Charcoal and LPG users

Minor Field study in Nyalenda, Kisumu, Kenya

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Summary

Charcoal is the main cooking fuel in urban regions of Kenya. The production and consumption contribute to several environmental, economical and health issues. This Minor Field study aims to find the possibilities and boundaries of implementing liquefied petroleum gas (LPG) and Biogas in an un-planned suburb to Kisumu. The target group consists of current charcoal and LPG users, and quantitative surveys were used as the main tool for conducting the study. The results show that, charcoal users cook food for a larger number of people than LPG users. LPG is cheaper than charcoal if used in a small sized household consisting of 2-4 people. Charcoal users cook a variety of foods with charcoal which include long time cooking (more than an hour) while LPG is mainly used for short-time cooking (less than an hour). One of the main findings was that both charcoal and LPG usage is needed in order to meet the eating habits of long-time cooking, and make the cooking fuel expenses as low as possible. The primary obstacle for implementing biogas, according to the interviewees, is the initial costs, while the foremost possibility is the awareness of biogas and positive attitudes towards an implementation.

1. Introduction

In Kenya, solid fuels (firewood and charcoal) and liquid fuels (kerosene and Liquefied Petroleum Gas) are the key energy sources for household cooking. Charcoal alone stands for 87 % of the urban cooking fuel demand where the majority of the users are low income households. The production of charcoal is prominently unsustainable, meaning that trees are not replanted after harvest. The production also has an illegal status, which among other factors, contribute to a high price of charcoal (UNEP 2006). Only in Kenya 110 million trees are used for charcoal production every year which leads to negative environmental consequences on a local to global scale. Such consequences are deforestation causing soil erosion, change in precipitation patterns and leaching of soil nutrients leading to eutrophication in the downstream recipients. The smoke from burning wood fuel also contributes to air pollution and induces health problems for the inhabitants, especially woman and children (Laichen & Wafula 1997). However, usages of other cooking fuel alternatives, such as liquefied petroleum gas (LPG), have increased in the mid and high income urban households. Between 1995-2002 household LPG cylinders increased from less than 50 000 to over 700 000 cylinders throughout the country (UNEP 2006). Nevertheless, promoting LPG is a short term energy solution considering that it is a fossil fuel. Renewable alternatives are therefore necessary in order to meet the cooking fuel demand and decrease environmental and health issues. Biogas, a renewable energy source is produced locally in many parts of Kenya (Jingura & Matengaifa, 2007). It is derived from organic waste such as sanitary waste, animal faeces and crop residues and can be used for heating water, power electrical generators and as cooking fuel. There are many advantages with biogas production for example reducing public health problems caused by poor sanitary waste management. The waste product (slurry) from the biogas processing, can also be utilized for agriculture (Akinbami et. al. 2000).

1.1 Study Area

Nyalenda, an unplanned suburb, to Kenya's third largest city Kisumu in the Nyanza Province (see figure 1*)* was chosen as the area of study due to that it is an urban area where the majority inhabitants use charcoal as cooking fuel**.** The area is situated between Kisumu town and The Victoria Lake, and is densely populated due to its proximity to the city centre and relatively inexpensive rental houses. It has more than 50 000 inhabitants which makes it one of the largest informal urban settlements in Kisumu. Its rapid urbanization implies pressure on sanitation infrastructure and environment. Today the area lacks garbage management and proper sanitation. Some houses have electricity and the majority of the inhabitants have access to drinking water through water vendors (Brunsell et. al. 2003).

Figure 1: Map of the Provinces in Kenya. Kisumu, the study area, is encircled in bold. The areas of charcoal production which is transported to Kisumu is situated in the larger circle (Architectafrica 2009-09-16).

1.2 Charcoal usage, production & transport, Nyalenda

Charcoal is the dominating energy source in Nyalenda while fire wood is seldom used due to fire restrictions in rental houses. Some of the charcoal users have the possibility of using LPG in their home because they have been able to save money for the initial costs of LPG, however, they are only a minority.

According to ESD (2005), there is no law that declares charcoal production and transportation to be illegal. Further, if a land owner wishes to cut down the trees on his/her property, there is only a policy that advices the owner to retreive a permit from their community leader. However, statements by Kenyan politicians concerning charcoal production have created an uncertainty among the charcoal producers and transporters and many believe that charcoal production is illegal. Nevertheless, there are charcoal producers who cut down trees without owning the land which is illegal. This has most likely contributed to the general illegal status that charcoal production has today (Anejo 2009[1]).

The charcoal, which is sold in Kisumu, is transported from other provinces in Kenya, such as the Central province, Baringo, Eldoret and Narok (Mau forest) in the Rift Valley province and the islands in Uganda, see figure 1. The long transports, high fuel costs and corrupt police officers that require bribes from the charcoal transporters contribute to the high price of charcoal. The price of charcoal also increases during the rainy season, due to that damp timber aggravates the burning process for charcoal production. In summary, the production and price of charcoal is affected by many factors and the availability for end users is therefore uncertain.

1.3 LPG usage, production and transportation, Nyalenda

LPG is found in oil- and natural gas fields, as well as, a bi-product from refinement of certain crude oils. When a natural gas field is tapped, propane and butane gases are liquefied and removed as liquefied petrolium gas. LPG is stored in pressurized tanks, in which the gas sustains as liquid. Further, the cylinders are transported and distributed to other regions. In Kenya the gas is extracted from the east coast of Africa and transported to Kisumu in cylinders (Wachira 2004). LPG is used among a minority of households and they all belong to mid and high income households in Nyalenda. Most LPG users also cook occasionally with charcoal.

1.4 A current biogas project in Nyalenda

An organization called Umande Trust, specialized on water and sanitation, focus on bio-sanitation in Nairobi. The organization co-ordinates local groups to construct bio digesters that are connected to public toilets. Further, Umande helps to solve human waste problems and create alternative cooking fuels in the slums of Nairobi. In 2002, Umande initiated a biogas project on the border of zone A and B in Nyalenda (see figure 2a). The construction of a biogas digester is in process in a school yard called Pandi Pieri catholic centre. However, the project has temporarily ceased due to lack of resources from Umande. Nevertheless, in this study, the biogas project in Pandi Pieri has been used in order to learn about the charcoal user and LPG users' awareness of biogas.

[1] Luka Anejo, Oral communication, International Centre for Research on Agroforestry, Kisumu, Kenya. 2009-06-01

1.5 Project

In December 2008 the Swedish company *Miljögiraff* initiated a student project aimed to investigate the possibilities and boundaries for switching from charcoal usage to gas usage in Nyalenda. Another aim was to inform the local community about the benefits with using LPG/biogas for cooking. *Miljögiraff's* long term vision is to implement biogas technology which will make the inhabitants less dependent on charcoal and lead to a more sustainable living in Nyalenda. Further, LPG could be a first step towards the implementation of biogas because there are similarities for usage of the two cooking fuels. Gas usage also has the potential to decrease the environmental consequences of charcoal production as well as reduce health threats from charcoal consumption.

The focus for this minor field study was to study the household use of charcoal and LPG and their awareness of different cooking fuels. We consider the users being a key to identify boundaries and possibilities for the biogas project because they are potential users for biogas. The study is mainly based on interviews with local users.

The project was conducted in co-operation with two students from Kungliga Tekniska Högskolan, Anna Bondensson and Maria Udén focus involved mapping the potential key stakeholders for implementing of LPG/biogas and investigating on the relationship among them. For further reading see their report: *Strategy for practical transformation from charcoal infrastructure for cooking. – Baseline study for implementing biogas in Nyalenda, Kisumu.*

1.6 Aim

The aim of this survey and report is to:

- collect data on the economical aspects of charcoal and LPG consumption and compare the costs of the two energy alternatives.
- gain knowledge about the general attitudes regarding usage of charcoal, Liquefied petroleum gas (LPG) and biogas among charcoal and LPG users in Nyalenda, Kisumu.
- formulate potential boundaries and possibilities for implementing gas usage in Nyalenda with focus on charcoal and LPG users.

1.7 Focus area

Nyalenda is divided into two administrative areas; zone A and B (Brunsell et. al. 2003). The focus of the minor field study was directed to Nyalenda zone B only (see figures 2a and 2b) due to lack of time for studying both zones and a desire to conduct a detailed investigation. The study mainly focused on charcoal users because they are a majority, as oppose to LPG users (a minority). Nyalenda zone B has more than 27 000 inhabitants which is more than half of the entire population in Nyalenda.

