Microenergizing Zanzibar

A field study about the basic needs, energy consumption habits and energy expenses of 47 rural interviewees in Zanzibar

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draft

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1. General Geographical Information about Zanzibar

Zanzibar consists of two main islands, Unguja and Pemba and some 50 smaller islands surrounding the archipelago. The population of Zanzibar is about 984,625 people. The majority of people inhabit the capital Stone Town. Many of the rural people prefer the fertile Northern section of the island, while the East Coast has coral rag and provides popular beaches and holiday destinations. Decades before the European colonization reaches Eastern Africa, Zanzibar was under strong influence from Arabic peninsula, Arabic tradesmen dominated the spice and slave trade from here. Today, Zanzibar is a semi-autonomous republic and federal connected with the mainland Tanganjika. 95 % of population are muslims; 5 % christians and hindus. The Zanzibar Islands are connected to the main lands national grid and electricity is available almost everywhere on the main islands but the reliability of grid supply is very bad due to the national energy crisis. In 2008 there was a complete 3 months breakdown of grid supply.

Languages:	Swahili, English, Italian, Arabic
Population:	984,625
Capital city:	Stone Town (also known as Zanzibar Town)
Currency:	Tanzanian Shilling
People:	Native African, Arabic, and Indian
President:	Amani Karume
Government:	Republic
Religion:	Muslim (95%), Christian and Hindu (5%)
Climate:	Hot and humid
Average Temp:	25ºC
Major Industries:	Tourism, Spice, and Fishing

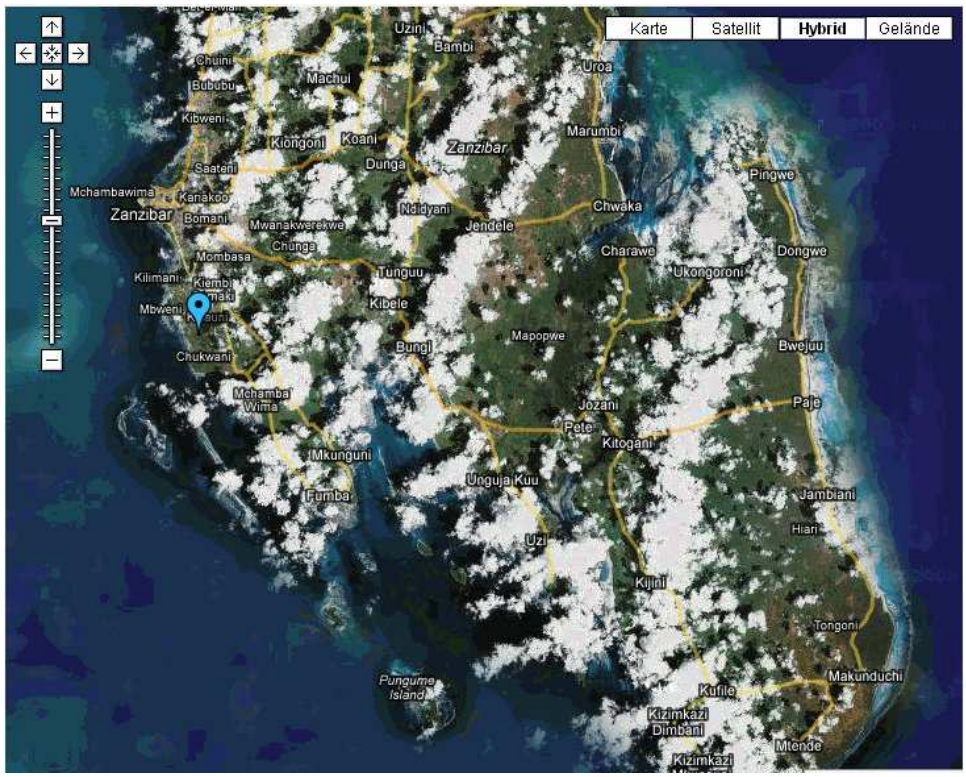

Figure 1 a: Satellite map of Zanzibar. A plotted research locations are only Chukwani (left, in the middle) and the Bububu ward (left, above).

[Sources: http://www.encounterzanzibar.com/general_info.htm; http://www.tanzania.go.tz/census; http://allafrica.com/stories/200806040501.html]

2. Overall Information about the Study and Researched Areas

This study aims to draw a picture about the living conditions regarding energy supply of rural population in Zanzibar. The findings shall provide a basis for developing a microcredit scheme for financing renewable energy systems for rural households. Therefore the results of this study do not fulfill strict scientific framework for postulating thesis. It is presenting assumptions, basing on descriptive statistics of 47 interviews with rural inhabitants out of a about 450.000 population of the 5 districts where the study was executed. The study was guided by the following main hypothesis:

Which down payments and installments for Solar Home Systems (SHS) loan rural clients could afford to pay?

How much is the cost saving potential if SHS replace established energy resources, especially kerosene?

Which are unsatisfied basic needs connected to energy supply?

How is the detailed local demand for energy?

Who are the local available lenders for private or business loans?

Are there opportunities for the business use of energy, especially electricity and mini grid?

The interviews were carried out by the German and Tanzanian volunteers Hannah Uckat, Hassan Omar , Kona Juma and Helge Eberbach from the NGO German-Tanzanian Partnership from February – August 2008; the areas were 17 villages in the Zanzibari districts Urban West, South Unguja and North Unguju. The villages and the overall context are described in the following table 2 a:

town/village	**ward**	**type**	**male**	**female**	**total**	**number of hhs**	**hh average size**	**district name**	**district total population**
bububu mkoroshoni, mwanyanya , mzambarauni	bububu	mixed	6.297	6.830	13.127	2.622	5,00	urban west	184.710
cheju chuchumile, ilisomanga, mgeni nani, risomanga	cheju	rural	876	701	1.577	342	4,60	south unguja	62.537
chukwani	chukwani	mixed	2.198	1.936	4.134	822	5,00	urban west	184.710
donge mtambile	donge mtambile	rural	1.440	1.581	3.021	590	5,10	north ungujua 'b'	52.605
ndijani mseweni, nyambiza	ndijani	rural	2.070	1.987	4.057	814	5,00	south unguja	62.537
nungwi banda kuu, hgagadu, kendwa mshangi, kiungani, mgagadu, mjikati, mwanda	nungwi	rural	3.883	4.033	7.916	1.705	4,60	north ungujua 'a'	84.348

Table 2 a: Integration of researched areas in the regional and national administrative context.

3. A Short Personal Introduction of the Interviewees

During the first half year of 2008 and beside their daily duties the four volunteers were traveling around in their operational area and ask several people for an interview. The choice of interviewees was done by the volunteers with the guiding idea to interview individuals who may represent potential customer groups for a household based energy supply. If most possible, the volunteers task was to address only the heads of rural households (or at least her/his standby) – so that she/he can draw a whole picture of typical rural daily life regarding energy.

This resulting 'sample' of 47 interviews is relatively balanced, 47% are female, 53% male. More than three quarters of them are married, 17% single and 4% widowed. The age structure clearly concentrates on the 3 clusters: 21 to 30 years, 31 to 40 and 41 to 50 years. Almost three quarters of all interviewees belong to it as in figure 3 a shown:

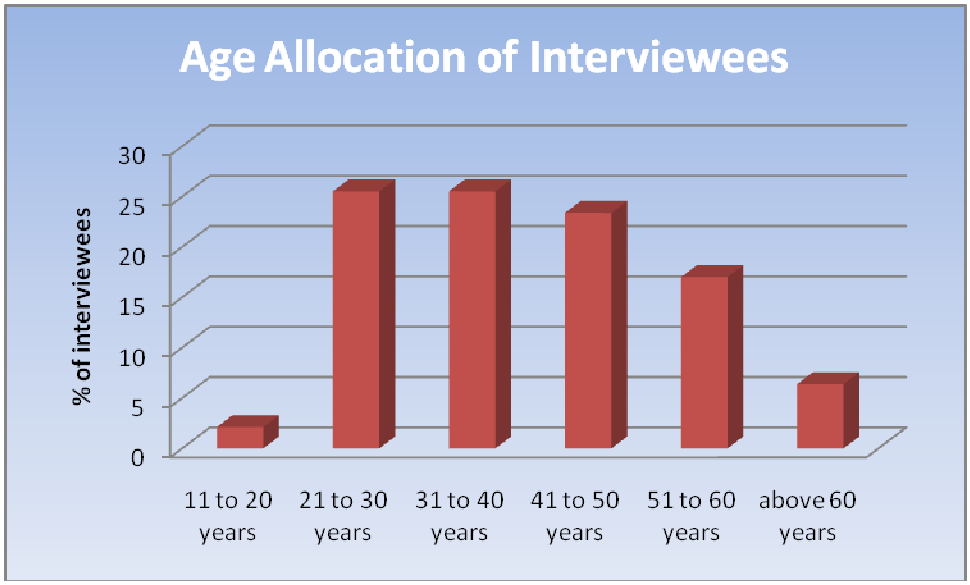

Figure 3 a: Percentages of interviewees in six age clusters

The interviewees preside over a rural household with mostly 5 to 8 persons:

