

# **REEECAP 2.1 RENEWABLE ENERGY** **BASELINE STUDY**

## **Executive Summary**

A baseline survey of renewable energy use was conducted in June and July 2007, with the objective of assessing the prevalence and use of renewable energy technologies amongst a select sample of Namibian rural and peri-urban households. Rather than only considering renewable energy technologies though, the survey also assessed the most prevalent energy sources used, and the monthly expenditure incurred by rural and peri-urban households in select localities in Namibia. The survey also gathered data on the most common services used by unelectrified households, and the associated costs for these services.

Questionnaire-based surveys were conducted in 21 localities across Namibia, focusing specifically on unelectrified rural and peri-urban communities or electrified low-income households. A total of 393 questionnaires were obtained, of which 348 questionnaires were analysed by the DRFN, while 45 questionnaires were rejected due to data inconsistencies. The data is presented on a per household basis, since the total household energy expenditure is regarded more relevant than the per capita energy consumption, which decreases rapidly as more persons live in a household, while not having an influence on the household's total disposable income.

DRFN field facilitation teams interviewed respondents in specific smaller areas within the localities, rather than attempt to survey the localities as a whole. The areas were residential neighbourhoods. The objective of this approach was to minimise the likelihood of diverse respondents resulting in outliers that would skew averages. This might for example occur when conducting interviews near a shop that is frequented by many different residents (poor, middle-class or wealthy) of the location. This does however imply that other members of the location's community were excluded from the survey. The survey results presented in this document therefore provided a snapshot view of a select group of low-income households in rural and peri-urban settlements in Namibia, where the majority of people do not have access to electricity, but rely on numerous other energy sources.

This Summary presents the aggregated findings of all individual data sets compiled during the survey, while the individual data sets per locality are presented in Sections 8 to

29 of this report. The aggregated results should not be regarded as representative of the national situation due to the limited scope of the survey and associated sample size.

Table 1 shows the percentage prevalence of energy sources per appliance for all households sampled. In the surveyed localities, wood, at 54% of the aggregate sample, is still the primary cooking fuel, while paraffin is not a very popular cooking fuel and is rather used for lighting (24%) or freezing (20%). Refrigeration and freezing are common in electrified households (as opposed to unelectrified households that need to rely on other, often more costly, energy sources). Candles remain the most common lighting “technology” and is used by 41% of the sampled group, followed by paraffin and electricity. Other lighting technologies, at 2%, mostly include battery-operated flash lights or torches.

Cell phones, at 30%, are almost as prevalent as radios (at 36%), by far surpassing both TV and Hi-Fi (both at 17%) use. For water heating, wood is the most common energy source followed by electricity. Electricity usage for water heating includes heating water in pots using an electric stove or hot plate, and electric geysers. Similarly, for 67% of the aggregated sample, wood is the prevalent energy source for space heating. The most common fuel to operate a generator is petrol, followed by solar (however, this statistic is influenced by the solar village of Spitzkoppe which has a higher than normal occurrence of this technology and the very small sample size of the RE baseline survey).

Table 1 is best compared with the pie chart in Figure 1, which shows what appliances are most commonly used in households. This demonstrates that all households have certain basic minimum appliances, while others appliances are only used by more affluent households, or only become available if certain energy sources are available, such as electricity. By far the most common appliances are those used for lighting (92%) and cooking (95%), followed by radio and cell phones (collectively). Water heating at 64% of all sampled households is more common than refrigeration and freezing, both at 26% and space heating appliances at 21%. The survey also confirmed the high prevalence of appliances for ironing in rural households, which appears to be an essential household appliance. Of the 46% of sampled households who operate an iron, kettle and hair curlers, 90% used an iron, while only 1% used a kettle.

Table 1 shows two sets of percentages. The first percentage indicates the number of respondents operating a certain appliance (e.g. 26% of sampled households have a refrigerator). The second set of percentages shows what energy source is used to operate a specific appliance (e.g. of the 26% of households operating a refrigerator, 22% use LPG, 8% use ice and 70% use electricity). Electronics 1, Electronics 2 and Other, show appliance type and not energy source.