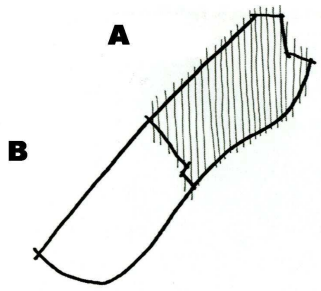
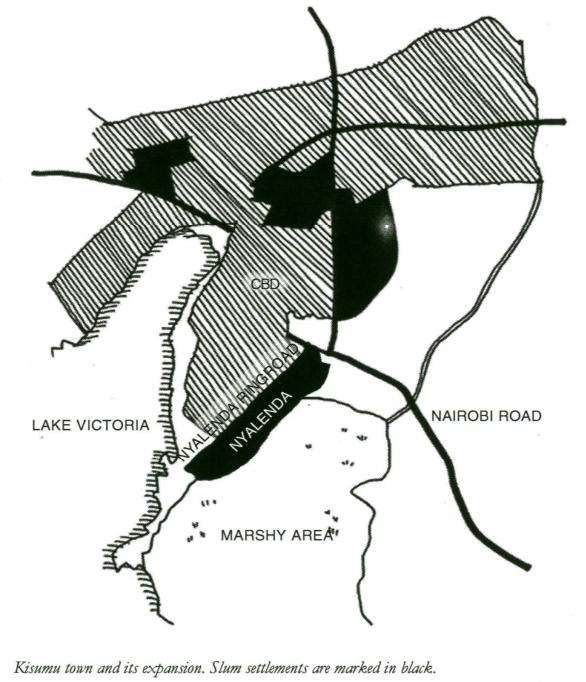


Figure 2a: Illustration of Nyalenda zone A and B.



Kisumu town and its expansion. Slum settlements are marked in black.

Figure 2b: Kisumu town. Slum settlements are marked in black (Brunsell et. al. 2003).

2. Method

2.1 Literature Review

A literature study (scientific articles, web pages, reports and books) was made about charcoal production, environmental degradation, health issues regarding charcoal and LPG production and usage. A background study was also made regarding the potentials of biogas production and preparation for the interviews was made through literature studies regarding practical interview techniques.

2.2 Interviews

- Pilot-interviews

Qualitative research seeks to understand the world through interacting, empathising with and interpreting the actions and perception of its actors. Data is collected in its natural settings rather than artificial and constructed contexts. Theories are therefore built up from observations rather than testing already existing theories (Kvale 1997). In this study eight semi-structured qualitative interviews concerning charcoal & LPG usage were conducted in Nyalenda zone B. These interviews functioned as a guide for constructing quantitative surveys for charcoal and LPG users.

- Quantitative interviews

Quantitative research starts off with a theory that is tested through collection empirical, spatial and quantifiable data which in turn can be statistically tested. Further, quantitative interviews (surveys) generates better statistical data than qualitative interviews due to that a greater number of people can participate under a shorter amount of time and more raw data is produced (Scheyvens & Storey 2003). In this study, thirty quantitative surveys with pre-formulated answers, for charcoal users, were conducted in Nyalenda zone B. Each interviewee represented their household and a requirement was that the interviewee

was responsible for cooking in the household. The majority of the charcoal interviewees were students in their 20's and middle-aged women working as street vendors. Finally, five LPG surveys were conducted in the same way as the charcoal surveys.

2.3 Structure of report

The following text is divided into five main parts:
- Charcoal users
- LPG users
- A comparison of charcoal & LPG
- Biogas
- A discussion concerning the economical, social and environmental possibilities and boundaries

The survey involved questions about LPG and biogas. In this report the word gas refers to both cooking fuels. The results from the charcoal surveys were calculated in percentage and presented in graphs and charts. However, percentage calculations for the five LPG surveys were not done due to the small amount of participants. These results were presented in texts instead of graphs and charts.

3. Results & Findings

3.1 Charcoal users

In this study charcoal users are defined as people who use charcoal as cooking fuel at least 4 times a week. Each interviewee represents the household they cook for.

3.1.1 The household – size & income

A household is defined as the amount of persons that eat lunch and dinner in the house. The survey found that the number of people in a household ranges between 2-9 people and the average numbers of people in a household consists of 5 people. The majority (57%) of the household's weekly income ranges between 0-2000 Ksh[2] which is the equivalent to 0-27 USD/week (Convertworld, 2009-09-04).

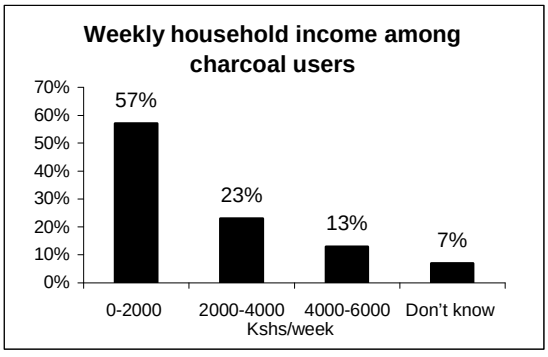


Figure 3: Weekly household income among charcoal users.

[2] The currency for Kenya is Kenyan shilling, the abbreviation is Ksh.

3.1.2 When buying charcoal

Charcoal is transported by charcoal Lorries (trucks) to Nyalenda and sold off the trucks to local street vendors and to private people. There are two units which charcoal can be bought in: tins and sacks. The majority (57%) of the users buys their charcoal in tins (35 ksh/tin) due to the high onetime cost of a sack (700 Ksh/sack). However, the calculated price per kilo reveals that it is much cheaper to buy charcoal in a sack (16.3 Ksh/kg) compare to in a tin (35 Ksh/kg) see table 1. When buying a tin the amount of charcoal you get is approximately 1 ¼ tins weighing 1 kg. In this study, a tin is defined by this amount of charcoal. A sack weighs on average 43 kg. The weight and the quality[3] of the charcoal vary depending on the production procedure and the tree specie. The weight of a tin/sack can therefore vary. See table for weight of charcoal from a charcoal vendor in Nyalenda zone B.

Table 1: weight and price of charcoal for a tin respectively a sack

	Weight (kg)	**Price (Kenyan Shilling)**
Tin	1	35 (35 Ksh/kg)
Sack	43	700 (16.3 Ksh/kg)

According to this survey, the majority (70%) of the charcoal users buy their charcoal from different vendors and, most frequently (60%), from local street vendors in Nyalenda or local markets in Kisumu. This means that neither the users nor the vendors are dependent on a specific vendor/customer.

3.1.3 Cooking routines

Charcoal is burnt in a jiko (The Kenyan ceramic jiko), a portable stove shaped like an hourglass. This stove is constructed of metal but has a ceramic lining in its top half which is perforated with small holes. The bottom half works as a container for the ashes. The ceramic lining is where you place the charcoal and to let the ashes fall into the bottom of the jiko.

77 % cook with charcoal inside their house, the remaining 23 % cooks both inside and outside.

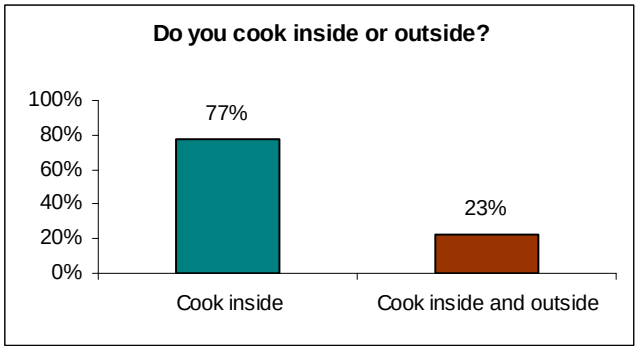


Figure 4: Users cooking inside or outside the house

[3] Quality can be defined by the wood density & combustion temperature during production

There are two types of cooking routines used in this survey: short-time cooking and long-time cooking. Short-time cooking is conducted for meals prepared in less than an hour. Ugali and sukumawiki are traditional corn flour and vegetable meals which only need shot-time cooking. Long-time cooking is conducted for meals prepared in more than an hour e.g. beans and raw maize. The results from the charcoal surveys indicate that charcoal is used for both long-time and short-time cooking, however, the majority of the meals (68 %) are prepared using short-time cooking. Long-time cooking requires on average three times as much charcoal compared with short-time. This explains why long-time cooking is less frequent than short-time cooking.

