

**Draft Report on
Energy access among the Urban and Peri-Urban Poor in Kenya**

**Prepared for
Global Network on Energy for Sustainable Development (GNESD)
“Urban and Peri -Urban Energy Access” Working Group – (Thematic Study)**

By

Stephen Karekezi, John Kimani, and Oscar Onguru

Energy Environment and Development Network for Africa (AFREPREN/FWD)

P.O. Box 30979, 00100 GPO Nairobi, Kenya

Tel: +254 20 3866032/571467

Fax: +254 20 3861464/3866231/3740524

E-mail: afrepren@africaonline.co.ke or skarekezi@form-net.com or

Stephengk@africaonline.co.ke

Website: www.afrepren.org

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Executive Summary

Urbanization, commonly referred to as the increase in the proportion of people living in towns and cities is usually brought about by movement of people from the rural to the urban areas, in search of better living conditions. It usually entails changes both in production and consumption structures which alter energy usage patterns. Urbanisation is a common characteristic of developing countries (<http://www.geography.learnontheinternet.co.uk/topics/urbanisation.html#urb>) and is occurring very rapidly in the Kenya. It is estimated that 40% of Kenya's population is urban and nearly half of the entire population will be urban by the year 2020. Poor urban planning leads to increased pressure on the demand for energy resources and, in particular, modern energy sources including electricity, refined petroleum products and improved biomass – the key energy options within the urban areas. This can lead to acute shortages and price fluctuations.

The principal objectives of this study include;

- (i) Assessing Modern Energy Sources available to the Urban Poor
- (ii) Identifying the cost of energy sources.
- (iii) Identifying Subsidies offered and Policies Promoting energy access among the urban poor

A more detailed analysis of the above objectives of the study are presented in chapter 4 of this report.

Some of the Study findings pertaining to the two energy sources are summarised as shown below:

In spite of the high levels of poverty, rapid urbanization is expected to result in an increase in energy use. Typical activities of the average urban resident are usually more modern and energy-intensive than the activities of a rural resident. Consequently, the ongoing rural-urban demographic shift is expected to result in a large increase in modern energy consumption (Karekezi, 2002). The rapid rate of urbanization in Kenya has not been accompanied by a corresponding expansion of the formal sector thus resulting in growing urban unemployment and on expanding informal sector.

Rapid urban and peri-urban population growth rate in Kenya has been accompanied by higher levels of urban and peri-urban poverty. The distribution of urban and peri-urban income in the country shows a large disparity between the poor and the non-poor. Within the urban population, about 49% are considered poor and live below the poverty line. Commonly referred to as the urban poor, their population is set to increase with the population growth (GoK, 2007).

Findings of the study indicate that charcoal, kerosene and LPG are important options for urban poor. A summary of findings on the fuels is discussed below;

Kerosene is the most commonly used source of fuel used in Kibera. It is used by a majority of the population especially in households, mainly for lighting and cooking. The main reasons for using kerosene within the survey area is that it is fast, efficient, easy to use and cheap. Kerosene has a long and elaborate distribution which has numerous middlemen, who all add a mark up to their sales, thus increasing the cost of kerosene to

the end user. Lack of supportive legislation that would increase access of kerosene among the local population is almost non-existence; therefore, the industry is subjected to the market forces of supply and demand, and left to regulate itself, thus leading to the status quo. In addition, although kerosene is cheap and affordable, its related technologies are fairly expensive in comparison to the income levels of the urban poor. For example, an ordinary kerosene stove would cost about 4-5 times the national per capita of the country. This normally forces the locals to adapt and use low efficient technologies such tin lamps and stoves which are locally made and have very little safety measures exposing them to the hazardous effects of kerosene smoke as well putting them at risk of causing a fire.

Charcoal is derived from carbonising wood in the absence of air, and has twice the calorific value per unit weight as compared to wood, and doesn't produce as much smoke as the latter. In spite of charcoal production being outlawed, it has a very distinct and elaborate distribution network, right from the burning fields to the stoves in the house where it is used. Its availability and constant supply is almost assured as it is easy to package and transport over long distances. Most of the charcoal consumed in urban areas is mainly produced in the rural areas, where the Forest Department is always on the look out to arrest individuals engaging in the exercise. Its production in the country is not efficient. The energy recovery efficiency using the best charcoal making kiln is about 30% but in Kenya, where charcoal production is done in the traditional earth kilns which have very low energy recovery systems, ranging between 10-20%. Most of the energy ends up being lost and tonnes of wood wasted in the process. Charcoal production is yet to be legitimised by the Government. The ban on logging by the Government has directly affected the supply of raw materials used for charcoal production in the country, leading to a general increase in the end user price. Charcoal emits carbon monoxide (CO), a poisonous gas, as one of its by products. If used in a room that is not well ventilated, charcoal can lead to serious respiratory ailments and possible death if large quantities are inhaled. Charcoal is a leading contributor to indoor air pollution which can lead to serious cases of bronchitis.

In spite of LPG not being a very common source of fuel among the urban poor population, trends indicate that its use and dissemination is steadily growing. LPG has a very high upfront cost which is normally beyond the reach of the majority of the urban poor. The overall cost of a simple cylinder with its related accessories is approximately 10 to 15 times the national per capita income. This has greatly affected the dissemination of LPG mainly among the urban poor. In addition, although the cost of refilling the LPG cylinders is normally affordable and within reach of the urban poor population, the prices are dictated by the world oil prices which fluctuate from time to time. This causes uncertainty about its use within the target group. The safety aspect and reliability (volume found in each cylinder may vary substantially pertaining to the use of LPG is also of great concern among the urban poor population in Kibera.

Electricity was mainly used in Kibera for provision of light, both at the household and SME level. The study find out that most of the people using electricity did not source it directly from the main utility company KPLC, but paid for electricity as part of their monthly rent. Majority of the houses connected to electricity in the area either had illegal connections or were tapped from a single point. In spite of the utility company's efforts to

electrify the slum area, electrification levels in Kibera are very low. A very large portion of the population in the survey area do not have access to electricity in spite of their houses being near electricity transformers and power supply lines. This has been mainly occasioned by not only the high upfront cost of electricity connectivity charges by the utility company but also, the rising cost of electricity which has a direct relation to the world oil prices. This has led to the actual cost of electricity being high, well beyond the affordability of a majority of the urban poor population. In the survey area, the majority of the population seem to be wary on the use of electricity mainly owing to the safety of electricity as there have been numerous incidences of electrocution and electrical-based fires.

After Kerosene, LPG is becoming more widely acceptable among the residents in Kibera and its use is steadily rising. Some of the factors that have slowed its dissemination are the high upfront cost of the cylinders plus their related accessories, which are normally beyond the affordability levels of the majority of the urban poor. Other factors also include safety concerns and the sale of half filled cylinders by unscrupulous dealers and suppliers.

Chapter 1 is an introduction to the study, providing the background and rationale of the study. It discusses urbanisation; its causes; who the urban poor are; rationale for carrying out the study; and the study's objectives and limitations.

Chapter 2 of the study reviewed the energy situation in the country. It includes a detailed analysis of the energy sources available in the country as well as national demand, consumption, supply and distribution in the country was undertaken.

Chapter 3 presents the methodology used by the study. This study was a combination of both desk research and primary data collection. For the preliminary study, a data and statistics compilation exercise was carried out to gather relevant data pertaining to the study. The chapter further justifies the specific scope of the study discussing the target subject area for the study and the rationale for selecting the study area.

Chapter 4 includes a description of findings of the scoping phase; what the study looked at; and, why it was necessary for the study to be undertaken. This chapter also analyses and discusses the policies supporting energy access among the urban poor, both in terms of access and pricing. Furthermore, the chapter highlights the areas that the study identified for the thematic phase and the transition from scoping to thematic phase.

Chapter 5 provides a description of the thematic phase highlighting the issues being looked at and giving a detailed analysis of the study findings, availability of the two principal energy sources being researched, their consumption patterns at the household and SME level and issues related to access and use of both fuels.

Finally, Chapter 6 presents conclusions and recommendations based on the study findings. It further proposes areas of research that future GNESD studies could look at.

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Acronyms and Abbreviations

ADB	African Development Bank
AFREPREN/FWD	Energy Environment and Development Network for Africa.
CO ₃	Carbon Monoxide
GNESD	Global Network on Energy for Sustainable Development
GWh	Giga Watt Hour
HIV	Human Immuno Deficiency Virus
ITDG-EA	Intermediate Technology Development Group- East Africa
KENGEN	Kenya Electricity Generation Company
kg	Kilogram
kg/yr	Kilograms per year
kg/ hse/ per year	Kilograms per House per Year
km	Kilometre
Ksh	Kenya Shillings
kW	Kilo Watt
kWh	Kilo Watt Hour
LPG	Liquefied Petroleum Gas
m/s	Meters per Second
M ²	Meters Squared
MW	Mega Watt
NEMA	National Environment Management Authority
PV	Photovoltaic
SME	Small Micro Enterprise
toe	Tones of Oil Equivalent
US\$	United States dollars

Chapter 1: Introduction to the UPEA Study

1.1 Background and rationale of the Study

1.1.1 Description of Urbanisation, its Causes and who the urban poor are

Urbanization - the increase in the proportion of people living in towns and cities is usually brought about by movement of people from the rural to the urban areas, in search of better living conditions - usually entails changes both in production and consumption structures which alter energy usage patterns. Urbanisation is a common characteristic of developing countries (<http://www.geography.learnontheinternet.co.uk/topics/urbanisation.html#urb>) and is occurring very rapidly in the Kenya. It is estimated that 40% of Kenya's population is urban and nearly half of the entire population will be urban by the year 2020. Inadequate urban planning has led to rapidly growing demand for energy resources, in particular, electricity, refined petroleum products and biomass – the key energy option of the poor in urban and peri-urban areas. This often results in acute shortages and price fluctuations.

Urbanization causes changes in the living conditions especially in developing countries. The negative effects of urbanization include the following:

- (i) Heavy industrial pollution
- (ii) Congestion in terms of housing, poor sanitation especially in regards to the urban poor
- (iii) Stress on the little available amenities
- (iv) Increased crime rates
- (v) Prevalence of Diseases e.g. HIV, malaria, cholera, typhoid etc

However, there are positive impacts of urbanization. For example over the past few decades, the amenities and infrastructure in urban areas of Nairobi have been expanded and improved. In comparison to rural villages and communities, they are considered more developed. The most outstanding positive effects of urbanization evident in most urban areas of the country include;

- (i) Better housing
- (ii) Improved healthcare
- (iii) High rates and greater access to electrification
- (iv) Access to treated tapped water
- (v) Better roads
- (vi) Better communication facilities
- (vii) Increased industrialization leading to more and better jobs
- (viii) Better educational facilities

The distribution of urban and peri-urban income in the country shows a large disparity between the poor and the non-poor. According to the Government's definition, anyone with an income below Ksh. 2,913 (roughly US\$ 42) per adult per month, in urban areas is considered to be poor (GoK, 2007). Within the urban population, about 34% are considered poor and live below the poverty line. Poverty levels, which have a direct correlation with type and quantity of energy used, play a vital role in the access of energy sources among the urban and peri-urban poor. Using the US\$ 2 per capita per day threshold, in urban and peri urban areas, which is the focus of this study, about 80%

of the population can be considered poor. If the US\$1 per capita per day is used, then about 49 % (GoK, 2007) of the urban population lives below the poverty line. It is predicted that the urban poor, is set to increase in line with population growth (GoK, 2007).

The urban poor are expected to increase as the agricultural sector, which is the main source of employment and livelihood for majority of the rural population, can not meet the employment and aspirational needs of a young and growing population, consequently, the rural urban migration is accelerating.

Although the supply of modern energy resources in urban areas being far much better than in rural areas, access of modern energy among the urban poor is still inadequate. This is largely because the urban poor, in most cases, live in informal settlements/slums around or within the urban areas, which are not usually planned for and have very limited access to modern energy infrastructure. The informal nature of urban poor housing/residence makes provision of modern energy sources to the urban poor difficult.

1.1.2 Rationale for Carrying Out this Study

There is some evidence that a larger proportion of Government financing, subsidies and international development aid is aimed at developing modern energy infrastructure that largely serves the needs of the urban-based formal sector, commercial and industrial sectors and the medium and high income urban and peri urban households. Energy sources for the poor in urban and peri-urban areas is not a high priority on the development agenda.

Urban electrification levels in the country is still very low. Only 47.5% of the entire urban population (nearly the entire medium and high income population) have access to electricity (World Bank, 2006). The limited available evidence indicates that the situation is worse in low-income urban households and in most peri urban areas. This is particularly troubling since the low-income areas are usually not very far from major electricity transmission and switching stations. Low-income areas are often close to the city centre and are densely populated, thus the associated transmission and distribution costs of electricity extension are not high. In many cases, the costs are lower than the cost of extending electricity to low-density high-income areas.

