4.3 Uhuru CPC, Siaya

4.3.1 Introduction

Uhuru is a market centre located 10 km from Siaya town.

The market centre has a good number of shops offering various services including restaurants, general merchandise shops, Barber Shops etc.

The market centre is currently on grid power but the CPC was established when there was no grid connection nearby.

The idea of the establishment of the Uhuru CPC was initiated by UNIDO and UNDP as part of Siaya District Business Solution Centre (DBSC) activity aimed at poverty reduction. Siaya is one of the districts where DBSCs have been established with the support of UNDP and the Government. The CPC is therefore a component of DBSC.

Figure 4.3.1: Uhuru CPC

The Uhuru CPC was designed to generate electricity for the following applications within the community:

- Lighting and operating appliances in the shops at the market
- Charging of mobile phones and rechargeable LED lamps
- Powering social entertainment centre equipped with Satellite TV and Video players
- Barber shop or Hair Clipping

- Powering an ICT centre that would provide internet access and ICT services such as photocopying, printing, computer use training, etc.
- Powering metal and wood workshop equipment
- Micro grid for sale of electricity to the market buildings for various applications
- Soap making business
- Poultry Incubator

The persons listed in table 4.3.1 were interviewed during the performance audit survey:

Table 4.3.1: CPC personnel interviewed during the survey

	Name	**Designation/Role**
1	Nixon Aboge	DBSC Manager
2	Daniel Ageng'a	CPC Manager

4.3.2 Power System Status

vii) Renewable energy sources and harnessing technologies

The energy sources for Uhuru CPC are Solar and biofuel i.e. Straight Vegetable Oil and automotive Diesel.

The harnessing technologies employed are photovoltaic technology (PV) and Duo-fuel straight vegetable oil (SVO)/Diesel electric generator.

Kenya has good solar radiation spread across the country, so the choice of solar PV by UNIDO was good.

The choice of SVO generator was based on the assumption that oil fuel can be obtained from lake Basin Development Authority (LBDA) oil press whose revival was planned but did not take off. It was further assumed that farmers would grow Sunflower from which the oil could be extracted.

According to UNIDO, the Uhuru community undertook to grow oil crops for the production of vegetable not only for fuel but also for human consumption.

viii) System configuration, capacities and Loads

The system is configured to operate as illustrated in Figure 4.3.2.

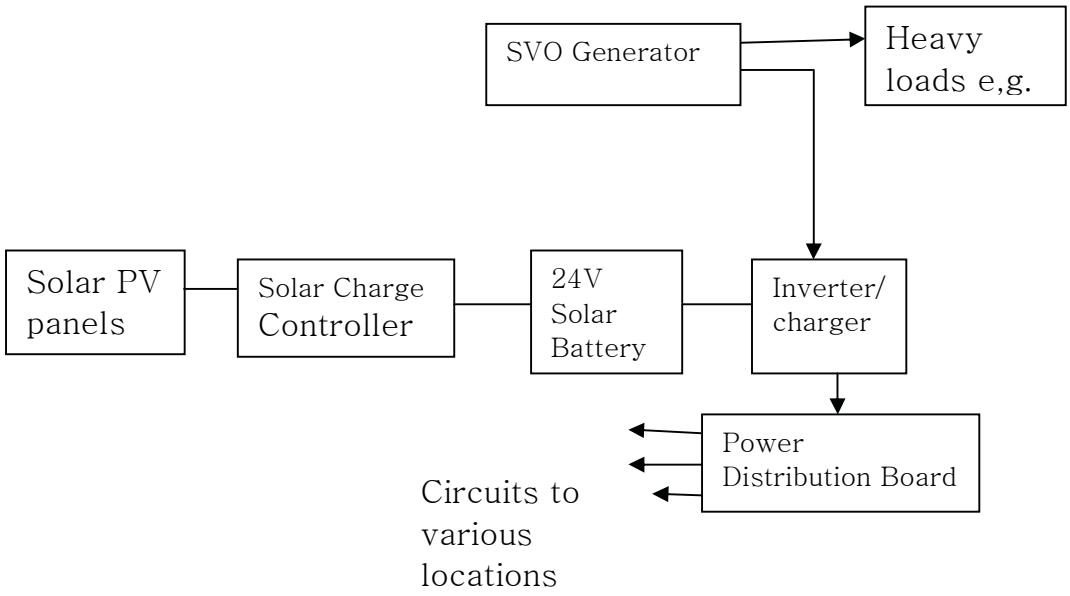

Figure 4.3.2: Power system configuration

The installed total system peak capacity is 9.8 kW broken down as under:

PV system = 1.8 kW
SVO = 8 kW

ix) Suppliers and equipment source countries

The power system was supplied and installed by Premier Solar Systems of India. The equipment and manufacturers and source countries are provided in Table 4.3.2.

Table 4.3.2. Equipment suppliers and source Countries

	Equipment/Component Description	***Supplier***	***Manufacturer***	***Source Country***
1	150W PV Panels,12 No.	Premier solar systems	Premier Solar Systems	India
2	Solar Charge Controllers, 2No.40A and 60A	Premier solar systems	Xantrex Corp	USA
4	Inverter / charger 2.4kW, 1No.	Premier solar systems	Xantrex	USA
6	Flooded Batteries type 350AH, 6V, 8 No.	Premier solar systems	Fulmen	France
8	System Controller/Stabilizer	Premier solar systems	Optisolar	USA
9	8 kW Duo-Fuel (SVO/Diesel) Raptor Generator	Premier Solar systems	Fully Green Power Co. Ltd	China

NB: The source country refers to the country where the manufacturer's headquarters is based rather than where the equipment is made. Almost all the companies have subsidiaries in other countries.

