of TV is significantly higher in Sulawesi (see Table 24). Household members above 11 years who have a TV at home watch on average 51 minutes more TV than those in Sumatra. What is striking is that even many TV non-owners in Sulawesi watch more TV per day than TV owners in Sumatra. These households go to neighbors or friends to watch TV.

Chart 16: Purpose of TV usage



The access to information (“news”) is the main purpose of watching TV for 85% of fathers in Sumatra and 93% in Sulawesi (see Chart 16). Women use the TV mostly to watch soap operas, but a considerable share also states that watching news is the major or second purpose. Note that the question for which purpose the TV is used was posed openly, i.e. no answers have been proposed.

This point is additionally underpinned by the following fact: Approximately 73% of the households that have a TV state that their main source of information is TV. The second most important information sources are neighbors or friends (12%). Only few people get their information from radio or newspaper. Those households that do not have TVs at home get their information primarily from neighbors or friends (44%).

Social Commitment and Sense of Security

The availability of electricity and the thereby increased media access may change the households’ habits to participate in associations, social, political, or religious groups. Olken (2008), for example, finds evidence in Indonesian villages for a negative effect of television on social activities. The increase in time spent watching television and listening to radio may lower the household members’ incentive to leave the home in the evening and participate in social organizations. On the other hand, information provided through the TV may induce higher social or political commitment.

⁵ See, for example, La Ferrara, Chong and Duryea (2008), Grentzkow and Shapiro (2004), Jensen and Oster (2008), Olken (2008), and Peters and Vance (2011) for evidence on TV usage and different directions of impacts.

The membership in associations, social, political, or religious groups is much higher in Sulawesi than in Sumatra. Whereas in Sumatra around 20 percent of mothers and fathers are engaged in some group, in Sulawesi this share amounts to more than 50 percent (see Table 25). Most of the parents are members in farmers associations. There is basically in all villages at least one farmer association. Their activities are mainly the organization of mutual help at their fields, but also government subsidies for premium seeds or fertilizer are allocated through these associations.

Table 25: Membership in groups

		Membership in association	frequency of participation per month
father	Sumatra	19%	1.9
	Sulawesi	61%	2.2
Mother	Sumatra	20%	2.7
	Sulawesi	51%	2.7

In Sumatra, also religious groups play an important role. 59 percent of the mothers that are member of a group participate in Quran reading groups and 14 percent of the fathers do. Political movements are rather negligible. Women, especially in Sulawesi, participate also in women’s groups that mainly include the preparation of social events, but also saving activities. In Sumatra, many of these groups have a religious background.

From the perspective of villagers in remote areas one of the most important benefits of electricity is improved lighting in order to improve security, but also for subjective reasons. Darkness is simply scaring and improved lighting contributes to an improvement of the subjective well-being. Yet, irrespective of electricity usage, 98% of the interviewees in Sumatra and 81% of the interviewees in Sulawesi think that darkness is dangerous.

71% of men and 77% of women in Sumatra stated that they are afraid of being outside after nightfall. The corresponding figures in Sulawesi, 30% of men and 57% of women, are considerably lower, though the difference between the sexes is greater. With regards to their children being outside after nightfall, 97% of fathers and 85% of mothers in Sulawesi are fearful for their children. In Sumatra, around 90% of fathers and mothers feel afraid when their children are outside after nightfall. In both towns, only negligible shares of 2% or less reported being afraid at home after nightfall.

Table 26: Fear of going out after nightfall (in %)

	Sumatra		Sulawesi	
	m	f	M	f
Him/herself outside	71	77	31	57
Children outside	88	90	97	85
At home	2	2	1	1

3.4.4 Attitude towards Electricity

Virtually all households in the surveyed regions are eager to get a connection to the MHP – including households that already use another electricity source. Only few households in Sulawesi (4%) state that they do not want to get connected and name financial reasons. One household prefers its PLN connection. This clearly reflects the superiority of MHP electricity compared to other sources. The advantages are straightforward: For genset- or PLN-users the costs are crucial; waterwheel and Solar Panel users want higher power electricity.