Provision of modern energy resources among the urban poor is a very important policy challenge especially considering the rapid rate of urbanisation and recent focus on poverty alleviation in the country. It is widely noted, that the majority of the population who migrate from the rural to urban areas, are poor, therefore, have very limited options vis-à-vis energy sources/types affordable to them. To address this challenge, the Global Network on Energy for Sustainable Development (GNESD) launched a study to examine the status of energy access in urban areas

In spite of limited access to modern energy sources, in comparison to the rural poor, the urban poor tend to carry out activities that are more energy intensive than their rural counterparts, both at the household and SME level. Some of the energy intensive activities carried out by the urban poor at the domestic and SME levels include;

- (i) Cooking
- (ii) Lighting
- (iii) Space heating

- (iv) Domestic based enterprises such as laundry services e.t.c
- (v) Food Kiosks
- (vi) Food Vending
- (vii) Welding and carpentry workshops
- (viii) Garages
- (ix) Car wash

1.1.3 Previous GNESD Urban Poor Energy Access Scoping Phase study

The previous study that was undertaken by AFREPREN/FWD on behalf of GNESD, was an initial regional assessment of the urban energy situation in East Africa and focused on Kenya and Uganda. The study identified viable and proven policy options that can assist in providing cleaner and more sustainable energy sources to the rapidly growing urban population in the context of a rapidly reforming energy sector. The study further assessed whether the energy policy reforms address the challenges or contribute to the growing problem of inadequate energy sources. The focus of the study was on ongoing and planned energy policy reforms addressing the questions of how likely they are to lead to improved, cleaner and more sustainable energy sources for the poor, and how the processes can be improved to promote better access to cleaner energy sources from the poverty alleviation, environmental and productive use of energy point of view.

1.1.4 Objectives of the current study

The principal objectives of this study included the following:

- i. Assessing modern energy sources available to the urban poor
- ii. Identifying the cost of energy sources
- iii. Identifying subsidies offered and policies promoting energy access among the urban poor

1.1.5 Key Challenges and Limitations of the study

There are several key challenges that were faced in the course of the study. These were as follows:

1. The small size of respondents was relatively small. Therefore, the findings are only indicative and might not be the true reflection of energy access among the urban poor either within Nairobi or at the national level.
2. The time and financial resources allocated for this study were not sufficient to sample a much wider population of the urban poor such as those in other slum areas of Nairobi.
3. There have been very few studies that have been carried out on this subject area, therefore secondary data and information sources were unavailable for crosschecking the data collated for consistency and accuracy.

4. Primary data collection was the main source of obtaining the relevant information. However, not all respondents were comfortable with providing information as they were unsure on the use of the information that they provided. Other respondents found it difficult to take time off their business transactions as they viewed the survey taking up too much of their valuable time.
5. Respondent fatigue: Kibera is a locality that interests a lot of researchers carrying out any study on the poor. Therefore, the residents of this slum area appear to be tired of too many researchers including those carrying out opinion polls for the 2007 General Elections.
6. Kibera is a relatively high security risk area, hence difficult to conduct interviews with minimal intimidation. This was compounded by the recent post election violence of January 2008 which rocked the slum area making it impossible to conduct any surveys in the locality.

1.1.6 Structure / Organisation of the report

This report is sub-divided into seven (6) Chapters: Chapter one is an introduction to the study and discusses the rationale, objectives and challenges of the study. Chapter two discusses the current state of energy access in the country as well as policy responses at the national level. Chapter three discusses the methodology adopted for the study and the approach taken when carrying the research work and the research frame work adopted. Chapter four describes the scoping phase. Chapter 5, discusses the thematic phases of the study and addresses the findings of the thematic phase. Chapter 6 provides the study conclusions and recommendations while highlighting relevant policy options and present an outreach plan as well as identifies areas for further research and the way forward.

Chapter 2: Status of Energy Access in the Country.

2.1 Energy Sources Available in the Country

The key available energy supply options in Kenya include biomass (wood fuel and charcoal), petroleum, electricity (hydropower, wind, geothermal) and to a small extent, coal. Like most sub-Saharan African countries, biomass dominates the country's energy supply. The following section, discusses in detail, the available energy sources, consumption as well as access to modern energy sources in the country.

2.1.1 Biomass

Biomass is the most dominant and the principal source of primary energy for the majority of the population in Kenya. According to the 2004 statistics from the Government, sustainable biomass energy supply was estimated at 15.4 million tonnes annually against a demand estimated by the National Environment Management Authority (NEMA) to be over 38.1 million tonnes (AFREPREN/FWD, 2006, GoK 2004b NEMA, 2005). Therefore, the supply/demand deficit of biomass energy supply in the country is about 60%.

2.1.2 Large Hydropower

The Ministry of Energy (MoE) estimates that the undeveloped hydroelectric power potential of economic significance is about 1,557 MW of electricity. This hydro power potential is located in 5 different geographical areas, representing Kenya's major drainage basins; Lake Victoria basin with a potential of 434 MW, Rift valley basin with a potential of 264 MW, Athi river basin with a potential of 109 MW and the Tana and Ewaso Ng'iro North Basins with 604 MW and 146 MW respectively.

2.1.3 Electricity

Grid electricity is the main source of modern energy in the country. In Kenya, it is generated from various source which include hydro (large and small), thermal (oil) and renewable sources such as geothermal energy, wind energy and cogeneration. The Ministry of Energy estimates the effective power generation capacity in the country as 1,177.1MW, against a peak demand of 930 MW, which is projected to rise by 14% per annum to 1,370 MW by July 2008 (MoE, 2006). The demand for electricity in the past, outstripped supply, precipitating a significant level of unserved demand, which in 2004 was estimated to be 413 GWh (CAN, 2004). However, the situation has improved and the generation currently boasts of a modest and rapidly shrinking reserve margin of about 14%.

2.1.4 Petroleum Products

Kenya relies heavily on imported petroleum for its local consumption, making petroleum the major source of commercial energy in the country. Petroleum provides about 22% of the country's energy requirements (GOK, 2002b). At the national level, the transport sector consumes about half of the petroleum used in the country while other sectors combined consume the remaining 50%. The high dependence on petroleum in the country cannot be overemphasised in terms of foreign exchange drain. For example, crude oil and imported refined petroleum products are among Kenya's main imports accounting for 47% and 52% of total exports in the years 2005 and 2006, respectively

(GOK, 2007), however, a significant proportion of the imported oil is re-exported to the neighbouring countries

Petroleum is the major driving force of modern sector of the economy and its importation in 2006 rose by 6.8%. However, the unusual high oil prices experienced in 2006 lead to a decline in crude oil importation by an average of 7.4%. Nonetheless, the demand for petroleum products at the national level increased by 12%, up from 2,797,200 tonnes in 2005 to 3,131,500 tonnes in 2006 (GoK, 2007). This could be attributed to the country's growing economy as well as the increased number of motor vehicles registered in the country i.e. monthly registration of new vehicles totaling about 5,000 units.

Kerosene is a refined petroleum product that is highly flammable. It is mainly used for lighting, cooking and heating at the domestic level. About 83% of the urban residents have access and use kerosene and it is mainly used for cooking (76% of the respondents) and for lighting (61% of respondents). At the local market, kerosene is supplied and distributed by multi-national oil companies as well as smaller oil companies. Kerosene has a very effective distribution chain that ensures that it reaches the most remote of places. This has been enabled by numerous kerosene retailers who buy kerosene for resale. However, due to the high number of "middlemen" included in kerosene distribution as well as taking into account the transportation and distribution costs, kerosene ends up being a high cost fuel.

2.1.5 Renewables

Kenya has a significant amount of diverse sources of renewable energy which include biomass, wind, solar, geothermal, biogas, mini/micro hydro and co-generation (Mbuti, 2004b; AFREPREN/FWD, 2004). The exploitation of large-scale renewable energy in Kenya, apart from geothermal and to some extent, cogeneration, has largely remained low. However, in the wake of increased global attention to renewables on account of their environmentally benign attributes as well as their suitability to isolated rural areas which are too far from the national power grid, more attention is being given to renewables. A detailed discussion on the status of the different renewables in the country is highlighted below;

2.1.5.1 Solar Energy

The country receives an estimated 4 to 6 kWh per square metre per day of solar insolation. This is equivalent to about 300 million tonnes of oil equivalent (toe) per day. However, only a tiny fraction of this resource is harnessed for commercial and household use including crop and animal products drying, water heating, water pumping and lighting and entertainment (Karekezi and Kithyoma, 2005, GoK, 2004b). Today, solar energy is utilised in different ways in the country. Some of the solar technologies (both for lighting and thermal) that have been disseminated in Kenya include solar photovoltaic systems, solar water heaters, solar cookers, solar stills and solar dryers (Karekezi, 2002). (Karekezi and Ranja, 1997).

Solar PV technologies are mainly used for providing off- grid electricity in urban and rural areas, which are considered to be too far away from and too costly to extend grid lines to. It is estimated that there are 120,000 units of solar PV systems that have been disseminated across the country, mainly installed by institutional and corporate clients, and are estimated to be producing a total of 4.4 MWe. It is estimated that by the year 2020, the installed capacity from solar PV home systems will be projected to be over 10

MWe In addition, it is estimated that a total 140,000 M² of solar water heaters has been installed in the country and the demand for solar water heating, which is mainly used by institutional and corporate clientele, is estimated to reach 400,000 units by the year 2020 (MOE, 2004) reflecting a growth rate of 10 % per year. (Karekezi and Kithyoma, 2005).

2.1.5.2 Wind Energy

In spite of wind being a very significant energy resource in the country, very little of it has been harnessed and utilised so far. Kenya has a wind energy potential of 3 - 10 m/s. Wind energy has been harnessed and used in the country, mainly for pumping water in remote rural areas. It has also been used, but to a very limited extent, for electricity generation with limited installations based in Ngong hills in Nairobi and in Marsabit, North Eastern province. The wind generators installed in the country generate only, an estimated 0.55 MW of electricity that is transmitted to the national grid, representing less than 1% of the total electricity generated. However, there is an ambitious 30 MW wind power project that is currently being implemented at Kinangop in Nyandarua District by Kenya Electricity Generation Company (Kengen), a 70% Government owned electricity generation company, and is expected to inject a further 30MW of electricity to national grid upon completion.

Furthermore, Bob Harries Engineering Ltd, a company based in Thika, in the outskirts of Nairobi, has been very instrumental in the production and installation of wind pumps in the country. So far, the company has installed about 284 wind pumps that are set up and are operational in the country. They are mainly in the arid and remote and arid areas of Kenya, largely to supply portable water as well as drinking water for livestock and wild animal in the national parks and game reserves (Karekezi and Kithyoma, 2005; ESI, 2006; Harries, 2006).

2.1.5.3 Geothermal Energy

The technical potential of geothermal has been estimated at about 3,000 MW across the whole Kenyan Rift Valley¹. In Kenya, geothermal energy has mainly been used for electricity generation and to a limited extent, for greenhouses heating. There are other potential uses that can have direct impacts on poverty reduction but have not been fully exploited. Geothermal energy is arguably, the most successfully exploited renewable energy source/technology in the country. The country's experience in the development of the technology has not only made Kenya a market leader in geothermal related issues in the region, but also a world leader. Its implementation started in the early 80's with a 45 MW installation and has gradually grown with time to produce about 130 MW of electricity; about slightly over 10% of the total electricity generated in the country (Karekezi and Kithyoma, 2005). Kengen, with an installed generating capacity of 115 MW and OrPower, with an installed and generating capacity of 15MW are the two companies at the forefront of exploiting this technology in Kenya for electricity generation in the country.

¹ Excluding ground heat pump option and heat application

2.1.5.4 Cogeneration

Cogeneration refers to an energy recovery system, which simultaneously generates electrical power and thermal energy. Bagasse from sugar cane milling can be burnt in boilers to generate steam, which is used to drive prime movers and the excess energy exported in the form of electricity to the grid. It is estimated that Kenya has a generation potential of 423GWh of electricity per year using bagasse based cogeneration at 80 bars pressure (Deepchand, 2006).

There is a very large potential to meet energy needs and demand from cogeneration as it is a technology that can be practiced in any agro-industry e.g. the sugar, paper and pulp, rice, timber e.t.c. In Kenya, this technology has mainly been adopted in the sugar industry where the sugar factories meet their electricity needs by generating their own electricity.

In Kenya, there are a total of eight (8) sugar factories, of which, only six (6) are currently operational. The sugar factories crushed a total of 4,889,529 metric tonnes of cane in 2006, generating about 1,878,153 metric tonnes of bagasse. It was estimated that the bagasse had a potential of nearly 120 MW of electricity generation capacity. All the sugar factories in the country have a cogeneration plant embedded as part of the sugar factory's design, and generate electricity for their own internal consumption. The total combined generation installed capacity for the six sugar factories is 36.4 MW, but due to inefficiencies both at the operational level and with the equipment used, the sugar factories only produce a total of 26.1 MW of electricity. Only one sugar factory, Mumias Sugar Company, is self sufficient in electricity generation as it produces enough for its own internal consumption as well as exporting an excess of 2 MW to the national grid. There are initiatives to promote cogeneration technology in the country, including the "Cogeneration for Africa Project" an initiative of GEF, UNEP and AFDB and implemented by AFREPREN/FWD

2.1.5.5 Small Hydropower

In Kenya, small hydropower has been harnessed for over a century. However, the development was mainly aimed at supplying mechanical power for agro-processing activities such as maize milling and – in very few cases – for electricity generation for villages far from the grid.