Figure 4.3.3: Uhuru CPC system components: Optisolar Controller ,Inverter, storage batteries

Figure 4.3.4: Uhuru CPC system components: Solar array on container roof and a section of 8kW SVO Generator in the power house.

The system installed loads are provided in Table 4.3.3.

Table 4.3.3: Uhuru CPC Installed Load

	Load Description
1	Mobile phones and LED lanterns charging bay
2	ICT Centre: 4 No. Dell desktop computers c/w keyboard, LCD screens; 1 Canon Photocopier; 1 HP Scanner; 2 HP Printer all c/w accessories and lighting
3	Social Hall: DSTV Decoder, TV, DVD/CD Players
4	Workshops: Welding Machine, metal Grinder and wood working machine
5	Hatchery: Poultry Incubator
6	Microgrid supplying various premises at the market. Mostly used for lighting, hair clipping, TV and charging.

Based on the above, the estimated the power demand after diversity is about 10kW. The power system is adequate to meet the demand.

The system was designed, installed and commissioned by UNIDO appointed contractors and Consultants. The main supplier and installer of the system was Premiew Solar Systems of India.

4.3.3 Operation and Maintenance status

i) Operation situation

The installation of the CPC was carried out in year 2009. The system was commissioned in May 2009.

According to the CPC manager, the solar system has operated fairly well save for a single but prolonged failure (6 months) in 2010. The SVO generator worked well for about two months but developed problem with the Injector pump and Starter. These two problems have not been solved to date.

No Vegetable Oil production and supply mechanism was established. It was anticipated that vegetable oil fuel would be sourced from the Lake Basin Development Authority (LBDA) which has an oil press. This press does not work so the SVO was only using the expensive diesel fuel.

Currently only the solar PV system is operating well. However, it cannot meet the demand. The system frequently shuts down especially when the weather is cloudy.

The CPC operates only during the day and the system is shut down at night, from around 8pm.

Asked to comment on this state of affairs, UNIDO indicated that the Solar power system was installed purely for light loads mainly charging, entertainment and ICT services. The main power source for the CPC was to be SVO generator. UNIDO also acknowledged that the

SVO generator was problematic and even getting spares was a challenge as there are no establishments in the country providing aftersales service for these generators.

ii) Maintenance Situation

No planned maintenance activities are carried out at the CPC. The CPC attends to breakdowns only.

During the visit, it was discovered that one set of four batteries had been disconnected from the system on the advice of a technician apparently because the batteries had lower terminal voltage. Consultant measured the voltages of the four batteries and found them to be allowed 5.8V, 0.2V lower than the nominal rated voltage and advised that the batteries be reconnected otherwise they will be damaged permanently if they are kept for long in a discharged state.

It is expected that such a CPC would keep an inventory of consumables and spares for maintaining and servicing such power systems, even though the systems are low maintenance. No such inventory exists.

In general very little maintenance activities are undertaken to keep the system in good working condition.

UNIDO's comment on this was that maintenance and maintenance systems are the responsibility of the CPC management once the system has been handed over to them.

iv) Technical capacities for operation and maintenance

Well designed and operated RE systems require little attention to keep them in good operating condition. There is therefore a need to build appropriate technical capacities for operation and maintenance for such systems.

According to the CPC officials interviewed, CPC personnel were not provided with adequate training to operate and maintain the systems. Whenever the system has a problem, the CPC manager looks for ordinary technicians for help. The CPC contacts DBSC in Siaya and UNIDO for assistance if the problem is beyond the technician's capability. Support by DBSC has been good.

According to UNIDO, some training was provided by the contractors and that the person who was trained left because of dispute within the community. It is true that the current CPC manager came in early 2010.

It is expected that user operation and user manuals would be provided to the CPC. No such manuals were provided. UNIDO confirmed that no manuals were indeed provided.

In general, no significant technical capacity for proper operation, servicing and maintenance exists at the CPC.

v) Performance monitoring, evaluation and reporting

It would be expected that the CPC, being a centre generating and selling energy and related services would set up a monitoring system that would involve data capture, evaluation and reporting on the system operation. One would expect to see a record of energy generated, energy sold, record on servicing, repair and maintenance operations, monthly reports and even annual reports.

The CPC manager keeps daily amount collected record.

When asked to comment on this lack of records, UNIDO stated that they initially asked for some data especially regarding collections but they stopped soon after systems were handed over. It was expected that CPCs would introduce own performance monitoring and evaluation systems.

This CPC has no adequate performance monitoring and evaluation system.

vi) Technical design, equipment procurement and construction plans

The Consultant did not gain access to the technical designs, procurement and construction plans used. UNIDO played the lead role in all cases and took charge of the technical designs, equipment procurement and construction planning of the CPC.

In this CPC, UNIDO used external consultants and contractors for the design, supply, construction and commissioning. That the systems were procured, installed and commissioned before they were handed over is not in doubt. UNIDO role in this respect was good.

4.3.4 Business Status

The CPC was set up to provide electricity for productive use and also for sale to businesses in the market centre.

The establishment of the Uhuru CPC was accompanied with the establishment of business activities which are provided in Table 4.3.4. Their status is also provided.