The most important purpose that the households would like to use the MHP electricity for is lighting (see Table 27). While the second most important purpose in Sumatra is TV usage, in Sulawesi it is the possibility to study after nightfall. It is remarkable that for households in Sulawesi TV is much less important than in Sumatra. This is certainly due to the fact that people in Sulawesi already watch much more TV today – even before they have one at home. 40 % of non-electrified households in Sulawesi watch TV outside their homes, while only 3 % do so in Sumatra. Apparently, watching TV with neighbors is much more common in Sulawesi.

Table 27: Purpose of electricity usage from MHP (in %)

Sumatra			Sulawesi		
	1. Purpose	2. Purpose		1. Purpose	2. Purpose
Lighting	80%	12%	Lighting	79%	29%
TV	9%	57%	Study	6%	29%
Reduction in expenses	5%		Reduction of expenses	6%	10%
Entertainment		10%	TV	4%	9%

These priorities do not look substantially different if we distinguish between the households that already use some electricity source and the non-users. For the non-users, lighting is slightly more important, while those with electricity highlight the reduction of expenses in Sumatra. In Sulawesi it is the other way round: those households without electricity insist more on potential reduction of expenditure than those with electricity.

The households that do not have any electricity connection so far have been asked about their willingness to pay for different electricity services. The results are displayed in Table 28. It can be seen that the willingness to pay is substantially lower in Sulawesi than in Sumatra. Furthermore, households are willing to pay more for a better service quality. Only few households reserve a fixed amount of their budget for electricity – irrespective of the quality.

Table 28: Willingness to pay for electricity services (in IDR)

Willingness to Pay for electricity connection that allows to use...	Sumatra	Sulawesi
...lighting, all day	20,524	13,718
...lighting, radio and TV use, charging mobile, 5 p.m. – 7a.m.	25,403	15,589
...lighting, radio and TV use, charging mobile, all day	27,070	19,526
...lighting, radio and TV use, fridge, electric stove, all day	32,333	23,889

Also the ability to afford the connection costs for a future MHP differs a lot between Sulawesi and Sumatra (see Table 29). While for the majority of households in Sulawesi a connection cost of 200,000 IDR (18 EUR) would be too high, nearly all interviewed households (94%) in Sumatra state to be able to pay this. 27% of the households in Sumatra say that 350.000 IDR (31 Euros) would be the highest acceptable price and 25% would be able to pay even 500.000 IDR (44 Euros) or more.

Table 29: Highest affordable price for connection fee

connection fee in IDR	Sumatra	Sulawesi
less than 200,000	6%	79%
200000	42%	12%
350000	27%	2%
500000	25%	5%

The majority of households to be electrified in the future want to finance the installation in cash or with a loan (see Table 30).

Table 30: How are you planning to pay for the MHP connection?

	Sumatra	Sulawesi
Cash	51	71
Loan	28	21
Savings	9	6
in instalments	9	

Only very few households see negative effects of electricity usage. In Sumatra the share is lower than 5% and in Sulawesi lower than 8%. Possible negative impacts mentioned are house fires and children watching too much TV. Those households that already have electricity see the problem that also parents go to bed too late.

In a self-judgment question households were asked if they could improve activities by using electricity, which 71% of the already electrified households in Sumatra and 63% in Sulawesi claim. The channels of improvement are better working conditions thanks to lighting, as the majority of households stated on both islands. For households in Sumatra the possibility to use electric appliances is secondly important and households in Sulawesi highlight that they do not need (so many) kerosene lamps anymore.

More than 70 percent of the households think that it is more important to have street lighting than lighting at primary schools (see Table 31). Electric appliances are considered more important at health stations than at secondary schools especially in Sulawesi but also to a lower degree in Sumatra.