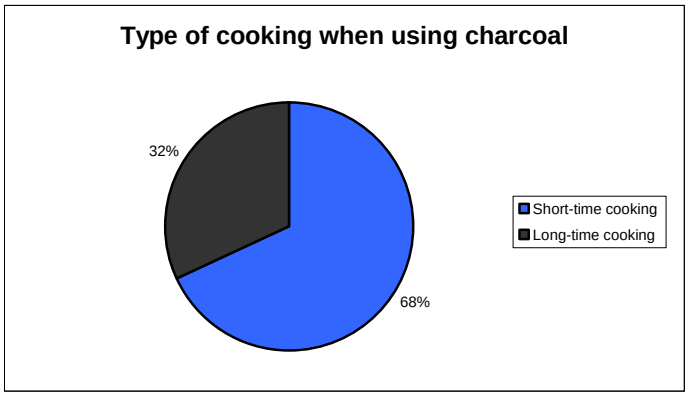


Figure 5: indicate type of cooking when using charcoal

3.1.4 Actual charcoal consumption

A household using tins consume on average 6.3 tins / week (6.3 kg) which covers on average of 12.1 meals / week. Hence, a tin of charcoal covers almost two meals according to the tin users. A household using sacks consumes on average 0.24 sacks / week (10.2 kg) which covers on average 10 meals / week. These result shows that sack households use almost double the amount of charcoal per meal, see table 2. A possible explanation to this difference in charcoal use per meal is that households buying charcoal in sacks use it in a more wasteful way. Another contributing factor may be that sack households cook more long-time cooking than tin households.

Table 2: Actual charcoal consumption per household & meal coverage

	Tin consumers	**Sack consumers**
Charcoal consumption/week	6.25 tins/week (= 6.25 kg/ w)	0.24 sacks /week (=10.2 kg/ week)
Amount of meals / week	12.1 meals/w	10 meals/w
Meal coverage / kg of charcoal	Ca 2 meal/kg	Ca 1 meal/kg

3.2 Attitudes regarding Charcoal usage

3.2.1 Advantages/disadvantages with charcoal

Every interviewee could have several answers to one question when asking about different attitudes. Hence the total percentage from all categories adds up to more than 100%.

The four mayor advantages with charcoal usage compared to LPG usage according to the charcoal users are that it is: cheap, suitable for cooking different types of food, fast when cooking and that heat is evenly distributed in the jiko. The remaining advantages are presented in figure 6. The mayor disadvantage with charcoal usage are according to the interviewees: health threat like CO intoxication and smoke production from charcoal combustion as well as human injury and degradation of house interiors. The remaining disadvantages are presented in figure 7.

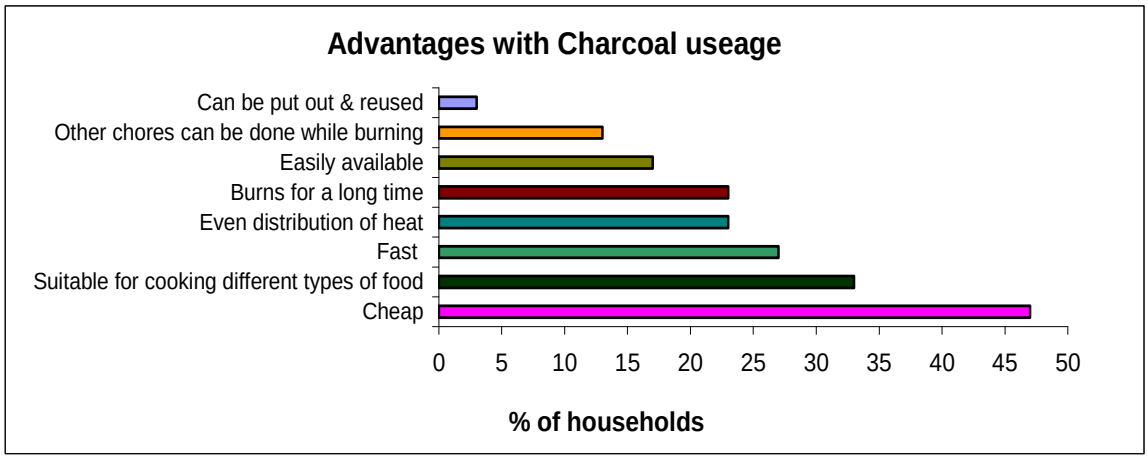


Figure 6: Advantages with charcoal usage

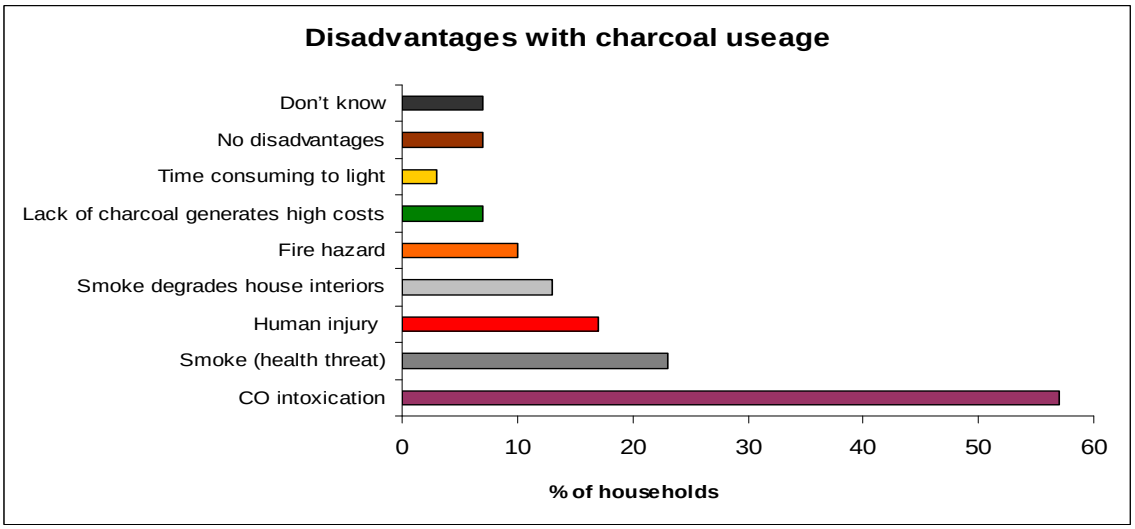


Figure 7: Disadvantages with charcoal usage

3.2.2 Health

63% of the charcoal users claim that their health has not been affected by charcoal combustion while cooking, though 58% considered the health aspect as the most important disadvantage with charcoal usage. The following ailments were mentioned by the persons who claim that their health has been affected by charcoal combustion:

- Cough
- Respiratory problems
- Eye problem
- Headache
- Dizziness
- Sore throat