Table 4.3.4: Business activities at the CPC and current Status

	Business Activity	**Current Status**
1	Charging station	Operating
2	Electricity sales (micro-grid system)	Not operating
3	Barber or Hair Clipping	Not operating
4	ICT services	Only social centre and ICT training operating occassinally

5	Wood working workshop	Not operating
6	Entertainment from Satellite TV and Video players	Occasionally operating
7	Hatchery/Poultry Incubator	Not operating
8	Metal welding	Working occassionaly

The nature and performance of each of the above business activities is briefly described hereunder

i) Charging station

This business started at the same time as the CPC. This was made possible by UNIDO which provided a Container in which the charging station is housed. UNIDO also provided some LED rechargeable lamps, some for free to the residents which created a client base for the charging station.

Car battery charging needs a conventional mains charger which was not procured so this activity never commenced.

The charging station is simply a bank of power sockets that are connected to the power supply. It is used to charge mobile phones, rechargeable LED solar lanterns and car batteries. Mobile phones and LED lamps have own power adaptors so one needs only plug them into the socket.

This business has been in operation for the three years the CPC has been in operation and it is

still functional.

Customers pay KShs 10 per phone, KShs 15 per LED lamp. Between 30 and 50 mobile phones are charged per day.

The LED lamps charging business is good at about 120 lamps per month.

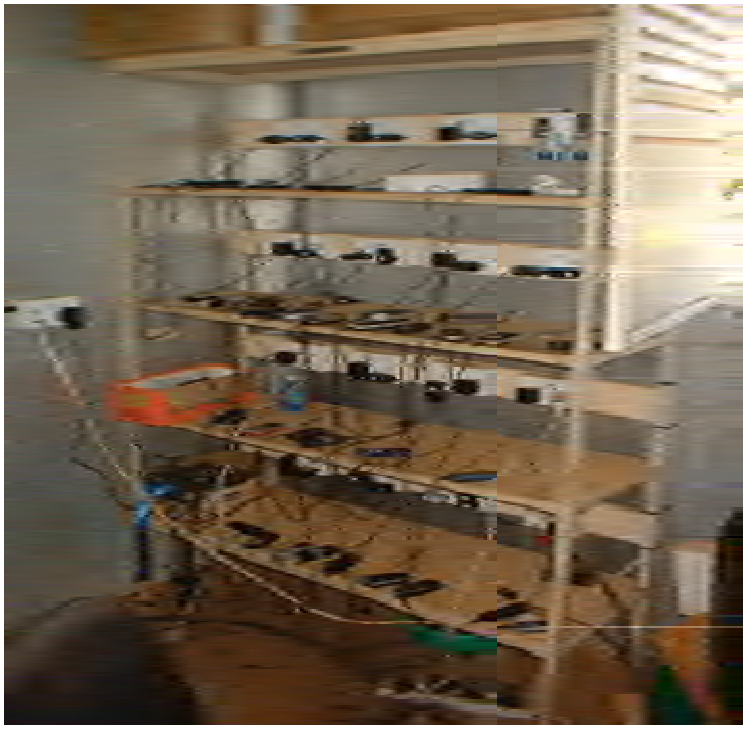

Figure 4.3.5: Charging station for mobile phones and LED lamps

ii) Hair Cutting

Hair cutting just needs a premises with power sockets that are connected to the power supply, chairs and Hair clippers and of course the Barbers.

Three entrepreneurs had connected to the micro-grid but could not be supplied because the SVO generator did not work well to maintain the service, so they closed down. The Barber shops were paying KShs 400 per month.

iii) Electricity sales to neighboring premises and a Shop.

Power distribution wiring had been done and about 50 Shops had been connected in anticipation of power supply from the micro-grid.

This never happened because of lack of capacity after the SVO generator failed to work. The ordinary shops were to pay KShs 200 per month.

These premises are now connecting to the national grid that has been extended to the market.

iv) ICT services and entertainment from Satellite TV and Video players

This business started immediately the CPC was operational.

UNIDO facilitated the business by donating 4 computers, a Photocopier; a Scanner and two Printers.

Figure 4.3.6: ICT Centre

UNIDO also provided the TV and Satellite TV receiving equipment to the CPC to offer entertainment services.

The Photocopier and Printer became faulty and have not been repaired.

The only ICT business operating is computer training being carried out by the CPC manager himself and entertainment, especially watching football matches on TV. The CPC charges KShs 20 per person per football match.

v) Metal Welding, and Wood work and Poultry Incubator

UNIDO provided a welding and a woodworking machines to start this business.

Figure 4.3.7: Welding motor cycle parts at Uhuru CPC

UNIDO also provided a Poultry Incubator and a woodworking machine.

Figure 4.3.8: The Poultry Incubator provided by UNIDO

The welding business operates using the PV system. There is a Welder who is self-employed but pays KShs 70 per day of CPC system use. Due to inadequate capacity of the PV system, welding is occasional.

The poultry and woodworking machines can only operate from the SVO generator which requires either Diesel or Vegetable Oil. Tthe SVO generator failed soon after installation and could not be repaired successfully. Furthermore Diesel is very expensive and vegetable oil is

unavailable as no supply mechanism exists. So the poultry and woodworking businesses never took off.

vii) Soap Making

Soap making was anticipated but no equipment was procured for this purpose so the business never took off.

4.3.5 Financial Analysis

The CPC project was fully financed by UNIDO with the support of the UNDP at a total cost of US $ 208,500 (KShs 17.72 million). The community contributed the land the CPC occupies.

The CPC has a simple record keeping of expenditure and income from the businesses that are operational. The money is collected and delivered to DBSC in Siaya. Table 4.3.5 shows the income and expenditure data for the 18 months the data was available.