Available literature gives conflicting figures on the actual potential for small hydropower. However, a more reliable source at the Ministry of Energy estimates small hydropower potential to be about 3,000 MW (MoE, 2004a). A number of small hydropower schemes have been implemented in Kenya by the Kenya Electricity Generation Company (Kengen), private investors (e.g. tea companies, mission hospitals), individuals and community groups. Currently, there are a total of 14 known small hydro power plants installed in the country producing a total combined electricity output of 33.098 MW of electricity. Furthermore, the Ministry of Energy (MoE) in collaboration with the Intermediate Technology Development Group – East Africa (ITDG-EA) has undertaken several initiatives to develop a sustainable infrastructure for isolated small hydropower development in the country. These include the following:

- A pilot community based micro-hydropower project in Mbuiro village, Meru South District with a capacity of 14 kW. The energy generated is for powering micro enterprises such as grain milling and oil processing.

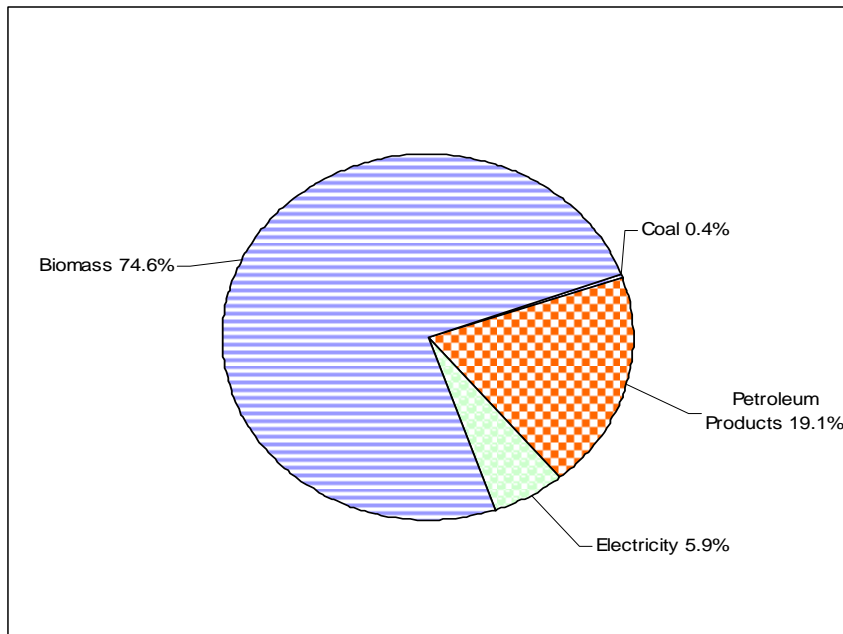
- Two community based pico- hydropower schemes in Kirinyaga district generating 1.1 kW and 2.2 kW providing electricity to 65 and 165 households respectively

2.1.5.6 Biogas Energy

Biogas technology was introduced in Kenya in the mid 1950s by white settler farmers. The technology is a viable supplementary source of rural energy for cooking and lighting while the slurry can be used as a source of manure. It is estimated that about 1,100 units have been installed in Kenya (Karekezi and Kithyoma, 2005). But due to poor construction and maintenance of the biogas digesters, it is estimated that only about 25% or less of the installations are currently operational in the country.

The following figure shows the contribution of the aforementioned energy options to the national energy supply balance:

Figure 1: Energy Supply by Source in Kenya



Source: IEA, 2007

2.2 Energy Demand and Consumption in the Country

Some of the main challenges facing the energy sector in the country today include the diminishing biomass resources, over reliance on importation of crude oil, an overstretched power transmission and distribution network and limited priority given to renewables. All these challenges eventually, affect both the energy supply and subsequent use, especially among the urban poor in the country. The following section provides an overview of the consumption of the various different energy sources available in the country as well as consumption by source.

Biomass is the dominant source of primary energy for the majority of the population in Kenya. According to a recent study, the biomass resource base is estimated at a

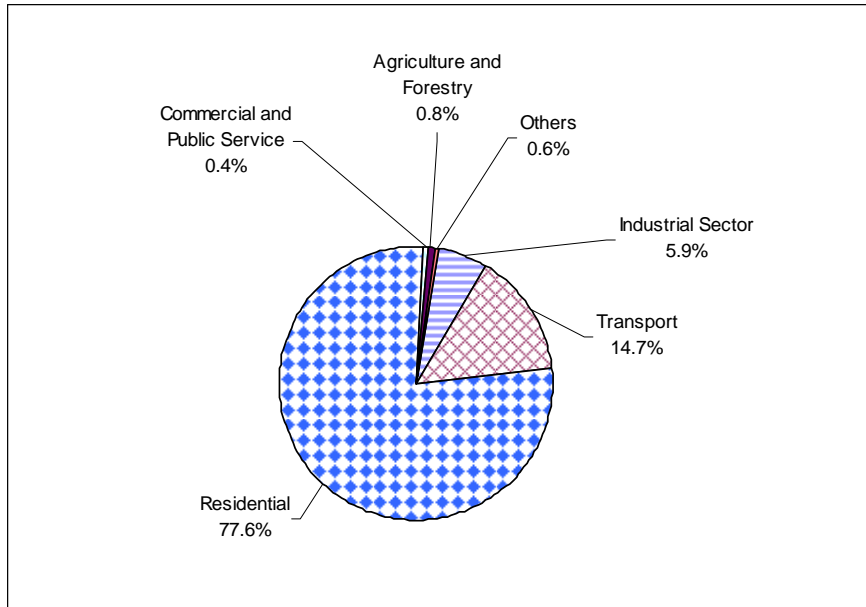
standing stock 35 million cubic metres (MoE, 2003b) grown mainly on farms through agro-forestry accounting for about 84% of the total consumption, while gazetted forests and trust lands supply about 8% each. The current demand for wood is estimated at 35 million metric tonnes relative to a sustainable supply of 15 million metric tonnes. This translates to a deficit of some 20 million tonnes. Without energy efficiency and other policy interventions, this deficit is expected to rise to 28 million metric tonnes by 2010 and 34 million metric tonnes by 2020 (MoE, 2004a; AFREPREN/FWD, 2006; GoK 2004b; NEMA, 2005)

Grid electricity is one of the key supplies of modern energy in the country. In Kenya, it is generated from various sources which include hydro (large and small), thermal (oil) and renewable sources such as geothermal energy, wind energy and cogeneration. In 2006, the effective power generation capacity in Kenya was 1,197.1MW, against a peak demand of 987MW. The peak demand is projected to rise by 14% per annum to 1,370 MW by July 2008 (MoE, 2006). Consequently, the current situation is that of a rapidly diminishing electricity generation reserve margin reportedly now at less than 5% down from a reserve margin of about 17% in 2006/2007 period (KPLC, 2007). Electricity consumption in the country is relatively low, especially when the per capita consumption level is compared with those of other developing countries in Africa. The per capita consumption is estimated to be 119.7 kWh (World Bank, 2006) and is mainly due to the low level of access to electricity in the country which currently stands at 47.5% in the urban and 4.3% in the rural areas and an average of about 15% at the national level (World Bank, 2006). In addition, the cost reflective end-user electricity prices are relatively high compared to those charged to some of the neighboring countries thereby discouraging intensive electricity consumption among households.

Kenya relies heavily on imported petroleum for its local consumption. At the national level, the transport sector consumes about half the total oil imported into the country while the other sectors combined, consume the remaining amount. The high dependence on petroleum in the country cannot be overemphasized in terms of foreign exchange drain. For example, crude oil and imported refined petroleum products are among Kenya's main imports accounting for 47% and 52% of total exports in the years 2005 and 2006, respectively (GOK, 2007), however, a significant proportion of the imported oil is re-exported to the neighboring countries. Petroleum is the major driving force of modern sector of the economy and its importation in 2006 rose by 6.8%.

On the demand side, the energy consumption sub-sectors include residential (households) industry, transport, agriculture & forestry, commercial & public service and other sub-sectors. As the figure below indicates, the residential sector appears to be the largest energy consumer followed by the transport sub-sector:

Figure 2: Energy Consumption by Sub-sector in Kenya



Source: IEA, 2007

2.3 Access to Modern Energy Sources.

In spite of an expanding modern energy infrastructure, modern energy sources are not accessible to many of Kenya's poor. Modern energy, which includes electricity, refined petroleum products and improved biomass such as charcoal has very low consumption among Kenya's urban poor population. For example, a significant proportion of the urban poor live just yards away from electricity transmission poles and transmission stations but are yet to get connected to the grid. This section examines access levels of modern energy among the urban poor population.

2.3.1 Electrification Levels

Until recently, the electricity industry in Kenya was characterized by a monopoly structure, and dominated by vertically integrated, state-owned power utility company, the Kenya Power and Lighting Company (KPLC). This monopoly structure is thought to be a large contributor to the under performance of the power utility leading to the low levels of electricity access in the country but this is no longer the case the case as the power utility has been unbundled.

The current situation in the country is such that provision of electricity is largely confined to high and middle income groups in urban areas, as well as the formal commercial and industrial sectors. The poor, who are the majority and live mostly in rural areas, have limited access to electricity. Household electrification is very low (less than 5% in rural and 51% in urban areas). The national electrification levels in Kenya is alarmingly low and only about 13% of the total population have access (World Bank, 2006, World Bank, 2007).

2.3.2 Supply and distribution of modern energy sources.

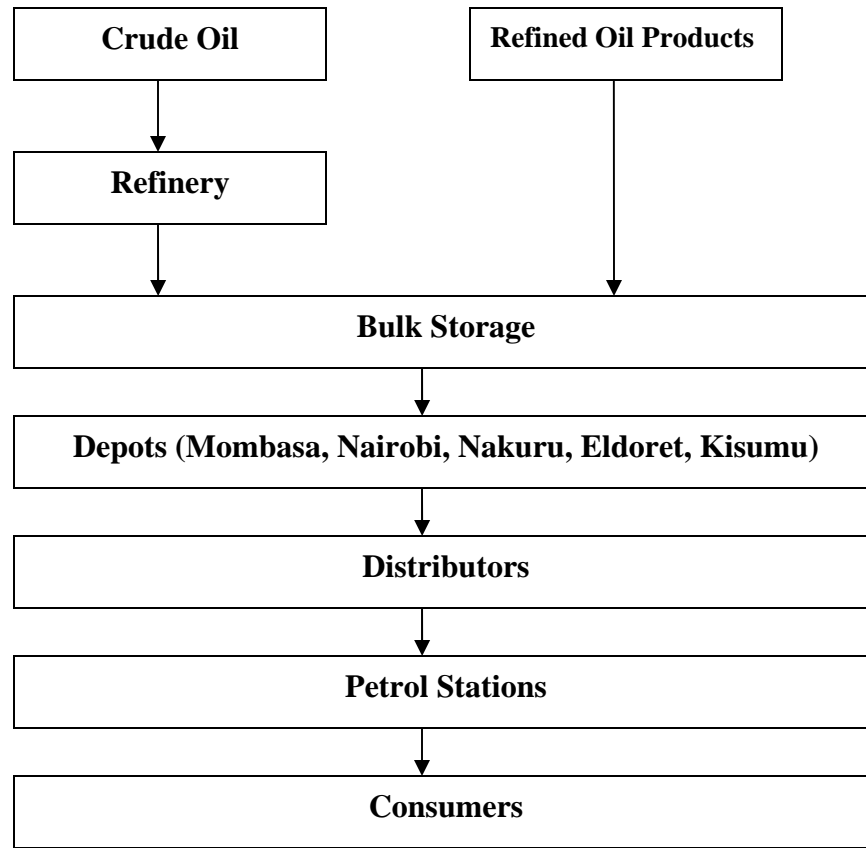
In the country, there are several sources of modern sources which include; improved biomass (charcoal), kerosene, LPG and electricity.

Charcoal which is derived from carbonising wood in the absence of air, has twice the calorific value per unit weight as compared to wood and doesn't produce as much smoke as the latter. It is the most common modern energy source among the urban population as about 82% of the total households in the urban areas use it (MoE, 2002). In spite of charcoal production being outlawed, it has a very distinct and elaborate distribution network, which ranges from the burning fields to the transporters, to wholesalers, to distributors to the numerous small scale vendors who finally sell it to end users in the households.

Kerosene is a refined petroleum product that is highly flammable. It is mainly used for lighting, cooking and heating at the domestic level. About 89% of the urban residents have access to and use kerosene with urban households consuming on average, 90 litres a year and is mainly used for cooking (36% of the households) and for lighting (82% of households) and for heating water (39% of the households). At the local market, kerosene is supplied and distributed by multi-national oil companies as well as smaller oil companies. Kerosene has a very effective distribution chain that ensures that it reaches the most remote of places. This has been enabled by numerous kerosene retailers who buy kerosene for resale. However, due to the high number of "middlemen" along the kerosene distribution chain as well as taking into account the transportation and distribution costs, kerosene ends up being a high cost fuel.