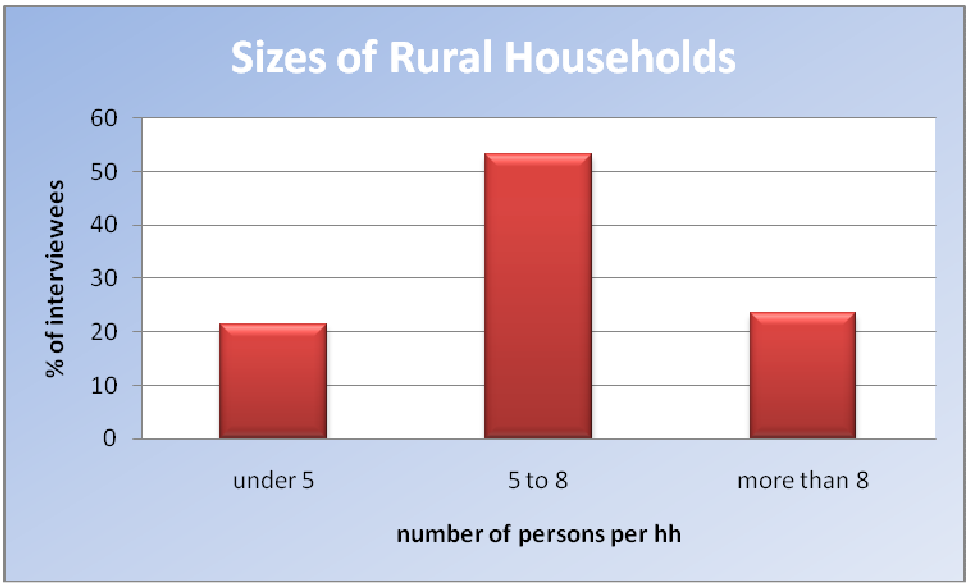

Figure 3 b: Number of persons living in the interviewees household and percentage of namings.

Because the maximum of interviewees were in the 'fertile ages' and married, around 70 % have between 2 and 8 children, two of them are attending school:

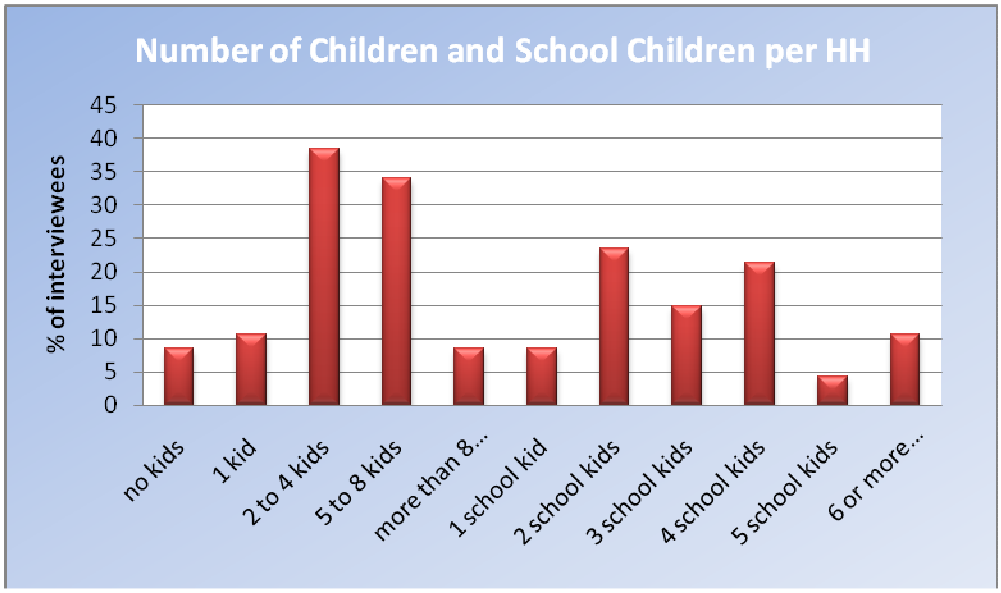

Figure 3 c: Number of kids and number of kids attending school and percentages of interviewees

Furthermore 23% of the interviewees are taking care of 1 to 2 other, especially older family members, 6% are even taking care of more than 5 family members.

Coming up to the private equipment for life, 36% of rural households have an direct water access. Most of 64% remaining interviewees are forced to spend 1 to 4 hours daily to go fetching water for the household:

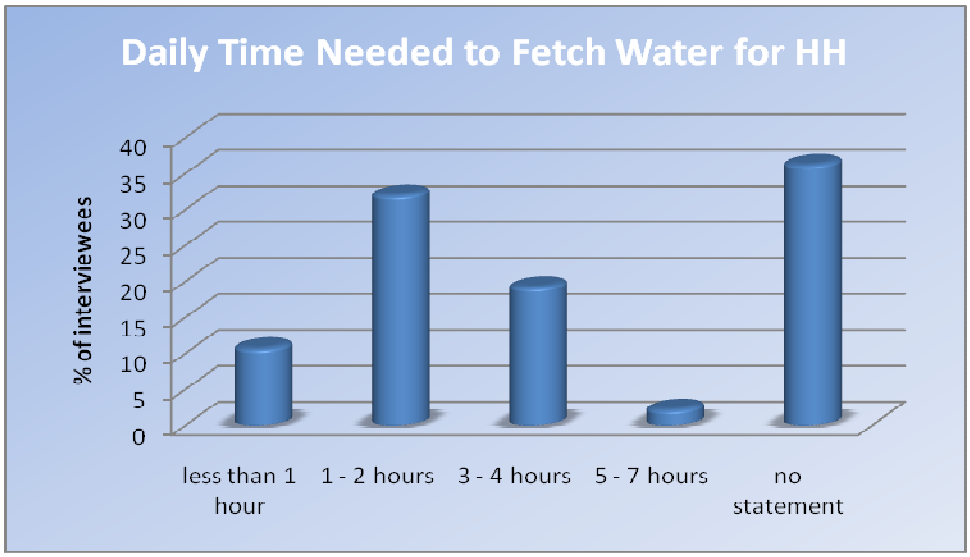

Figure 3 d: The daily time needed to fetch water and percentage of statements.

These amounts of daytime are spent mostly by the spouses and the children:

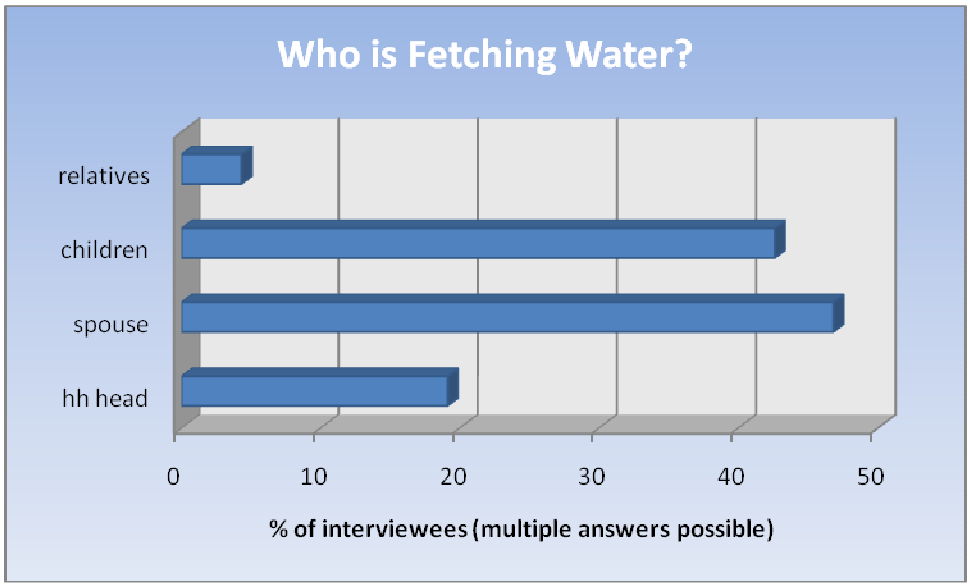

Figure 3 e: Percentages of named persons who are fetching water.

Water for household consumption is purified for drinking by boiling by only 40% of interviewee's households. Thus it can be assumed that water situation should be considered for renewable energy project. Opportunities should be reviewed that renewable energy can be utilized for water pumping. The easiest way can be rainwater collecting by water tons and rain pipes on corrugated metal sheet roofs. Pumping can be done mechanical or electricity driven. An answer to the important question of water purifying can be relatively small solar thermal assets.

The volunteers were also requested to evaluate each interviewee's house as shown in figure 3 f:

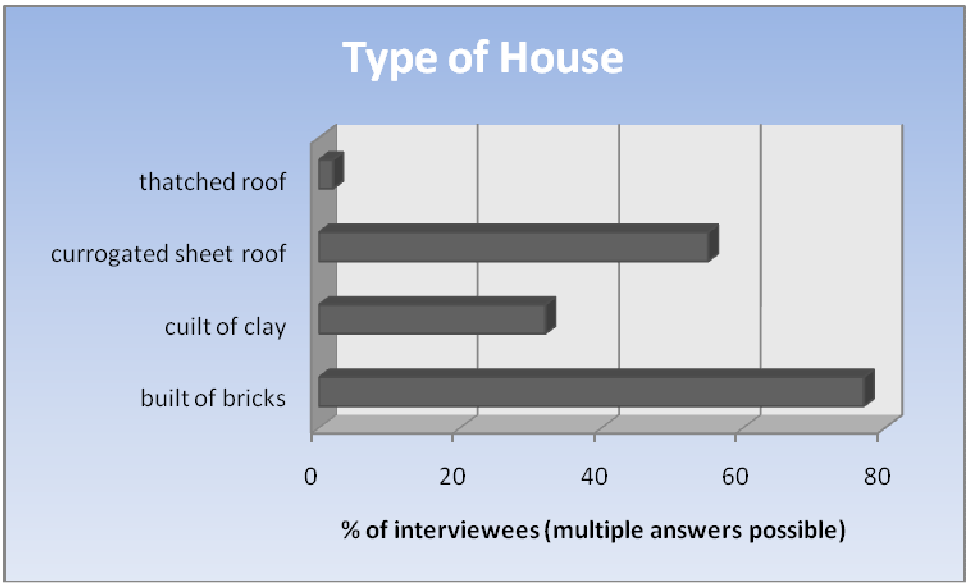

Figure 3 f: Evaluations of the volunteers for each interviewees house

4. Economic Situation of Rural Households

It seems that the majority of interviewees' households count on classical rules of a patriarchal society. Therefore the financial power of the household is clearly dominated by men. As shown in the figure 4 a, most of households' income earners as well as major income earners are male.

