Electricity use and affordability among rural households in Lesotho

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Abstract

This paper shares the results of a study into Lesotho's rural households' electricity usage and affordability. To get a holistic view, results from a number of recent studies are used to compare and/or corroborate the present study. In this study, a survey using a semi-structured questionnaire was conducted in three villages in different parts of Lesotho – Ha Lejone (Leribe District), Ha Seboche (Butha-Buthe District) and Ha Sekake (Qacha's Nek District). The study revealed that rural households used 26% of their monthly expenditure towards energy costs including 9% on electricity. Similarly to households without electricity, biomass is the predominant energy source for cooking and heating while electricity was mainly used for lighting. It also came out that 75% of households perceived the current electricity tariff to be high and 64% wanted the government to prioritise keeping tariffs low. Also, 42% have reduced the use or switched from electricity to traditional sources due to the past tariff increases while 55% indicated their plans to do the same in future hikes. The severity of affordability accounts for progressive decline of the average usage of about 60% between 2000 and 2016 nationally (from 2,951 kWh/year down to 1,157 kWh/year). On the contrary, connections increased by a factor of 10 from around 25,000 to approaching 210,000 within the same period. The bulk of the new connections are to the rural households as the majority of urban households are already connected (>70%). This shows that prioritising access without taking affordability into account may not be addressing the energy challenges of the rural households.

Keywords: Electricity usage; electricity affordability; rural households; Lesotho.

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1. Introduction

The major reason why governments especially of the poor countries, are aggressively allocating resources and drafting policies to achieve high levels of rural electrification is because it is believed to help alleviate rural poverty [Tanguy, 2010]. This is because, with time, local economic activities enabled by access to reliable source of power are expected to benefit the poor through higher productivity and enhanced employment opportunities. Hence electrification is indeed perceived as a necessary pre-requisite for productive activities [Kanagawa and Nakata, 2008; IEA, 2013].

Like many other African countries, to fast track rural electrification, Lesotho established Rural Electrification Unit (REU) in 2004 within the Department of Energy and embarked on a variety of electrification programmes that aimed at bringing electrical power to rural and remote areas. Despite these serious efforts of the Government of Lesotho (through REU and the Lesotho Electricity Company (LEC)), non-governmental organisations (NGOs) and other stakeholders, the level of rural households connected to the grid is still very low. For example, in 2015 about 72% of the households in urban regions were connected to the grid while the share of households in the rural areas with access to electricity was just 5.5%. This brought the overall national electrification rate to 35% owing to the fact that only 34% of the population is urban [LEWA, 2017a].

The continued low rural electrification rates in spite of all the efforts clearly show that there are challenges that need be addressed. The major challenge to rural electrification is significantly attributed to the capital costs and limited returns in the short and medium term. The investment for grid extension and off-grid schemes to reach remote and scattered households is often substantially high yet accompanied by low electricity consumption level of rural households [Tanguy, 2010].

Due to the inherent challenges in achieving high rural electrification rates, it is imperative to consider both initiatives to ensure grid connections as well as households' attitudes towards different types of energy acquisition, usage, affordability and preferences. In this study, we hypothesize that in under the grid areas, the process of connecting households to the distribution network is impeded by the high connection fee that may not be affordable for many low-income households. We further anticipate that the current electricity pricing scheme and the relative prices of electricity (compared to other forms of energy) provides insufficient incentives to make comprehensive use of power and to replace other conventional forms of energy. Finally, we observe that the poor quality of power supply makes the people hesitant to connect. To check these suppositions a comprehensive survey was conducted to acquire more detailed information about the energy attitudes and energy consumption patterns of rural households. The inhabitants of three villages in different parts of Lesotho were interviewed using a standardized questionnaire. The survey was conducted in early 2017.

This paper first looks at the relevant recent literature review followed by the design of the case study carried out in three different districts. The results are then analysed followed by discussions.

2. Literature Review

This section looks at some of the recent literature on energy consumption in developing countries with a special focus on grid connection and electricity consumption in Lesotho. The objective is to compare such findings with the results from our study to observe whether or not there is a general improvement in achieving the targeted goals.

Although there is a continued trend towards urbanisation in Lesotho, 24% in 2006 to 34% in 2016, as reported by the 2016 population census carried out by the Bureau of Statistics (BoS), the majority of people still reside in rural areas. Even by 2030, the urban population is projected to grow at most to 40% [LEWA, 2017a]. Considering that the majority of the population is rural yet its electrification rate is less than 10%, any shift towards parity of urban and rural electrification rates implies significant intervention. Furthermore, households in Lesotho predominantly rely on biomass (i.e. fuelwood, agricultural residues and dung) for their energy needs. The proportions of household energy from biomass, other intermediate fuels (i.e. coal and kerosene) and modern fuels (i.e. electricity and LPG), is depicted in Figure 1 [Letsela et al., 2003; ProBEC, 2009; Dasappa, 2011; Taele et al., 2012a]. Where electricity is available, it is used mainly for lighting, TV and radio rather than for cooking and heating and therefore represents a small share of the domestic energy consumption [Taele et al., 2012a]. Over 80% of all households in Lesotho use biomass and paraffin as main source of energy for cooking and space heating. Only 8.4% of the households, mainly in urban areas use LPG while electricity use for cooking is marginal due to its cost and low connection rates [National Environment Secretariat, 2002].

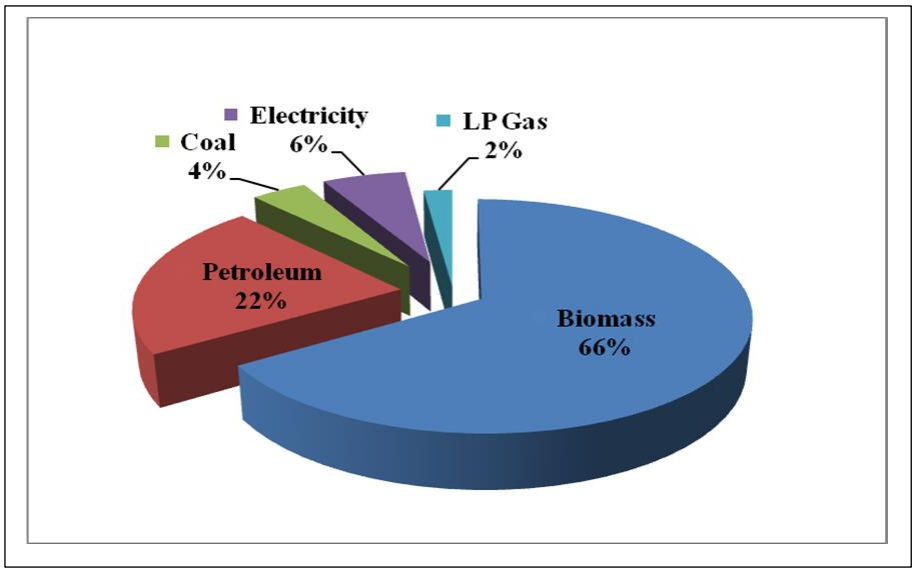


Figure 1: Lesotho's energy consumption in 2008. Adapted from [Taele et al., 2012a]

Other than lack of access to electricity, one of the major drivers of reliance on biomass as the primary energy source is the issue of affordability. According to the Gesellschaft für Technische Zusammenarbeit (GTZ) study, all commercial fuels were perceived as being expensive by some households. Households perceive the cleaner sources of energy such as gas,

solar and batteries as more expensive than traditional biomass fuels and paraffin, as shown in Figure 2 [GTZ, 2007]. In all cases, the households reported being forced to buy the fuels, either because of lack of access to crops or physical problems such as age and illness preventing the collection of fire wood. Households collecting biomass fuels did not report expense associated with the fuel, either in terms of collection time or opportunity cost due to lost time that could have been spent on other activities. Access to fuels did not seem to be the major problem experienced by households, but affordability was identified as the main barrier to using other fuels than biomass [GTZ, 2007].