In urban areas, LPG is used as a supplement for electricity, charcoal and kerosene. It is mainly used for cooking and lighting. One of the main reasons for the low adoption of LPG in urban areas is the high upfront cost of LPG based appliances and the fact that the LPG components from the various different oil companies are not interchangeable. Depending on the oil company marketing the LPG products, the available cylinders for domestic use range from 3 kg to 15kg. In the urban setting, 23% of households use LPG as a source of energy. Most of the households (99%) use LPG for cooking while 18% and 17% of households also use it for water heating and lighting, respectively. There also exists an elaborate supply and distribution chain for LPG within the locality of the urban poor. LPG is mainly supplied and distributed by the multi-national oil companies, however, just as the case for kerosene, numerous distributors who buy LPG from the large multi-nationals and retail it to the urban poor. A typical flow diagram of petroleum products distribution is as shown below;

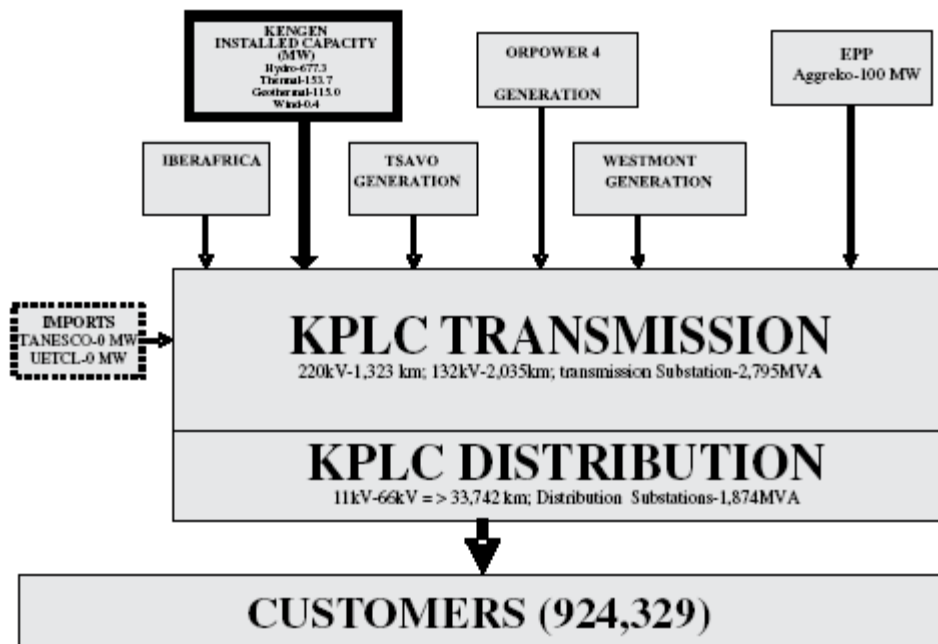
Figure 3: Petroleum Distribution Network in Kenya



Source: Authors' Compilation

The Kenya Power and Lighting Company (KPLC), a 51% Government owned national utility company, still remains the sole body licensed to transmit and distribute electricity in the country. The generation segment has several players; chief among them is the 70% state owned Kenya Electricity Generating Company (KenGen), and several other IPPs, namely IberAfrica, Tsavo Electricity Generating Company, Orpower4 electricity generating company and Westmont Power. Combined, all these companies generated a total of 6,169 GWh (KPLC, 2007) of electricity, which was transmitted all over the country by KPLC over there expansive distribution network. The diagram below shows the structure of the electricity sub-sector in Kenya.

Figure 4: Structure of the Electric Power Sub-sector after Reforms and Restructuring



Source: KPLC, 2007

Chapter 3: Methodology, approach and research framework

The study was a combination of both desk research and primary data collection. A data and statistics compilation exercise was carried out to gather relevant data pertaining to the study. Supplementary secondary data was obtained from an extensive review of literature such as energy policy documents, energy acts and other relevant publications with related material or information on urban energy. Primary data was obtained from a survey in Kibera - the selected area of study and in areas that are inhabited by the urban poor.

The scope of the study was to provide a brief assessment of key urban and peri urban energy access issues in Kenya. The study paid special attention to clean modern energy sources for the urban and peri urban population particularly the poor in Nairobi City. The city of Nairobi was selected as it is the largest city, not only in Kenya, but also in East Africa as a whole. Nairobi's estimated population is about 3 million people (or 650,000 households). Nairobi is rated as the fourth largest city in Africa and has the highest population growth rate in the continent at about 6.9% per annum. Nairobi has established itself as a prominent city, both politically and economically and is home to several leading multi-national companies and international organizations, making it a regional hub for business.

It is estimated that about half the population of Nairobi stay either in the slums or in informal settlements around the city, which cumulatively, account for only 5% of the total land area of Nairobi. Kibera is the largest slum in Nairobi and among the largest in Africa. The estimated population of Kibera alone accounts for about a third of the population of Nairobi. Consequently, Kibera is the largest informal settlement in the country, accounting for a significant proportion of Nairobi's urban poor population. It has a very cosmopolitan population consisting of people of different regional backgrounds and ethnicity. The majority of the population living in Kibera are poor and live below the US\$ 1 a day threshold. The energy use and demand patterns of Kibera's households largely revolve around household energy end-uses such as cooking and lighting as well as energy sources for home-based commercial and productive activities in SMEs.

Kibera was an ideal location for the study for the following reasons:

- Being the largest slum where the urban poor live, findings would be, in many respects, indicative of the situation among the urban poor.
- Kibera is within very close proximity to the AFREPREN/FWD offices.

Chapter 4: Description and Findings of the Scoping Phase. Areas Identified for Thematic Phase and Transition from Scoping to Thematic Phase.

4.1 Description of the Scoping Phase and what it looked at.

The scoping phase of the GNESD UPEA working group, Phase 1, was an initial assessment of the energy access situation in East Africa. The study gave a broad assessment of the key urban and peri urban energy access issues in the region, giving special attention to clean modern energy sources for the urban and peri urban population, majority of whom, are poor.

In line with the overall GNESD “UPEA” study objectives, the primary objective of the east African regional study, was to carry out an assessment of the urban energy situation and identify viable and proven policy options that can assist in providing cleaner and more sustainable energy sources to the rapidly growing urban population in the context of a rapidly reforming energy sector. This included an assessment of whether previous energy policy reforms have addressed these challenges or whether they actually contributed to the growing problem of inadequate energy sources, through neglect, for the poor living in the urban and peri-urban areas. The focus of the study was on ongoing and planned energy policy reforms and addressing the questions of how likely they are to lead to improved, cleaner and more sustainable energy sources for the poor, and how the processes can be improved to promote better access to cleaner energy sources from the poverty alleviation, environmental and productive use of energy points of view.

4.1.1 *Reasons why the study was undertaken*

The importance of carrying out a detailed study on the urban and peri-urban energy East Africa was emphasised by the increasing urban and peri urban population as well as the fact that the bulk of modern energy consumption occurs in urban and peri urban areas. A significant proportion of the urban and peri-urban poor have no access to modern energy sources, especially electricity, in spite of proximity to modern energy infrastructure and the fact modern energy sources in urban and peri urban areas being far much better than those in rural areas.

The distribution of urban and peri urban income in most countries in East Africa shows a large disparity between the poor and the non-poor. However, the rapid urbanization is expected to result in large increases in energy use. The rapid rate of urbanization in East Africa, has not been accompanied by a corresponding expansion of the formal sector, and has resulted in growing urban unemployment and an expanding informal sector that is estimated to be employing about 10-25 % of the region’s labour force.

There are other reasons that justified focusing on the urban and peri urban energy in the region. They include:

- Modern energy sources could contribute to reducing poverty in urban and peri urban areas
- Due to high density in urban and peri urban areas, provision of modern energy is less costly and quicker

- Although urban and peri urban poor households in most cities in east Africa constitute over 50% of the total household, the provision of modern energy sources to these households does not seem to be receiving the requisite attention from policy makers
- The poor in urban and peri-urban areas have limited access to affordable, adequate and reliable modern energy sources
- As urbanization accelerates, so is energy use in urban and peri urban areas
- There is a significant impact of urban energy on fossil fuel imports
- SMEs / Informal sector & energy – is a major source of jobs and incomes for urban poor
- Heavy reliance on bio-fuels e.g. charcoal and fuel wood that harm human health and the environment.

4.2 Findings from the Scoping Phase

As part of the study, the National Energy Policy document was reviewed in order to identify the relevant policies that are supportive of provision of modern energy sources among the urban poor. The National Energy Policy for Kenya was approved in December 2006. It is the main document that provides the overall policy guidance and streamlines the energy sector in the country. The findings of the review of the National Energy Policy document revealed that it contained explicit policy statements that supported energy access among the urban poor. Some of the key statements are highlighted below:

“In light with the low electrification levels and subsequent low consumption of electricity in the country, the government intends to increase the electrification levels in the country by at least 10% per annum.

“In line with the environmental effects caused by deforestation due to excessive logging, mainly in the indigenous forests the Government intends to widely promote the use of kerosene and LPG in households as alternative sources of fuel, to improve the quality of household energy and mitigate the demand on wood fuels.

“The ban on charcoal production by the Government seems not to have a major impact as illegal and inefficient charcoal production is still very rife in the country especially in the rural areas. In order to mitigate this, the Government intends to license charcoal production to encourage its commercial production in a sustainable manner.

“Furthermore, in a bid to further increase biomass energy access in the country, the Government intends to promote private public sector participation in biomass energy production, distribution and marketing.

“The Government’s bid to diversify energy use in the country, to curb over dependence on few energy sources, it intends to promote inter fuel substitution among the population.

“The development of a retail network for the supply and distribution of petroleum products through-out the country and establishment of common user storage facilities where they do not exist. This will further widen and increase the

distribution network across the country, therefore making petroleum energy more accessible.

“Lack of an energy storage facility for LPG in the country has greatly hampered the distribution capacity and network in the country. In order to meet LPG Demand, the Government intends to construct LPG import handling, storage and distribution facilities all across the country in relation to the rising incomes and demand.

“The Governments bid to counter the regional imbalances in the supply of petroleum fuels and to improve the level and pace of socio-economic development in the country; it intends to ensure that there always is adequate supply and distribution of petroleum products all over the country at the least cost”.

The review of the National Energy Policy document also revealed explicit policy statements that appear to be targeting the favourable energy pricing for the poor. Examples of such statements are given below:

“Retention of a lifeline tariff, where domestic consumers who use less than 50 kWh of electricity on a monthly basis get a subsidised tariff on their electricity consumption.

“To make electricity more affordable to the masses of the population, the Government removed VAT on electricity consumption of less than 50 kWh per month.

“In line with spreading and disseminating renewable energy technologies to promote their wide spread usage in the country, the Government allowed duty free importation of renewable energy hardware.

“Furthermore, in a bid to promote the wide spread use of renewable energy technology, the Government provided tax incentives to producers of renewable energy technologies and their related accessories.”

4.3 Areas Identified for Thematic Phase and Transition from Scoping to Thematic Phase

The survey identified four energy options for assessment, namely: Biomass energy, kerosene, liquefied petroleum gas (LPG) and electricity. There are several reasons for selecting the aforementioned energy options for further analysis. To begin with, the energy options have the potential for meeting the energy needs of the urban poor. The requisite infrastructure for the promotion and use of the energy sources is already in place. For example, in Kibera, there are several transmission and distribution lines passing overhead that can be tapped for distribution in the slum.

Charcoal, kerosene, electricity and, to a lesser extent, LPG appear to have elaborate energy distribution networks in Kibera. Although the distribution network of LPG is not as extensive as that of the other three energy options, it appears to be relatively good. This demonstrated by the fact that most of the LPG users in Kibera indicated that they only need to travel a maximum of 1 kilometre to refill their cylinders.

The four fuels are appealing to the urban poor as they are relatively affordable (if the upfront cost of both electricity and LPG is not considered) in comparison with their average incomes. The cost of the energy sources are as follows:

- US\$ 0.08 per kWh for electricity
- US\$ 5 per 36 kg sack of charcoal
- US\$ 13 to refill a 6kg cylinder of LPG
- US\$ 0.85 per litre of kerosene

Biomass: In most urban areas in Kenya, biomass energy is mostly used in the form of charcoal. Urban households like charcoal because it does not produce a lot of smoke and its calorific value is twice as much as that of wood and therefore last longer, especially when used with improved cookstoves. Charcoal is considered to be relatively affordable, economical and convenient. Charcoal is sold on average, at about US\$ 5 per 36 kg bag. It's relatively low price and an extensive distribution network ensures its availability within Kibera making it a popular fuel of choice for many of its poor residents especially for cooking food that requires a lengthy duration of boiling.

Kerosene: Kerosene is the most common fuel among poor urban households who use it for cooking, lighting, water heating. Kerosene is also used in the formal sectors of the economy for industrial and commercial purposes. Kerosene is popular among the urban poor population because they consider it quick and easy to use. According to the survey findings, about half of the residents Kibera residents interviewed depend on kerosene for lighting services. For household cooking, about one-third of the respondents use kerosene. In Kibera, kerosene resellers (mainly consisting of kiosks and informal pump stations) form the dominant channel through which the fuel reaches the households. Most of the resellers purchase kerosene in bulk from formal fuel stations.

Liquefied Petroleum Gas (LPG): In the urban areas of Kenya, LPG is used as a supplement to electricity (among those who can afford it), kerosene and charcoal. In spite of the high upfront cost of LPG, its penetration has recorded some significant level of success, albeit among the middle and high income urban households. About one-third of the urban residents use LPG as a source of energy. LPG is packaged in cylinders of sizes ranging from 3kg to 15kg for domestic applications, with the smaller cylinder sizes (3 and 6kg) being the most common sizes among the urban poor such as those living in Kibera. LPG is mainly used for cooking and lighting. Other major uses of LPG at the domestic level include heating water. LPG has a relatively elaborate distribution channel which is demonstrated by the fact that about half of the LPG users claimed that they get their LPG refills within a radius of 1 km.

Electricity: While this form of energy registers the lowest level of access among poor residents of Kibera, it is considered to be the best energy option as it can be used for multiple applications. Among the few users of electricity found in Kibera, they mainly use it because they find it cheap and affordable and that it is always available whenever they want to use it. However, there are several factors that hamper the widescale use of electricity among the urban poor population in Kibera. Chief among them is the high upfront cost of components such as meter board, circuit breakers and cabling.