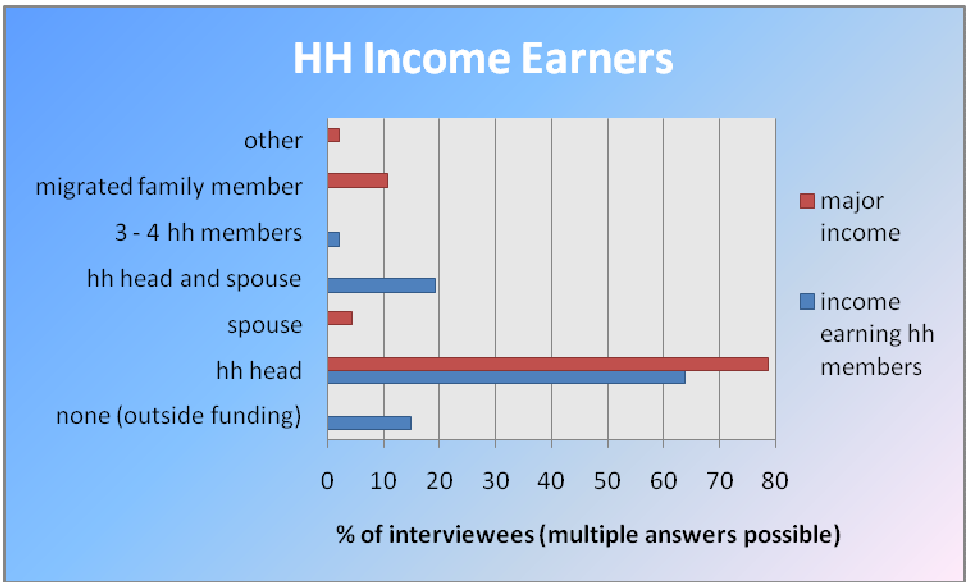

Figure 4 a: Income earners and major income earners of rural households and their percantage of namings.

This trend is shown even more distinct if you consider the question of the financial responsibily in the household: almost 90% of interviewees name the household head as in duty of this task.

The main income source of rural households is agriculture but short followed by self employment:

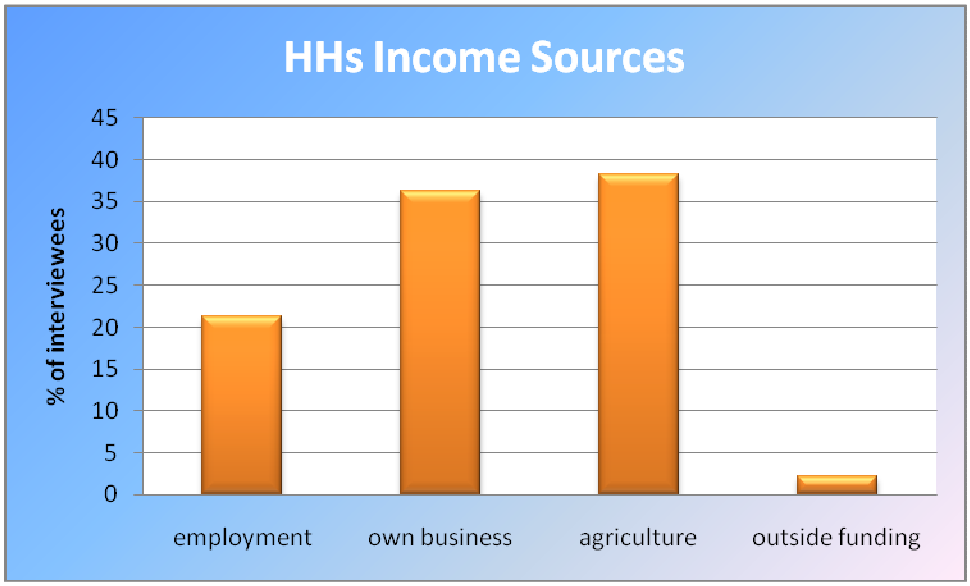

Figure 4 b: Named income sources of rural households

The open question for the type of income generating business was answered by the 47 interviewees with a small range of businesses:

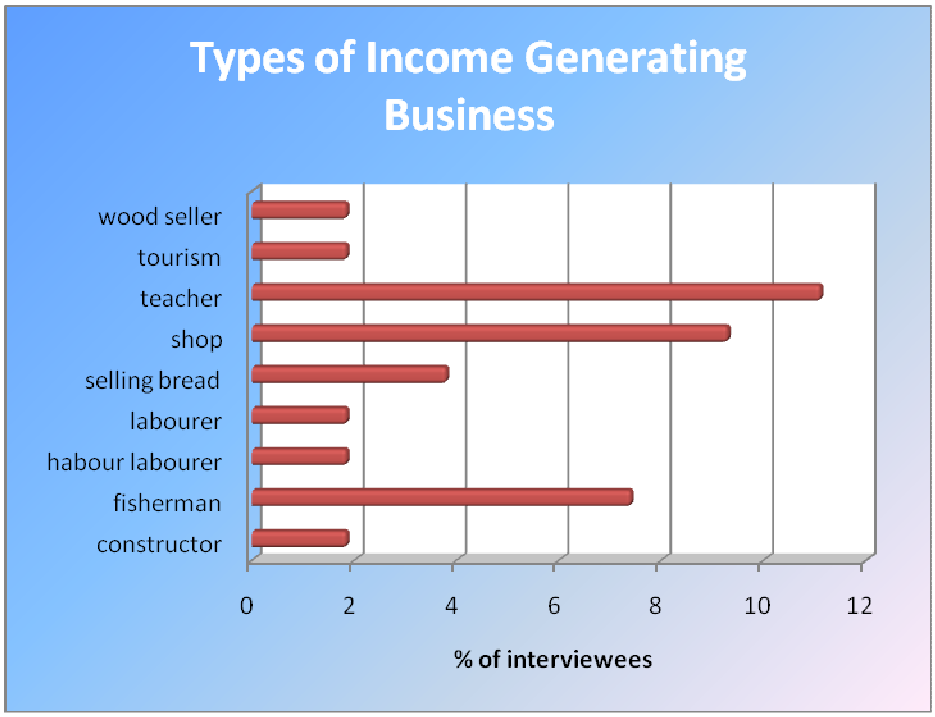

Figure 4 c: Specifications of interviewees about their household income sources

Although the list presented in figure 4 c does not show a business type with a direct connection to energy supply as productive business would do 19% of interviewees replied that they would use energy for income generating business:

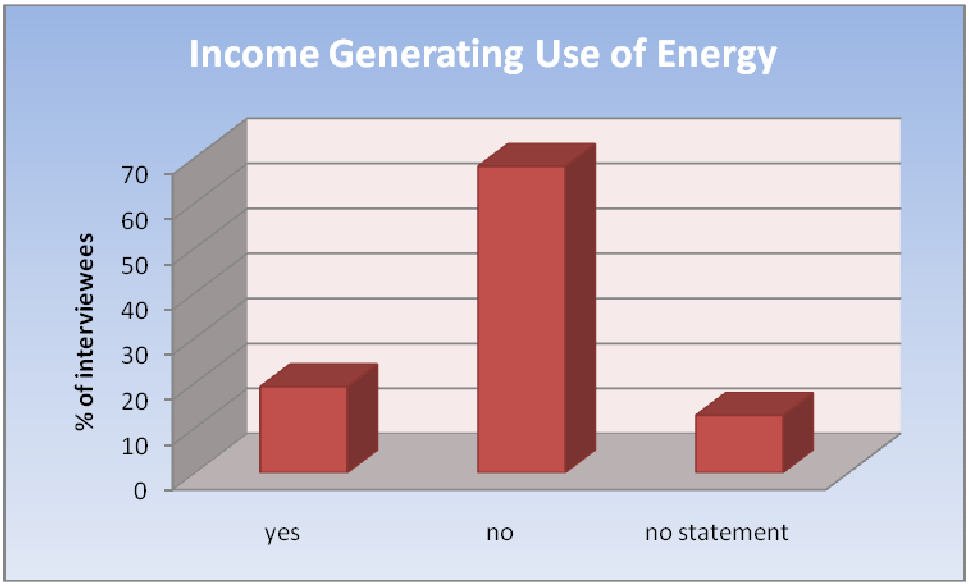

Figure 4 d: The interviewees' replies on the question how they would use energy.