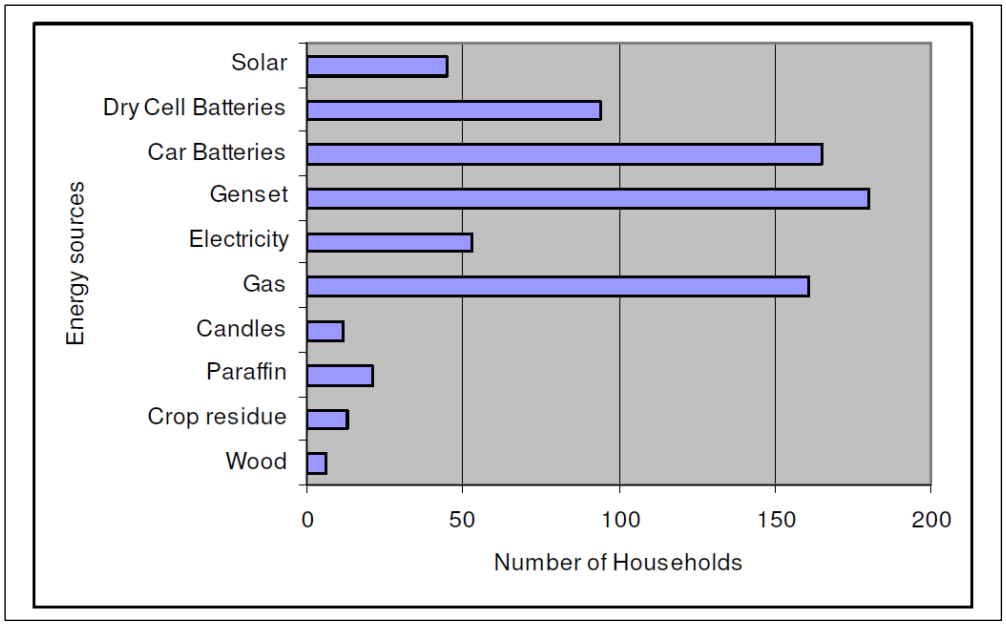
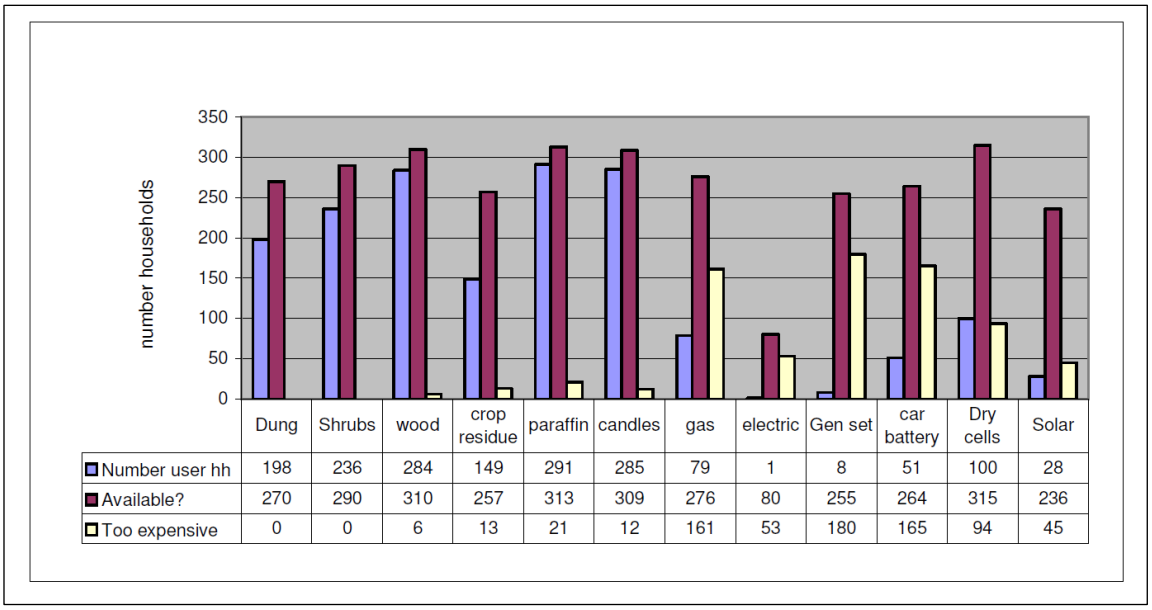


Figure 2: Number of households considering specific fuels expensive. Adapted from [GTZ, 2007].

Wood, which emerged as the most used biomass fuel source was not experienced as unavailable by the majority of the sample (98%), as shown in Figure 3. However, if the average wood fuel collection trip of 3.2 hours twice a week across the sample is considered, it is clear that households, especially women responsible for collection, spend a lot of time to secure the energy source. Only one household out of 80 (1.25%) that have electricity is using it. 66% of all households that use electricity considered it to be expensive. As a result, a significant share of energy services is still produced by other forms of energy, such as, biomass, paraffin and candles. This explains why the average household consumption of electricity is declining, as shown in Figure 4. The bulk of connected households are not using electricity and this could be attributed primarily to affordability. Figure 4 shows how the LEC customer base has increased by almost a factor of 10 from around 25,000 in 2001/02 to approaching 210,000 in 2016/17 although the average consumption per household decreased by over 60% during the same period (from 2,951 kWh/year to 1,157 kWh/year). As a consequence, economies of scale are not fully exploited. Thus, lacking grid coverage is not the only obstacle to a more comprehensive use of electricity.



	Dung	Shrubs	wood	crop residue	paraffin	candles	gas	electric	Gen set	car battery	Dry cells	Solar
Number user hh	198	236	284	149	291	285	79	1	8	51	100	28
Available?	270	290	310	257	313	309	276	80	255	264	315	236
Too expensive	0	0	6	13	21	12	161	53	180	165	94	45

Figure 3: Number of households using different fuels [GTZ, 2007]

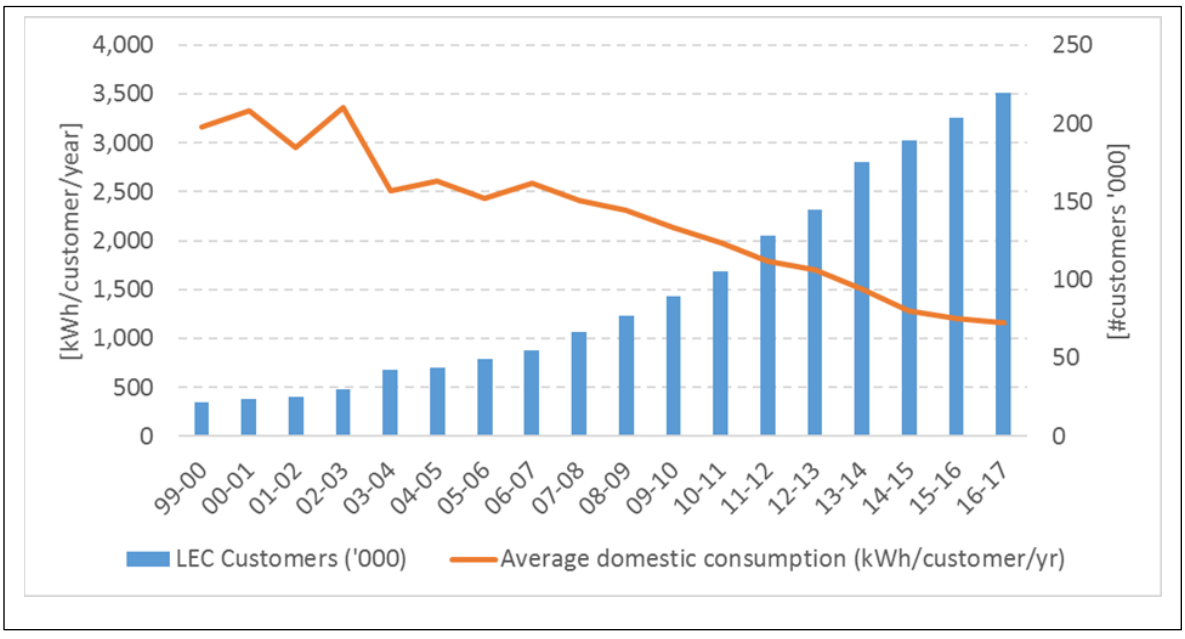


Figure 4: LEC customer numbers and average consumption per domestic customer from 2000 to 2016. Adapted from (LEWA, 2017b)

As shown in Figure 4, access without affordability may not be helpful. This is exemplified by Bulgaria and Turkey which have universal access to the grid but a huge of number of households does not consume electricity. In Turkey over a quarter of all households, and half the poorest households, declared no electricity consumption. In Bulgaria the figures are lower by 10% overall but constitute nearly a third of the poorest decile [Price, 2009]. Hence, being

connected to a grid does not imply usage of electricity, and especially so by the poor households. In fact it can be argued that, since a huge majority of Lesotho's urban households are connected to the grid (over 70%), it implies that the bulk of recent new connections (shown in Figure 4) is primarily to the remote and rural poor households through REU and other players. Figure 5 shows the household average consumption pattern of electricity in 2016 grouping the households by the year they got connected to the grid, from 2002 to 2015. The figure clearly shows a consistently declining average consumption for all subsequent years. This implies that every subsequent year poorer and poorer households get connected to the grid whose consumption is very low or non-existent.