Table 1: Aggregated prevalence of energy source for a range of appliance types																										
Stove / Cooker 95%							Refrigerator 26%		Freezer 26%		Lighting 92%			Electronics 1 80%												
Paraffin	Wood - Braai	Energy Efficient Wood	Open Fire	LPG	Ethanol Gel	Solar Cooker	Microwave	Electricity	LPG	Ice	Electricity	LPG	Paraffin	Electricity	Paraffin lamp	Candles	Open Fire	Electric Light bulb	Other	TV	Hi-Fi	Radio	Cell Phone			
10%	13%	6%	35%	11%	0%	0%	3%	20%	22%	8%	70%	19%	20%	62%	26%	41%	7%	24%	2%	17%	17%	36%	30%			
Electronics 2 25%					Water heater 64%				Space heater 21%					Generator 9%			Other 46%									
Computer	Hair cutter	Power tools	Fan	Other	Solar	Paraffin	LPG	Wood	Electricity	Paraffin	Wood	Energy-Efficient Wood	Open Fire	LPG	Ethanol Gel	Solar Cooker	Electricity	Diesel	Petrol	LPG	Wind	Solar	Other	Iron	Hair curlers	Kettle
15%	25%	24%	28%	7%	1%	10%	6%	58%	26%	4%	31%	2%	36%	7%	0%	0%	20%	15%	50%	6%	9%	18%	3%	90%	9%	1%

Figure 1: Aggregated prevalence of appliances in households from baseline survey

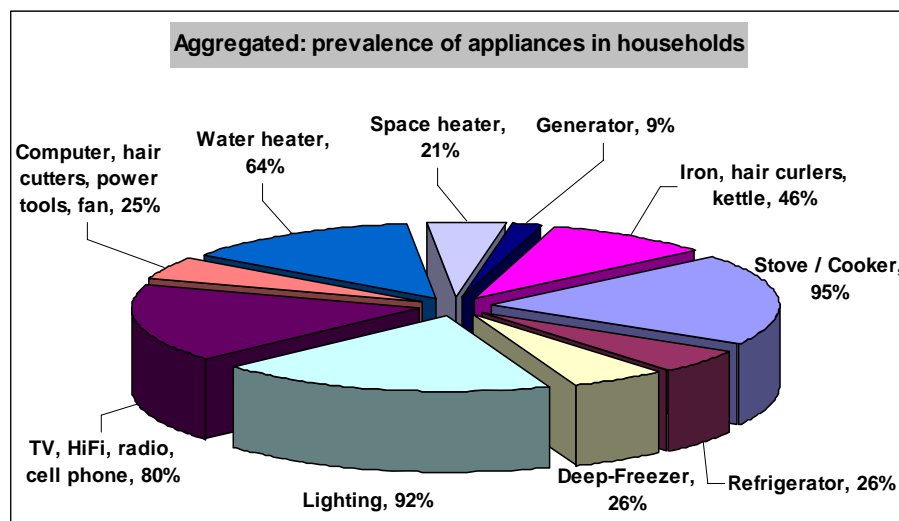


Table 2 compares various energy sources and their most prevalent uses. It is to be noted that many households in the surveyed sample use more than one fuel for any particular use, and the percentage within the columns and rows do therefore not add up to 100%. The data shows that paraffin and candles are fuels used primarily for lighting, while LPG is used mostly for food preparation and water heating. Wood is used extensively for

cooking and water heating, but also for ironing. Charcoal is also an energy source used for ironing, but is not a common fuel for cooking and water heating. Electricity generated by diesel, petrol or solar powered devices, is used for lighting, TV, radio, Hi-Fi and power tools (if sufficient power is available). Plastic is used as a substitute for wood fuel in very poor households.