Another link between the economical respectively financial situations of households and energy is presented in the figure 4 e. While 85% of interviewees label their income situation as 'inadequate' the willingness to pay monthly fees for electricity is higher. About 17% of the interviewees with inadequate income would pay 10.000 to 30.000 TSh. per month. This leads to the assumption that energy supply is recognized as an essential basic need from the customers side. The provider of energy supply should keep in mind that income generating aspects of energy systems are always a key point for rural customers.

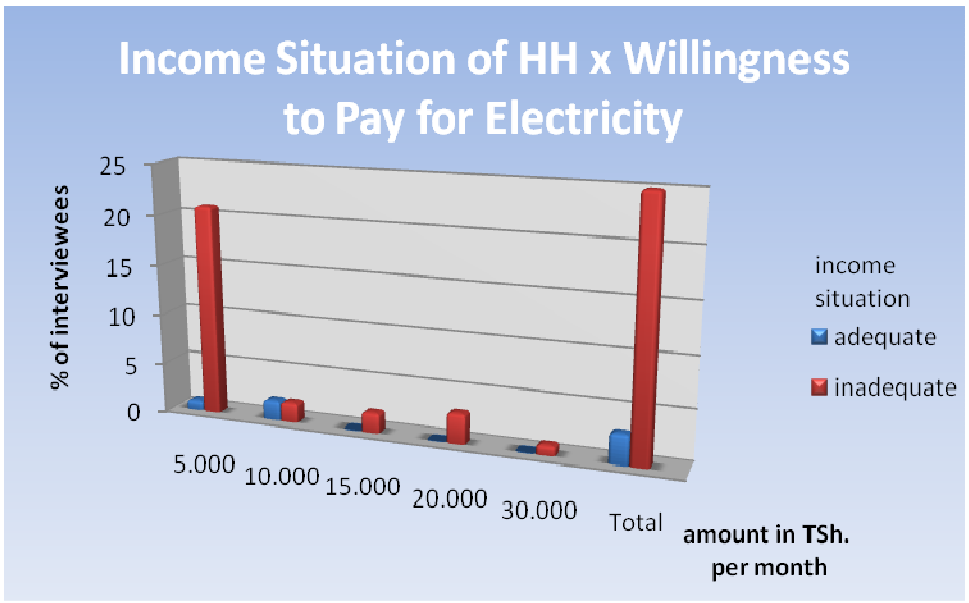

Figure 4 e: A cross tabulation of the variables income situation and willingness to pay for electricity.

4.1 Loans and Savings of Rural Households

As it is typical for sub-Saharan rural areas the self sufficient economy plays a crucial role. Around 74% of interviewees said that they grow their food at least partially on their farm. However, having the ability to save money and to get a loan is crucial for economic subjects, foremost when they are connected to the inter-regional outside world. The figure 4 f lists the amounts of savings the rural interviewees reported.

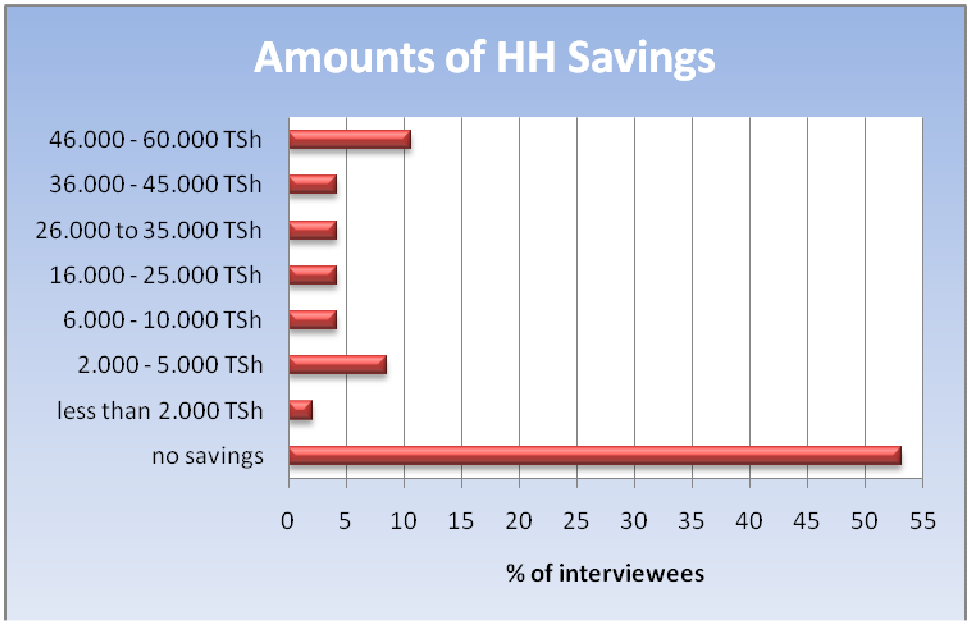

Figure 4 f: Amounts of savings and the percantage of mentions by interviewees

Around 20% of interviewees have savings from 26.000 to 60.000 TSh. This can be seen as indication for the bigger investments rural interviewees are able to do. In a microfinance scheme with down payments and constant installments for a renewable energy system the savings can indicate possible amounts for down payments.

In many cases of a technological innovation reaching the broader market this change is pre-financed by customer loans. The figure 4 g shows loan amounts the rural interviewees got from different lenders (compare figure 4 h).

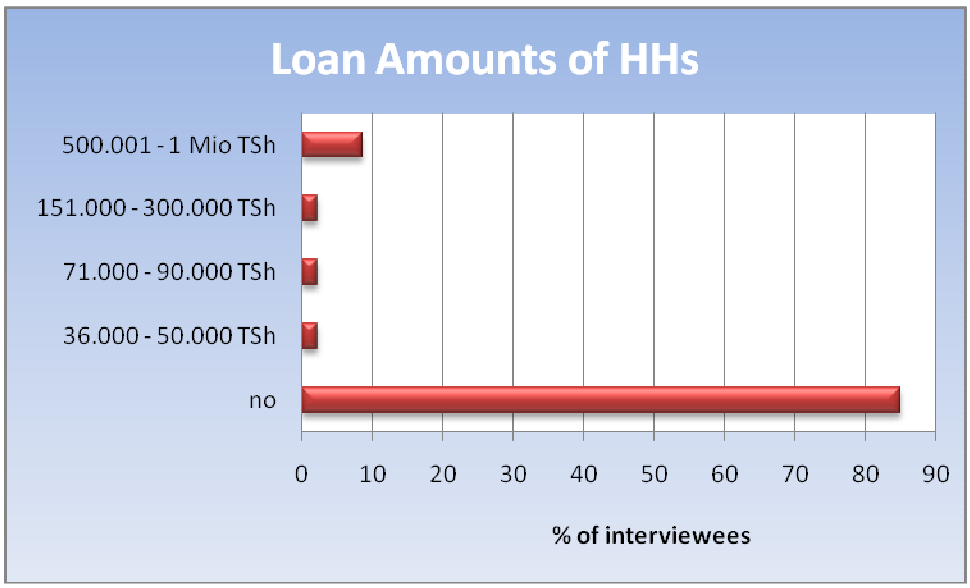

Figure 4 g: The loan amounts of 15% of rural interviewees.

About 15% or the interviewees got a loan. Almost 9% got a loan with a range from 500.000 to 1 million TSh. This range reaches the prices for smaller to medium sized Solar Home Systems (compare chapter 8 'Conclusions'). Most borrowers got their loan from formal lenders:

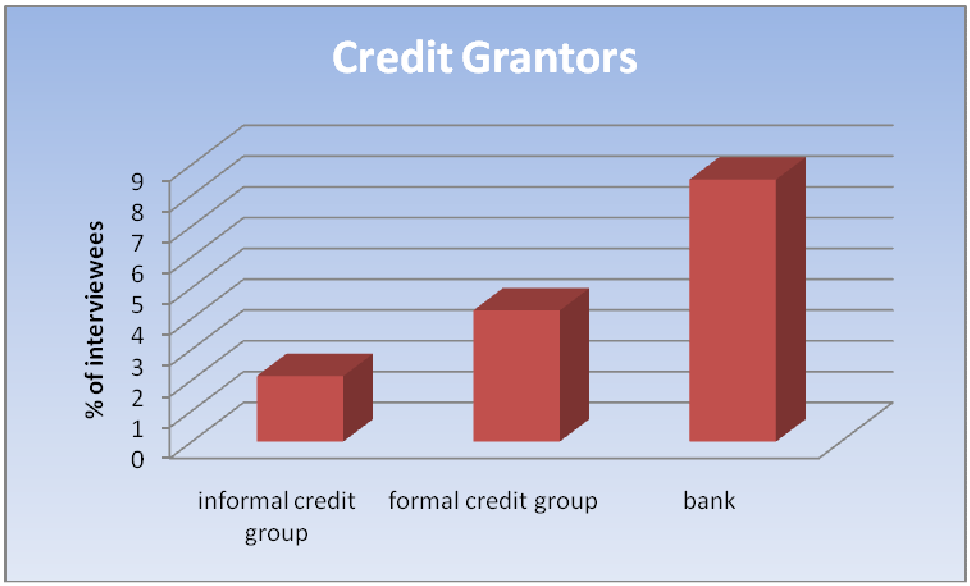

Figure 4 h: Informal and formal loan grantors of rural interviewees

Two thirds of borrowers already managed to pay back. The loans were used mainly used for constructing or complete the house:

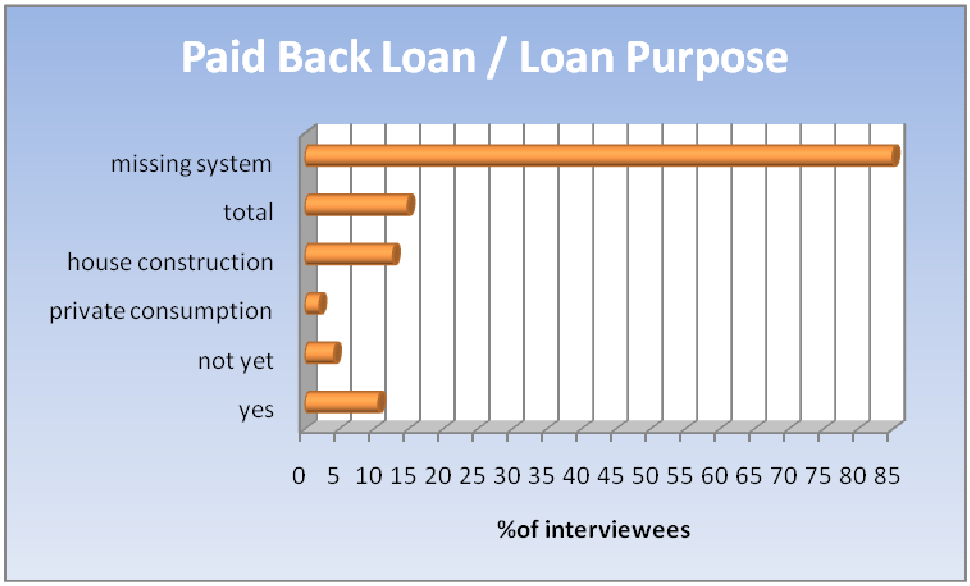

Figure 4 i: Purposes of interviewees to raise a loan

5. Rural Households Energy Consumption

5.1 Cooking

The main energy consumption of rural households in off grid or underserved areas in the sub-Saharan Africa consists of energy for cooking. This is quite obvious in areas with no energy infrastructure. The wide-spread use of simple stoves and herbal biomass for cooking and together with the population growth during the last 40 years created serious consequences like deforestation, soil erosion and (local and regional) climate change which is destroying agricultural usable land and threatens the primary nourishment.

This use of very simple stoves is also common in the researched areas of Zanzibar. Almost 75% of interviewees are using 3-stone-stoves and 60% of them have a (second) bricked firewood stove without chimney:

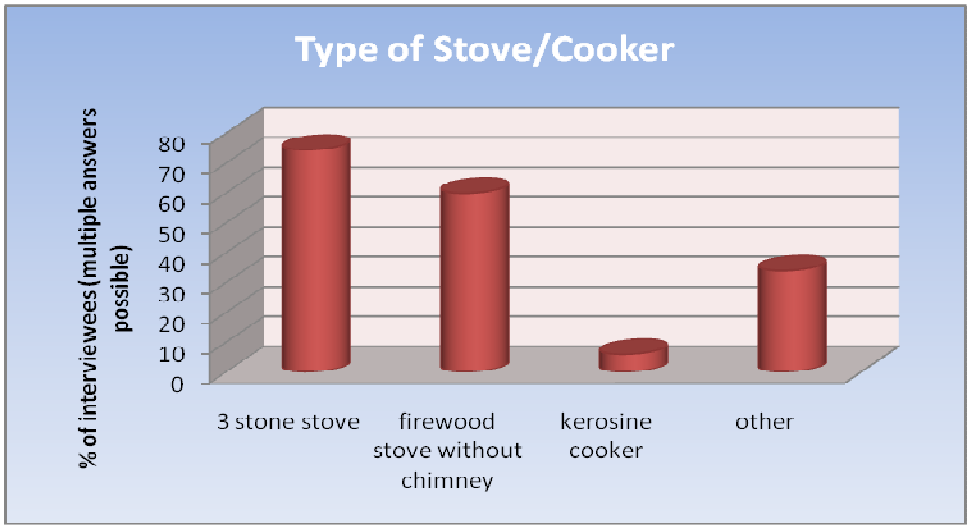

Figure 5 a: Established stoves or cookers used in the researched area of Zanzibar

The energy consumption for cooking is the largest referred to the amount of resources needed to produce it but maybe not if you consider the price for the energy resources as the only value. This is a crucial part of the unsolved problem of rural cooking. In many rural areas biomass, especially wood, is a common good and collectable for free by the rural consumers. In other, especially dense populated rural areas, the situation is changing. Because almost all usable biomass resources became rare in the periphery of settlements and the time needed for collecting extended it changed into a marketable good. Only if this development occurs there can be an opportunity for establish renewable energy systems for cooking. The research in Zanzibar backs the thesis that maybe a change in energy market happens. 28% of interviewees buy their cooking resources, 19% do both and 53% are only collecting the biomass. Collecting resources for cooking saves money but entails other costs as the figure 5 b is showing. It is occupying the time of a quarter of household heads, 56% of the spouses and 21% of children. 66% of all interviewees spend between a half and 3 hours per day to collect biomass.

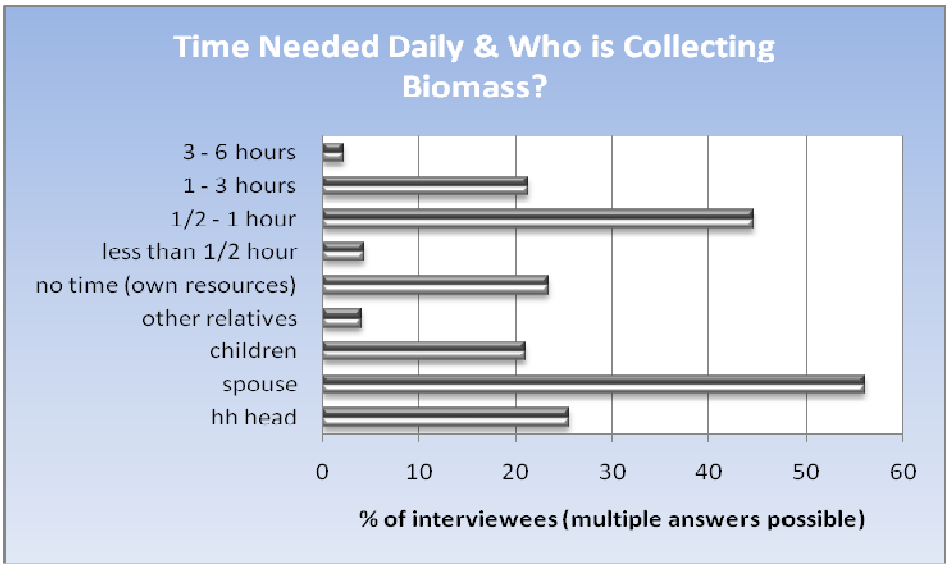

Figure 5 b: A comparison between persons who are collecting the households' cooking energy resources and the times needed daily to collect.

The biomass which is mostly collected consists in 82% of the cases of wood and 2% crop residues. Kerosene is used for cooking by 8,5% of interviewed households and 34% consume charcoal (multiple answers were possible).

5.2 Electricity

Beside the importance of a solution for sustainable cooking energy electricity is the key to give rural areas opportunities for modernization, communication, mechanization and the involved economic potential. It is shown in figure 5 c that the productive use of energy is dominated by grid electricity.

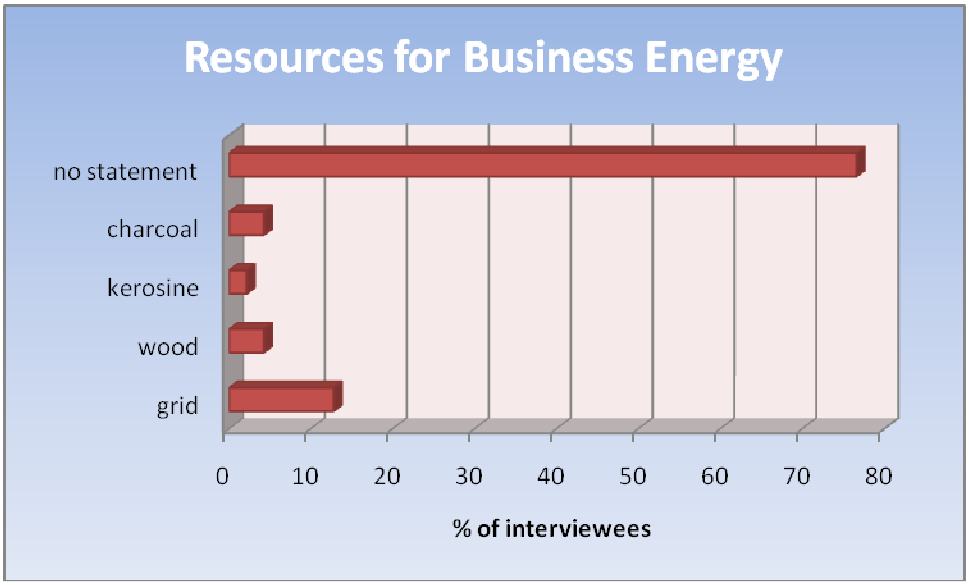

Figure 5 c: Percentages of interviewees with their resources for business energy

The figure 5 d demonstrates the research for alternative electricity sources to the national grid supply. Distinctly there is hardly any user of small diesel generators, rechargeable car batteries for household use or a small electricity supply from neighbor (mini grid).