43.1 Businesses operated by the urban poor

Another key finding of the study is the fact that there are several kinds of businesses that employ or are owned by the urban poor in Kibera. These businesses range from household based enterprises to fully-fledged and operational workshops, and food vending. The activities are many and are of varied nature. The tables below highlight the various different kinds of businesses run by the urban poor in Kibera, giving the main energy output, energy devices used and their alternatives if applicable.

The SMEs can be classified under two distinct categories, (i) Serviced based enterprises which include shop keeping (both wholesale and retail), vegetable and fish selling, tailoring shops, garages, electronic repair shops. e.t.c and (ii) Production based enterprises which include carpentry workshops, welding workshops, metal smelting and joinery workshops. These activities, based on the survey findings, are not as energy intensive as the heavy industrial processes undertaken in the more formal establishments of the economy. The table below highlights the various different kinds of businesses run by the urban poor in Kibera, giving the main energy output, energy device used and their alternatives where applicable.

Table 1: Service-based Activities Employing or Owned by the Urban Poor Kibera

Services Based Activities			
Activity	Main Energy Input	Energy Device Used	Alternatives
Food kiosks	charcoal, kerosene	stoves	LPG, Efficient biofuel stoves
Small restaurants	charcoal, kerosene, electricity, gas	stoves, electric cookers	Efficient biofuel stoves, and more efficient electricity stoves
Small shops	kerosene, electricity	fridges, stoves, lanterns	More energy efficient devices
Laundry	charcoal, electricity, solar	Flat iron, washing board	
Tailoring	animate, electricity	sewing machines, flat irons	Sewing machines with efficient motors
Beer bars / halls	Kerosene, electricity	fridges, stoves, electric cookers	LPG, efficient biofuel stoves & more efficient electric cookers
Informal video halls	Electricity		Time of day electricity tariffs
Taxi service	Petroleum	Petrol & diesel engines	Efficient internal combustion engines, improved engine tuning & maintenance
Commercial pick-up transport	Petroleum	Petrol & diesel engines	Efficient internal combustion engines, improved engine tuning & maintenance
Vehicle repair	Electricity, gas, animate	Welding equipment, grinders, compressors	Efficient motors for welding
Electrical goods repair	Electricity	Soldering equipment	
Butcheries	Animate, electricity	Incandescent lights	Tubes and CFLs
Tyre puncture repair	Kerosene	Heaters, compressors	Efficient heaters and motors

Table 2: Production/Manufacturing Activities Employing or Owned by the Urban Poor in Kibera

Production/Manufacturing Activities			
Activity	Main Energy Input	Energy Device Used	Alternatives
Metal works	Electricity, gas	Welding equipment, lathe machines, grinders, incandescent lights	Efficient electric motors, tubes and CFLs
Metal household items	Charcoal, electricity	Heaters	Use of efficient heaters, and electricity
Pottery / clay products	Animate, wood	Rollers	Solar dryers, electric rollers
Woodwork and furniture	Animate, electricity	Cutting and planning equipment	Efficient motors
Basket makers	Animate	sewing machines, flat irons	Efficient motors
Construction	Electricity		
Grain milling	Electricity, diesel	Electric motors	Efficient motors
Paint manufacture	Animate, electricity	Mixers, Incandescent lights	Efficient motors, tubes and CFLs
Activity	Main Energy Input	Energy Device Used	Alternatives
Bakeries	Electricity, animate	Mixers	Efficient motors and Ovens
Fabric manufacture	Electricity, animate	Motors	Efficient motors
Coffee processing	Electricity, firewood	Heaters, blowers, motors	Efficient dryers, blowers and motors

Source: AFREPREN/FWD, 2001b, Dube, 2001, Katyega, 2001, Kalumiana, 2001, Kebede, 2001, Kyokutamba, 2001

It is often argued that the urban poor spend a bigger proportion of their income on energy sources as compared to their richer and more affluent counter-parts in the urban areas. From the survey on Kibera, while getting information on the expenditure on energy in SMEs level was relatively difficult, however, it was not as difficult as getting the same information from the households in the area. The SMEs were more worried about giving out information relating to their energy use for fear of competition as well as avoiding such information reaching the tax authorities. According to this survey, the low income households spend an average of Ksh. 319 on energy e.g. for lighting, Ksh. 330 on electricity and Ksh. 280 on Kerosene and an average of Ksh. 348 on cooking fuel. It can therefore be assumed that energy consumption pattern at the SME level is higher than that of the household sector but is not expected to be as significant as energy consumption in the more established formal industrial sector.

Kibera has a very elaborate energy supply structure that spans almost the entire slum area. This is demonstrated by the high levels of energy access as well as the numerous suppliers and distributors existing in the area. Most of the residents using the least used source of energy such as LPG, do not need to go very far to refill their cylinders. LPG in the country comes from suppliers, who are mainly multi-national companies.

4.3.2 Issues relating to energy Sources Identified

There are other challenges that, not only have a direct impact on the use of the aforementioned energy options, but also present serious challenges to the urban and peri-urban poor. These are as highlighted below:

Kerosene

Firstly, there is the problem of kerosene storage in homes- a major fire hazard. Most of the residents of Kibera normally purchase and store kerosene in soda bottles. These can easily be mistaken for a beverage and as a result incidences of children accidentally drinking kerosene are not uncommon. Secondly, kerosene being a highly flammable liquid, it is normally not advisable to store kerosene in large quantities in the house, especially in the typically crowded settings of Kibera, where entire families share one room.

The price of kerosene has been on the rise over the last few years. The main cause is the rising cost of crude oil in the world market. Recently, the world crude oil price rose to record high of over US\$ 120 per barrel. The sharp rise in the crude oil prices has a direct impact on the local cost of kerosene, making it more expensive for a majority of the urban poor population.

Given the importance of kerosene in meeting urban poor household energy needs, targeted and time-limited subsidies for kerosene stoves and lamps could expand the kerosene market, widen access among the urban poor, lead to local investment in kerosene stove and lamp manufacture and reduce overall energy costs.

Electricity

The analysis of the cost of electricity reveals that the actual cost of electricity paid by the consumer includes several components, namely:

- The base electricity tariff
- Value Added Tax (VAT)
- Adjustments for foreign exchange rate fluctuations
- Fuel consumption (and cost) adjustments
- Rural electrification levy
- A levy to finance the Electricity Regulatory Board (ERB)

In spite of the base tariff remaining relatively low and unchanged for nearly a decade, over time, as the cost of each of component rises, cumulatively, the resultant actual cost of electricity is relatively high making it unaffordable to a significant proportion of the urban poor population.

Electricity safety has become a major concern among the users in the surveyed area. There have been several incidences of electrocution and electricity-related fires owing to the poor handling of electricity and overloading of electricity sockets.

Charcoal

In Kenya, charcoal production is still considered an illegal activity as it has not been legalized. For this reason, charcoal is produced in an uncoordinated manner and using very low efficiency technologies. This often leads massive waste of the biomass feedstock hence accelerating the rate of deforestation.

There are health hazards associated with the use of charcoal. When charcoal is burnt, it produces carbon monoxide. If charcoal is used in a room that is not well ventilated, it could lead to high concentrations of the carbon monoxide posing danger to the user. Carbon monoxide is a poisonous gas that can lead to death if it gets into the body blood circulation system in large quantities.

Charcoal is normally considered low cost and affordable. But due to the fact that it is repeatedly bought in small quantities it ends up being more expensive in the long run compared to other energy sources e.g. LPG gas.

LPG

Liquid Petroleum Gas (LPG) is increasingly seen as an option with significant potential for enhancing access to modern energy sources among the poor. However, incompatible LPG cylinders allow oil companies to lock in customers and charge higher prices. However, if customers could retain the same cylinder and have the flexibility to change LPG suppliers, the cost of LPG is likely to come down.

One of the key barriers to wider use of LPG among the poor is the high up-front cost of cylinder acquisition. Targeted and time-limited subsidies for reducing the cost of small size cylinders can expand the LPG market size among the poor as well as bring LPG cylinder prices down.

In terms of safety, there are several concerns linked to the use of LPG. There have been cases of LPG cylinders exploding and causing serious damage to both property and human life. This is mainly caused by misuse of cylinders (i.e. not adhering to the safety standards for use of LPG) and faulty cylinders and valves supplied by the oil companies.

There have also been cases of sale of half-filled cylinders by unscrupulous dealers in the market. This practice is rife in the low income areas and has greatly affected the credibility of LPG suppliers.

Kenya appears to lack adequate strategic storage facilities for LPG both at the national and local levels. This at times greatly hampers the supply distribution of LPG leading to shortages.

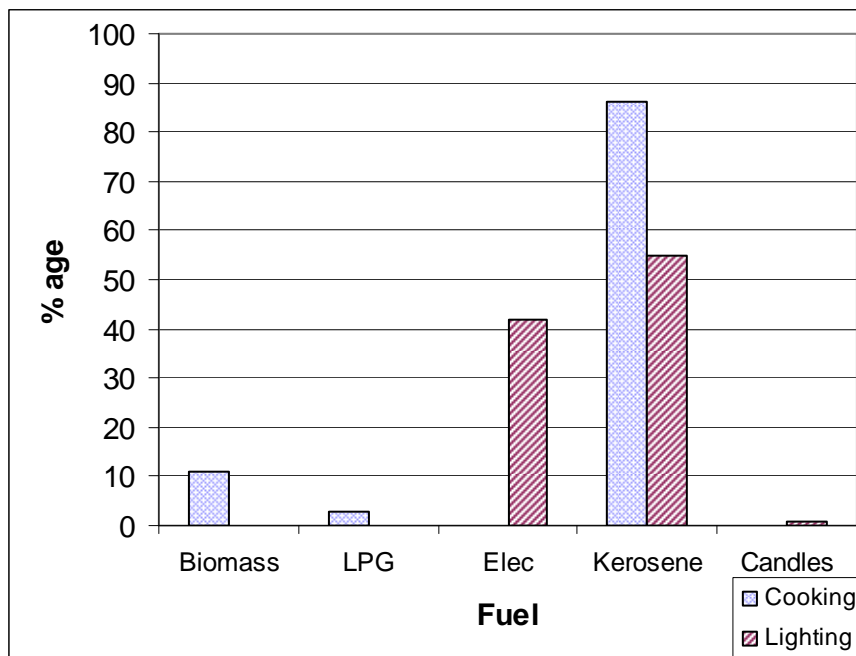
Chapter 5: Description of findings of the thematic phase surveys.

5.1 Brief Discussion of the Energy Sources available in Kibera and their use

There are several energy sources available to the urban poor residing in Kibera. The availability and usage of energy sources in Kibera are closely linked. While Kibera is large and expansive, it has several energy sources that are available in and around its vicinity. They include kerosene, LPG, charcoal, electricity, candles, firewood and crop and animal residue as well as solar. In overall terms, energy use among households in Kibera can be categorized into two: Energy for lighting and for cooking. For lighting purposes, the survey revealed that there are three main energy options utilized among the respondents - kerosene, electricity and candles. For cooking, kerosene, biomass and LPG appear to be the key energy options in Kibera.

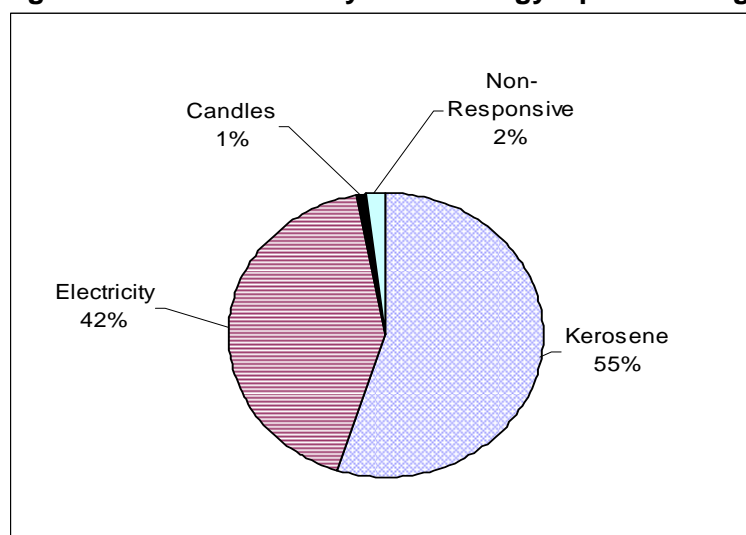
The household survey findings clearly demonstrate the role that kerosene, electricity, biomass and LPG can play for cooking and lighting in Kibera. According to the survey findings (see the following figure); kerosene is the most important modern energy option for the poor both for lighting and cooking. Electricity also appears to be a relatively important energy option but mainly used for lighting. Biomass in the form of charcoal as well as LPG appear to be consumed by a relatively small segment of the urban poor in Kibera.

Figure 5: Energy Use among Households in Kibera



For lighting, as the following figure shows, kerosene is the predominant energy option. About 55% of the respondents indicated the fuel as the most commonly used for lighting in Kibera. Electricity is the next most commonly used energy option for lighting and is used for meeting the primary lighting needs of about 42% of the Kibera residents. Candles appear to account for a miniscule 1%.