<b>Table 2: Energy sources and their respective uses</b>															
	Paraffin	LPG	Wood	Lead Acid Battery (12V)	Candles	Dry Cell Batteries (1.5V)	Diesel	Petrol	Ethanol Gel	Solar Electricity	Plant Material	Charcoal	Dung	Old building materials	Plastic
Food Preparation	14%	18%	76%	0%	1%	0%	0%	0%	0%	0%	4%	0%	0%	3%	17%
Room Heating	1%	1%	4%	0%	2%	0%	0%	0%	0%	0%	0%	1%	0%	0%	2%
Lighting	36%	1%	4%	1%	57%	1%	1%	1%	0%	1%	0%	0%	0%	0%	0%
Water heating – laundry	2%	2%	32%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	4%
Water heating – bathing	6%	7%	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	7%
Refrigerator	0%	6%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Freezer	1%	5%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Generator	0%	0%	0%	0%	0%	0%	1%	5%	0%	1%	0%	0%	0%	0%	0%
Torch / flashlight	0%	0%	0%	0%	0%	19%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Radio	0%	0%	0%	7%	0%	38%	0%	0%	0%	2%	0%	0%	0%	0%	0%
HiFi	0%	0%	0%	2%	0%	3%	0%	1%	0%	2%	0%	0%	0%	0%	0%
TV	0%	0%	0%	2%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%
Power tools	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Ironing	0%	1%	16%	0%	0%	0%	0%	0%	0%	0%	0%	18%	1%	0%	0%

Figure 2 shows the penetration of different fuels in Namibian rural and peri-urban low-income households surveyed in this project. In the surveyed sample, reliance on wood is very high (84%), followed by candles (59%) and dry-cell batteries (47%). 43% of the surveyed households use paraffin, and 24% use LPG. Plastic is a source of fuel in 21% of the surveyed households. The remaining fuels are far less common, except charcoal (18%), and are confined to far fewer users.

**Figure 2: Percentage energy source usage**

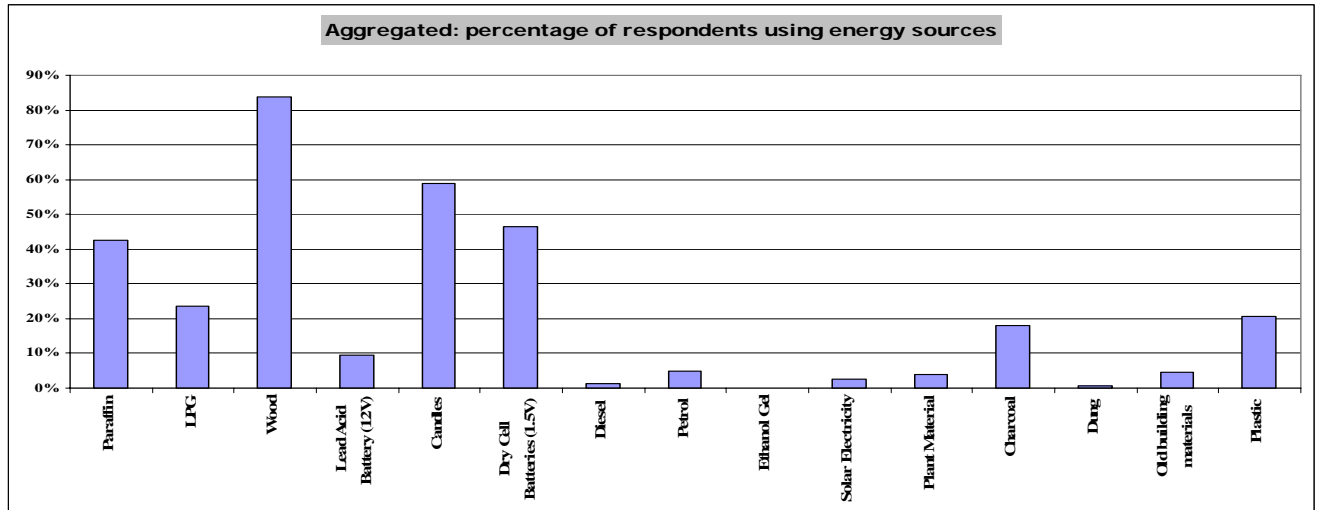
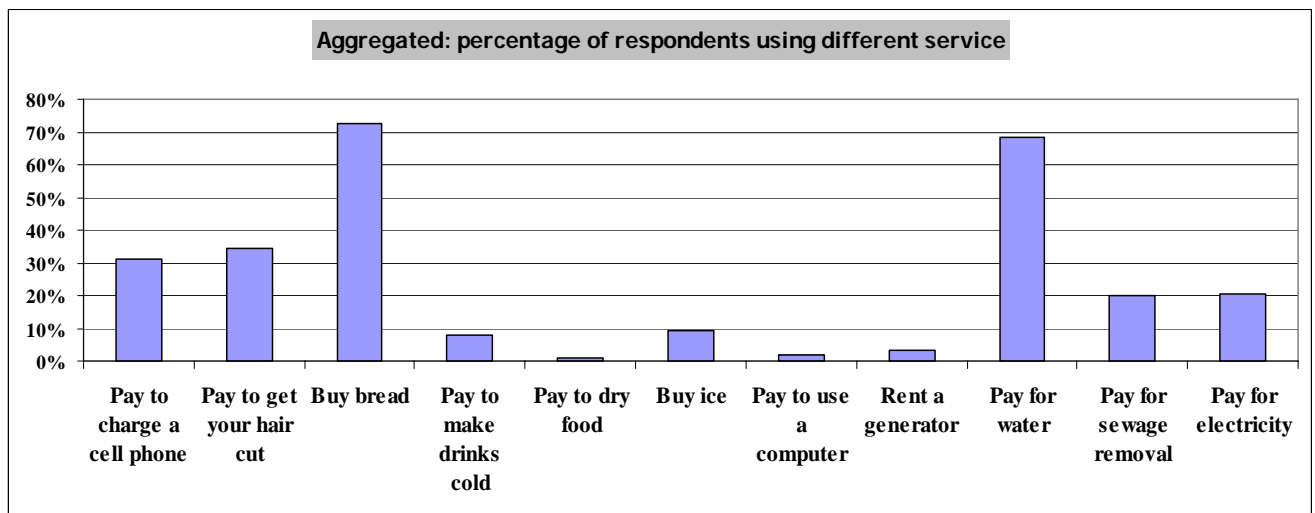