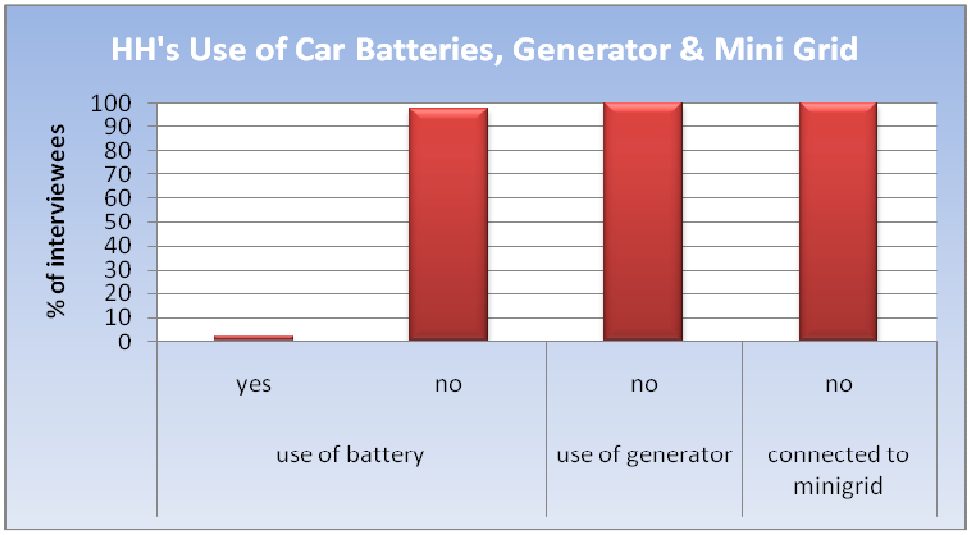

Figure 5 d: Only 1 of the interviewees is using an alternative electric energy resource to grid; a rechargeable car battery

Despite the lack of alternatives to grid supply 43% of the interviewees are convinced that electricity would improve their standard of living as the figure 5 e indicates.

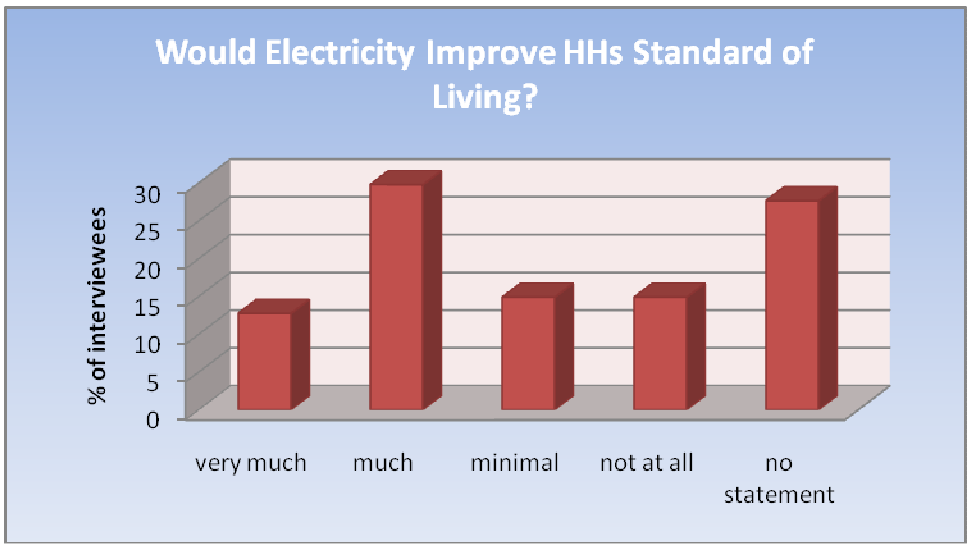

Figure 5 e: Interviewees' opinions about electricity and living standard of their household

Asked the hypothetical question if they would be able to pay for electricity (an access to grid) 45% of the interviewees estimated that they are.

However, 23% of the interviewees have an access to national grid supply. But the energy crisis of Tanzania clearly suggests that grid accesses do less and less compete with decentralized electricity

supply. The Tanzanias' national grid capacity is far overloaded. Keeping in mind the last 3 months complete breakdown of Zanzibars' grid in 2008 the rating of the interviewees regarding the grid reliability is not astonishingly (figure 5 f):

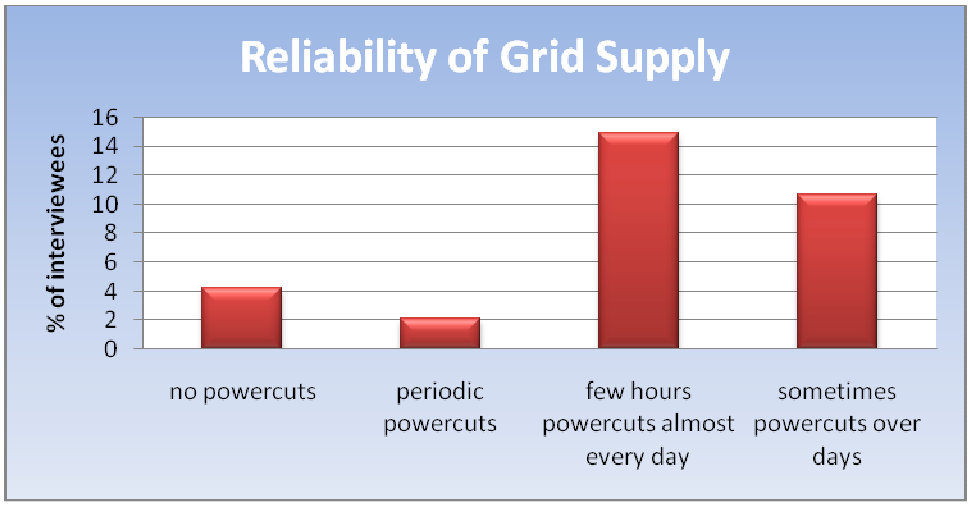

Figure 5 f: Ratings of grid connected interviewees for their supply security

Due to the unreliability of grid the demand for backup systems is very high. An overwhelming majority of grid access owners are demanding it as it is shown in figure 5 g.

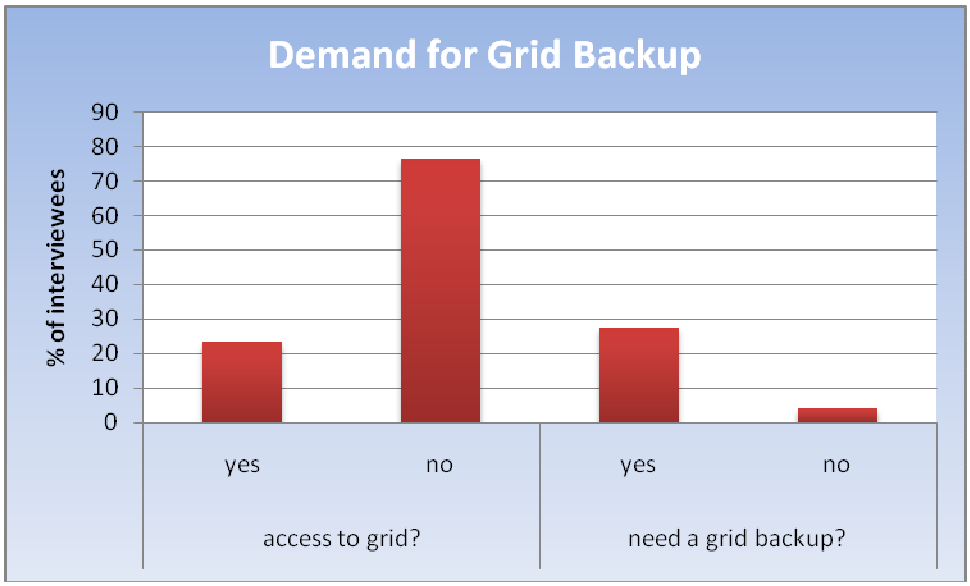

Figure 5 g: Comparison between grid access owners and their notion about a need for grid backup systems.

Although a lot of interviewees are claiming grid backup but the resulting willingness to pay for backup systems is very low. Only 6% would pay between 50.000 and 100.000 TSh, while 21% are willing to pay less than 50.000 TSh and 72% gave no statement.

5.3 Lighting

For lighting their houses 79% of interviewees are using kerosene lamps, 27% electric light and 6% candles (multiple answers were possible). As long as there is hardly any other sufficient source for lighting than electricity and kerosene lamps with relatively high running costs are wide spreaded this remains as a key task for solar home systems in rural areas (compare to chapter 6 'Rural Households Energy Expenses'). Accordingly 53% of interviewees are only minimal or not satisfied by their light supply while 47% are quite or very satisfied.

The question "How would you improve your lighting situation?" was openly asked by the volunteers. But the results are very clear as shown in figure 5 h.