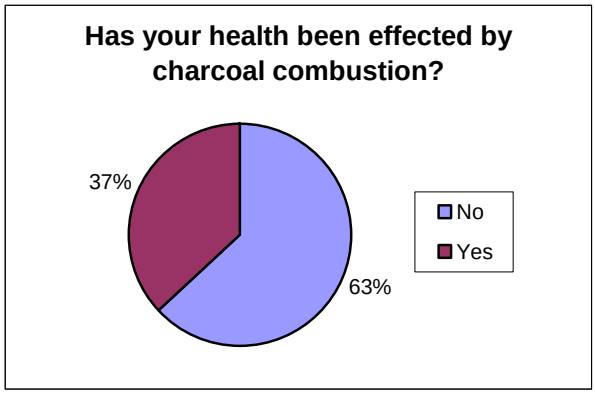
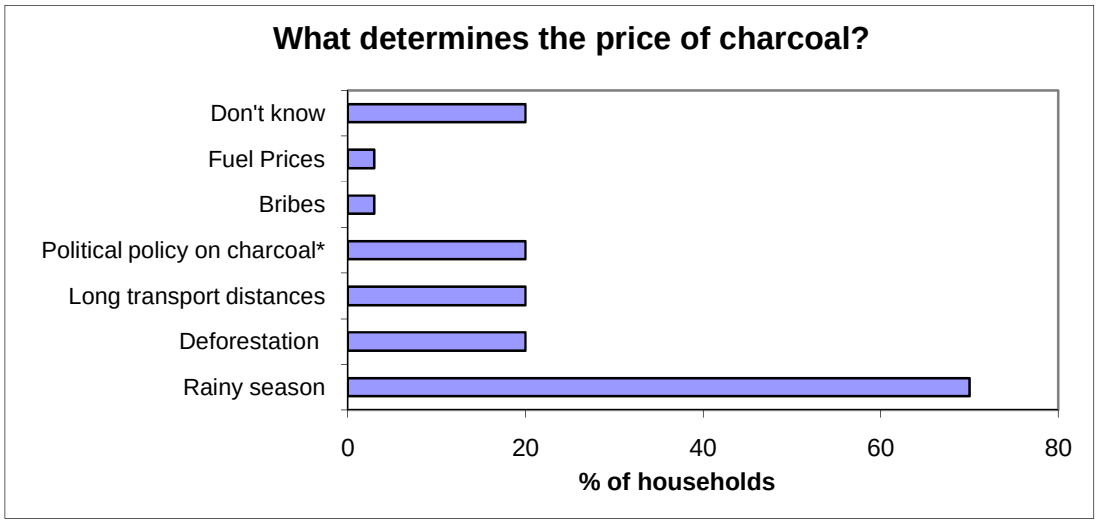


Figure 8: Opinion on health affect of charcoal combustion

3.2.3 User's opinion about charcoal price

According to the interviewees the rainy season is the dominant factor that decides the price of charcoal (figure 9). Every household could have more than one answer.



*Obstructed production/transportation due to the illegal status of charcoal

Figure 9: Opinion on charcoal price

3.2.4 User's opinion about deforestation

According to 67% of the interviewees the major consequence of cutting down trees is less precipitation in Kenya.

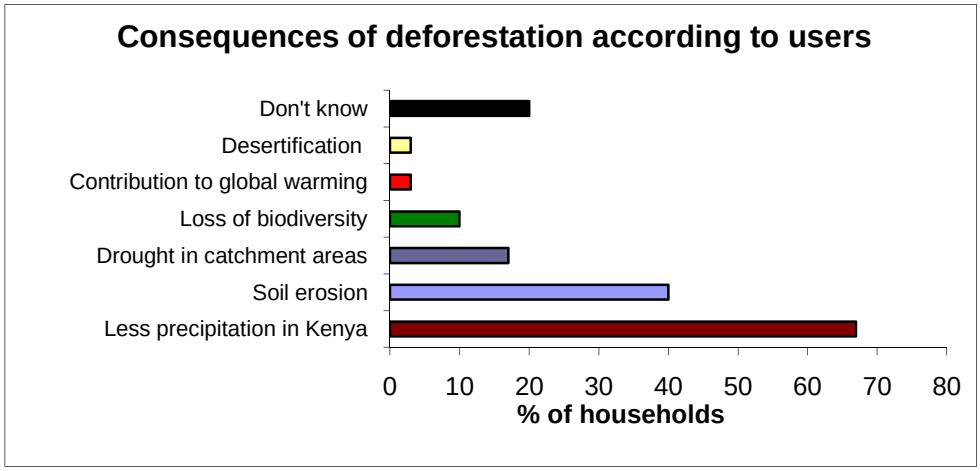


Figure 10: Consequences of deforestation according to users. Every household could have more than one answer.

3.3 Current LPG usage in Nyalenda

LPG is used among a minority of households in Nyalenda and primarily in households with a mid to high income. Some charcoal users, with a higher income than the average charcoal users, have the possibility of using LPG due to the fact that they can afford it to some extent.

In Nyalenda there are no vendors selling or refilling LPG cylinders. Therefore, LPG users have to travel to the city centre of Kisumu when they wish to refill their cylinder.
For LPG usage, a cylinder and burner or grill, depending on the size of the cylinder, is needed. There are different sizes of cylinders:

- 6 kg (grill)
- 13 kg (burner, pipe and regulator)
- 25 kg (burner, pipe and regulator)
- 35 kg (burner, pipe and regulator)
- 50 kg (burner, pipe and regulator)

For a 6 kg cylinder a grill is required and placed on top of the cylinder. For a 13-50 kg cylinder a burner, regulator and pipe is required. The regulator regulates the gas flow and the pipe connects the burner to the cylinder.

There are six LPG companies that use Supermarkets and petrol stations as reseller. The LPG companies sell specialised cylinders, meaning that once the user has chosen company the cylinder can't be refilled by another LPG company.

3.3.1 LPG usage among charcoal users

Among the charcoal users 26% have considered using LPG and 26% are currently using it.

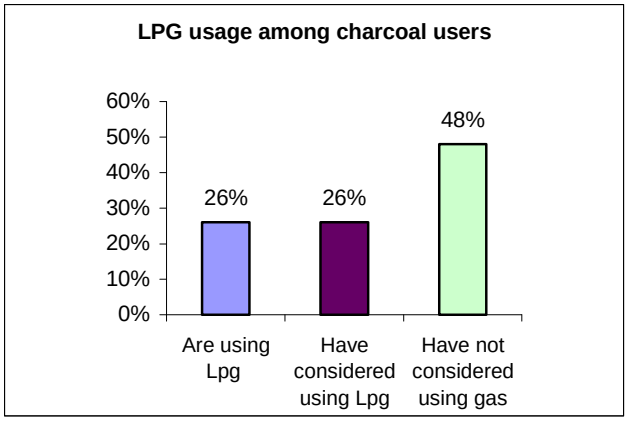


Figure 11: LPG usage among charcoal users

The motives for wanting to use LPG among those who've considered using LPG are:

- Cheaper in the long run
- The food cooks faster
- No smoke from gas combustion

The motives for why 26% of the charcoal users have considered to use LPG but have not done so are:

- The initial costs are too high
- Risk of explosion

3.3.2 Public gas stove

Installing a public gas stove in Nyalenda, which can be used by anyone, could be a good pilot project in order to demonstrate how to use a gas stove and spread information about the usage. People could pay an amount of money for cooking by the gas stove. When asking charcoal users if they could consider using a public gas stove 47 % of them where positive. They considered an option of preparing lunch fast during the day when people are busy with work, as a good motive for using public stoves.

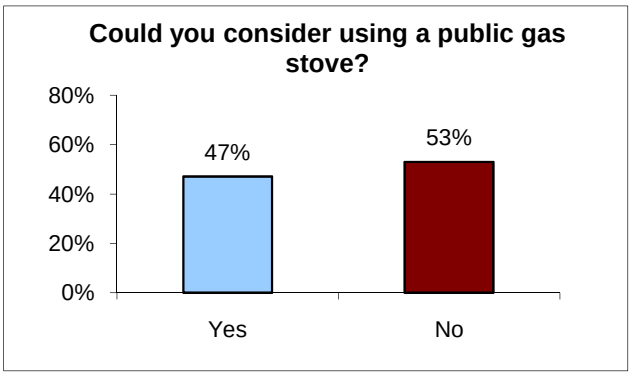


Figure 12: indicates whether charcoal users could consider using a gas stove.

The motives among the 53 % that replied no to the question of using a public stove were:

- People cook at the same hours during the day which might cause a queue to the gas stove and create irritation between different households.
- Not wanting pass-buyers to see the food cooked causing jealousy of the food between different families.

3.3.3 LPG usage among LPG users

The following results are derived from the 5 household interviews conducted among LPG users in Nyalenda zone A. The LPG users required to cook a minimum of 3 meals / week using LPG.

The household – size & income

The LPG users cook for 2-4 persons which show that families using LPG are smaller than families using charcoal. On average, LPG users cook for 3 persons which are less compared to the charcoal survey (average of 5 people). The gas user's average weekly income for a household is 3000-4000 shilling.

When buying

The LPG users can refill their cylinders in different places. Places mentioned in the interviews are supermarkets like Nakumatt megaplaza and Ukwala (Located in the centre of Kisumu), Total petrol station, Kobil petrol station and Kal petrol station. The survey shows that two out of five people always buy LPG from the same LPG vendor. All LPG users could also considers buying LPG locally in Nyalenda if somebody would start selling gas.