Figure 3 shows the most frequent services that households procure. This expense is in addition to purchasing energy sources. The result serves to highlight the additional expense that unelectrified low-income households incur to satisfy their basic energy needs. The phrasing “*Pay to .*” is extracted directly from the survey questionnaire, where the question was “*Do you pay to ...?*” (refer to Appendix A). Of all respondents surveyed, only 20% have access to electricity and pay for this service, while 69% pay for water on a regular basis. In aggregate, over 30% of all respondents report that they pay to charge their cell phones (the average amount is N\$ 5.76 per charge), while the remaining 70% either charge their phones for free at home, friends or work or do not have a cell phone. Similarly, 34% of respondents pay for having a hair cut (at an average cost of N\$ 21.43 per cut) with remainder obtaining this service for free. Over 70% buy bread (at an average cost of N\$ 5.98 per loaf) rather than baking their own or not eating bread at all<sup>1</sup>. There is a low prevalence of hiring generators (at 3%), but the average cost to hire per day is relatively high at N\$ 132.08<sup>2</sup>.

<sup>1</sup> This indicates the scope of operating small-scale rural-based bread bakeries, preferable with a low running cost technology such as a solar box cooker.

<sup>2</sup> This result merits an investigation into the feasibility of offering mobile solar-operated electricity generators for hire.

**Figure 3: Percentage of respondents using different Services**



Figures 4 and 5 show the monthly fuel and service expenditures (respectively) for households using the specific fuel and service. The figures comprise three bars for each fuel and service:

1. **Average:** indicates the arithmetic mean value of all individual sample values. As a result of the considerable spread of the aggregate sample, an average value in isolation may not offer a representative value for the aggregate sample, and is therefore best read in conjunction with the standard deviation and median of the sample.
2. **Median:** indicates the actual individual sample value “in the middle” of the entire sample set ordered from low to high values<sup>3</sup>. The lower the median is to the arithmetic average of the data sample, the more the average is skewed by (sometimes only a few) very high values in the data set.
3. **Standard deviation:** is a measure of the spread of the data set about the average value, and is an indicator of how variable or dispersed the data is. If the standard deviation is small and less than the average, it indicates that individual sample values are closer together. If the standard deviation is large and more than the average, it indicates that the individual samples cover a wide spectrum with low minimum and high maximum values.