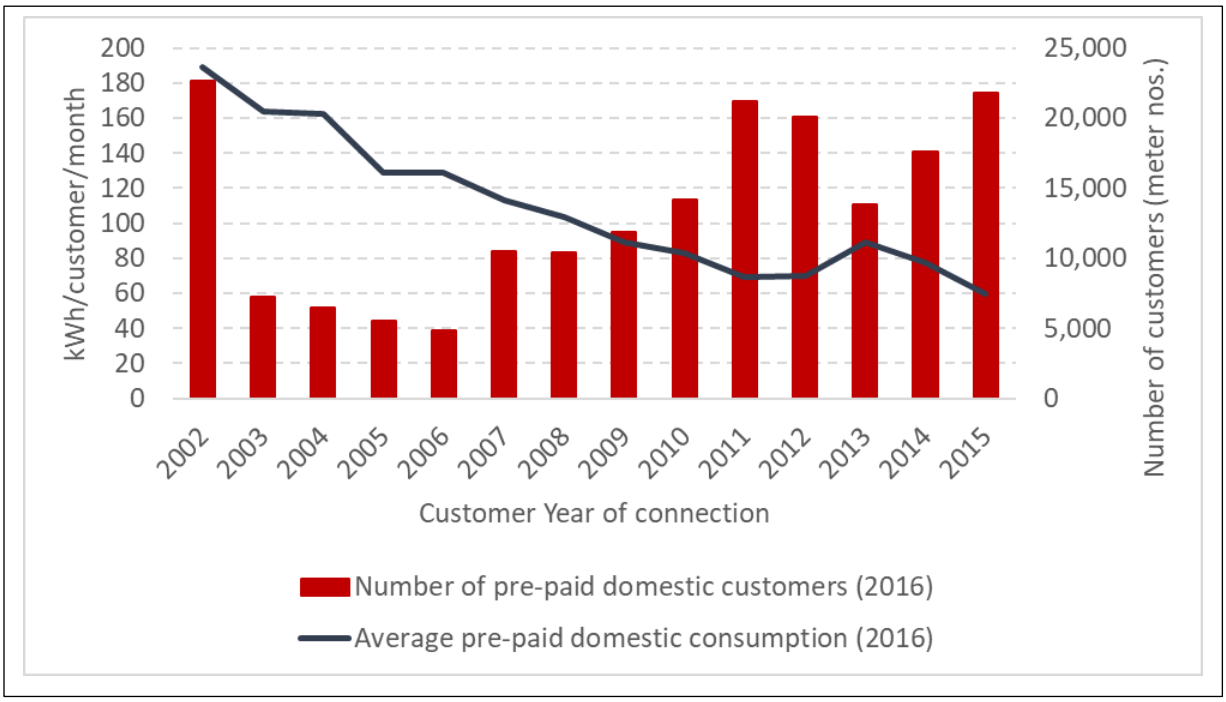


Figure 5: Average pre-paid domestic consumption in 2016 by customer year of connection. Adapted from [LEWA, 2017b].

The issue of affordability goes hand in hand with income. According to the available data, subsistence farming is the second most common economic activity (after wages & salaries) for household heads residing in rural areas [Bureau of Statistics, 2011a]. The proportion of economically active population was recorded at 38.7% and the economic dependency ratio was 2.00. Thus, for every one working-person there were two people who were not working. Furthermore, almost 71% of the households earn an income of less than M1,000/month (~$85) or nothing at all while 3.9% of the households earn a monthly income of M5,000 (~$420) or more. Segmentation of income by level indicated that 94.3% of the households who earned less than M3,000/month (~$255) had an average household income of M404.43/month (~$35). Considering the time value of money, the M404.43 is now equivalent to M647.09 (~$55) using the annual inflation rates from 2003 to 2017 [World Bank, 2018].

Taele et al. (2012a) argues that to promote economic development and growth, electricity must also be put to work towards wealth-creation – providing power for businesses, as well as improving healthcare, education and crop production]. In the 2007 GTZ study, very few households were involved in income generating activities that required energy input, as shown in Table 1. Production of beer accounted for most instances of household industries using energy in their processes. Approximately 70% of the respondents claim that their businesses activities make 'a very small contribution' to household income while there is a fairly even split between the remaining households where such activities represent a 'significant but not principal source of income' (17%) or 'more than half of the household income' (14%). Household incomes procure a range of goods and services such as shoe repairs, sewing and the use of public phones, mostly in the local economy. This suggests that the local economy can sustain a reasonable level of micro-enterprise and, in many instances, such enterprises would benefit from improved energy provisions [GTZ, 2007].

Table 1: Energy input in income generating activities. Adapted from [GTZ, 2007]

Activity	# of HHs	Energy source					
		Solar PV	Generator	Paraffin	LPG	Woody biomas	Dung
Grass products	10	-	-	-	-	-	-
Sewing clothing	25	1	-	-	-	-	-
Metal work	4	-	3	-	-	-	-
Blocks/bricks	4	-	-	-	-	-	-
Carpentry	4	-	-	-	-	-	-
Hair dressing	13	-	-	-	1	1	-
Beer making	94	-	-	1	1	86	6
Shoe repairs	2						
Traditional healer	1						
Clay products	1						1

3. Target and Design of the Case Study

In order to determine the energy attitudes and energy consumption patterns of rural households, a survey using a semi-structured questionnaire was conducted in three villages in different parts of Lesotho – Ha Lejone (Leribe District), Ha Seboche (Butha-Buthe District) and Ha Sekake (Qacha's Nek District). In line with the 2006 census report by the BOS, these three villages have the estimated number of households of 154, 219 and 112, respectively. The interviews were conducted in a one day visit per village on the following dates: 3rd March 2017, 10th March 2017 and 17th March 2017, respectively. The final year undergraduate students from the Department of Economics at the National University of Lesotho who received training prior to the survey and their supervisors were used to administer the questionnaire[1]. The questionnaire (see the appendix) had both closed-ended and open-ended questions and was divided into three sections. The first section had questions regarding households' energy use and expenditure patterns while the second one had questions concerning the households who are under the grid

[1] However, the interviewers were unable to make return visits to the not-at-home households because of limited funds. On the other hand, members of the households who were 18 years or older were interviewed on behalf of the household owners where the owners were not at home.

but not connected to the grid. The last section had questions related to the demographic background of the households and the respondents.

4. Results

This section provides a descriptive analysis of the obtained data in the form of frequency distributions given in tables and figures. The household electrification distribution by characteristics in three villages is shown in Table 2. Ha Lejone, Ha Seboche and Ha Sekake constituted 33%, 37% and 30% of the 266 households interviewed, respectively[2]. In terms of electrification, 64% of total households are using electricity. Ha Lejone registered a highest proportion of electricity users (92%), followed by Ha Sekake (71%), while Ha Seboche recorded the lowest (33%). For most villages where a grid extension has to be undertaken to connect the village, the villagers normally form an electricity scheme where each member will be expected to contribute a stipulated amount within a certain timeframe. When all members have paid up, the scheme approaches REU so that they could be considered for connection. REU has a backlog of electricity schemes seeking services growing at a high rate. For instance, new schemes, 135, registered in 2016/17 brought the list to a total of 680 schemes and only 26 were served during that year [Rural Electrification Unit, 2017]. In all the three villages, 30% of electricity users and 33% of non-electricity users had subscribed to such local electrification connection schemes. Moreover, most of the households had an average size of 5 members and they depended on wages and salaries (32%) as well as household businesses (29%) as their main sources of income.

[2] The response rates for Ha Lejone, Ha Seboche and Ha Sekake, based on the 2006 BOS census report, are 56%, 45% and 88%, respectively

Table 2: Household distribution by characteristics and by villages

Household Characteristics		Villages			
		Ha Lejone	**Ha Seboche**	**Ha Sekake**	**Total**
Household Type	Electricity Users	80 (92%)	33 (33%)	57 (71%)	170 (64%)
	Non-electricity Users	7 (8%)	66 (66%)	23 (29%)	96 (36%)
	Total Sample	87 (33%)	99 (37%)	80 (30%)	266 (100%)
Members of Electricity Connection Schemes	Electricity Users	30 (37%)	7 (21%)	14 (25%)	51 (30%)
	Non-electricity Users	0 (0%)	19 (29%)	13 (57%)	32 (33%)
Main Source of Household Income	Wages & Salaries	30 (34%)	23 (23%)	32 (40%)	85 (32%)
	Farming	18 (20%)	14 (14%)	2 (3%)	34 (13%)
	Household Business	20 (23%)	27 (27%)	29 (36%)	76 (29%)
	Remittances	3 (3%)	8 (8%)	3 (4%)	14 (5%)
	Pensions / Grants	18 (9%)	13 (13%)	3 (4%)	24 (9%)
	Others	8 (9%)	14 (14%)	11 (14%)	43 (12%)
Average Household Size		5	5	4	5

4.1 Energy Use for Cooking, Heating and Lighting

Tables 2 to 4 give the mean responses of the main uses of different types of energy sources by households in all three villages. The results from Table 3 indicate that gas and firewood are the ones that are almost often used for cooking by electricity users (with mean responses of 2.74 and 2.55, respectively) while paraffin, electricity and other sources of energy such as cow dung and corn cobs or stover are rarely used for cooking (with mean responses of 2.25, 1.92 and 1.52, respectively). On the other hand, non-electricity users often used firewood for cooking (with mean responses of 2.98) while at times used paraffin, gas and other sources of energy

(with mean responses of 2.36, 2.09 and 1.77, respectively). As for coal, solar and diesel or petrol (for generator), they were generally never used for cooking by both electricity users and non-electricity users.