Figure 6: Most Commonly Used Energy Option for Lighting in Kibera



The following table highlights reasons given by the respondents for choosing either kerosene or electricity for lighting. For both energy options, affordability and availability are key factors of consideration:

Table 3: Reasons for Using Energy Options for Lighting²

Reasons	Kerosene % of respondents	Electricity % of respondents
Cheap and affordable	46	22
Always available	19	49
No Electricity or generator	23	-
Convenient	4	24
Has brighter light	2	22
Economical	6	9
Easy to use	7	2
No other source of lighting	17	-
Can be used for both lighting and cooking	2	7

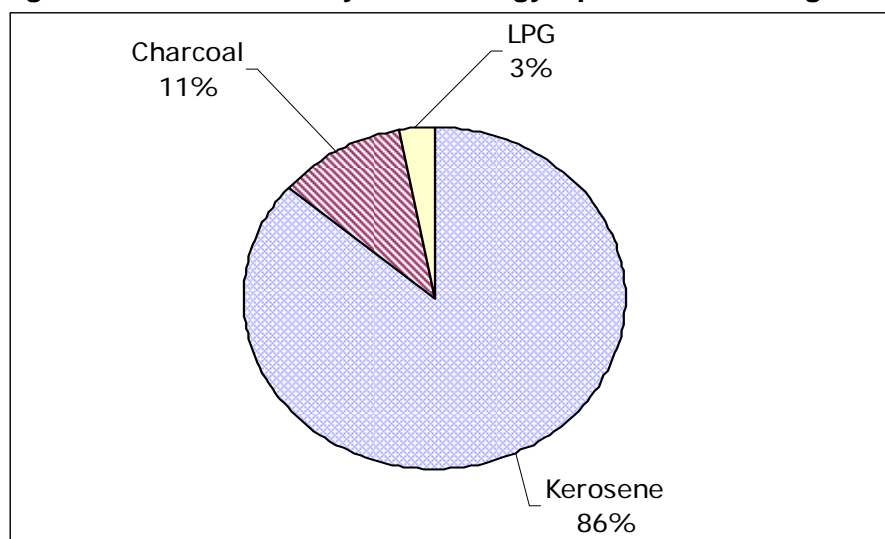
In addition, the survey identified a life line tariff which subsidizes the cost of electricity where end users who consume less than 50 kWh of electricity are billed at a rate that is lower than the actual electricity generation cost. This subsidy is meant to encourage electricity use among the poor. The only limitation of the subsidy is that it has leaked out of the target group and is currently being enjoyed by both the rich and non-rich.

With regard to cooking, again, kerosene emerges as the predominant energy option. According to survey findings, nearly 90% of the respondents indicated kerosene as the most commonly used cooking energy option. Charcoal is the next popular option but accounts for only 11% while LPG for cooking is a distant third accounting for 3%. As was expected, electricity is not a commonly used energy option for cooking among

² Most of the households surveyed had no mention of using LPG or any other energy source for lighting. The total number of respondents does not add up to 100% because respondents gave more than one reason. Inadequate data available for use of candles.

Kibera residents. The following figure shows the most commonly used energy options for cooking:

Figure 7: Most Commonly Used Energy Option for Cooking in Kibera



Like in the case for lighting, the study probed the reasons for selecting the different energy options for cooking. According to the survey findings (see following table), it appears that for kerosene, charcoal and firewood, affordability was a key factor for selection. The next most important factor cutting across all the energy options was its effectiveness in cooking a meal fast and efficiently. This is probably linked to the fact that most urban residents are often time constrained:

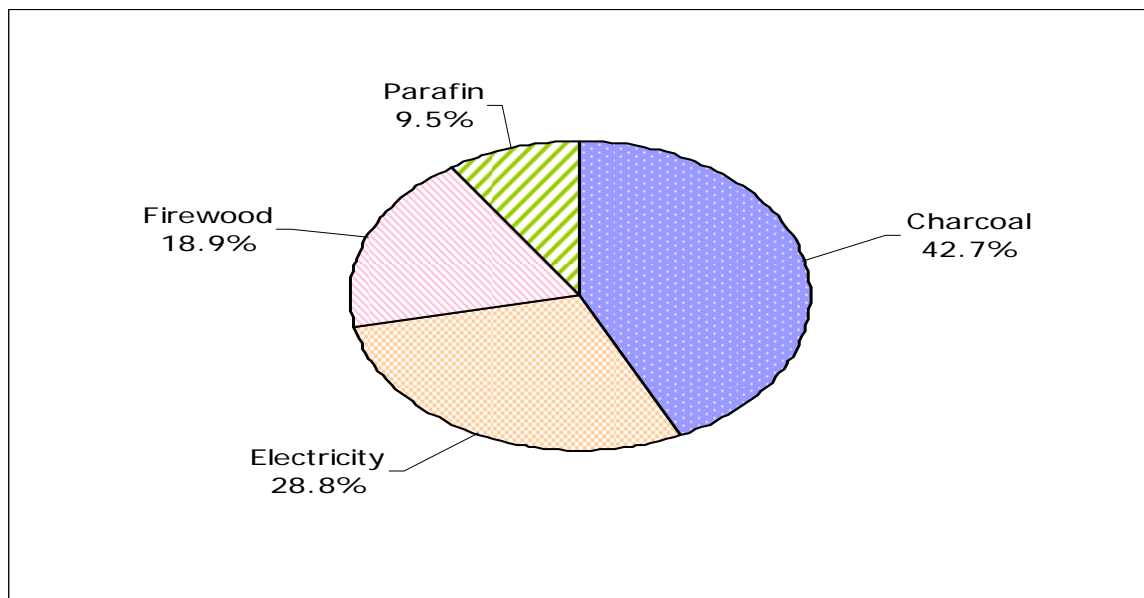
Table 4: Reasons for Using Energy Options for Cooking

Reasons	Kerosene % of respondent s	Charcoal % of respondent s	Firewood % of respondent s	LPG % of respondent s	Electricity ³ % of respondent s
Cheap/Affordable	51	49	19	1	-
Fast and Efficient	29	12	12	41	33
Always available	14	3	4	7	-
Easy to use	9	2	8	17	33
Economical	8	9	1	7	-
Convenient	8	7	4	1	67
Clean	3	2	-	17	-
Doesn't Smoke	2	2	-	17	-
Lasts longer	3	5	4	3	-
Keeps cooking pots clean	-	2	-	1	33

³ Most of the households surveyed did not use electricity for cooking but merely expressed their perception of the benefits of using electricity for cooking. However, the few households that used electricity for cooking (but not as the main energy option for cooking), either had illegal connection or only used it for preparing quick meals such as tea or for heating food or water. The total number of respondents does not add up to 100% because respondents gave more than one reason.

Energy consumption patterns among SMEs in Kibera differ markedly with those of household energy consumption. For example, as shown in the following figure, charcoal is consumed by nearly half of the SMEs in the area. Kerosene which is the most prevalent energy option among households appears not to be used as much in SMEs. In addition, use of firewood is seldom mentioned in the household survey. However, nearly 20% of SMEs use this energy option. Furthermore, there is no mention of LPG us among SMEs possibly due to the high upfront cost of acquiring LPG cylinders and associated components.

Figure 8: Most Commonly Used Energy Option among SMEs in Kibera



The domination of charcoal as the fuel of choice among the SMEs could be attributed to its availability, low cost, economy and that it lasts longer (when used with improved technologies) as well as the fact that it doesn't produce a lot of smoke when compared to firewood. The relatively low levels of electricity use among SMEs is largely due to the high cost of electricity, particularly, the upfront cost of connection.

5.2 Analysis of the survey findings

5.2.1 Findings on biomass

Charcoal is derived from carbonising wood in the absence of air, and has twice the calorific value per unit weight as compared to wood, and doesn't produce as much smoke as the latter. In spite of charcoal production being outlawed, it has a very distinct and elaborate distribution network, right from the burning fields to the stoves in the house where it is used. Its availability and constant supply is almost assured as it is easy to package and transport over long distances. Most of the charcoal consumed in urban areas is mainly produced in the rural areas, where the Forest Department is always on the look out to arrest individuals engaging in the exercise. Its production in the country is not efficient. The energy recovery efficiency using the best charcoal making kiln is about

30% but in Kenya, where charcoal production is done in the traditional earth kilns which have very low energy recovery systems, ranging between 10-20%. Most of the energy ends up being lost and tonnes of wood wasted in the process.

The ban on logging and charcoal production was effected by the Government to check on the excessive rates of deforestation in the country. The ban has directly affected the supply of raw materials used for charcoal production leading to a general increase in the end user price of the fuel, higher than the disposable incomes of the urban poor. Charcoal retailers often sub-divide it into smaller containers which retail at relatively affordable prices averaging US\$ 0.5 per tin. This makes it affordable to the mass of the urban poor population who tend to buy the charcoal in small quantities on a day-to-day basis. In the long run, this leads to much higher expenditure on charcoal, making it more expensive than other alternative energy sources.

As was mentioned earlier, there are health hazards associated with use of charcoal. Charcoal emits carbon monoxide (CO), a very poisonous gas, as one of the by products. If used in a room that is not well ventilated, charcoal use could lead to serious respiratory ailments and possible death if inhaled in large quantities. Furthermore, charcoal is a contributor to indoor air pollution which can lead to serious cases of bronchitis, mostly among children. This is especially the case when charcoal from certain trees is used or if charcoal was not properly carbonized.

5.2.2 Findings on LPG

In spite of LPG not being a very common source of fuel among the urban poor population, trends indicate that its use and dissemination is steadily growing. LPG has a very high upfront cost which is normally beyond the reach of the majority of the urban poor. The overall cost of a simple cylinder with its related accessories is approximately 10 to 15 times the national per capita income. This has greatly affected the dissemination of LPG mainly among the urban poor. In addition, although the cost of refilling the LPG cylinders is normally affordable and within reach of the urban poor population, the prices are dictated by the world oil prices which fluctuate from time to time. This causes uncertainty about its use within the target group. The safety aspect and reliability (volume found in each cylinder may vary substantially pertaining to the use of LPG is also of great concern among the urban poor population in Kibera.

5.2.3 Findings on Electricity

Electricity was mainly used in Kibera for provision of light, both at the household and SME level. The study find out that most of the people using electricity did not source it directly from the main utility company KPLC, but paid for electricity as part of their monthly rent. Majority of the houses connected to electricity in the area either had illegal connections or were tapped from a single point. In spite of the utility company's efforts to electrify the slum area, electrification levels in Kibera are very low. A very large portion of the population in the survey area do not have access to electricity in spite of their houses being near electricity transformers and power supply lines. This has been mainly occasioned by not only the high upfront cost of electricity connectivity charges by the utility company but also, the rising cost of electricity which has a direct relation to the world oil prices. This has led to the actual cost of electricity being high, well beyond the affordability of a majority of the urban poor population. In the survey area, the majority of

the population seem to be wary on the use of electricity mainly owing to the safety of electricity as there have been numerous incidences of electrocution and electrical-based fires.

5.2.3 Findings on Kerosene

Kerosene is the most common source of fuel used in Kibera. It is used by a majority of the population especially in households, mainly for lighting and cooking. The main reasons for using kerosene within the survey area is that it is fast, efficient, easy to use and cheap. Kerosene has a long and elaborate distribution which has numerous middlemen, who all add a mark up to their sales, thus increasing the cost of kerosene to the end user. Lack of supportive legislation that would increase access of kerosene among the local population is almost non-existence; therefore, the industry is subjected to the market forces of supply and demand, and left to regulate itself, thus leading to the status quo. In addition, although kerosene is cheap and affordable, its related technologies are fairly expensive in comparison to the income levels of the urban poor. For example, an ordinary kerosene stove would cost about 4-5 times the national per capita of the country. This normally forces the locals to adapt and use low efficient technologies such tin lamps and stoves which are locally made and have very little safety measures exposing them to the hazardous effects of kerosene smoke as well putting them at risk of causing a fire.

5.3 Analysis of Availability of Biomass, Electricity, Kerosene and LPG

5.3.1 Availability of Biomass

The availability of the charcoal in Kibera is relatively adequate and is particularly evident by the huge stacks of charcoal bags found among vendors in the area. Almost all the energy vendors, including those located deep in the heart of the survey area, have adequate stock of charcoal in their yards. Furthermore, the main distributors of charcoal in the area, normally buy charcoal, in bulk (several hundred bags) from suppliers, and store them in their yards, from where they sell them to distributors at wholesale price. This is replicated in several other areas of the expansive Kibera slum. This practice always ensures availability of charcoal in Kibera.

5.3.2 Availability of LPG

Liquefied Petroleum Gas (LPG) is mainly produced at the Kenya Petroleum Refinery in Mombasa and marketed by the various multi-national oil companies. In Kibera, LPG is normally bought from the Multi-nationals and marketed and sold by the numerous small scale distributors in the survey area. Despite being a risky practice, distributors often have stocks of LPG in their premises, greatly increasing availability of the fuel in Kibera. As long as the supply of LPG in country is adequate, availability of LPG in Kibera is almost always guaranteed. Problems from the suppliers such lack of importation of LPG into the country are usually the main issues that threaten its availability.