Figure 4 shows average and median fuel expenditure of the sampled households, as well as the standard deviation of the aggregated data set. It is noted the two fuels with significant variance are paraffin and petrol. Monthly household expenditure for paraffin varies significantly, while the median is N\$ 36. This suggests that a few very high paraffin consumers skew the average, which otherwise might lie more within the region of between N\$ 36 and N\$ 71. This similarly applies to respondents using petrol. High petrol consumption applies to households that operate their petrol generator to for extended periods (e.g. to run a refrigerator), compared to those that use a petrol generator only for a few hours in the evenings. It is furthermore cautioned that some respondents might have included vehicle petrol consumption into their response. Expenses for LPG

<sup>3</sup> **Example:** The RE Baseline surveyed 348 households, of which 291 use wood, but pay different amounts per month (some more, some less). If the individual N\$ amounts are structured in an ordered sequence from low to high, the median represents the N\$ amount for respondent number 146.

are also quite high and should be re-assessed. The high monthly cost is only really possible where a household uses LPG for refrigeration, lighting and cooking, i.e. where LPG is the primary energy source for several appliances. Sample values for wood, candles, dry cell batteries (1.5V) and diesel also cover a wide spectrum, but the median is relatively close to the average.

**Figure 4: Monthly household energy source expenditure (only showing the results for respondents using the specific energy source)**