Month	Income	Expenditure	Net Income
Jan-2011	13032	8970	4062
Feb	10248	8372	1876
Mar	15876	14250	1626
Apr	12970	6030	6940
May	6489	6950	-461
Jun	13635	8940	4695
Jul	17920	14290	3630
aug	10155	29160	-19005
Sep	11559	15625	-4066
Oct	21043	16425	4618
Nov	17989	17842	147
Dec	21404	23839	-2435
Jan-2012	21805	26900	-5095
Feb	16115	22045	-5930
Mar	13140	15959	-2819
Apr	27845	25521	2324
may	24620	24000	620
Jun	20260	16000	4260
Jul	9900	5201	4699
Aug	23095	15932	7163
Totals (KShs)	**392,100**	**322,251**	**6849**

The monthly income and expenditure patterns for the 18 months are shown in Figure 4.3.5

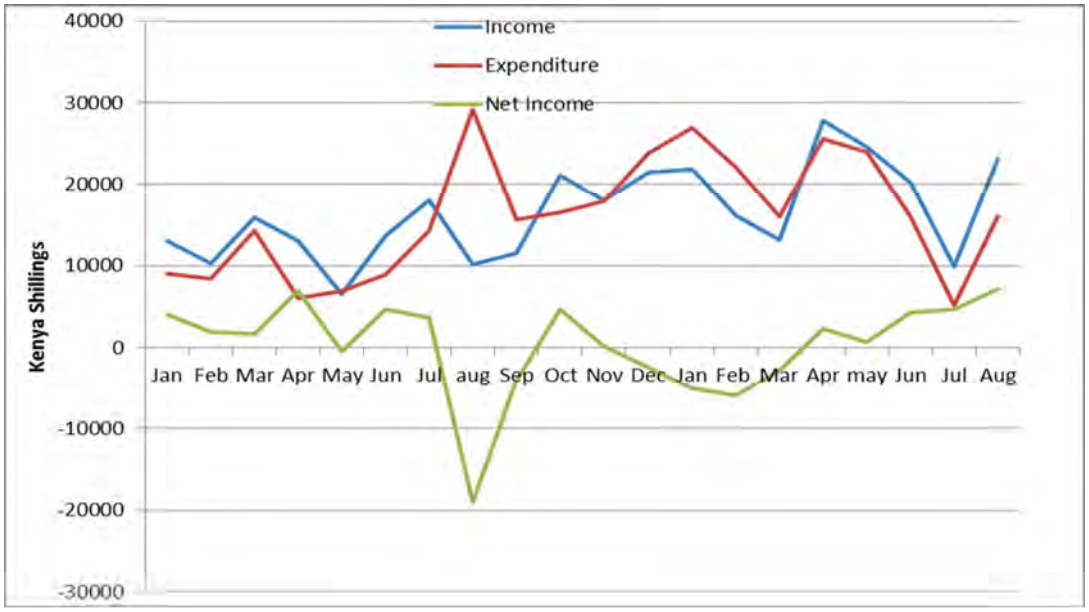

Figure 4.3.5: Income and expenditure patterns

Using year 2011 data which was the only full year data availed, the annual net income was KShs 1627. The initial capital cost of the project was KShs 17.72 million meaning that the investment would never pay back from current operation.

UNIDO donated the CPC equipment so the CPC does not have to pay it back and UNIDO does not expect any monetary returns from CPC investment. The CPC should at least generate adequate revenue to meet its recurrent expenses (i.e. salaries, routine maintenance, consumables etc.) and occasional equipment repair and replacement costs. The CPC can't do this from its current operation.

From the above analysis, the CPC is certainly not viable as a business.

4.3.6 Institutional Analysis

i) Ownership

The CPC was constructed as part of the DBSC activity and therefore belongs to DBSC. The community benefits from the services the CPC provides.

ii) Organization structure

The CPC is managed by DSBC Manager under the guidance of the DBSC steering committee which comprises 10 people elected from across the District.

The DBSC steering committee sets the agenda for CPC operation but has not employed any staff to manage the CPC other than the DSBC Manager who oversees its operation. Indeed the CPC manager is a volunteer and only gets some volunteer alliance.

iii) Business management systems

No management systems of any nature have been established for the CPC.

vi) Management Challenges

The CPC is facing some challenges.

There was an ownership dispute initially between DBSC and the Uhuru community members. This dispute was however resolved through dialogue that resulted in a consensus that DBSC own the equipment and operate the CPC. The community benefits from the services the CPC offers.

The first major challenge is lack of properly trained and skilled technician to operate and maintain the system. The SVO generator has presented technical problems which have become impossible to solve.

The second major challenge is lack of funds to engage permanent and properly trained personnel to run the CPC to stop relying on a Volunteer.

The third major challenge is lack of SVO fuel. The anticipated LBDA oil press repair never took off hence there would have been no fuel supply even if the Generator was working.

4.4 Nyongara Biogas Project

4.4.1 Introduction

Nyongara Biogas Project (NBP) is a joint pilot project of a private business enterprise, Nyongara Slaughterhouse Company (Nyongara SC), Kenya Industrial Research and Development Institute (KIRDI), United Nations Environment Programme (UNEP) and UNIDO.

Nyongara SC is situated in Dagoretti market which is 20 km from Nairobi. The Slaughterhouse is connected to the national grid.

The NBP was triggered by UNEP when it requested UNIDO to suggest appropriate technology options to address the Nairobi River pollution due to effluents from slaughterhouses in Dagoretti Division. Dagoretti Division has 4 Abattoirs effluent was being polluting the Kabuthi-Nairobi River stretch.

Figure 4.4.1: Nyongara Slaughterhouse and Plague of the Biogas plant

UNIDO and UNEP engaged consultants who carried out a feasibility study and recommended the implementation of Biogas digesters.