Table 31: Priority concerning lighting and electric appliances (in %)

	Sumatra	Sulawesi
Street lighting is more important than lighting at a primary school	75%	74%
Electric appliances at health stations are more important than at a secondary school	64%	83%

The perception of households that darkness is dangerous is also reflected in the answers concerning electricity provision in the villages (see Table 32): 83% of households in Sumatra give highest priority to street lighting, 64% of households do so in Sulawesi. Around 50% of households in Sumatra give priority to lighting at school and health facilities, whereas just 23% of households give priority for electricity provision at schools in Sulawesi. Electricity provision at health facilities is seen as priority by 57% of households in Sulawesi.

Table 32: Importance of electricity provision in social infrastructure in the village (in %)

	Sumatra			Sulawesi		
	Priority	desirable	Not necessary	priority	desirable	Not necessary
At school?	47	52		23	71	5
At health facility?	54	45	0.5	57	42	0.5
At administrative offices?	13	84		8	87	5
For street lighting?	83	16		64	36	0.5

4. Conclusion

This report has presented results of a baseline survey that serves as a yardstick for a future ex-post evaluation of the GIZ micro-hydro electrification project in Indonesia. It is implemented by the Micro Hydro Power Technical Support Unit (TSU) under the umbrella of the Dutch-German Energy Partnership program Energizing Development (EnDev). Between September and October 2010, in total 392 households were interviewed in the target regions of the project in Sulawesi and Sumatra.

The maybe most striking result of this baseline study are the high pre-electrification rates in the surveyed villages. This has implications on different levels: From the future MHP operator’s perspective, the high pre-electrification has advantages because the future customers have already electric appliances and are generally used to electricity. The implication for the monitoring of the TSU project is that data on electricity usage should be collected also in other target villages of the project that were not included in the survey, since pre-electrification rates might differ there. Somehow accurate numbers are necessary to report reliable figures to the overall Energizing Development monitoring system. The implication for the impact evaluation of this project is that the electrification “treatment” will be less accentuated for the households already using electricity. For around half the population it will be rather an improvement in service provision than newly provided access. Perceptive questions in the baseline survey suggest that people see many benefits in switching from their current electricity sources to the MHP. Therefore, the future ex-post evaluation should put emphasis on this improvement of the service. Guiding questions are:

- How much do the households pay compared to their pre-electrification source?
- How does the objective quality of lighting change (number of lamps, size of lamps, number of illuminated rooms, lighting hours)?
- How does the subjective quality of lighting change? Which advantages do the users experience?
- Which new energy services become possible (fridges, TV, rice cookers etc.)?

Furthermore, the baseline data has exposed that the two regions, Sumatra and Sulawesi, are quite different, in particular with regards to cash income and ability to pay. The villages in Sumatra exhibit

much higher incomes, mainly due to the cultivation of cash crops. This also suggests higher impact potentials in Sumatra, not least with regards to productive usage of electricity. The transformation of certain cash crops like coffee and cocoa bears potentials to use electric applications and, thereby, increase the value added in the region.

In general, the productive non-agricultural sector appears to be weak in the regions. In particular in Sulawesi, the villages are mostly difficult to access, which limits the potentials to expand production beyond the local demand. Local demand, in turn, can be expected to be low in the light of a dominating agricultural sector, low transit traffic and, consequently, low cash incomes. Nevertheless, some potentials exist, mostly for crop transformation. In these regards, it bears noting that not all MHP plants are operating the whole day but are started in evening hours only. If demand for motorized crop transformation is existent – for example indicated by the presence of fuel driven mills – the MHP operators might consider a full time operation of the plant. However, a distorting fact may lie in the proximity of many sites to the national electricity grid (PLN). For some productive users there may be the alternative of connecting to the PLN grid instead of an MHP connection and thereby obtaining higher capacity and cheaper electricity.

For the future ex-post evaluation of the EnDev 2 project it is recommended to intensify the examination of productive use activities and the importance that electricity could have to them. While home businesses and home based appliance usage are covered by the structured questionnaire also used for the present survey, in addition a more qualitative approach could focus on micro-enterprises. In-depth interviews could be conducted to explore why micro-enterprises connect or not and invest in machinery or abstain from doing so.