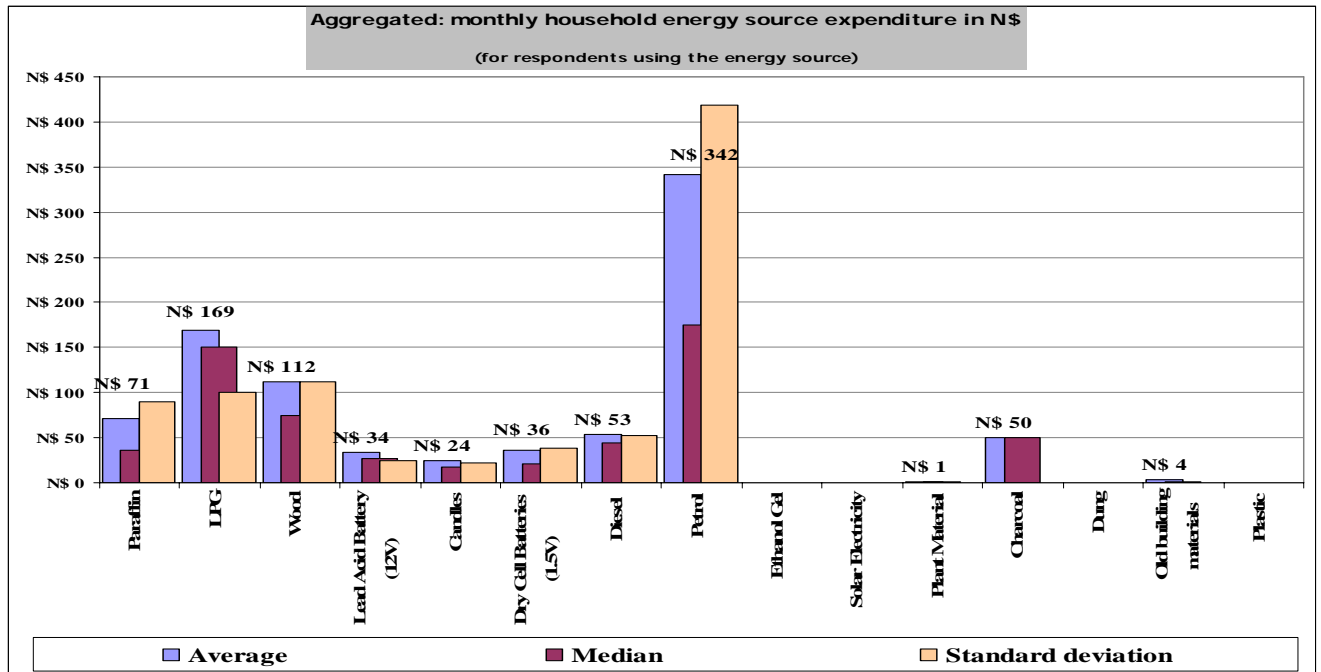


Figure 5 shows the expenses incurred by households for certain services, where a household procures such a service on a regular basis. The services with significant variation are “paying to dry food”, “buying ice”, “renting a generator” and “pay for water”. Individual values for the first three vary greatly, mostly due to the fact that these are ad hoc services. “Paying to dry food” is also perceived as an ambiguous service, since some respondents included the cost of purchasing dried food (it is assumed), rather than purchasing the service only. This can be observed through the low median of N\$ 9, while the average is N\$ 50. “Buying ice” is heavily influenced by the great difference in the amounts and frequency of ice purchased. The standard deviation for “pay to get your hair cut” is quite high, but this is mostly due to the difference in frequency that respondents have a hair cut. “Pay for electricity” is also worth noting, since the relationship between standard deviation (N\$ 144), average (N\$ 202) and median (N\$ 190) suggests that low-income households spend at least N\$ 50 per month for electricity, but with an overall average of closer to N\$ 200. This is exceptionally high and denotes low penetration of energy efficiency technologies, such as compact fluorescent lights and solar water heaters.

**Figure 5: Monthly household service expenditure (only showing the results for respondents using the specific service)**

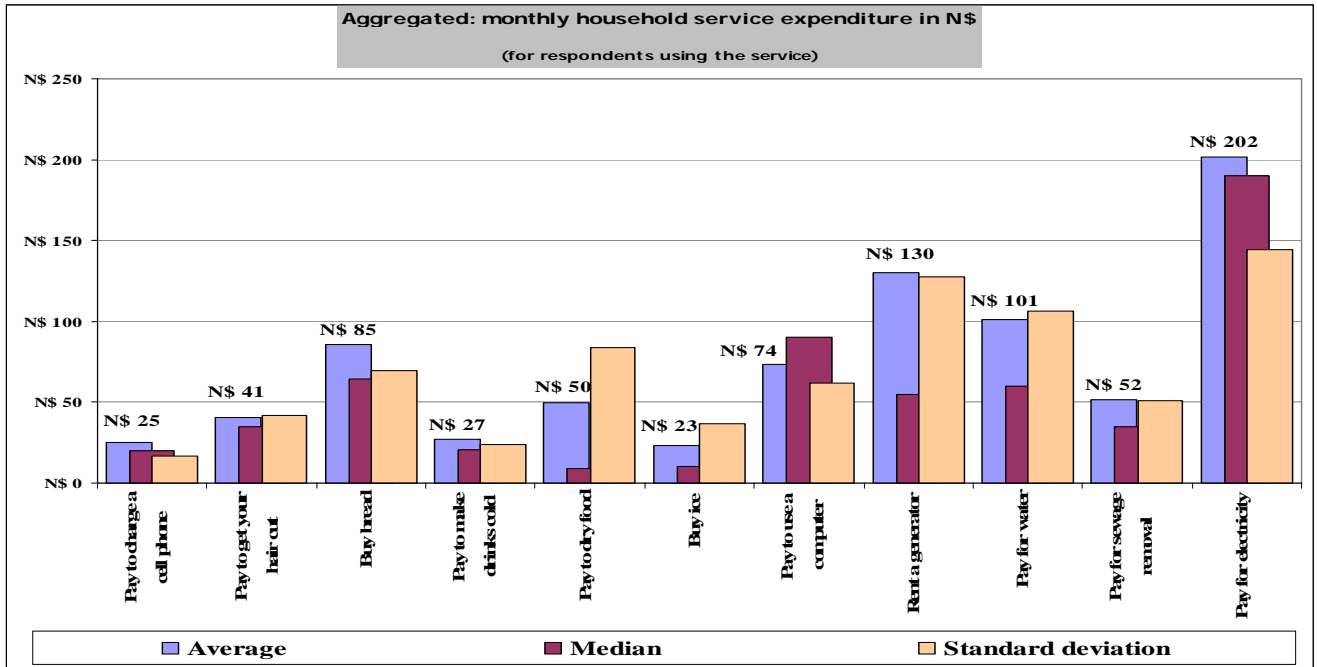
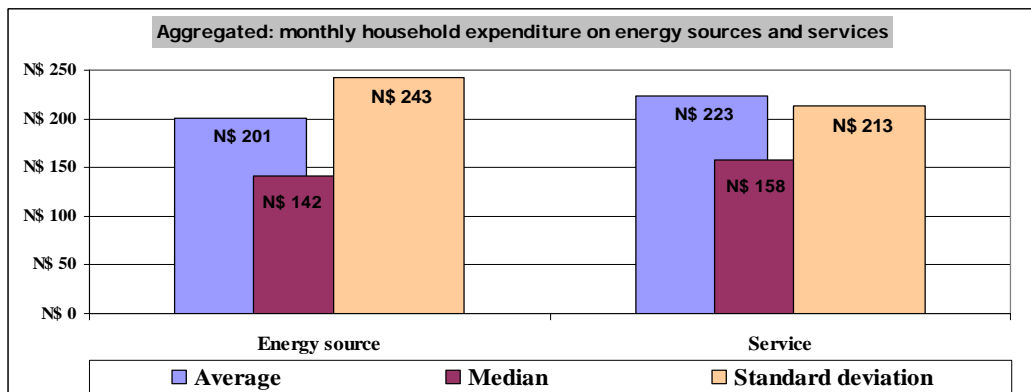