Nyongara slaughterhouse which had been affected adversely by the closure of its business due to waste management problems and due to its enthusiasm and support to the idea was chosen for a pilot project.

Kirdi was loped into the project and the NBP was born.

The Nyongara Biogas Project was designed to manage Abattoir waste by rendering it harmless and reducing the final disposable waste to minimum and for generation of electricity for the following applications within the slaughterhouse:

- Lighting

- Operating animal hoisting Crane
- Running air compressor for cattle de-hiding.

The persons listed in Table 4.4.1 were interviewed during the performance audit survey:

Table 4.4.1: NBP personnel interviewed during the survey

	Name	**Designation/Role**
1	Kennedy Ababa	Nyongara Plant Manager/Operator
2	Chrispin Omondi	KIRDI Representative
3	Peter Shitote	KIRDI Representative

4.4.2 Power System Status

x) Renewable energy sources and harnessing technologies

The energy sources for Nyongara Biogas Project are liquid and solid wastes generated by the Abattoir.

The harnessing technologies employed are high performance temperature controlled (HPTC) anaerobic digestion and Biogas/Diesel duo-fuel generator.

The choice of these technologies is good since the feedstock is readily available and HPTC technology is much more superior to the traditional biogas technology as it produces close to 15 times more gas for the same amount of feedstock.

xi) System configuration, capacities and Loads

The system is configured to operate as illustrated in Figure 4.4.2.

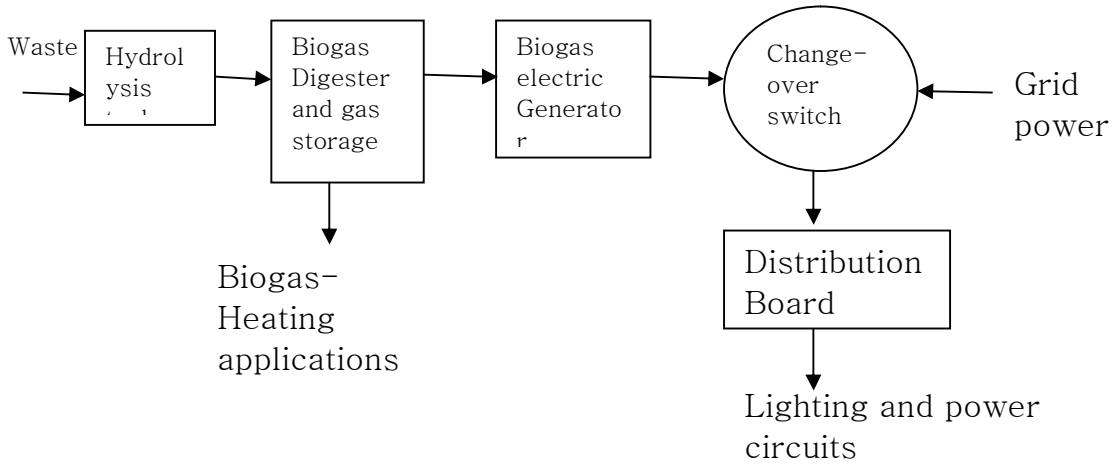

Figure 4.4.2: Biogas system configuration

The biogas is currently used for electricity generation using a biogas generator. The electricity is used for supplying power to the slaughterhouse instead of using the grid power.

The biogas generator is rated at 9kW maximum output.

xii) Suppliers and equipment source countries

The power system was supplied and installed by BME GmbH of Germany. The equipment and manufacturers and source countries are provided in Table 4.4.2.

Table 4.4.2. Equipment suppliers and source Countries

	Equipment/Component Description	***Supplier***	***Manufacturer***	***Source Country***
1	Biogas digester c/w solar heating system and controls	BME	Rottaler	Germany
2	Biogas Generator (Powermac)	BME	Schick GmbH	Germany

Figure 4.4.3: Biogas Digester

Figure 4.4.4: Digester Solar Heating System

Figure 4.4.5: Gas bag

Figure 4.4.6: The 9 kW Powermac Biogas Electric Generator

Figure 4.4.7: The Biogas Cooker

The system was designed, installed and commissioned by the UNIDO appointed contractor, BME of Germany.

4.4.3 Operation and Maintenance status

i) Operation situation

The installation of the NBP was carried out in year 2009. The system was commissioned in March 2010.

According to the persons interviewed, the biogas system has operated very well from the time it was commissioned. When operating, the generator runs all the slaughterhouse loads.

The biogas system is operated at night between 2 a.m. and 6.a.m. when the slaughterhouse electrical load is highest.

The plant operation requires daily attention covering:

- Pumping of slaughterhouse effluent to the hydrolysis tank
- Feeding of the solid slaughterhouse waste to the hydrolysis tank
- Stirling the above mixture 3 times per day
- Cleaning of the solar heating system collectors
- Inspection of the condensation traps
- Monitoring the Digester temperature
- Checking generator lubrication oil
- Generator cleaning

ii) Maintenance Situation

The system is in very good operating condition.

Maintenance and user manuals were provided to the plant and the following maintenance activities are undertaken daily:

- Cleaning of the solar heating system collectors
- Inspection of the condensation traps
- Monitoring the Digester temperature
- Checking generator lubrication oil
- Generator cleaning

The gas blower and hot water pressure pump failed once and were replaced. No other significant failure has occurred since the system was installed.

It is expected that the biogas plant would keep an inventory of consumables and spares for maintaining and servicing such a systems. No such inventory exists. The plant can however buy when required only that the plant would be shut down for long while awaiting the spares from abroad.

iv) Technical capacities for operation and maintenance

Well designed and operated RE systems require little attention to keep them in good operating condition. There is therefore a need to build appropriate technical capacities for operation and maintenance for such systems.