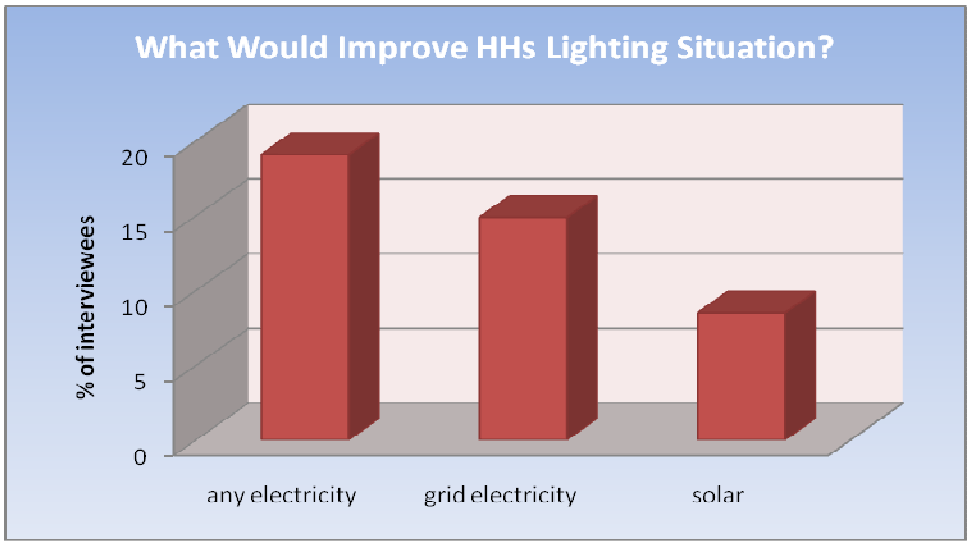

Figure 5 h: The interviewees answers to the open question what would improve the households' lighting situation

6. Rural Households' Energy Expenses

This chapters' task is to illustrate the rural consumers' energy expenses. This is crucial to estimate the potential of the rural energy market. Theoretically, supposed that you divide the high initial investment costs of renewable energy systems into a down payment and periodic payment in installments the actual weekly or monthly energy expenses can be changed into the installments. This requires that renewable energy systems are able to compete with established energy systems (e. g. kerosene lamps), and can replace and modernize them.

The weekly expenses for cooking are described below. According to the 72% of interviewees who collect their cooking energy resources partially or fully (compare to chapter 5.1), 55% have no financial expenses for cooking energy. Anyhow 41% have relatively high expenses of more than 1.000 to more than 2.000 TSh.

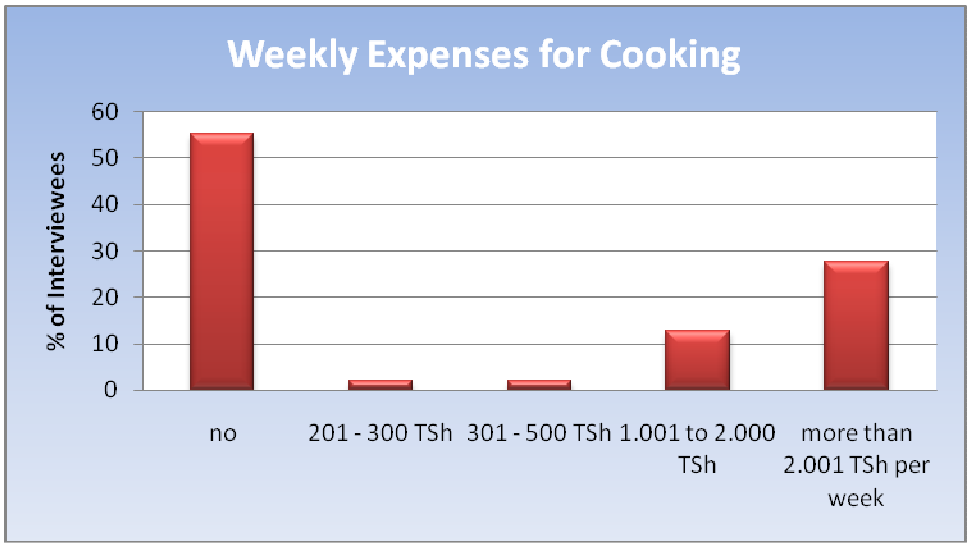

Figure 6 a: Costs of cooking energy of interviewees

Resources for cooking energy does not only may change from a free common good to a commercial good (comp. to chapter 5.1); its price were also increasing during the past 2 years as 53% of the interviewees mentioned (45% gave no statement).

Because the intended Renewable Energy project is focused on Solar Home Systems the direct competitor in the rural energy market of Zanzibar is grid electricity. Most of the 23% share of interviewees who are connected to grid pay between 8.000 and 15.000 Tsh. per month (figure 6 b).

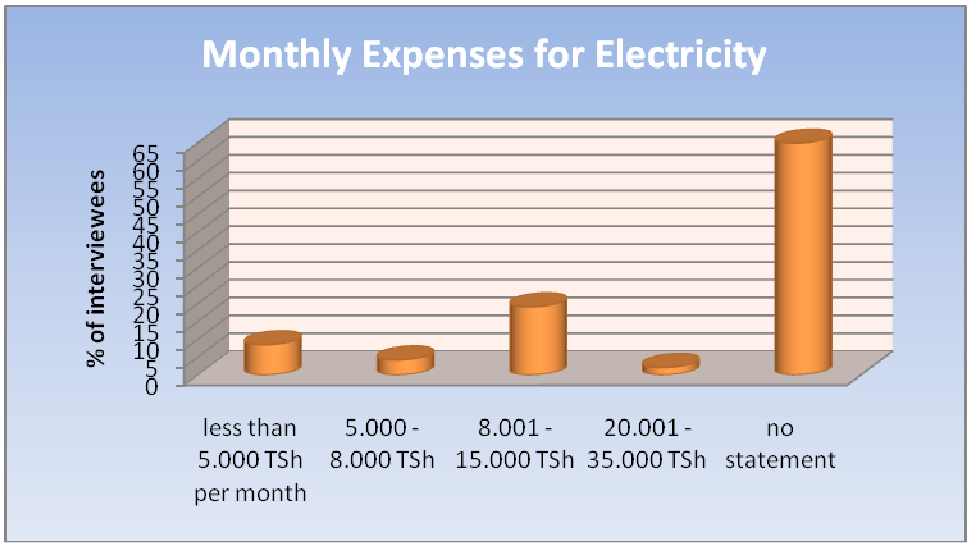

Figure 6 b: The monthly expenses for electricity stated by the grid owners

The amounts of 8.000 to 15.000 Tsh. per month can give an orientation for the amounts of monthly installments for Solar Home Systems (SHS) because these are the current costs for electricity in most of the researched area.

Because 79% of interviewees are using kerosene lamps for lighting their houses, expenses for kerosene are an important item to be replaced with solar energy. The majority of 57% are paying between 501 and 2.500 TSh. for lighting energy as shown in figure 6 c.

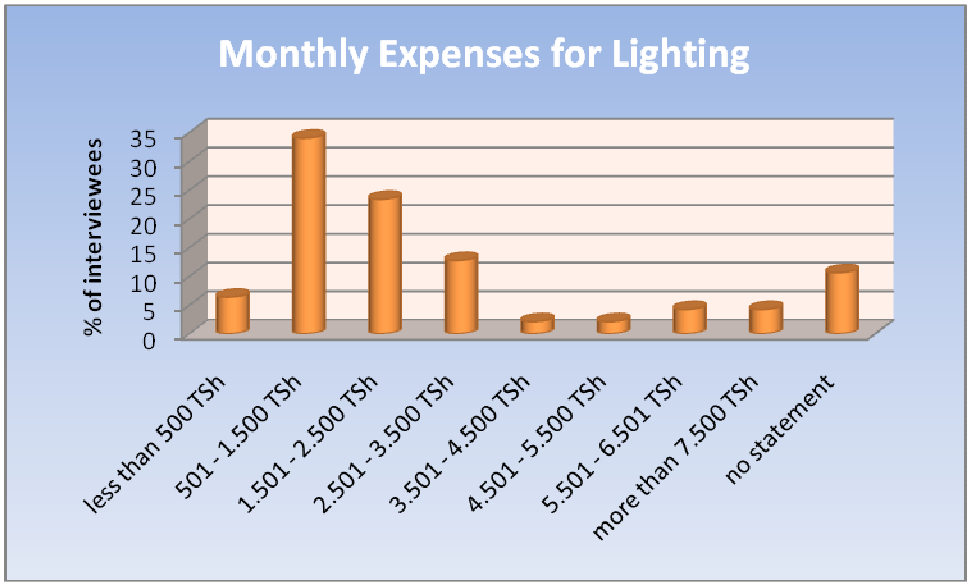

Figure 6 c: The monthly expenses for lighting their houses by the interviewees

7. Electrical Applications of Rural Households

Electricity consumption is not only related to lighting. The individual electricity consumption is much more detailed; it shows a spectrum of different, mostly smaller devices.