Figure 6 summarises the average monthly expenditure for household energy sources and monthly expenditures paid for services for the aggregate data obtained during the baseline survey, along with the median and standard deviation values. The data shows that individual household expenditures vary significantly (standard deviation), but the median value is sufficiently close to the average value to indicate that monthly expenses beyond N\$ 100 per month are common for the majority of respondents.

**Figure 6: Average monthly household expenditure on energy sources and services**



The RE Baseline Survey indicates that the penetration of renewable energy technologies on a household level in the surveyed sample is extremely low. At the same time, in many cases, the use of renewable energy technologies would significantly reduce household



energy expenditures. At present, average household energy expenditure of about N\$ 200 per month is predominantly spent on candles, wood (burnt on open fires) and paraffin. Added to this expenditure is a further N\$ 200 of which at least cell phone charging (N\$ 24) and hair cutting (N\$ 41) could be reduced through operating a small solar home system. The example below illustrates how possible reductions of energy expenditure through acquisition of a modern energy service technology might indeed be sufficient to purchase such technologies. Although this is a rudimentary basic example, it merits further investigation if a national programme towards ensuring access to modern energy technologies is to be pursued.

### **Financing modern energy technologies through savings in energy expenditure**

A basic 50 W solar home system with two lights and a 180 VA inverter costs approximately N\$ 7,000 (inclusive of 220 V power sockets), and a wood-saving stove costs about N\$ 500. Therefore, a combined investment of N\$ 7,500 could have the following impact on current monthly household energy and service expenditures:

- Candles: reduce expenditure from N\$ 24 to N\$ 0 (100% reduction as a lighting fuel)
- Paraffin: reduce expenditure from N\$ 50 to N\$ 0 (100% reduction as a lighting and cooking fuel)
- Wood: reduce expenditure from N\$ 100 to N\$ 50 (50% reduction as a cooking and water heating fuel; a wood efficient stove reduces wood consumption by 50% to 70% compared to an open fire)
- Dry cell batteries: reduce expenditure from N\$ 36 to N\$ 0 (100% reduction as radio power source)
- Cell phone charging: reduce expenditure from N\$ 20 to N\$ 0 (100% reduction)
- Hair cutting: reduce expenditure from N\$ 40 to N\$ 0 (100% reduction if done by household; to be considered though is the purchase of a hair clipper set at a cost of between N\$ 30 to N\$ 90)

Using a solar home system would allow a household to save some N\$ 220 per month. It is to be noted that it takes just under 3 years to save these funds in order to purchase the solar system (not considering interest). However, under suitable financial support mechanism, like the Solar Revolving Fund, expenditure saved could be sufficient to pay for a modern energy technology. Under the Solar Revolving Fund's loan conditions (5% interest rate, 5 year pay-back) for instance, a monthly amount of N\$ 208 allows for the repayment of a system worth approximately N\$ 10,000.