According to the Nyongara and KIRDI officials interviewed, 7 people, two of them qualified technicians were trained to operate, maintain and service the systems including undertaking minor repairs. Three people who were trained are employees of KIRDI and Nyongara slaughterhouse and are still available and do carry out maintenance works on the system.

In general, this plant has good technical capacity for proper operation, servicing and maintenance of the biogas plant.

v) Performance monitoring, evaluation and reporting

It would be expected that the Biogas plant would set up a monitoring system that would involve data capture, evaluation and reporting on the system operation. One would expect to see a record of biogas generated, electricity generated, records on servicing, repair and maintenance operations, monthly reports and even annual reports.

The only records that have been kept are monthly reports whose content includes the operating status of the plant, system breakdowns and repairs carried out and any spares requirements.

KIRDI and Nyongara indicated that a comprehensive performance monitoring and evaluation system was not put in place because this was a pilot system. It is precisely for this reason that a comprehensive monitoring system should however have been established!

vi) Technical design, equipment procurement and construction plans

The Consultant did not gain access to the technical designs, procurement and construction plans used. UNIDO played the lead role in all cases and took charge of the technical designs, equipment procurement and construction planning of the NBP.

UNIDO used external consultants, including KIRDI experts and contractors for the design, supply, and construction and commissioning. That the systems were procured, installed and operates very well is testimony to good planning.

4.4.4 Business Status

The Nyongara biaogas plant was set up as pilot plant for slaughterhouse waste management and also to promote renewable energy.

So far, the biogas has only been used for electrical energy generation. According to the plant operator, it has significantly reduced the power use from the grid. However, no monitoring and verification system was put in place hence no records have been kept to quantify the benefits.

It is however clear that the biogas system has reduced the amount of electricity bought from the grid and more importantly it has eliminated the waste management problems and expenses of Nyongara slaughterhouse. It also produces manure that can be used in farms in place of fertilizer.

Though not quantifiable, it is clear that Nyongara biogas presents a good business case.

4.4.5 Financial Analysis

The CPC project was fully financed by UNIDO, UNEP and KIRDI with the support of the Nyongara Slaughterhouse which provided the land and contributed in kind.

The total cost to UNIDO was US $ 109,642 (KShs 9.32 million)

Without record of quantities of biogas generated, electricity generated, reduction in waste disposal, amount of manure produced, operation and maintenance costs, and all other costs including projected costs, it is not possible to undertake any financial analysis.

The biogas equipment was financed by parties (UNIDO and UNEP) who do not have to pay it back and the two do not expect any monetary returns from the investment.

Even though no data exists to show that the project is financially viable, reports by the Slaughterhouse show that the Biogas system can displace electricity from the grid, provide gas for heating and solve slaughterhouse waste pollution.

4.4.6 Institutional Analysis

i) Ownership and management

This is a joint pilot project of KIRDI, UNEP, UNIDO and Nyongara slaughterhouse.

The plant is operated by Nyongara Slaughterhouse but managed by KIRDI.

The ultimate ownership is yet to be decided upon.

ii) Organization structure

As stated above, there is no formal organization structure for the biogas plant. The plant is operated by Nyongara Slaughterhouse but managed by KIRDI.

iii) Management Challenges

There are no major management challenges facing the biogas plant.

There are some technical challenges that have been encountered in operating the plant.

Firstly, the manual feeding of the hydrolysis tank is very involving as it requires constant attention. Secondly the manual mixing of the feedstock in the hydrolysis tank is also tedious. Lastly, keeping the Digester temperature constant at about 37 °C to maintain high yields requires continuous monitoring especially because the solar system heating performance depends on available solar radiation.

It is noted that the above challenges are technical in nature and technical solutions are possible. The technologies for addressing these challenges exist so the solutions are available.

4.5 Homabay Municipal Council Biogas Project

4.5.1 Introduction

Homabay Municipal Council Biogas Project is a joint project of Homabay Municipal Council (HMC) and UNIDO. The idea of the establishment of the Biogas plant was introduced to HMC by KIRDI.

KIRDI linked the Council with UNIDO and the Biogas project was initiated.

HMC biogas project is located at the HMC abattoir within Homabay town. The Abattoir is connected to the national power grid.

The HMC Biogas Project was designed to manage Abattoir waste by rendering it harmless and reducing the final disposable waste to minimum and for generating biogas. The biogas would then be used for following activities:

- Electricity generation for Slaughterhouse use to reduce electricity bills
- Cooking by Fish meal processors comprising four communities in the neighbourhood. These communities are:
  - Kadiege fish processors
  - Shauri Yako fish processors
  - Lera B fish processors
  - Cahed fish processors.

The above communities are currently using traditional stoves that use charcoal and firewood for processing fish meal

Figure 4.5.1: Tradition Stoves the biogas cooking is meant to replace

Figure 4.5.2: Traditional fishmeal processing (frying) in progess

The persons listed in Table 4.5.1 were interviewed during the performance audit survey:

Table 4.5.1: NBP personnel interviewed during the survey

	Name	**Designation/Role**
1	Alfred Chewa	HMC Town Clerk
2	Ben Otieno	HMC Chairman and Project Chairman
3	Nicholas Ambogo	HMC Works Officer
4	Peter Onyinge	Secretary

4.5.2 Power System Status

xiii) Renewable energy sources and harnessing technologies

The energy sources for HMC Biogas Project are liquid and solid wastes generated by the Abattoir.