Table 3: Household Energy Use for Cooking

Energy Sources	Mean Responses	
	Electricity Users	**Non-electricity Users**
Coal	1.05 (*SD* = 0.21)	1.03 (*SD* = 0.17)
Electricity	1.92 (*SD* = 1.09)	1.00 (*SD* = 0.00)
Firewood	2.55 (*SD* = 1.22)	2.98 (*SD* = 1.10)
Gas	2.74 (*SD* = 1.25)	2.09 (*SD* = 1.26)
Diesel/Petrol (for generator)	1.00 (*SD* = 0.00)	1.00 (*SD* = 0.00)
Paraffin	2.25 (*SD* = 0.98)	2.36 (*SD* = 1.09)
Solar	1.01 (*SD* = 0.08)	1.00 (*SD* = 0.00)
Others (cow dung, corn cobs/stover)	1.52 (*SD* = 0.96)	1.77 (*SD* = 1.12)

Notes: The scale is 1 (never), 2 (sometimes), 3 (often) and 4 (always); *SD* = Standard Deviation.

Table 4 highlights that paraffin was used a bit more often by electricity users for heating (with mean response of 2.52) while firewood was rarely used (with mean response of 2.11). However, these electricity users almost never used coal, electricity, gas, diesel/petrol, solar and other sources of energy for heating. Conversely, firewood, paraffin and other sources of energy were occasionally used by non-electricity users for heating (with mean responses of 2.22, 2.05 and 1.65, respectively) while coal, gas, diesel or petrol, and solar were nearly never used for heating. With regard to lighting, the results in Table 5 show electricity was always used for lighting by its users (with mean response of 3.89), while paraffin and other sources such as candles and battery lamps or torches were used in rare cases (with mean responses of 1.89 and 1.51, respectively). As for non-electricity users, paraffin was often used for lighting (with mean response of 3.10) while others sources were used at certain times (with mean response of 2.24). Other energy sources such as coal, firewood, gas, diesel or petrol and solar are almost never used by both users and non-users of electricity.

Table 4: Household Energy Use for Heating

Energy Sources	Mean Responses	
	Electricity Users	**Non-electricity Users**
Coal	1.08 (*SD* = 0.38)	1.06 (*SD* = 0.32)
Electricity	1.28 (*SD* = 0.71)	1.00 (*SD* = 0.00)
Firewood	2.11 (*SD* = 1.23)	2.22 (*SD* = 1.29)
Gas	1.08 (*SD* = 0.41)	1.05 (*SD* = 0.34)
Diesel/Petrol (for generator)	1.00 (*SD* = 0.00)	1.00 (*SD* = 0.00)
Paraffin	2.52 (*SD* = 1.15)	2.05 (*SD* = 1.39)
Solar	1.00 (*SD* = 0.00)	1.00 (*SD* = 0.00)
Others (cow dung, corn cobs/stover)	1.33 (*SD* = 0.83)	1.65 (*SD* = 1.11)

Notes: The scale is 1 (never), 2 (sometimes), 3 (often) and 4 (always); *SD* = Standard Deviation.

Table 5: Household Energy Use for Lighting

Energy Sources	Mean Responses	
	Electricity Users	**Non-electricity Users**
Coal	1.00 (*SD* = 0.00)	1.00 (*SD* = 0.00)
Electricity	3.89 (*SD* = 0.46)	1.00 (*SD* = 0.00)
Firewood	1.00 (*SD* = 1.00)	1.04 (*SD* = 0.25)
Gas	1.00 (*SD* = 0.00)	1.00 (*SD* = 0.00)
Diesel/Petrol (for generator)	1.01 (*SD* = 0.08)	1.00 (*SD* = 0.00)
Paraffin	1.89 (*SD* = 0.89)	3.10 (*SD* = 1.28)
Solar	1.04 (*SD* = 0.27)	1.16 (*SD* = 0.62)
Others (candle, battery lamp/torch)	1.51 (*SD* = 0.62)	2.24 (*SD* = 1.25)

Notes: The scale is 1 (never), 2 (sometimes), 3 (often) and 4 (always); *SD* = Standard Deviation.

These overall results therefore reveal that the main use of electricity in rural areas is lighting. This is followed by cooking even though it is done rarely. As for heating, electricity seems almost not being used for such a purpose.

4.2 Energy Spending and Inability to Pay

Table 6 presents households' energy spending as a share of monthly total spending. The results show that electricity users spent about 26% of their total household expenditure per month on energy sources, with electricity (9%), gas (7%) and paraffin (7%) constituting the highest shares of monthly total spending. On the other hand, non-electricity users spent approximately 21% of their monthly total expenditure on sources of energy, and that is mainly on gas (8%), paraffin (6%) and firewood (6%). Nevertheless, the monthly spending shares for other energy sources such as coal, diesel/petrol, solar and others, were 2% or below for both electricity users and non-users. Alternatively, Table 7 gives the mean responses of the household inability to pay for energy sources. The results indicate that although both electricity and non-electricity

users agreed that at times they were unable to pay for the sources of energy, that only happened nearly in rare cases.

Table 6: Household Energy Spending as a Share of Monthly Total Spending

Energy Sources	Share of Monthly Total Spending	
	Electricity Users	**Non-electricity Users**
Coal	0.00 (*SD* = 0.01)	0.00 (*SD* = 0.00)
Electricity	0.09 (*SD* = 0.11)	0.00 (*SD* = 0.00)
Firewood	0.02 (*SD* = 0.05)	0.06 (*SD* = 0.12)
Gas	0.07 (*SD* = 0.09)	0.08 (*SD* = 0.14)
Diesel/Petrol (for generator)	0.00 (*SD* = 0.00)	0.00 (*SD* = 0.01)
Paraffin	0.07 (*SD* = 0.11)	0.06 (*SD* = 0.07)
Solar	0.00 (*SD* = 0.00)	0.00 (*SD* = 0.00)
Others	0.01 (*SD* = 0.04)	0.01 (*SD* = 0.03)
All Energy Sources	0.26 (*SD* = 0.19)	0.21 (*SD* = 0.18)

Table 7: Household Inability to Pay for Sources of Energy

Energy Sources	Mean Responses	
	Electricity Users	**Non-electricity Users**
Coal	1.90 (*SD* = 0.99)	1.50 (*SD* = 0.58)
Electricity	1.53 (*SD* = 0.69)	-
Firewood	1.61 (*SD* = 0.72)	1.92 (*SD* = 0.95)
Gas	1.89 (*SD* = 0.74)	2.00 (*SD* = 0.79)
Diesel/Petrol (for generator)	2.33 (*SD* = 1.15)	2.00 (*SD* = 0.00)
Paraffin	1.63 (*SD* = 0.72)	2.08 (*SD* = 0.74)
Others	1.35 (*SD* = 0.59)	2.19 (*SD* = 0.82)

Notes: The scale is 1 (no, never), 2 (yes, sometimes), 3 (yes, many times); *SD* = Standard Deviation.

The results presented above generally highlight that households using electricity spend a higher share of their income for energy than households without electricity. Even though the shares of energy spending are relatively high for both the electricity and non-electricity users, the results reveal that the inability to pay for energy sources is not prevalent.

4.3 Electricity Benefits, Price Increases, Quality of Supply and Government Policies

Figures 1 to 6 show households' frequency distribution by various factors such as type of benefits derived from getting electricity, perceptions about electricity prices and its quality of supply, and government policies concerning provision of electricity. With regard to the benefits derived from getting electricity, it can be observed from Figure 6 that 71% of households enjoyed the fact that electricity saves time for cooking while 49% enjoyed the extended times of doing trading or business. Moreover, 48% and 43% of the households derived physical comfort and easiness of movements at night, respectively. Other benefits that the households enjoyed from having electricity include entertainment (30%), longer periods of study (28%), ability to work at night (11%) and others (43%) such as lighting, refrigeration and charging.