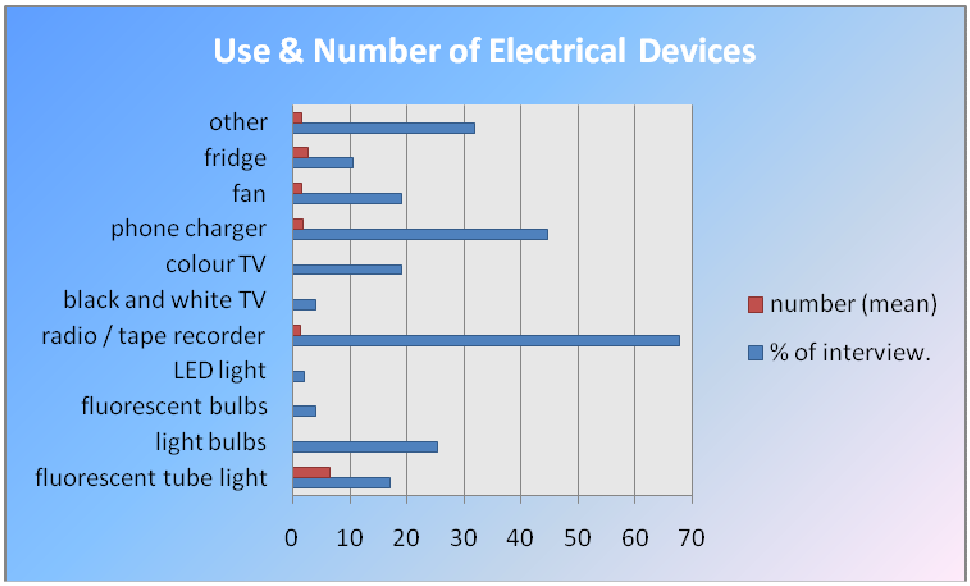

Figure 7 a: The diagram shows a comparison between the spread of several device and the means of numbers of devices each interviewees named.

It is possible to estimate the whole energy needed for supplying a rural household with electricity by correlating the types and numbers of electrical devices with the using times of the devices. This is approximately done in the figure 7 b.

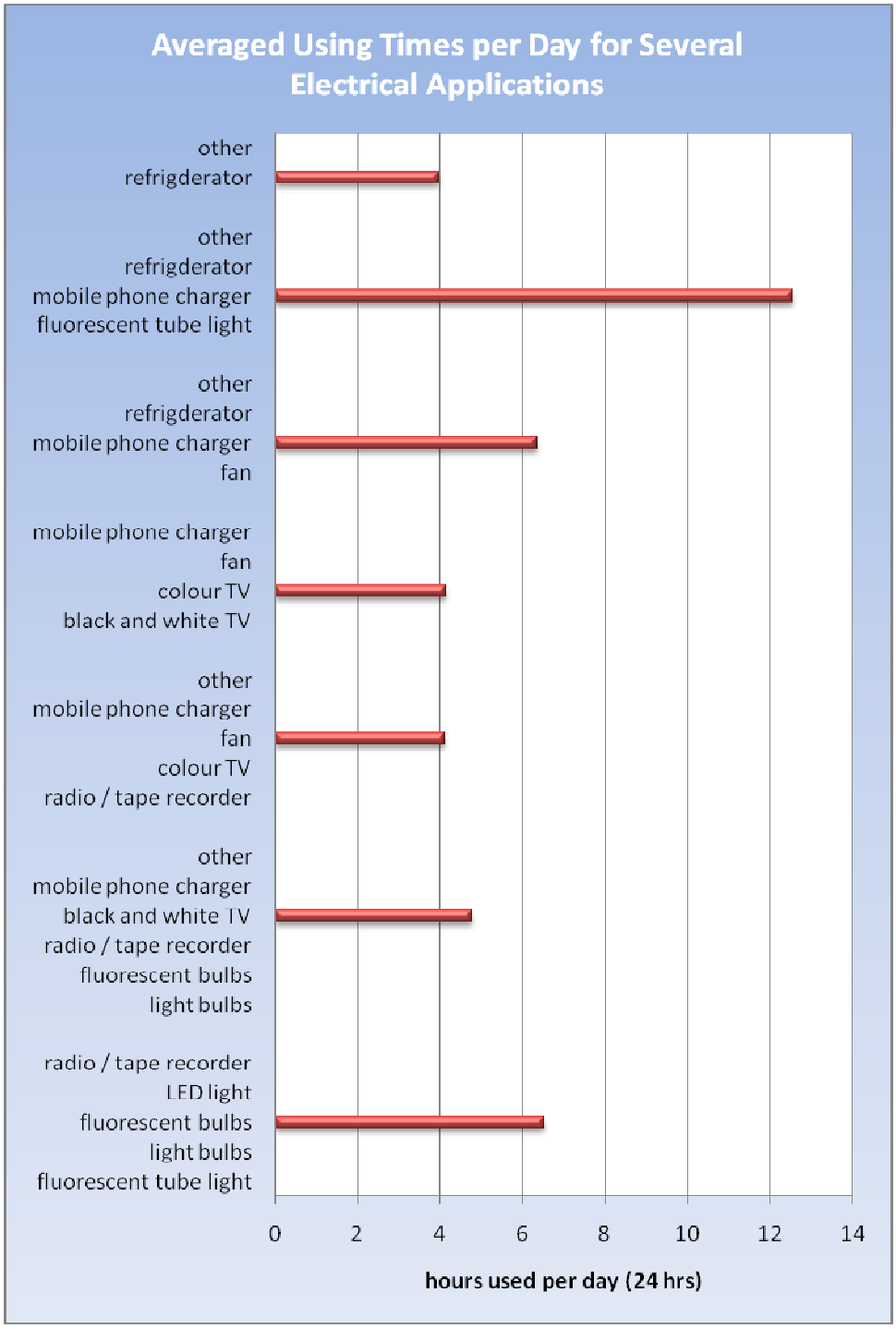

Figure 7 b: Means of using times for electrical devices clustered with the types of devices rural interviewees are using daily

Power outputs (watts) of the several devices could be collected and the means of it could be correlated with the means of the device numbers and using times. This would result in a detailed picture of capacities needed for supplying several rural households.

8. Conclusions

Finally, we should look at the 6 research hypotheses and conclude the findings. The first 2 hypotheses are connected:

Which down payments and installments for Solar Home Systems (SHS) loan rural clients could afford to pay? How much is the cost saving potential if SHS replace established energy resources, especially kerosene?

As we have seen in chapter 4.1, around 20% of interviewees have savings from 26.000 to 60.000 TSh. This indicates the amounts of money rural consumers would invest in bigger and long-term investments. Broken down into a potential microfinance scheme the savings can indicate the amount of down payments rural customers are able to pay.

The full amount of a solar leasing loan (the complete price for a Solar Home System minus the down payment) is implicated by current loan amounts rural interviewees got and were able to pay back. About 15% or the interviewees got a loan, almost 9% with a range from 500.000 to 1 million TSh. A comparison with the wholesale prices for different sized Solar Home Systems of the Tanzanian renewable energy distributor 'Umeme Jua' shows that this is reaching a margin of capital which is needed (table 8 a)

SHS size (watts)	SHS wholesale price from Umeme Jua (TSh.)
14 W	280.000
28 W	475.000
42 W	680.000
56 W	840.000
70 W	1.140.000

Table 8 a: Wholesale prices of different SHS from Umeme Jue (status june 2008)

The market price for electricity in the researched area is defined by the grid because there is hardly any other electricity resource (figure 5 d). Most of the 23% interviewees with grid connection are paying between 8.000 and 15.000 Tsh. per month (figure 6 b). Therefore this range defines the monthly market price for electricity and should be seen as an orientation for the monthly installments for SHS.

Because there is no real alternative energy resource to electricity for a sufficient light supply current lighting expenses, mostly for buying kerosene (chapter 5.3), can be substituted with Solar Home Systems. The majority of 57% are paying 501 to 2.500 TSh. for lighting (figure 6 c). Consequentially, more than the half of interviewees is not or only minimal satisfied by their light supply (chapter 5.3) and

openly asked for their ideas to improve their lighting situation they only reply “electricity” or “solar” (figure 5 h).

Which are unsatisfied basic needs connected to energy supply?

As we found out in chapter 4, a lot of interviewees are classifying electricity as a basic need. Even 17% of the interviewees with an inadequate income situation would pay between 10.000 to 30.000 TSh. per month for an electricity supply. Chapter 3 suggests that the situation with the basic need water is problematic regarding the access to drinking water and its cleanliness. Opportunities for rainwater collecting, water pumping and purifying water with renewable energies should be reviewed.

How is the detailed local demand for energy?

The most fundamental question regarding the rural energy demand in Zanzibar is whether there is a energy market or not. It would be difficult to introduce a new energy product to the rural if resources for producing energy are free collectable, common goods. Regarding cooking energy the study suggests that there maybe happens a change to a commercialization of energy resources; 28% of interviewees buy their cooking resources, 19% do both and 53% are only collecting the biomass. About 41% of interviewees are paying more than 1.000 TSh. weekly for cooking.

About 43% of the interviewees are convinced that electricity would strongly improve their standard of living (figure 5 e). Asked if they would be able to pay for an electricity access, 45% estimated that they are (chapter 5.2). Almost a quarter of the interviewees are grid connected but the overwhelming majority of them are not satisfied with the supply security (figure 5 f). The demand for grid backup system is overwhelmingly but the willingness to pay for it is very low (compare to chapter 5.2). Also the income generating aspects of energy supply is strongly connected to electricity (figure 5 c).

Who are the local available lenders for private or business loans?

Almost all of borrowers (15% of all interviewees) got their loan from formal lenders like banks or financial institutions (figure 4 h).

Are there opportunities for the business use of energy, especially electricity and mini grid?

The diagram in figure 4 c does not show a business type with a direct connection to energy supply but 19% of interviewees estimated that they would use energy for income generating business. There is no sign of small energy entrepreneurs who are using mini grids to supply small number of rural customers.