5.3.3 Availability of Electricity

Electricity in Kenya is generated from various different sources which include large hydro, thermal (oil) and renewable sources of energy such as geothermal, cogeneration, wind, small hydro and solar. The current electricity installed capacity stands at 1,197

MW is just but sufficient to met the demand in the country, which currently is 987 MW. The electricity peak demand is projected to rise by 14% per annum to 1,370 MW by July 2008 (MoE, 2006). As long as there is no generation capacity shortfall, it is anticipated that the electricity supply in Kibera will be readily available. However, past experiences indicates that when load shedding is introduced in the country, low income areas such as Kibera are the first to be affected.

5.3.4 Availability of Kerosene

Kerosene being the most preferred energy source after biomass in Kibera, its availability can not be over emphasised. The elaborate supply and distribution chain in the survey area ensures the constant supply and availability of the fuel among the residents of Kibera. As earlier mentioned, kerosene is sold in shops, kiosks, and vendors who are numerous and are conveniently located within trading centers or residences all across Kibera.

5.4 Analysis of Consumption of Energy Sources both at the Household and SME level

5.4.1 Consumption of Biomass, electricity, Kerosene and LPG at the household level

At the household level, electricity, kerosene, charcoal and LPG are used either for cooking and/or for lighting. Biomass is the most prevalent energy source used by the urban poor in Kibera and its use is mainly limited to cooking. Over 60% of the households surveyed claimed to use charcoal for cooking. There are mainly two major sources of charcoal to the urban poor consumers. Most of them buy it from retailers' charcoal yards, conveniently located near their dwellings. A very small number claim to produce their own charcoal- this is especially the case of "charcoal briquettes"- a mixture of charcoal and charcoal ash.

Of all the urban poor population surveyed, 42% of claimed to use electricity for lighting and none of them used it for cooking. The main reason for this is that most of the landlords in the area of survey have electrified their houses and lease with the electricity connected and just charge a one off fee that covers the rent as well the electricity consumed. It is worth noting that most of the electrified houses had an illegal connection.

Kerosene on the other hand, was used for lighting by 55% and 86% of the urban poor surveyed for lighting and cooking respectively. Kerosene is mainly preferred by the urban poor because of its affordability i.e. can be bought in small quantities, availability and convenience among the users.

On the other hand, a very small percentage about 3% of the total household's survey used LPG, mainly for cooking. Its use for lighting was even lower among the households surveyed, with less that 1% of the total respondents using it for this purpose. The LPG users mainly sourced it from shops located around their residences and nearby petrol stations.

5.4.2 Consumption of Biomass, electricity, Kerosene and LPG at the SME level

There are several SME activities undertaken by the urban poor residing in Kibera. The SMEs can be classified under two distinct categories, (i) Serviced based enterprises which include shop keeping (both wholesale and retail), vegetable and fish selling, tailoring shops, garages, electronic repair shops. e.t.c and (ii) Production based enterprises which include carpentry workshops, welding workshops, metal smelting and joinery workshops. These activities, based on the survey findings, are not as energy intensive as the heavy industrial processes undertaken in the more formal establishments of the economy.

Charcoal is the most prevalent source of fuel used by SMEs as it is used and consumed by about 43% of all the establishments surveyed followed by electricity at 29%, firewood at 19% and paraffin at 9.6%. There was very little mention of use of LPG among the SMEs surveyed as most of them noted that the high upfront cost of acquiring LPG and its components was the main hindrance. The domination of biomass as the fuel of choice among the SMEs could be narrowed down to its availability, low cost, economy and that it lasts longer (when used with improved technologies) as well as it doesn't produce a lot of smoke compared to firewood. There was no mention on the use of electricity among production based enterprises mainly owing to the high cost of electricity and low penetration levels.

The nature of business, to some extent, dictates the kind of fuel used therein. Production based enterprises in Kibera which are energy intensive, tend to consume various different kinds of energy/fuel. From the survey findings, only 10% of these businesses consume charcoal as their main energy source. On the other hand, service based enterprises are the most prevalent in the area. They are not as energy intensive but also, consume various different kinds of energy sources. About 86% of these enterprises consume charcoal as their primary source of fuel. Some of the service-based enterprises such as hair salons and barber shops mentioned that they use electricity for their daily operations. Very few other SMEs mentioned that they used electricity for their daily operations.

A detailed analysis of the biomass usage in one food kiosk was carried out for duration of one week in the course of the survey to determine the energy consumption patterns of the SME, and it established that on average, the establishment bought 2.5 kgs of charcoal at a cost of KShs. 40 per kg per day for its operations.

Kerosene was mainly used by service based enterprises with a majority of users being food kiosks, laundry mats (Dhobis) and home based enterprises, and they were mainly used for mainly for cooking, heating water and provision of light. In spite of the cost of kerosene being high (the price of kerosene is linked to the world oil price), the consumption of kerosene among SMEs in the area is relative high. This is mainly due to the numerous distributors and retailers of kerosene in the survey area and the fact that kerosene is sold in small quantities, which are more affordable to the local community. The study was not able to establish the exact per capita consumption of kerosene among the SMEs but, on inspection, most of the SMEs visited either had or used a kerosene stove and there was a high mention of kerosene use among the SMEs surveyed

In relation to the gender of business owners, most of the businesses were female owned and accounted for nearly 70 % of all businesses surveyed. The remaining businesses (about 30%) were owned and operated by men. Charcoal was mainly used among the

female owned businesses because most of the female owned businesses mostly evolved around food preparation.

Only a very small percentage (less than 1%) of the SMEs that the study surveyed used LPG for their operation. The use of LPG in the SMEs is mainly centered on cooking and provision of light. The main reasons given by the SMEs for the use of LPG were that it cooks faster, has less emission as compared to other sources and it can be used both for lighting and cooking.

5.5 Issues related to Access of Biomass, Electricity, Kerosene and LPG

Access and availability to various sources of fuels for domestic and commercial use is dependent on numerous factors, some of which include the cost and location. All these fuels have very good access levels among the urban poor in Kibera, and evidenced by the numerous suppliers and distributors selling the commodities. Some of the issues related to the access of electricity, Kerosene, biomass and LPG that were captured from the survey include;

a. Electricity

- i. As has been mentioned in the report, the electricity tariff has remained relatively constant since the last review in 1999, but the actual cost of electricity charged to the consumers, which takes into account additional costs such as value added tax (VAT), foreign exchange loss adjustment etc, and has been steadily rising over the years.
- ii. Electrifications levels among the urban are still relatively low and most of the households get their electricity from a single connection or through illegal connections that pose safety risks.
- iii. The initial upfront cost of electricity i.e. the cost of cabling and purchasing accessories such as circuit breakers, switches etc is very expensive and normally not affordable to the urban poor.
- iv. There are times when users experience frequent blackouts which can make electricity an unreliable source of energy for use both in households and SMEs.
- v. Lack of target specific subsidies for encouraging electricity use among the urban poor in the country.

b. Kerosene

- i. There are numerous middle men along the supply line of kerosene who normally add a margin to the price of kerosene. This normally leads to high retail prices for the consumers forcing them to purchase it in small quantities, where they end up spending more, from small distributors.
- ii. Traditionally, kerosene subsidies provided by the Government have not been effective as they have also been captured by the non poor as there have not been any systematic and targeted policies that explicitly target the poor.
- iii. The safety issues related to the use and storage of kerosene both at the domestic and SME level has raised a lot of concern amongst users owing to the numerous incidences and cases of fire outbreaks.

c. Biomass

- i. Lack of policies to ensure that energy supply sources are not completely depleted and to always ensure their sustainability for example, rigorous reforestation exercise across the country to ensure sustainable supply of biomass.
- ii. Legislation governing the supply of improved biomass i.e. the ban on charcoal production), has greatly hampered the sustainable production and supply of charcoal and other improved sources of biomass.

d. LPG

- i. The long supply chain made up of middlemen who supply the energy sources. Each middle man adds some mark-up to their sales thereby increasing the cost of the energy service by the time it gets to the consumers.
- ii. Lack of political will in promoting or legislating bills that directly target increased availability of energy sources that have direct benefits to the poor for example subsidies that would enable the poor to afford and have access to LPG or lowering the upfront cost of LPG purchase.
- iii. Lack of innovative financing mechanisms that would enable the urban poor to have increased access to modern energy sources that are currently not affordable to them, e.g. financing for LPG equipment.
- iv. Lack of an establishment of adequate oil reserves that would act as cushion against the rising world oil prices.

5.6 Survey Findings on the use of Electricity, Kerosene, LPG and Biomass

The following table summarizes the key survey findings in Kibera highlighting the reasons for use of the various different energy sources, issues related to their use as well as the good and bad practices.

Table 5: Summary of Key Survey Findings

Fuel	Reason for Use	Issues Related to the Fuel	Best/Bad Practices
Charcoal	<ul style="list-style-type: none"> - It is cheap and affordable when bought in bulk - Easily accessible - Easy to use - It is economical - It is convenient - It lasts longer (When used with improved stoves) 	<ul style="list-style-type: none"> - Charcoal production is an illegal activity that has not been licensed by the Government. - - There is a ban on logging that has affected the supply of raw material for charcoal Production. - - Too costly owing to the small quantities in which it is packaged in. - - Health hazard mainly due to the high carbon monoxide content of the charcoal necessitating use in an open and well ventilated room. - - Takes too long to light. 	<p><u>Best practices:</u></p> <ul style="list-style-type: none"> - Use of energy saving charcoal cooking stoves. - Efficient distribution mechanism for improved cook stoves. - Policy for sustainable charcoal production. <p><u>Bad Practices</u></p> <ul style="list-style-type: none"> - Illegal logging - Unsustainable charcoal production practices
LPG	<ul style="list-style-type: none"> - It is quick and efficient - It is easy to use - It is clean - It does not produce smoke - It is economical - It is mostly available - Can be used for both lighting and cooking 	<ul style="list-style-type: none"> - Upfront cost of typical equipment plus the cylinder are too high for the urban poor. - - Price of the gas (refill) is always prone to high world oil price fluctuation. - - Inadequate national storage - - Safety concerns - - Sale of half filled cylinders 	<p><u>Best Practices:</u></p> <ul style="list-style-type: none"> - Effective distribution channels - Liberalized petroleum sector. - Introduction of a 6kg and 3kg gas cylinders mainly targeting the poor. - Introduction of weighing scales at refilling stations. <p><u>Bad Practices:</u></p> <ul style="list-style-type: none"> - Sale of half filled gas cylinders. - Lack of standardized gas cylinders.

Fuel	Reason for Use	Issues Related to the Fuel	Best/Bad Practices
Kerosene	<ul style="list-style-type: none"> - It is cheap and affordable when bought in bulk - Easily available - It is convenient to use - Low Access to electricity - High cost of electricity - Has dual functions of both cooking and lighting - Easy to use <ul style="list-style-type: none"> - It is economical - It is quick and efficient 	<ul style="list-style-type: none"> - Purchased in small quantities from small distributors resulting in high retail price. - - Traditionally, subsidies provided by the Government have also been captured by the non poor. - - Safety aspects related to use and storage. 	<p>Best Practices:</p> <ul style="list-style-type: none"> - Deregulation of the petroleum industry has seen small scale kerosene pumping stations opened. These are delivering kerosene in a cheap and safer way than kiosks
Electricity	<ul style="list-style-type: none"> - It is cheap and affordable (once upfront costs are paid and if used only for lighting) - It is always available - Convenient - Easy and convenient to use - Has bright light - Can be use both for lighting and cooking - It is quick and efficient - Does not produce smoke - It lasts longer 	<ul style="list-style-type: none"> - Electrification levels among the urban poor is still very low & most of the households connected either acquired electricity communally or through illegal connections. - - Electricity connection is still very expensive for the urban poor. - - There are sudden and frequent blackouts making it at times unreliable source of energy for use both domestically and in the SMEs - - Safety of the energy source is a main concern mainly due to high cases of electrocution and death caused by misuse or tampering with the supply. 	<p>Best practices:</p> <ul style="list-style-type: none"> - Use of energy saving devices both at household and SMEs level, avoiding wastage of electricity and employing energy efficiency measures. -Introduction of communal electrification programme. -Introduction of flood lighting in slums <p>Bad Practices:</p> <ul style="list-style-type: none"> - illegally tapping electricity from the supply lines exposing user to potential risks and not wastage of electricity by not employing energy efficiency and saving measures.

Chapter 6: Conclusions, Study Recommendations and Areas for Future Research

From the survey, it is clear that the four energy sources – electricity, kerosene, charcoal and LPG-are important fuels among the poor. They both enjoy high levels of awareness and dissemination. They have distinct and elaborate supply and distribution networks.

Kerosene is the most used source of fuel in Kibera, both for lighting and cooking. It is mainly used because it's cheap, easily affordable, easily available, quick and efficient, economical, easy to use and due to the low penetration of electricity in the area. The main issues affecting the spread and use of kerosene in the Kibera are its safety, high retail prices owing to the numerous middlemen and lack of supportive subsidies that would increase its use among the urban poor.

Biomass, in the form of charcoal, is main used in Kibera due to its availability, ease of use, low cost and because it lasts longer, (when used with improved technologies). In spite of the high penetration levels of charcoal use, there are still some issues affecting its access and subsequent dissemination, e.g. the outlawing of charcoal production by the Government and the use of traditional low efficiency energy recovery technologies for charcoal production which leads to massive wastage of both energy and wood in the process.

LPG is becoming more acceptable among the residents in Kibera and its use is steadily rising. Some of the factors that have slowed its dissemination are the high upfront cost of the cylinders and related accessories, safety concerns and the sale of half-filled cylinders by unscrupulous dealers and suppliers.