When consuming

The amount of meals cooked with LPG per week ranges between 12-21 meals. The remaining meals were cooked with charcoal, kerosene or paraffin. The amount of meals per week for each of the involved households is presented in table 3. To get an overview of the amount of meals per week we calculated an average (13,8 meals) which also is presented in the table below.

Table 3 the table present the amount of meals cooked with LPG as an energy source.

Cooking with LPG	
Meals/week	**Household number**
21	Household 1
14	Household 2
12	Household 3
20	Household 4
20	Household 5
Average of meals per week=13,8 meals per household	

Money spent on LPG

In order to compare the price of charcoal to the price of gas, **cost per meal** was calculated for charcoal and LPG.The comparison is presented in 3.5.

The following calculation presents the price per meal for LPG. Enquiries were made about amount of:

- meals cooked per week
- how often the users refills the cylinder
- size and price for refilling a cylinder

The table below presents the money spent per meal for every individual LPG household. The cost per meal ranges between **8-15 ksh/meal**.

Table 4 the table presents price per meal for every individual household. The costs per meal are calculated by using the prices from the company that every individual household uses.

Household	LPG Company	Size	Cost per meal
Household 1	Total	Cylinder: 6 kg	8 ksh/meal
Household 2	Kobil	Cylinder:6kg	11,3 ksh/meal
household 3	K-gas	Cylinder:6kg & 13 kg	10 ksh/meal (6 kg) 8,9ksh Ksh/meal (13 kg)
Household 4	Triton	Cylinder:13 kg	15 ksh/meal
Household 5	Total	Cylinder: 25 kg	15 ksh/meal

3.3.4 Distribution system

Three out of five users are satisfied with the current LPG distribution system. One of the interviewee explained that the LPG companies sell specialised cylinders (can be compared to a monopoly on LPG). All the interviewee answered that you are not able to refill your cylinder by another LPG company, hence the customer is forced to be loyal to one LPG Company.
Concerning reliability for LPG resellers, one out of five interviewees has experienced half full cylinders when refilling at a local LPG vendor. An LPG vendor is mainly selling LPG to the end consumer, and not producing it. According to the interviewee petrol stations and supermarkets always fill up the cylinders and are therefore more reliable than local gas vendors. Four out of five have not experienced half full cylinders and if it has occurred they were not aware of it.

3.3.5 LPG users cooking with charcoal

Four out of five LPG users are using charcoal 1-2 times per week as a complement to LPG. They use charcoal for long time cooking (more than an hour) because they consider it to be too expensive to use LPG for this purpose. LPG users cook maximum 3 long time meals a month using LPG and a majority of the users (three out of five) never use long time cooking with LPG.

3.3.6 Knowledge about LPG usage

People have gained information about LPG and how to use it from friends and family. A minority of the LPG users have learned about LPG usage through media and from reading the instructions (one out of five interviews). Experience in how to use the gas stove has also been gained by the daily LPG usage at home and one of the interviewees has learned it through school.

3.4 Attitudes regarding LPG usage among Charcoal and LPG users

46% of the charcoal and LPG users are positive to LPG, 28.5% are negative to LPG usage and 17% consider LPG usage as both positive and negative.

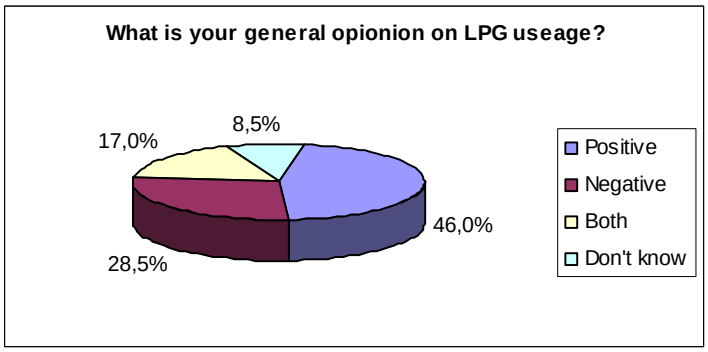


Figure 13: Attitudes on LPG usage among charcoal & LPG users

What is positive with using LPG?

The survey show that LPG and charcoal users consider LPG to be faster when cooking than with charcoal and is therefore timesaving. The majority of the LPG users have not experienced any problems when using LPG. Other reasons for using LPG are:

- More Environmental friendly than charcoal
- Cheaper in the long run
- Easy to use
- Available
- Clean (No smoke)

What is negative with using LPG?

The risk of an explosion when using gas seems to be an overall concern among charcoal and LPG users. For a safer usage the interview had some suggestions:

- Adding an instruction manual when buying gas as well as oral information from the gas companies.
- To place the cylinder further away from the burner/stove to decrease the risk of injuries in case of an explosion.

The mentioned suggestions above on how to make the usage more safe was mentioned by one out of five LPG users. Two out of five people didn't feel insecure or scared when cooking with gas and three out of five did feel insecure or scared.

Other negative arguments for LPG usage are:

- Fire hazard
- Expensive
- Gas usage requires knowledge about how to use it
- Not fast if you want to boil water

3.5 Comparison – charcoal vs. LPG

3.5.1 Attitudes regarding costs among charcoal users

The majority (53%) of the charcoal users considered charcoal to be cheaper than LPG. 43% considered LPG to be cheaper than charcoal and 33 % did not know.

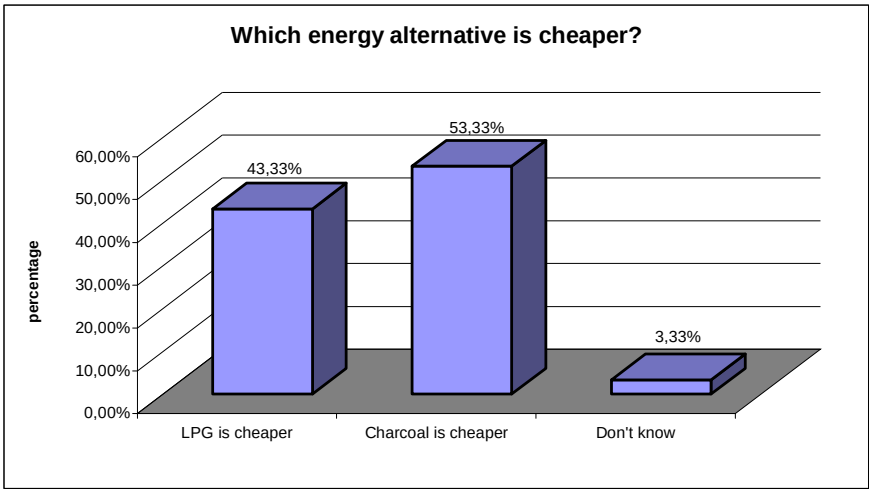


Figure 14: Attitudes on price of charcoal and gas among charoal users

3.5.2 Price comparison – charcoal vs. LPG

According to the current study charcoal users are mainly low-incomers while LPG users have a considerable higher income. LPG users earn at least 1000 ksh (13.68 USD) more per week compare to a charcoal user.

Initial costs – a comparison of LPG and charcoal

The numbers of years a gas stove/ jiko can be used before it breaks is dependent on maintenance.The LPG users claimed that a gas stove can last 5 -50 years. Among the charcoal users, a majority believed that a jiko will last less than 2 years. The minimum initial cost for LPG usage (including a 6kg cylinder, refill and grill) is 4315 ksh. The refill can last for 1, 5-2 months depending on the amount of meals being cooked during that time and number of people in the household. The minimum refill cost for a 6kg cylinder is 850. The initial costs for charcoal usage (a jiko) ranges between 150-400 ksh depending on the size of the jiko. Hence, the initial cost is almost ten times higher for LPG users than charcoal users.

Example of initial cost for number 1 using LPG.
6 kg cylinder are refilled by Household 1 every 1 ½ month and covers for 84 meals/month (21 meals/week).
Cost for refill is = 985 Ksh
Cost for cylinder is= 2875 ksh
Cost for grill is=1265 ksh
Total initial costs are = 5125 ksh
After the initial costs only refill are needed. This result of cost per meal is 8 ksh/meal and a weekly cost of 168 ksh/meal.