In order to increase impacts of micro-hydro electrification the usage of rice cookers bears potentials. The vast majority of households uses firewood for cooking purposes and, thus, is exposed to the related risks and burdens (health, time/work load, costs). Unlike rural areas in Africa, households seem to be in principle easily willing to switch to electric cooking devices, at least to prepare rice. The capacity of the MHP plants in most cases, however, will not allow for the widespread usage of cookers, which require 500-1000 Watts. For the design of future MHP schemes this might be taken into account: For sites with high hydro power potentials opportunities to make available the required capacity could be considered.

Beyond the potential impacts by the use of electricity cooking purposes or productive applications it must not be underestimated that people are unexceptionally looking forward to the MHP electrification – either because they will be using electricity for the first time or because their service level will be upgraded substantially. Even if the electricity is “only” used for lighting and entertaining purposes, the resulting improvement in well-being of people living in difficult environments is an impact as such.

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Annex 1

Survey site profiles Sulawesi

Bubun Batu

Kecamatan: Mamassa
Kabupaten: Mamassa
Distance to Main Road: 1,5 km

Planned to be connected

Households: 207
Schools: 1 SD, 1 TK
Community Center: 4
Productive Use: ca. 11 kiosks

Not planned to be connected (in access-area)

Already electrified households: 3
Productive Use: 10 carpenter (on demand)

Remarks: About half of the kiosks already have electricity. The carpenter only sporadically exercise their profession and do not have a fixed workshop.

Bumal

Kecamatan: Bumal
Kabupaten: Mamassa
Distance to Main Road: 3 km
Distance to PLN-grid: > 30 km

Planned to be connected

Households: 240
Schools: 2 SD, 2 SMP, 1 SMA, 3 TK
Health Centers: 1 Polindes
Religious Building: 3
Community Center: 1
Productive Use: ca. 3 kiosks

Not planned to be connected (in access-area)

Productive Use: 1 mill, 6 carpenter, 1 coffeemill, 1 rice flour machine, 3 photocopier

Remarks: There are 6 traditional water wheels with basically all households connected. The religious buildings today have a solar panel from government. 4 carpenter work with gensets. 2 only do manual work.

Lemsa

Kecamatan: Mamasa
Kabupaten: Mamassa
Distance to PLN-grid: 2 km

Planned to be connected

Households: 130
Schools: 1 SD, 1 SMP
Health Centers: 1
Community Center: 6
Productive Use: ca. 7 kiosk

Not planned to be connected (in access-area)

Already electrified households: 80 (other MHP)
Productive Use: 20 carpenter (on demand)

Remarks: There is already one MHP in the village. Approximately half of the kiosks are already conneted. The carpenters only sporadically exercise their profession and do not have a fixed workshop.

Limba Dewata

Kecamatan: Bambang
Kabupaten: Mamassa
Distance to Main Road: 7 km
Distance to PLN-grid: > 3 km

Planned to be connected

Households: 190
Schools: SD, TK
Health Centers: 1
Community Center: 3
Productive Use: ca. 3 kiosks

Not planned to be connected (in access-area)

Productive Use: 5 carpenter

Remarks: There are 9 traditional waterwheels in the village with the majority of the households connected, among them the 3 kiosks. Not clear if productive user will be connected to the MHP.

Mambuliling

Kecamatan: Mamasa
Kabupaten: Mamassa
Distance to Main Road: 5 km
Distance to PLN-grid: 5 km

Proposed Capacity of MHP:

Planned to be connected

Households: 270
Schools: 1 SD, 2 SMP
Health Centers: 4 Posyandu
Community Center: 4
Productive Use: ca. 5 kiosks

Not planned to be connected (in access-area)

Productive Use: 3 carpenter

Remarks: There is one genset in the village. Not clear if productive user will be connected to the MHP. Today they only work manually.