The harnessing technologies employed are high performance temperature controlled (HPTC) anaerobic digestion and Biogas/Diesel duo-fuel generator.

The choice of these technologies is good since the feedstock is readily available and HPTC technology is much more superior to the traditional biogas technology as it produces close to 15 times more gas for the same amount of feedstock.

xiv) System configuration, capacities and Loads

The system is configured to operate as illustrated in Figure 4.5.3.

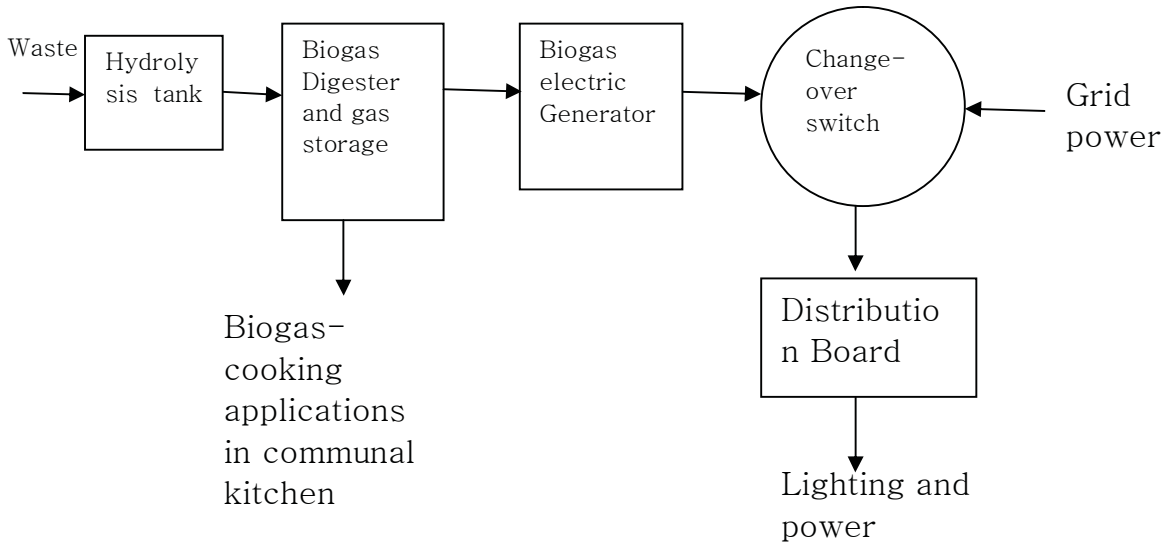

Figure 4.5.3: Biogas system configuration

The Biogas production design capacity is 40 m³/day. The biogas generator is rated at 9kW maximum output.

xv) Suppliers and equipment source countries

The Biogas system equipment was supplied and installed by BME GmbH of Germany. The equipment, supplier and/or manufacturers and source countries are provided in Table 4.5.3.

Table 4.5.3. Equipment suppliers and source Countries

	Equipment/Component Description	***Supplier***	***Manufacturer***	***Source Country***
1	Biogas digester c/w solar heating system and controls	BME	Rottaler	Germany
2	Biogas Generator (Powermac)	BME	PowerMac	China

Figure 4.5.5: Biogas Digester – digester tank underground

Figure 4.5.5: Digester Solar Heating System

Figure 4.5.6: The 9 kW Powermac Biogas Electric Generator

Figure 4.5.7: The Biogas Stove that is meant to replace traditional charcoal/firewood stove

The system was designed, installed and commissioned by the UNIDO appointed contractor, BME of Germany.

4.5.3 Operation and Maintenance status

i) Operation situation

The installation of the Biogas plant was carried out in year 2008. The system was tested and commissioned in November 2008.

To utilize the system however, the council and the community had to construct a common Kitchen and install a biogas pipe from the plant to the Kitchen in addition to buying the biogas stoves.

Due to financing constraints, it has taken over 3 year to construct the Kitchen shown in Figure 4.5.8.

Figure 4.5.8: The Kitchen that has been constructed but not yet equipped

The burner shown in Figure 4.5.7 was used for testing only. The council and the community have not yet equipped the Kitchen.

To utilize the power from the biogas generator, some electrical installation works to distribute the power are necessary. These have not been done again due to financing constraints.

Consequently, the HMC biogas plant utilization has yet to commence.

ii) Maintenance Situation

The equipment has not been in use.

iv) Technical capacities for operation and maintenance

Well designed and operated RE systems require little attention to keep them in good operating condition. There is therefore a need to build appropriate technical capacities for operation and maintenance for such systems.

According to the HMC officials interviewed, two HMC technicians and one member of the committee were trained to operate, maintain and service the systems including undertaking minor repairs. The two technicians are employees of the council and are available to operate and maintain the system once it is completed. Additional training will be requested too after the system utilization commences.

v) Performance monitoring, evaluation and reporting

This system has not been established since the plant is not in use.

vi) Technical design, equipment procurement and construction plans

The Consultant did not gain access to the technical designs, procurement and construction plans used. UNIDO played the lead role in all cases and took charge of the technical designs, equipment procurement and construction planning of the NBP.

UNIDO used external consultants and contractors for the design, supply, and construction and commissioning. That the systems were procured, installed and commissioned successfully is testimony to good planning.

4.5.4 Business Status

The HMC biaogas plant was set up for slaughterhouse waste management and also to generated renewable energy in the form of biogas for cooking applications by nearby fishmeal processors to replace traditional stoves and biogas.

Due to financial constraints, the necessary infrastructure for the utilization of the gas and electricity has not been completed.

The HMC biogas system has not started supporting any businesses.