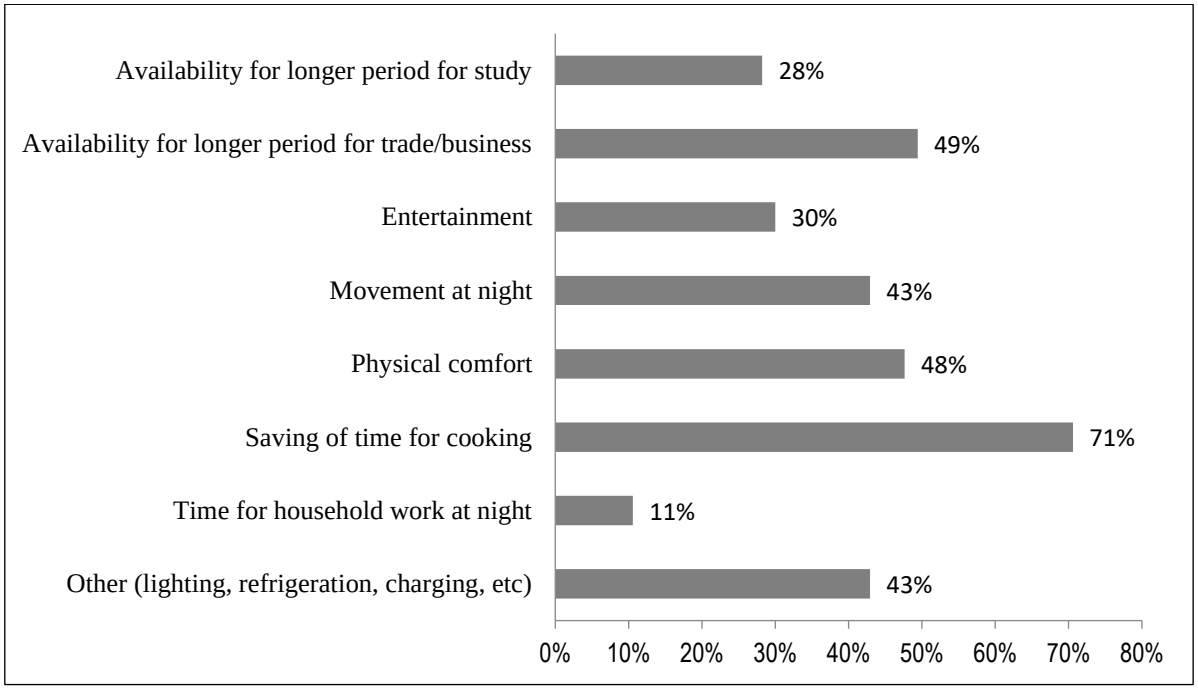


Figure 6: Household frequency distribution by type of benefits derived for getting electricity

Although there seems to be a number of benefits derived from electricity use, Figure 7 indicates that 75% of electricity users considered the current electricity price to be high while only 20% seemed to be fine with the current price. The current 2017/18 domestic tariff is M1.4240 (~$0.12). The results also show that almost none of the electricity users find the prices to be low as it is only 1% that considered the unit price to be low. Alternatively, 6% of the households did not know whether the current unit price for electricity is high, low or about right.

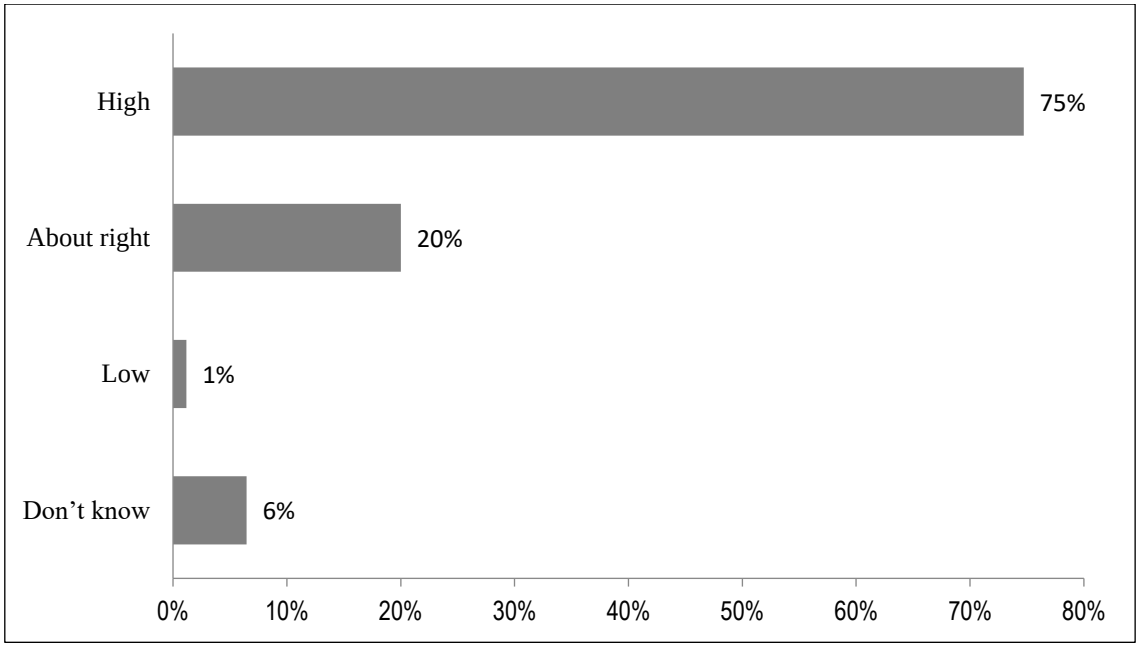


Figure 7: Household frequency distribution by perception of current unit price for buying electricity

Despite the fact that majority of households considered the electricity unit price to be high, Figure 8 depicts that 49% of the electricity users continued using electricity even after its unit price increased in the previous period by paying an extra amount to maintain the same level of electricity. Nevertheless, 31% of electricity users reduced their electricity consumption while only 11% shifted to other sources of energy. Interestingly, the results in Figure 9 seem to be consistent with the ones in Figure 8 as 46% of the electricity users claimed that they are willing to pay an extra amount in an event that electricity prices increased in the future in order to maintain the same level of electricity. Similarly, Figure 9 also shows that 28% of electricity users said that they will reduce the amount of electricity if prices increase. However, the results indicate that more households using electricity (27%) said that they will shift into other sources of energy if electricity prices will increase in the future.

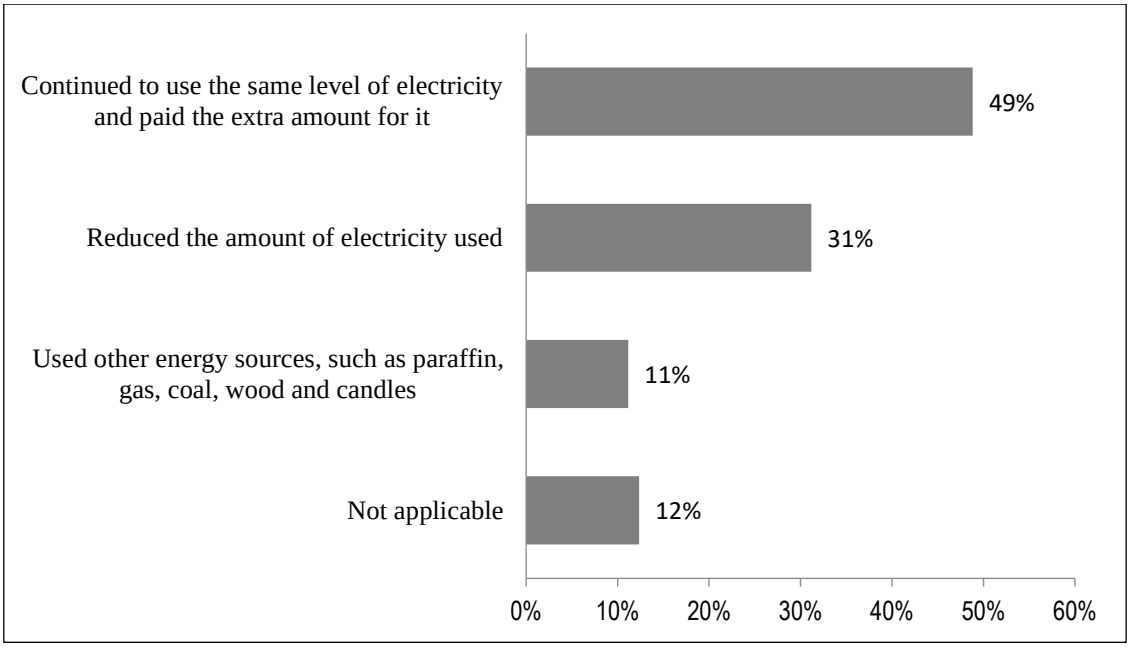


Figure 8: Household frequency distribution by reaction to electricity price increase in the previous period