Orobua Selatan

Kecamatan: Orobua
Kabupaten: Mamassa
Distance to Main Road: 3 km
Distance to PLN-grid: 0 km

Planned to be connected

Households: 258
Schools: 2 SD
Health Centers: 1 Pustu
Community Center: 4
Productive Use: ca. 4 kiosks

Not planned to be connected (in access-area)

Productive Use: 2 carpenter, 5 weaver, 1 blacksmith, 4 kiosks

Remarks: Not clear if productive user will be connected. The carpenters use today gensets. The weaver and blacksmith only work manually. 3 kiosks are connected to PLN and will not connect to the MHP.

Osango

Kecamatan: Mamasa
Kabupaten: Mamassa
Distance to Main Road: 0 km
Distance to PLN-grid: 0 km

Planned to be connected

Households: 200
Schools: 1 SD, 2 TK
Health Centers: 1
Community Center: 8
Productive Use: ca. 20 kiosks

Not planned to be connected (in access-area)

Already electrified households: 300 (PLN)
Productive Use: 2 carpenter, 5 restaurants

Remarks: Not clear if productive user will be connected

Salumokanan

Kecamatan: Rantebulahan Timur
Kabupaten: Mamassa
Distance to Main Road: 0 km
Distance to PLN-grid: 0,5 km

Planned to be connected

Households: 120
Schools: 5
Health Centers: 1
Community Center: 4
Productive Use: ca. 10 kiosks

Not planned to be connected (in access-area)

Productive Use: 4 carpenter, 1 blacksmith

Remarks: There are 6 gensets in the village with 2-3 households connected to each. Additionally, there is an old MHP. Approximately 5 kiosks are connectec to the MHP. Not clear if productive user will be connected. The blacksmith ony does manual work.

Salutambun Barat

Kecamatan: Bumal
Kabupaten: Mamassa
Distance to Main Road: 4 km
Distance to PLN-grid: > 3 km

Planned to be connected

Households: 92
Schools: TK
Community Center: 1
Productive Use: ca. 5 kiosks

Not planned to be connected (in access-area)

Already electrified households: 90 (kincir)
Productive Use: 5 rice huller, 2 carpenter

Remarks: Not clear if productive user will be connected. Two of the kiosks already have electricity. The rice huller is driven by diesel

Tabang

Kecamatan: Tabang
Kabupaten: Mamassa
Distance to Main Road: 0 km
Distance to PLN-grid: > 3 km

Planned to be connected

Households: 188
Schools: SD, SMP, TK
Health Centers: 1 Puskesmas
Community Center: 3
Productive Use: ca. 4 kiosks

Not planned to be connected (in access-area)

Productive Use: 6 carpenter

Remarks: There are 10 gensets in the village. Not clear if productive user will be connected to MHP. Three carpenters work with genset, the other 3 work manual

Survey site profiles Sumatra

Kampung Akat

Kecamatan: Linggo Sari Baganti
Kabupaten: Pesisir Selatan
Distance to PLN-grid: not in immediate vicinity

Proposed Capacity of MHP: 40-50 kW

Planned to be connected

Households: 73
Schools: SD
Health Centers: 1
Religious Building: 1
Productive Use: 5 kiosks, 1 carpenter

Lagan Gadang

Kecamatan: Linggo Sari Baganti
Kabupaten: Pesisir Selatan
Distance to PLN-grid: 0 km

Proposed Capacity of MHP: 5-6 kW

Planned to be connected

Households: 47
Religious Building: 2
Productive Use: 2 kiosks, 1 tailor

Not planned to be connected (in access-area)

Already electrified households: 290 (PLN)

Remarks: As the capacity will not be sufficient to connect all households, among 100 households will not be connected.