Cost per meal – a comparison of LPG and charcoal

The following calculations present a comparison of the cost per meal for LPG and charcoal usage. Separate calculations were made for households buying charcoal in tins respectively sacks. A calculation on average money spent on charcoal and LPG per week is also presented in table 5.

The following calculation was made from enquiries about amount of:

- meals cooked per week
- tins or sacks bought per week / how often cylinders are refilled
- price of tin and sack/ size and price for refilling cylinder

Table 5: The table shows the average price for a meal when cooking with charcoal compared to the prize when cooking with LPG.

	Price per meal	**Money spent on charcoal and LPG (weekly)**
Tins	17,4ksh/meal	210 Ksh/week (covers 12.1 meals/ week
Sack	16,8 ksh/meal	168 Ksh/week (covers 10 meals/ week)
LPG	8-15 ksh/meal	120-300 ksh/week (cover 14-21 meals/w)*

* because of a low number of LPG users, a range for costs were more suitable than an average calculation.

The results in table 5 indicate that the cost per meal for LPG usage varies a lot between the LPG households. The cost per meal, is however, lower for LPG users (8-15 ksh/meal) compare to charcoal users (16.8-17.4 ksh/meal). According to the result there is a minimum difference of 1.8 ksh between the two energy alternatives.

3.6 Attitudes about biogas among charcoal and LPG users

The awareness about biogas seems to be higher among LPG users in Nyalenda than among charcoal users. All LPG users knew about biogas while 60% of the charcoal users had heard about it. 49 % among charcoal and LPG users don't know whether they have a positive or negative view about biogas. However, 31% are positive about biogas usage and only 9% are negative. The major advantages and disadvantages according to the charcoal and LPG users are presented in figure 15 and 16.Regarding the biogas project in Pandi Pieri, the majority (88.5%) of the LPG and charcoal users have not specifically heard about the project in Pandi Pieri.

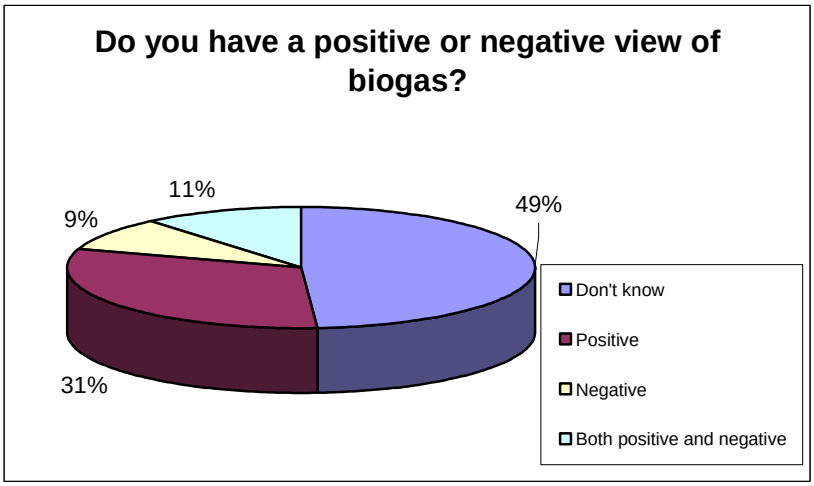


Figure 15: Opinion about biogas among LPG user and charcoal users

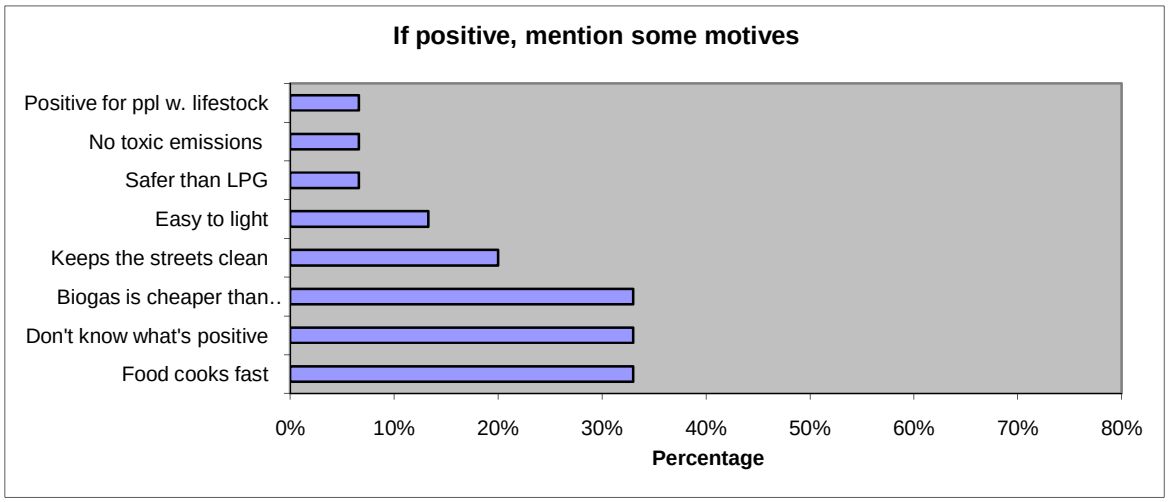


Figure 16: Opinion among 31% of the charcoal and LPG user who are positive

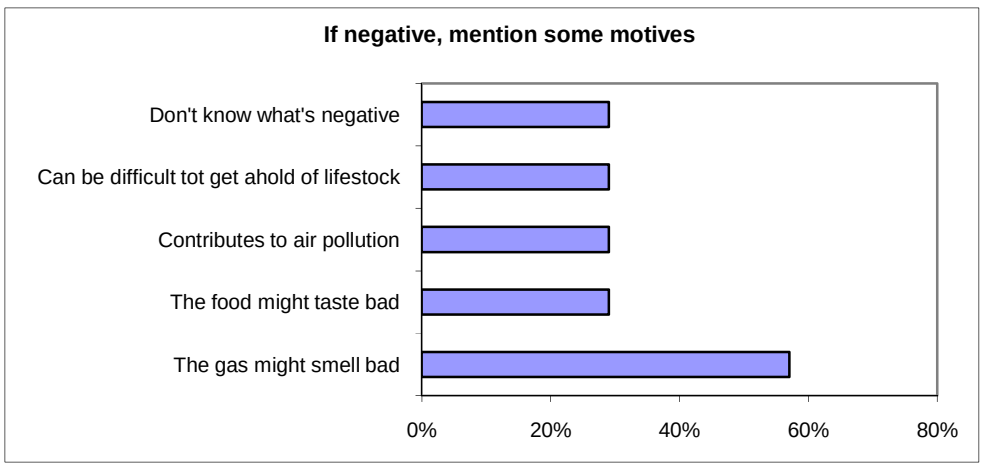


Figure 17: Opinion among 9 % of the charcoal and LPG user who are negative

The greatest obstacles for implementing biogas usage according to LPG users are:

- Cost (e.g. construction cost of biogas plant and users consumption cost)
- Lack of knowledge about biogas

3.7 Spreading Information in Nyalenda

According to LPG and charcoal users there are several possibilities for distributing information in Nyalenda:

- Informing women – there are established woman groups in Nyalenda
- Informing all different types of inhabitant's not only rich people
- Seminars
- Posters
- Informing in groups and asking the individuals to continue to inform others
- Informing on importing meeting points as schools and churches
- Demonstrating how to use biogas

4. Possibilities and boundaries for implementing LPG and Biogas

4.1 Economical

Boundaries

Household size and income

Charcoal users generally have larger household sizes and lower income compare to LPG users. The general impression from the surveys is that LPG is more expensive for a big household (more than 4 people) compared to a small household. This may restrict LPG usage among many charcoal users, since the charcoal households have a household size of more than 4 people.

Costs for users

The results prove that one of greatest hindrance for LPG usage, among charcoal user, is the high initial one-time cost. Further, we found that the opinion on whether LPG is cheaper than charcoal varies among charcoal users and LPG users. The majority of charcoal users consider charcoal to be cheaper than LPG which could be a boundary for getting people to use gas. The transportation cost for buying and refilling a cylinder can also be seen as an obstacle.It is therefore important to emphasize at a long term cost perspective - that gas can be just as cheap as charcoal.