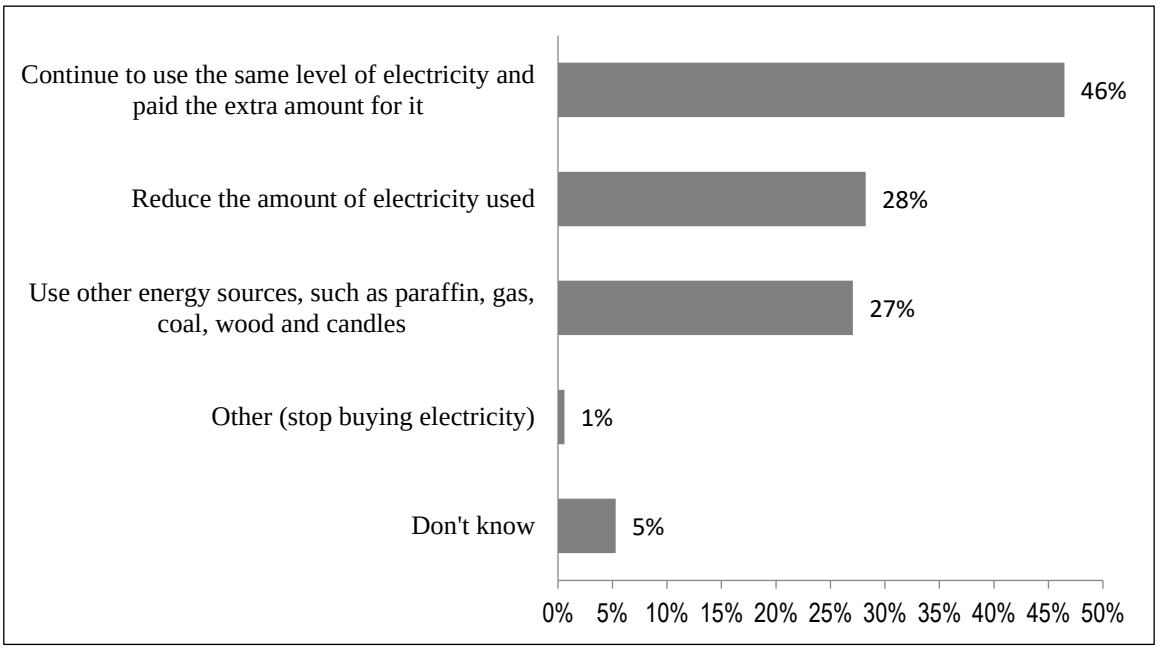


Figure 9: Household frequency distribution by reaction to electricity price increase in the future

Figure 10 shows households' perception of quality of electricity supply. The results reveal that in all three villages, few households using electricity perceived electricity supplied to be of good quality, particularly at Ha Lejone (8%) and Ha Sekake (2%). Furthermore, 53% of the electricity users at Ha Lejone considered the quality of electricity to be acceptable and 30% of the households using electricity at Ha Seboche have the similar perception. Nevertheless, only 2% of the electricity users at Ha Sekake regard electricity quality to be acceptable. Figure 10

also indicates that 48% and 40% of electricity users at Ha Seboche and Ha Lejone, respectively, considers the quality of electricity to be poor. This perception is even more pronounced at Ha Sekake, where 96% of the electricity users perceived electricity supply to be of poor quality.

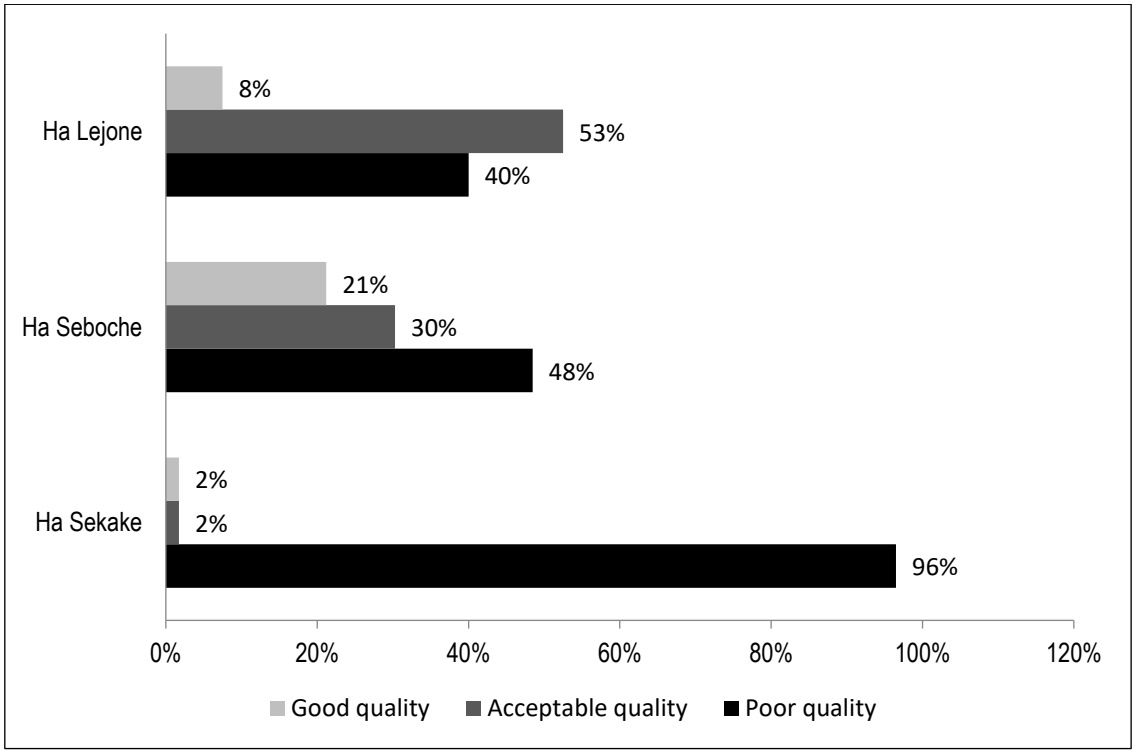


Figure 10: Household frequency distribution by perception of quality of electricity supply

The households' frequency distribution by what should be the top priority for the government when providing electricity is given in Figure 11. The results indicate that the top three priorities, in order of significance, should be keeping electricity prices low (64%), give free electricity to poor households (37%) and avoid load shedding or power cuts (35%).

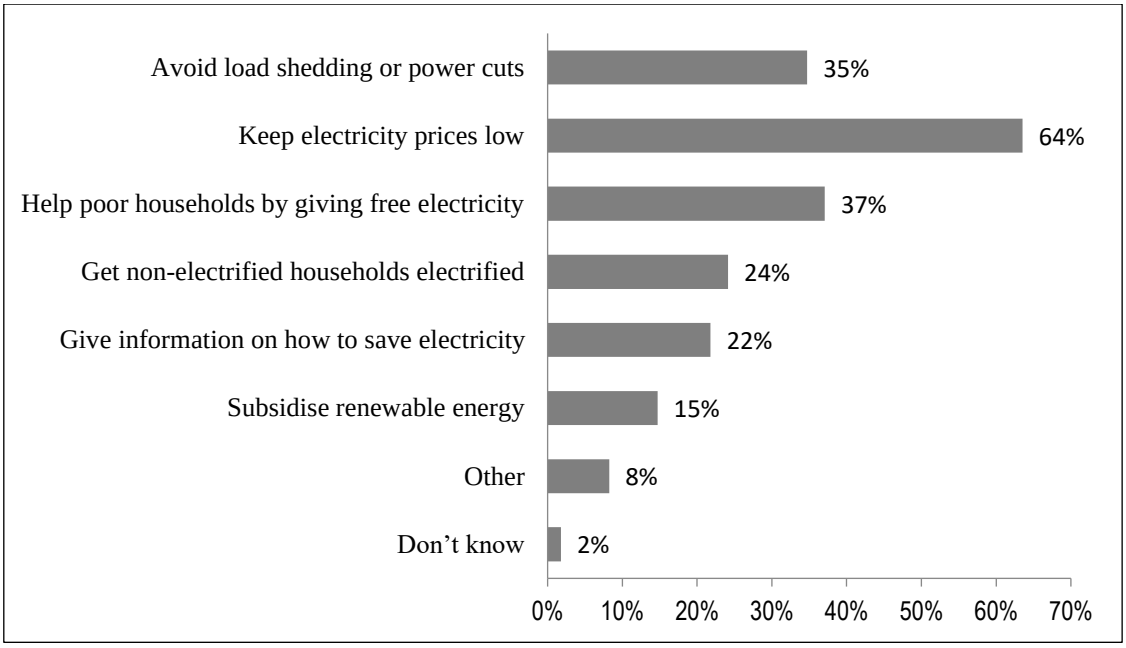


Figure 11: Household frequency distribution by what is regarded to be the top priority for Government when providing electricity