Electricity on the other hand, due to its versatility and ability to be used for multiple functions, its use is increasing in the area. Among the people who use electricity in Kibera, they mentioned that it was affordable (only after the initial upfront cost has been paid and when used only for lighting), easy and convenient to use, has bright light, can be use both for lighting and cooking, it is quick and efficient, does not produce smoke and that it lasts longer. The main issues relating to the use of electricity among the users were identified as the low levels of electrification in Kibera leading numerous illegal connections, the high upfront cost of electricity, frequent power outages and its safety due to the high number of electricity related fires and deaths.

There are several other factors that hamper the access and dissemination levels of the above mentioned fuels. These factors are as summarized below:

a) Electricity

- i. As has been mentioned in the report, the electricity tariff has remained relatively constant since the last review in 1999, but the actual cost of electricity charged to the consumers, which takes into account additional costs such as value added tax (VAT), foreign exchange loss adjustment etc, and has been steadily rising over the years.

- ii. Electrification levels among the urban are still relatively low and most of the households get their electricity from a communal connection or through illegal connections that are very risky and dangerous.
- iii. The initial upfront cost of electricity i.e. the cost of cabling and purchasing accessories such as circuit breakers, switches etc is very expensive and normally not affordable to the urban poor.
- iv. There are sudden and frequent blackouts which makes electricity a very unreliable source of energy for use both domestically and in the SMEs as the users find it hard to predict its availability
- v. The safety of electricity is a big concern mainly due to high cases of electrocution and death caused by misuse of or tampering with the supply.
- vi. Lack of target specific subsidies for encouraging electricity use among the urban poor in the country.

b) Kerosene

- i. There are numerous middle men along the supply line of kerosene who normally add a margin to the price of kerosene. This normally leads to high retail prices for the consumers forcing them to purchase it in small quantities, where they end up spending more, from small distributors.
- ii. Traditionally, kerosene subsidies provided by the Government have not been effective as they have also been captured by the non poor as there have not been any systematic and targeted policies that explicitly target the poor.
- iii. The safety issues related to the use and storage of kerosene both at the domestic and SME level has raised a lot of concern amongst users owing to the numerous incidences and cases of fire outbreaks.

c) Biomass

- i. Lack of policies to ensure that energy supply sources are not completely depleted and to always ensure their sustainability for example, rigorous reforestation exercise across the country to ensure sustainable supply of biomass.
- ii. Legislation governing the supply of improved biomass (i.e. the ban on charcoal production), has greatly hampered the sustainable production and supply of charcoal and other improved sources of biomass.

d) LPG

- i. The long supply chain made up of middlemen who supply the energy sources. Each middle man adds some mark-up to their sales thereby increasing the cost of the energy service by the time it gets to the consumers.
- ii. Lack of political will in promoting or legislating bills that directly target increased availability of energy sources that have direct benefits to the poor for example

subsidies that would enable the poor to afford and have access to LPG or lowering the upfront cost of LPG purchase.

- iii. Lack of innovative financing mechanisms that would enable the urban poor to have increased access to modern energy sources that are currently not affordable to them, e.g. financing for LPG equipment.
- iv. Lack of an establishment of adequate oil reserves that would act as cushion against the rising world oil prices.

Based on the findings of the survey in Kibera, as well as background literature review, the study recommends the following;

- (i) Taxes are a key determinant of the retail price of both kerosene and its related technologies mainly stoves. Key taxes include import duty, excise duty, value added tax (VAT) and the petroleum development levy. While kerosene has in recent past enjoyed tax reduction and/or waivers, this has not been the case for its appliances, in particular kerosene stoves. The current taxation on kerosene stoves stands at 35% import duty and 16% Value Added Tax which totals to 51% taxation on imported kerosene stoves. This has made the stove inaccessible to the poor. These taxes should be reduced to buy efficient and improved kerosene appliances to a wider proportion of the urban poor making them more accessible and affordable to a majority of the population.
- (ii) Past pro-poor incentive strategies have been exclusively focused on the kerosene fuel. While tax reduction in kerosene has resulted in motor fuel adulteration, it is believed that if similar incentives were targeted on kerosene appliances, the benefits to the poor would be higher and would minimize possibility of any diversion to unintended uses.
- (iii) In order to further make electricity more affordable, its generation from locally sources alternative fuels such as small hydropower, geothermal and cogeneration, which are abundant in the country, should be encouraged.
- (iv) Since the electricity life line subsidy is not target specific, it doesn't seem to benefit the poor. Therefore, a review of the subsidy specifically targeting it to the poor would be increase electricity access among the urban poor.
- (v) The government should develop policies and regulations that are directly targeted at reducing the upfront cost of access to electricity hence making it affordable and more accessible to a majority of the urban population.
- (vi) Since biomass (charcoal) plays an important part in the lives of the urban poor, issues affecting its access and dissemination and use i.e. the ban on logging, production of charcoal in traditional low efficient earth kilns e.t.c should be addressed so that it can be produced, promoted and distributed in a sustainable and efficient manner, with the formal economy.

- (vii) Promotion of biomass (charcoal) should be done in tandem with use of improved charcoal production and improved cookstoves in order to keep its demand in check.
- (viii) Innovative financing mechanism or subsidies targeting the poor, similar to that given for electricity supply, should be created and targeted directly to the poor, to enable them purchase LPG cylinders and its related accessories.
- (ix) Establishment of a penalty system, where LPG suppliers are made to pay a hefty fine for any cylinder found to be underweight as well as failure to adopt common cylinder regulators/valves. This would instill confidence in LPG among the urban poor.

Some of the policy pointers that the study proposes include;

- The need for energy subsidies that target the upfront cost of energy sources rather than the recurrent costs, in order to make modern energy more affordable and accessible to a wider population of the urban poor.
- Where energy subsidies on recurrent costs apply, there is need for them to be more targeted to the poor. For example, presently the electricity subsidies include sale of the first 50 kWh below the cost of delivery and no VAT on consumption less than 200 kWh per month. While the latter subsidy directly targets and benefits the poor, the subsidy on the first 50 kWh, however, is enjoyed by the non-poor as well, therefore, there is need for reviewing the subsidy to ensure that it is specifically targeted to the urban poor and the subsequent savings made can be used to cover the initial upfront cost of electricity connection for the urban poor by providing them with either;
 - Prepayment meters
 - Flood lighting the slum areas where they stay to increase electricity access among the urban poor
 - Provision of load meters to the urban poor residences
 - Provision of an electricity board to the low income urban areas
- There is need for introducing tax fiscal incentives such tax relief for energy equipment suppliers to encourage the private sector to produce locally or sell energy equipment to be used by the urban poor energy access.
- Setting up a system for improved distribution of biomass (charcoal) and LPG to cater for urban poor by;
 - Creating storage facilities in low income areas to increase supply of energy sources, thus reducing middlemen and lowering cost of energy.
 - Creating credit mechanisms to cover the upfront cost of and to cater for bulk purchases for LPG and Charcoal appliances.

6.1: Area for Future Studies.

In the foreseeable future, all the above mentioned fuels are likely to continue being important energy options for the urban poor. However, there are several areas that need further research in order to make the fuels more accessible and affordable to a wider

proportion of the population. The following areas could be examined further in future research studies.

- Efficient and sustainable charcoal production:

Charcoal production in the country is carried out using traditional technologies that are very low efficient and end up losing lots of energy in the process. This leads to the massive waste of wood, the raw biomass feedstock used for charcoal production. This normally leads to high production costs for charcoal subsequently affecting market retail price as well as contributes to deforestation. Future GNESD studies could investigate, in detail, efficient and sustainable ways of charcoal production in order to address these related issues.

- Energy Use in SMEs run and operated by the urban poor.

There are very few uncoordinated research studies on energy use among the numerous SMEs run and owned by the urban poor. Although individual energy consumption of the SMEs could be insignificant, cumulatively, their energy consumption is significantly high and they could influence the energy consumption patterns in the country. In spite of the SMEs playing a vital role in the energy supply and consumption patterns among the urban poor, detailed analysis of the kind of energy sources used, sources, the cost of energy sources as well as the urban poor's consumption patterns at the SME level, needs to be analyzed in depth.

- Potential Benefits to The Urban Poor of Standardizing LPG gas Cylinders and Accessories.

Currently, in the Kenyan market there are several multi-national oil companies producing LPG for local consumption. Each of these companies produce LPG cylinders to their specifications, meaning that LPG regulators are not interchangeable amongst the cylinders from the various different suppliers. A study looking at the potential benefits of standardizing LPG cylinders regulators and its benefits to the urban poor also needs to be analyzed in depth in future GNESD studies.

- An in depth analysis and study on the Kerosene marketing and distribution in urban poor areas

The main barrier to the supply and distribution of kerosene in Kibera is the long supply chain which is filled with numerous middle men. A detailed analysis of the Kerosene supply chain and its effect on the kerosene pricing among the urban poor could be analysed in order to propose measures that would drastically reduce the price of kerosene hence increase its availability among the urban poor.

References

- AFREPREN (2004c) The Potential Contribution of Non-Electrical Renewable Energy Technologies (RETs) in Poverty Alleviation in Eastern Africa: The Case of Wind Pumps, Ram Pumps, and Treadle Pumps in Kenya and Tanzania, Nairobi, African Energy Policy Research Network (AFREPREN).
- AFREPREN (2005a) AFREPREN Occasional Paper 26: Renewables in Kenya's Electricity Industry: A Review of Geothermal and Cogeneration Technologies, Nairobi, African Energy Policy Research Network (AFREPREN)
- AFREPREN/FWD (2005b) Sustainable Energy in Africa: Cogeneration and Geothermal in the East and Horn of Africa – Status and Prospects, Nairobi, Energy, Environment and Development Network for Africa (AFREPREN/FWD).
- AFREPREN/FWD (2006) Influencing Policy through the Active Involvement of a Research Institution in the Performance Contract Process - Lessons from the Experience of AFREPREN/FWD, Nairobi, Energy, Environment and Development Network for Africa (AFREPREN/FWD).
- Balla, P. (2005) The potential Contribution of Non-Electrical Renewable Energy Technologies (RETs) towards Poverty Alleviation: Non-electrical water pumping technologies for irrigation, Nairobi, Energy, Environment and Development Network for Africa (AFREPREN/FWD).
- Balla, P. (2006) National Study on Small Hydropower Development: Status and Potential of Small Hydropower Development in the Tea Industry in Kenya, unpublished report, Nairobi and Mombasa, UNEP/GEF and East African Tea Trade Association (EATTA)
- Balla P. (2004) The Potential Contribution of Non-Electrical Renewable Energy Technologies (RETs) in Poverty Alleviation in Eastern Africa: Wind Pumping and Treadle Pumps in Kenya, Nairobi, African Energy Policy Research Network (AFREPREN)
- CAN, (2004) Energy in the East African Community, Nairobi, Climate Network Africa (CAN).
- CIA,(2007): Central Intelligence Agency (CIA)The World Fact Book: Kenya,www.cia.gov/cia/publications/factbook/geos/ke.html, Washington DC, Department of State.
- ESI (2006): Wind Energy- Planning For East Africa's Energy Future, ESI Africa Issue 2 2006, Steenberg, South Africa
- GOK (1998) Kenya Gazette Supplement, ACTS, 1998, Nairobi, Government of Kenya (GOK)

GOK (1996) Rural Electrification Master Plan: Inception Report, Nairobi, Government of Kenya, (GOK)

GOK (2002a) Economic Survey 2002, Nairobi, Government of Kenya (GOK)

GOK (2002b) National Development Plan 2002-2008, Nairobi, Government of Kenya (GOK).

GOK (2003) GOK (2003) Economic Survey 2003, Nairobi, Government of Kenya (GOK)

GOK (2004a) Economic Survey 2004, Nairobi, Government of Kenya (GOK)

GOK (2004b) Sessional Paper No.4 of 2004 on Energy, Nairobi, Government of Kenya (GOK)

GOK (2004c) Draft National Energy Policy, Nairobi, Government of Kenya (GOK)

GOK (2007) Economic Survey 2007, Nairobi, Government of Kenya (GOK)

GOK (2007b) Energy Act, 2007, Nairobi, Government of Kenya (GOK)

IEA (2007) Energy Balances of non-OECD Countries, Paris, International Energy Agency, (IEA)

Karekezi, S. (2002) 'Renewables in Africa – Meeting the Energy Needs of the Poor', *Energy Policy, Vol. 30 Nos. 11-12. Special Issue – Africa: Improving Modern Energy Service for the Poor*, Oxford, Elsevier Ltd

Karekezi and Kithyoma, (2005) Sustainable Energy in Africa: Cogeneration and Geothermal in the East and Horn of Africa – Status and Prospects, Nairobi, AFREPREN/FWD

KPLC (2006): Annual Report, 2006, Nairobi, Kenya Power and Lighting Company (KPLC)

MoE, (2002): Study on Kenya's Energy Demand, Supply and Policy Strategy for Households, Small Scale Industries and Service Establishments, Nairobi, Ministry of Energy (MoE)

World Bank, (2004): African Development Indicators. Washington D.C: The World Bank

World Bank, (2006): World Development Indicators, 2006. Washington D.C: The World Bank

World Bank, (2007): Little Data Book on Africa, 2007, Washington D.C, The World Bank

<http://www.geography.learnontheinternet.co.uk/topics/urbanisation.html#urb>

<http://en.wikipedia.org/wiki/Nairobi>