Freedom to choose LPG Company

When new on the market, LPG companies start with relatively low price in order to get customers (Opiyo Olale) [4]. After establishment on the market they raise the price. In addition, once an LPG user has chosen LPG Company their cylinder can't be refilled by another company. Hence, companies are not competing among the current LPG users since LPG users usually can not afford to buy new cylinders every time they want to change company. In order to get competition on the LPG market it is necessary to offer cylinders that can be refilled by different LPG companies. Currently, this system does not give the freedom to choose a company with lower costs. Another hindrance is the reliability of LPG vendors, sometimes they fill the cylinders only by half although the customer pays full price which can have a big influence on whether it is cheaper to use LPG than using charcoal in the long run.

[4] Joseph Opiyo Olale. Oral communication, friends pioneer 2009.

However, from the result, in paragraph *3.3.4 Distribution system,* we can draw the conclusion that it is reliable to buy gas from the big supermarkets and petrol stations, compared to local LPG vendors.

LPG Vendors
There is no LPG business in Nyalenda. It is most probably because of the low number of LPG users. In order to sell LPG, a license is required and the vendor has to prove that the business is safe, In addition the bad reputation of vendors may influence the possibilities to start a small LPG business in Nyalenda.

Possibilities

Awareness of production and price of charcoal
The survey found that people are aware of the external factors, such as rain and political policy which effect charcoal production/transport and the price of charcoal. These factors can be emphasized when promoting gas as a better alternative.

Type of cooking (short-time/long-time)
Charcoal emits heat for more than 20 minutes and is therefore suitable for short-time and long-time cooking. LPG users prefer LPG when cooking short-time cooking because it's easy to light and reaches maximum heat faster than charcoal. Therefore, LPG is a possibility for charcoal users to reduce time spent on cooking. However, long time cooking with LPG is very expensive because it requires a lot of gas. This proves that promoting a combination of charcoal and LPG usage may be necessary if people wish to continue long time cooking (where charcoal as cooking fuel is the most economical).

Relationship between vendor and users
According to the results, a vendor is not dependant on a certain charcoal user and vice versa. This is positive when implementing gas usage. If one of them changes to selling or consuming gas there will not be a direct economical effect the vendor/charcoal user.

Costs for charcoal - tins vs. sacks
When buying charcoal in sacks it is only 1 shilling cheaper per meal for tins. The price per meal should be considerably lower for sacks considering that the price per kilo is half of the price per kilo for tins, see table 2. This can be due to sack households cooking more long-time cooking than tin households.

Costs for LPG vs. Charcoal usage – price comparison
The results indicate that the cost per meal for LPG usage varies a lot between the households. This can be explained by the fact that different types of food are cooked among the households. Compared to charcoal, LPG is at least 1.8 ksh cheaper per meal. Although, the initial costs are higher for LPG, the actual consumption costs are cheaper for LPG. Further, once the initial costs are paid off, it is cheaper to in the long run (according to the calculations of price per meal) to use LPG. If LPG would be sold in Nyalenda it could increase the LPG usage which would reduce transportation costs and make it simple more available.

4.2 Social/cultural

Boundaries

Knowledge and fears about LPG/ gas
People that don't use LPG are afraid of using it because of the risk for an explosion; this is due to lack of information about LPG and therefore lack of knowledge. Demonstrating how to use gas stoves and informing about how to use it can solve this problem. LPG companies provide very little information about the actual usage. If the companies educate new customers in how to use the gas stove, the fear and risk of explosion could be minimized according to the LPG users.

Attitudes on biogas
The greatest boundaries for implementing biogas usage according to LPG users are costs and lack of knowledge. Another potential boundary is that some believe that cooking with biogas smells bad. To overcome these boundaries information about biogas need to reach the citizens. Efficient ways of spreading information in Nyalenda, according to the interviewees are informing woman groups, putting up posters and seminars in schools/churches.

Possibilities

Attitudes about LPG usage
During our interviews we got the impression that people seems to be open for new ideas and eager to learn about biogas, which can facilitate spreading information about LPG and biogas. 46% of the charcoal and LPG users are positive towards LPG usage. The LPG users are in general positive towards LPG usage and are satisfied with using cylinders. Therefore it is suitable to distribute biogas in a similar way, since people are familiar with that distribution system. This is a great possibility for encouraging biogas usage.

Public gas stove as demonstration project
A public gas stove could work if people in Nyalenda are willing to share the stove with the rest of the people in the same area. However, due to the negative attitudes and practical problems with a public gas stove, it is probably better to have a demonstration project where people can try cooking with gas. A demonstration project can also be relevant if biogas is implemented.

LPG usage among charcoal users
Another possibility for implementing gas is that some charcoal users are aware of advantages with LPG usage such as fast cooking. Further, 26% of the charcoal users have considered using LPG and 26% are currently using LPG. This is a great possibility for overcoming the negative attitudes and insecurities about gas among the people. As mentioned before, by spreading information about LPG and biogas and having demonstration stations with a gas stove, people can get familiar with the energy source and the usage can spread.

Cooking routines (public gas stoves vs. Health)
The survey estimated that 77% of the charcoal users cook inside although the majority of the users are aware of the health damages, such as carbon monoxide intoxication, that can be caused by charcoal combustion, see figure 7 *Disadvantages with charcoal usage*. According to some, the explanation for cooking inside is to avoid jealousy of the food from by-passers. Some interviewees also anticipated on a fear of by-passers cursing the food. This attitude could be an obstacle for implementing public gas stoves in Nyalenda. However, if a household buy their own gas stove/burner they wouldn't have to worry about cooking outside nor about carbon monoxide intoxication.

Knowledge about biogas
The majority (60%) of the charcoal and LPG users have heard of biogas thanks to information during their years of secondary school. 49 % among charcoal and LPG users don't know whether it's positive or negative, however, 31% are positive about biogas usage and only 9% are negative. Among the people that are positive, some don't know why they are positive; others know that food can be prepared quickly with gas. Further, these results can be seen as a possibility for spreading information about biogas, since some interviewees are already aware of the advantages with biogas. It is also positive that all the LPG users have heard about biogas, considering that they might be first to utilize this fuel. The majority of the LPG and charcoal users have not heard about the project in Pandi Pieri which indicates that information has not been prioritized in that project.

4.3 Environmental

Possibilities
57% of the charcoal users and gas consider the health threat from charcoal as a disadvantage and 67% of the charcoal users are aware of that deforestation leads to decrease in precipitation in Kenya. If these attitudes on environment and health are emphasised when comparing with gas, people may realize that gas has many other advantages apart from the long term economical benefit.

5. Validity of the study

5.1 Is the study representative for the focus area?
It is important to emphasize that this is a small study that is based on results from 35 surveys (both charcoal and LPG) in an area of approximately 27 000 inhabitants (Nyalenda zone B). The interviewees where from different parts of the focus area but the study may not be representative for the whole of Nyalenda zone B.

5.2 Calculations – cost per meal
The validity of the calculations for costs per meal can be questioned since the interviewees seemed unsure of the approximate amount of:

- charcoal/LPG bought per week or month
- Meals cooked per week.

Another calculation that can be questioned is the amount of charcoal used per meal. Some of the households use on average a lot of charcoal because the majority of meals are long time cooking (requires triple amount of charcoal than short-time). Further, this may have increased the calculation for average costs per meal for charcoal. If this calculation was conducted only for short time cooking, the cost per meal for charcoal, may be just as low as the cost per meal for LPG cooking.

5.3 Charcoal users – sacks

In this study, 47 % of the interviewees buy charcoal in sacks, however our general impression from the study, is that buying charcoal in sacks is less frequent when looking at the whole of Nyalenda. The reason for getting a percentage of 47 could be explained by the fact that the interviewees were mostly woman working as street vendors with a relative high income. Because a majority is buying charcoal in tins we recommend to primarily look at the results from tin users when comparing with LPG costs.

5.4 Interviewers influence

Prior to the pilot interviews we thoroughly reviewed the questions in order to avoid leading questions. During the interviews we let interviewee reflect on the question and therefore avoid influence on the interviewees. We also emphasized on that we are students and not from an NGO. However, considering that there are many NGO's working in Kisumu and that many studies that have been conducted in the study area, it is important to keep in mind that the interviewee's answers' may have been prepossessed by impressions they have gotten of foreigners during previous studies in the area. The interviewee may believe that if they answer in a certain way, they can gain something from a potential project. For example 47 % of the interviewees that could consider using a public gas stove were quick at saying yes. In addition, the interviewee may not have primarily expressed their opinion.