4.4 Electricity Grid Connection

Figure 12 presents households' frequency distribution by reasons for not getting connected to the grid. The results show that, of all households that are not connected to the electricity grid, 67% considered connection to be too expensive. The other reasons for not being connected to the grid are that electricity and its devices are considered expensive (7% and 2%, respectively) and others (25%) such as the house has just been built and the application for connection has not been processed. Nonetheless, 3% of the households without electricity claimed that there is no need for electricity. When asked what they would use electricity for if they got connected to the grid, households indicated as shown in Figure 13 that they would mainly use it for lighting (86%), entertainment (70%), recharging devices (68%) and cooking (63%). The respondents in households without electricity were also asked if they would be willing to pay the M2,000 (~$170) minimum required for electricity connection. Figure 14 shows that 75% of them said yes while 24% said no. Only 1% percent said that they did not know whether they would be able to pay that amount or not.

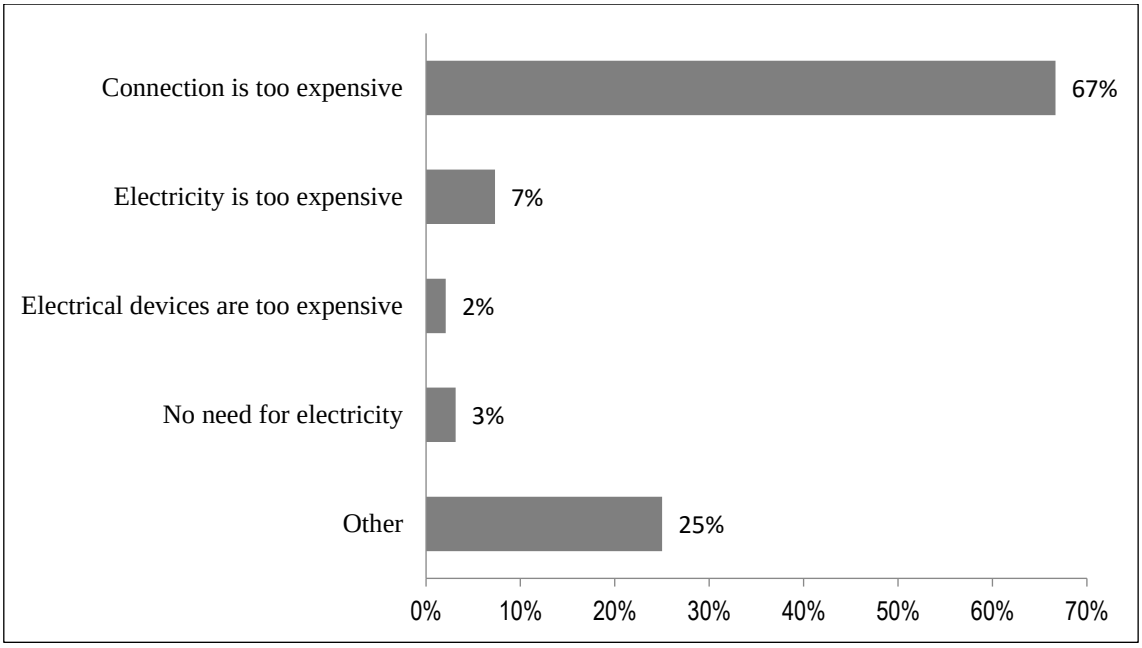


Figure 12: Household frequency distribution by reasons for not getting connected to the grid

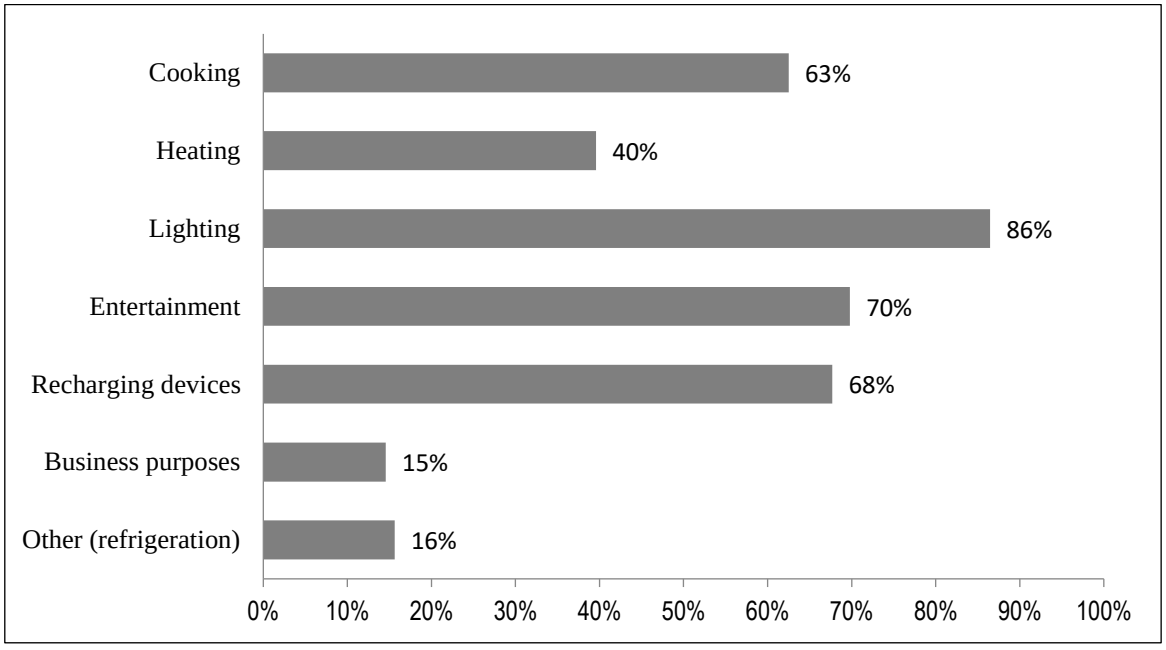


Figure 13: Household frequency distribution by main uses of electricity if connected to the grid

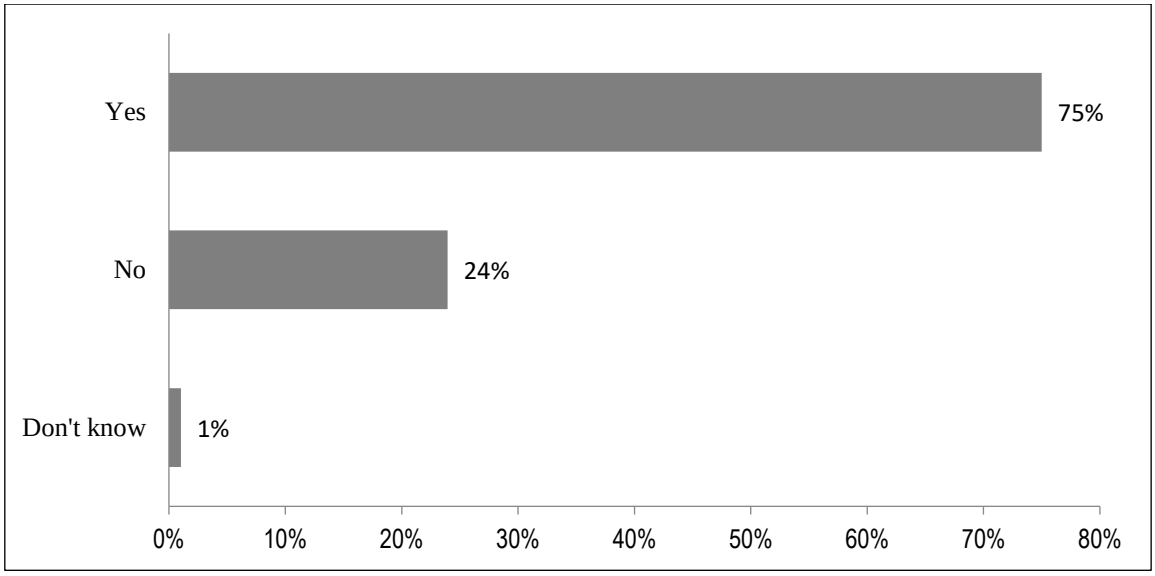


Figure 14: Household frequency distribution by perception of paying M2,000 (~$170) for electricity connection

The overall results show that although the majority of households without electricity believe that the connection fee to the grid is too expensive, more are willing to pay the M2,000 (~$170) which is the minimum fee for households that are within 50 m of the distribution line.