Sungai Sirah

Kecamatan: Linggo Sari Baganti
Kabupaten: Pesisir Selatan
Distance to PLN-grid: 0 km

Proposed Capacity of MHP: 20-25 kW

Planned to be connected

Households: 34
Religious Building: 1
Productive Use: 2 kiosks

Not planned to be connected (in access-area)

Already electrified households: 50 (PLN)

Taratak Paneh

Kecamatan: Sutera
Kabupaten: Pesisir Selatan
Distance to PLN-grid: 0 km

Proposed Capacity of MHP: 33 kW

Planned to be connected

Households: 63
Religious Building: 1
Productive Use: 5 kiosks

Batang Pasampan

Kecamatan: Koto Parik Gadang Diateh
Kabupaten: Solok Selatan
Distance to PLN-grid: 1.2 km

Proposed Capacity of MHP: 25 kW

Planned to be connected

Households: 70
Schools: SD
Religious Building: 2
Productive Use: 2 kiosks, 1 rice mill, 1 coffee mill

Not planned to be connected (in access-area)

Already electrified households: 52 (kincir)

Remarks: There are 52 households that already use electricity from a traditional waterwheel. Probably these households will not be connected to the MHP. The two mosques are connected to the kincir.

Simancuang

Kecamatan: Pauh Duo
Kabupaten: Solok Selatan
Distance to PLN-grid: 6 km

Proposed Capacity of MHP: 20-25 kW

Planned to be connected

Households: 183
Schools: SD, SMP
Health Centers: 1 Pustu
Religious Building: 0
Productive Use: 8 kiosks

Not planned to be connected (in access-area)

Productive Use: 7 rice mills, 4 carpenter (on demand)

Remarks: SD has a genset. SMP does not have electricity. One mosque has a genset.

Sungai Aro

Kecamatan: Koto Parik Gadang Diateh
Kabupaten: Solok Selatan
Distance to PLN-grid: 0 km

Proposed Capacity of MHP: 25-30 kW

Planned to be connected

Households: 37
Schools: SMP
Religious Building: 1
Productive Use: 1 kiosks, 1 soja mill

Sungai Keruh

Kecamatan: Sangir Balai Janggo
Kabupaten: Solok Selatan
Distance to PLN-grid: not in immediate vicinity ("micro grid" from palm oil plantation nearby)

Proposed Capacity of MHP: 20 kW

Planned to be connected

Households: 70
Religious Building: 0
Community Center: 2
Productive Use: 3 kiosks, 1 carpenter, 1 womens bakery

Not planned to be connected (in access-area)

Already electrified households: 238 (mini grid)

Remarks: The village is surrounded by a huge palm oil plantation. In one part of village there are also households of plantation workers which are connected to a mini grid that is operated by the plantation company.

Tanjung Durian

Kecamatan: Sangir Jujuhan
Kabupaten: Solok Selatan
Distance to PLN-grid: 1 km

Proposed Capacity of MHP: 15-20 kW

Planned to be connected

Households: 81
Schools: SD
Health Centers: 1 Posyandu

Religious Building: 0
Community Center: 3
Productive Use: 3 kiosks, 2 rice and coffee mills

Not planned to be connected (in access-area)
Productive Use: 2 carpenter (on demand)

Remarks: The access road is in a bad condition and can only be used by motorcycle. The SD only offers classes for 1st and 2nd grade. Today they use a genset. The musollah has a solar panel. The kiosks uses gensets.

Tanjung Nan Ampe

Kecamatan: Koto Parik Gadang Diateh
Kabupaten: Solok Selatan
Distance to PLN-grid: 1 km

Proposed Capacity of MHP: 20-25 kW

Planned to be connected

Households: 73
Religious Building: 2
Productive Use: 5 kiosks

Not planned to be connected (in access-area)

Productive Use: 2 koffee mill (itinerant), saw mill

Remarks: The mosques have one solar panel from a governmental program each. One is broken.

Annex 2

Survey Tools

Soft copies of the following documents are available on request.

T 1 Household Questionnaire

T 2 Community Questionnaire

T 3 Health Center Questionnaire

T 4 School Questionnaire