It is also in the nature of an interviewee to answer what they suspect that the interviewer wants to hear (Ekholm & Frannsson 1992). This can be applied to questions about their opinion on biogas. If they believe that the interviewer is positive towards biogas, they may answer that they are positive about it without reflecting over it.

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Appendix A

Calculation for AVERAGE charcoal consumption

The survey found that 17 out of 30 households buy charcoal in tins and 13 out of 30 households buy their charcoal in sacks. Further, an average for respective unit was calculated:

TINS (results representing 17 households)

On average a household using tins consumes:

6 tins/week (102 tins per week / 17 household = ca 6 tin/ w)

12.1 meals/week (206.5 meals per week / 17 households = 12.1 meals/week)

0.5 tins/meal (6 tins/12.1meals = 0.5 tins/meal)

This indicates that 1 tin of charcoal can on average be used for cooking 2 meals.
0.5 tins/meal (6 tins/12.1meals = 0.5 tins/meal)

Money spent on charcoal per household

210 ksh / week (6 tins/week x 35 ksh/tin = 210 ksh/week)

17.4 ksh/meal (210 ksh per week /12.1 meals per week = 17.35 ksh /meal)

SACKS (results representing 13 households)

On average a household using sacks consumes:

0.24 sack / week

10 meals / week

0.024 sacks/meal (0.24 sacks/10 meals = 0.024 sacks/meal)

Money spent on charcoal per household:

168 ksh /week (0.24 sacks/week x 700 ksh/sack = 168 ksh per week)

16.8 ksh / meal (168 ksh per week /10 meals per week = 16.8 ksh /meal)

Appendix B

LPG Users

Price for refill was collected from the supermarkets Nakumatt, Ukwala and Yatin situated in the center of Kisumu. Total petrol station and kobil petrol station also sell LPG but because of lack of time no quotation of prices were collected from them.
For our calculations we used quotation of prices from Nakumatt, except for household 2, where the quotation of prices was taken from Ukwala supermarket. The reason why we chose Nakumatt is because they offer a large range of different companies. The other supermarkets don't always have a majority of the different LPG companies available in store, this made it hard to get quotation of prices from Ukwala and Yatin. The reason why the quotaion of prices for household 2 were taken from Ukwala is that the LPG company chosen by household 2 where the only LPG company not available in Nakumatt.

Calculations for costs per meal

Costs per meal ranges between **8-15 Ksh / meal**

Household 1 Gas company-Total gas
21 meals/week using LPG as fuel (21 meals/week * 4 weeks= 84 meals/month)
Every 1 ½ month household 1 buy a refill (6 kg).
6 kg refill every 1 ½ month = 985 Ksh/refill
84 meals/month x 1 ½ month = 126 meals/1 ½ month
985 Ksh/126 meals = **8 ksh/meal**

Household 2 Gas company-Kobil
14 meals/week using LPG as fuel (14 meals/week * 4 weeks= 56 meals/month)
Every 1 ½ month household 2 buy refill (6 kg).
6 kg refill every 1 ½ month = 950 Ksh/ refill
56 meals/month x 1 ½ month = 84 meals/ 1 ½ month
950 Ksh / 84 meals =**11,3 ksh/meal**

Household 3 Gas company- K-gas
12 meals/week using LPG as fuel (12 meals/week * 4 weeks= 48 meals/month)
Every 2:nd month household 3 buy refill (6 kg), and every 4 ½ month they buy refill for a 13 kg cylinder.
6 kg refill every 2:nd month= 950 ksh
48 meal/month x 2:nd month = 96 meals/2:nd month
950 Ksh/96 meals = **10 Ksh/ meal**

13 kg refill every 4 ½ month = 1935 ksh
48 meals/month x 4 ½ month = 216 meals/4 ½ month
1935 ksh/216 meals = **8,9 ksh/meal**

Household 4 Gas company- Triton
20 meals/week using LPG as fuel (20 meals/week * 4 weeks= 80 meals/month)
Every 1 ½ month household 4 buy refill (13 kg) = 1817 Ksh/refill
80 meals/month x 1 ½ months = 120 meals/1 ½ month
1817 Ksh /120 meals = **15 Ksh /meal**

Household 5 Gas company- Total gas
20 meals/week using LPG as fuel (20 meals/week * 4 weeks= 80 meals/month)
Every 3:de de month household 5 buy refill (25 kg)= 3690 Ksh/refill
80 meals/month x 3:de month = 240 meals/3:de month
3690 Ksh /240 meals = **15 Ksh/meal**

Calculation for cost per week

Costs per week ranges between **120 ksh-300 ksh/week**

Household 1 Gas company total
21 meals per week
Price per meal= 8 ksh/meal
21 meals per week*8 ksh/meal= **168 ksh/week**

Household 2 Gas company-Kobil
14 meals per week
Price per meal=13,6 ksh/meal
21 meals per week*13,6 ksh/meal= **190 ksh/week**

Household 3 Gas company- K-gas
12 meals per week
Price per meal (6 kg cylinder)=10 ksh/meal
Price per meal (13 kg cylinder)=8,9 ksh/meal
12 meals per week*10 ksh/meal (6 kg)= **120 ksh/week**
12 meals per week*8,9 ksh/meal (13 kg)= **106,8 ksh/week**

Household 4 Gas company- Triton
20 meals per week
Price per meal=15 ksh/meal
20 meals per week*15 ksh/meal= **300 ksh/week**

Household 5 Gas company- Total gas
20 meals per week
Price per meal=15 ksh/meal
20 meals per week*15 ksh/meal= **300 ksh/week**

LPG prices

Price comparison for different LPG companies, the quotation of prices is from the supermarket Nakumatt.

Company						
	6 kg (grill)	**7 kg (grill)**	**13 kg (burner,pipe 1 meter,regulator**	**25 kg**	**35 kg**	**50 kg**
Total filling	985		2060	3690		8210
Total cylinder	2875		5035	8635		11635
total	**5125**		**15375**	**20605**		**28125**
	6 kg (grill)	**7 kg (grill)**	**13 kg (burner,pipe 1 meter,regulator**	**25 kg**	**35 kg**	**50 kg**
K-gas filling	950	-	1935	-	4555	-
k-gas cylinder	-	3245	4510	-	7070	-
total			**14725**		**19905**	
	6 kg (grill)	**7 kg (grill)**	**13 kg (burner,pipe 1 meter,regulator**	**25 kg**	**35 kg**	**50 kg**
¤ **Caltex** filling	-	1120	2075	4040	-	8060
Caltex cylinder	-	3010	3715	6520	-	9675
total	-	**5395**	**14070**	**18840**	-	**26015**
	6 kg (grill)	**7 kg (grill)**	**13 kg (burner,pipe 1 meter,regulator**	**25 kg**	**35 kg**	**50 kg**
Triton filling	865	-	1817	-	-	-
Triton cylinder	2755	-	5035	8635	-	11635
total	**4885**	-	**15132**	-	-	-
	6 kg (grill)	**7 kg (grill)**	**13 kg (burner,pipe 1 meter,regulator**	**25 kg**	**35 kg**	**50 kg**
Pan Gaz filling	850	-	1770	-	-	-
Pan gaz cylinder	2200	-	3900	-	-	-
total	**4315**	-	**13950**	-	-	-
	6 kg (grill)	**7 kg (grill)**	**13 kg (burner,pipe 1 meter,regulator**	**25 kg**	**35 kg**	**50 kg**
Handy gas filling	880	-	1900	-	-	-
Handy gaz cylinder	2465	-	3970	-	-	-
total	**4610**	-	**14150**	-	-	-

Initial costs for LPG and charcoal

Charcoal
Jiko 150-400 ksh

LPG (minimum initial costs)
Grill & 6 kg cylinder (includes refill)
Pan gas refill (6kg)= 850 Ksh/refill
Pan gas cylinder (6 kg) = 2200 Ksh
Price for grill = 1265 Ksh
Total initial cost = 4315 Ksh