5. Discussion of the Outcomes

In Lesotho the average usage of electricity by households keeps declining every year, as seen from the LEC data (Figures 4 and 5) going as far back as 2000. The GTZ study observed in 2007 that biomass was the predominant source of energy for cooking and heating (Figure 3) even for households that were connected to the grid. Our study shows that the situation has not changed (Tables 3 and 4) which implies that the overall national energy consumption pattern of 2008 (Figure 1) remains unchanged as well. As seen in Figure 13, this is clearly not a choice as the bulk of unconnected people plan to use electricity for cooking (63%) and heating (40%). In practice this changes after connection to the grid. Table 5 corroborates the observations made by Taele et al (2012a) that in rural areas electricity is primarily used for lighting. As far back as 2007, 66% of grid-connected households found electricity tariffs to be too high (Figure 3) and now the figure has risen to 75% of households (Figure 7). In fact, the majority of households (64%) regard the priority for the government should be keeping prices low. This situation is exacerbated by the fact that tariffs have consistently been rising. In the last ten years alone, the tariff has gone up by an average of 23.6% per annum. Future increases are going to result in the majority of households (55%) reducing consumption and using other alternatives (Figure 9). This is not unique to Lesotho though. For instance, in Armenia, 80% of the households partly substituted their electricity consumption with other energy sources following an electricity price increase, and in Kyrgyz Republic, consumption by the poorest households reduced by 15% [Gassmann, 2012]. On average, a 10% increase in electricity tariffs reduces electricity consumption by 1.5 per cent [Gassmann, 2012]. The local utility company, LEC, currently has lodged an application to increase tariffs by 23% for the year 2018/19. If that

percentage increase gets approved, the suppressing impact on rural household demand will be exacerbated.

Affordability is a function of income. In our study, households connected to electricity spend 26% of their monthly expenditure on energy including 9% towards electricity while un-connected household spend 21% towards energy. Globally, household's expenditure of more than 10% on energy sources is considered to be energy poor, i.e. being unable to afford energy sources. More so, the World Bank considers more than 5% expenditure just on electricity to be energy poor [Kojima, 2016]. Hence, the 9% expenditure on electricity in the sampled population suggests that households currently face electricity poverty. Using the average monthly household income of M647.09 (~$55), 5% results in M32.35 (~$3), which can only acquire 23 kWh at the current rate of M1.424/kWh (~$0.12/kWh). This is less than half of the recommended basic needs consumption per month of 50 kWh [Davidson, 2004; Winkler, 2011].

Grid-connection for rural households is a priority of governments, but this is undermined when the bulk of the newly connected households are unable to afford the current tariff. Access is important but it should not be considered in isolation. One of the critical challenges to access is the geographic situation of Lesotho being a mountainous country. The geographic situation has an impact on the population density and hence on cost of grid connection and power supply. For example, 56% of the population is concentrated in the lowlands which cover only 17% of the total area [Bureau of Statistics, 2011b]. The remaining large area covers mountain and foothills regions which are mainly rural and characterised by scattered settlement patterns. As a result, the terrain is a challenge for national grid electrification and the scattered settlements present low numbers for economic returns on the needed capital infrastructure [Taele et al., 2012b]. Implementing a strategy of complete grid coverage of all rural areas in Lesotho is not economical. Thus, provision of electricity to rural households must be based on decentralized technologies like solar home systems (SHS) or hybrid mini-grids. In other words, grid extension funds could instead be used to fund these technologies which would result in very low local tariff to the connected households just to maintain the plants.

6. Conclusions

Access to electricity has the potential to raise the standard of living and improve the prospects of income generation in rural households particularly when considered in conjunction with other key factors such as affordability. The Government of Lesotho spends millions of Maloti every year extending the grid to the rural and remote households. However, at the prevailing tariff rates the majority of rural households struggle to afford a comparable electricity consumption with their urban counterparts, as can be seen by the continually declining average household consumption. Between 2000 and 2016 average usage declined by 60% (2,951 kWh/year to 1,157 kWh/year) while connections increased by a factor of 10 from around 25,000 to approaching 210,000 within the same period. The bulk of the new connections are to the rural households as the majority of urban households are already connected. To show the

severity of the challenge, 75% of the grid-connected rural households find the current tariff to be too high and 64% regard the priority for the government should be keeping tariffs low. Sadly, the tariff has been rising and in the last ten years it rose on average at 23.6% per annum. This situation unfortunately leads to biomass continuing to be the predominant source of energy, even for grid-connected households. Other than the health related drawbacks of using biomass, its availability is dramatically decreasing which results in longer collection trips and serious soil erosion. Rural grid connected household spend 26% of their monthly expenditure on energy including 9% on electricity. This shows that they struggle to afford these services as global benchmarks for energy expenditure is approximately 10% and 5% for electricity.

There are a number of ways to address affordability. Subsidies could be introduced in the tariff. However, these have been found to be inefficient hence a targeted approach could be more effective, such as, introducing lifeline tariffs which are very common in developing countries and even in developed countries. Lifeline tariffs are targeted and limited to households who are not able to afford a minimum set consumption (normally 50 kWh/month) to meet the basic needs. Another method to address affordability is the usage of the grid extension funds to implement decentralised clean energy technologies, such as, solar and wind, and hybrid mini grids. Since the major expense in these technologies is the initial capital costs, the households would then only pay very low tariff just to cover the repairs and maintenance of the infrastructure.

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References

Bureau of Statistics (2011a). Household Budget Survey – 2010/2011.

Bureau of Statistics (2011b). Lesotho Demographic Survey Tables, Vol III.

Dasappa S. (2011). Potential Biomass Energy for Electricity Generation in Sub-Saharan Africa. Energy for Sustainable Development 15(3), pp. 203-213.

Davidson O. and Mwakasonda S. A. (2004). Electricity access for the poor: a study of South Africa and Zimbabwe. Energy for Sustainable Development VIII (4), pp. 26-40.

Gassmann F. (2012). Switching the lights off: The impact of energy tariff increases on households in the Kyrgyz Republic, United Nations University - Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT), ISSN 1871-9872.

GTZ (2007). Lesotho Energy Access Strategy project: Baseline Study Report

International Energy Agency (2013). World Energy Outlook 2013. International Energy Agency.

Kanagawa M. and Nakata T. (2008). Assessment of Access to Electricity and the Socio-Economic Impacts in Rural Areas of Developing Countries. Energy Policy 36 (6), pp. 2016-2029.

Kojima M. and Trimble C. (2016). Making Power Affordable for Africa and Viable for its Utilities. World Bank.

Lesotho Electricity and Water Authority (2017a). Electricity supply cost of service study: load forecast report. LEWA, Maseru.

Lesotho Electricity and Water Authority (2017b). Electricity supply cost of service study: lifeline tariff report. LEWA, Maseru.

Letsela T., Witkowski E.T.F. and Balkwill K. (2003). Plant Resources Used For Subsistence In Tsehlanyane And Bokong In Lesotho. Economic Botany 57(4), pp. 619-539.

Lesotho Electricity and Water Authority (2017). Approved Tariffs. http://www.lewa.org.ls/tariffs/Approved_2017-18_Electricity_Charges.pdf. Last accessed: 1st April, 2018.

National Environment Secretariat (2002). Lesotho Second State of the Environment Report for 2002.

Price C.W. and Pham K. (2009). The impact of electricity market reform on consumers. Utilities Policy 17, pp. 43–48.

ProBEC (2009). Programme for Basic Energy and Conservation - Basic Energy Facts: Malawi Profile.

Rural Electrification Unit (2017). Annual Report for 2016/17. REU, Maseru.

Taele B. M., Mokhutsoane L., Hapazari I., Tlali S.B. and Senatla M. (2012a). Grid electrification challenges, photovoltaic electrification progress and energy sustainability in Lesotho. Renewable and Sustainable Energy Reviews 16, pp. 973– 980.

Taele B. M., Mokhutsoane L., Hapazari I. (2012b). An overview of small hydropower development in Lesotho: Challenges and prospects. Renewable Energy 44, pp. 448-452.

Tanguy B. (2010). Impact Analysis of Rural Electrification Projects in Sub-Saharan Africa. The World Bank Research Observer Advance Access.

Winkler H., Simões A.F., La Rovere E.L., Alam M., Rahman A., and Mwakasonda S. (2011). Access and Affordability of Electricity in Developing Countries. World Development 39 (6), pp. 1037–1050.

World Bank (2018). Annual inflation rates reports. https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=LS&page Last accessed: 20th March 2018.