4.5.5 Financial Analysis

The HMC Biogas system equipment was financed by UNIDO and HMC which also provided. The Constituency Development Fund (CDF) is financing the utilization infrastructure.

The cost of the Biogas system cannot be established since it is not complete and certainly no financial analysis is possible. UNIDO spent US $ 109,542 (KShs 9.31 million).

4.5.6 Institutional Analysis

i) Ownership and management

This project is jointly owned by the Municipal Council and four community groups set to utilize the system. These groups are:

- Kadiege fish processors
- Shauri Yako fish processors
- Lera B fish processors
- Cahed fish processors.

Currently, the CDF project management committee manages all aspects of the project until it is complete. The said communities are represented in the committee by three elected officials.

ii) Organization structure

A formal organization structure has not been established yet.

iii) Management Challenges

The installation of the system utilization infrastructure is taking too long because of lack of funds. The major challenge faced by the project is therefore financing.

4.6 Bungoma Municipal Council Biogas Project

4.6.1 Introduction

Bungoma Municipal Council Biogas Project is a joint project of Bungoma Municipal Council (BMC) and UNIDO. BMC through the then Mayor approached UNIDO with the idea and UNIDO developed it into a project.

BMC biogas project is located at the BMC abattoir within Bungoma town. The Abattoir is connected to the national power grid.

The BMC Biogas Project was designed to manage Abattoir waste and reduce nearby River pollution from slaughterhouse effluent by using it for biogas generation. The biogas would then be used for electricity generation for running the slaughterhouse and any surplus would be used for street lighting.

Figure 4.6.1: BMC Biogas Plant

The persons listed in Table 4.6.1 were interviewed during the performance audit survey:

Table 4.6.1: BMC personnel interviewed during the survey

	Name	**Designation/Role**
1	John Kasembele Wafula	Slaughterhouse and Biogas Plant Manager

4.6.2 Power System Status

i) Renewable energy sources and harnessing technologies

The energy sources for BMC Biogas Project are liquid and solid wastes generated by the Abattoir.

The harnessing technologies employed are high performance temperature controlled (HPTC) anaerobic digestion and Biogas/Diesel duo-fuel generator.

The choice of these technologies is good since the feedstock is readily available and HPTC technology is much more superior to the traditional biogas technology as it produces close to 15 times more gas for the same amount of feedstock.

ii) System configuration, capacities and Loads

The system is configured to operate as illustrated in Figure 4.6.2.

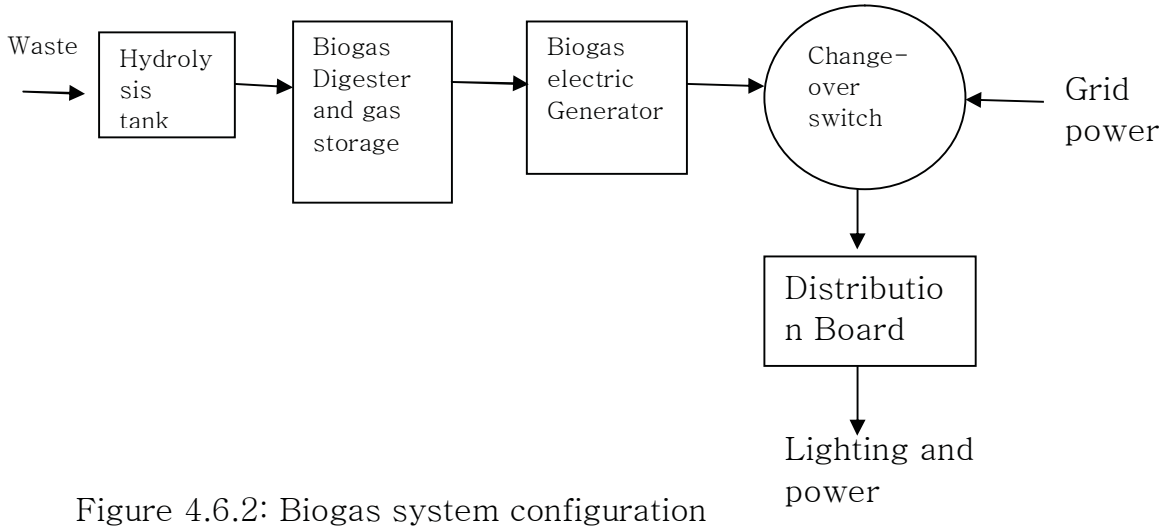

Figure 4.6.2: Biogas system configuration

The Biogas production design capacity is 40 m³/day. The biogas generator is rated at 9kW maximum output.

iii) Suppliers and equipment source countries

The Biogas system equipment was supplied and installed by BME GmbH of Germany. The equipment, supplier and/or manufacturers and source countries are provided in Table 4.6.2.

Table 4.6.2: Equipment suppliers and source Countries

	Equipment/Component Description	***Supplier***	***Manufacturer***	***Source Country***
1	Biogas digester c/w solar heating system and controls	BME	Rottaler	Germany
2	Biogas Generator (Powermac)	BME	PowerMac	China
3	Back up Power Inverter/Charger	BME	Tripplite	China
4	Back up power battery	BME	Gaston	China

Figure 4.6.3: Hydrolysis tank

Figure 4.6.4: Biogas Digester – digester tank underground

Figure 4.6.5: Digester Solar Heating System

Figure 4.6.6: The 9 kW Powermac Biogas Electric Generator

Figure 4.6.7: Backup power Inverter/Charger and Battery

The system was designed, installed and commissioned by the UNIDO appointed contractor, BME of Germany.