Review of Household Clean Energy Technology for Lighting, Charging and Cooking in East Africa – Kenya and Tanzania

A Learning Report

External Version

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Acronyms and Abbreviations

ABC-K	Association of Biogas Contractors of Kenya
ABCG	Africa Biodiversity Collaborative Group
ABPP	African Biogas Partnership Program
ACF	African Conservation Fund
ARTI	Appropriate Rural Technology Institute
ASD	African Solar Designs
AWC	African Wildlife Capital
AWF	African Wildlife Foundation
BATS	Biodiversity Analysis and Technical Assistance
BDL	Burn Design Labs
BoP	Base of Pyramid
CBO	Community Based Organization
CDTF	Community Development Trust Fund
CFG	Community Focus Group
CLOUT	Centre for Livelihood Opportunities Unlimited and Technologies
CSR	Corporate Social Responsibility
DEEP	Developing Energy Enterprises Project
DGIS	Netherlands' Directorate-General for International Cooperation
DRC	Democratic Republic of Congo
ELCT	Evangelical Lutheran Church in Tanzania
FIDE	Friends In Development
FIs	Financial Institutions
GGE	Greater Gombe Ecosystem
GHG	Greenhouse Gases
GMUE	Gombe Masito-Ugalla Ecosystem
Hivos	Humanist Institute for Development Cooperation
ICS	Improved Cookstove
ICSEE	Tanzania International Collaborative for Science, Education and the Environment
IGR	Imbirikani Group Ranch
JGI	Jane Goodall Institute
KCJ	Kenya Ceremic Jiko
KDA	Karatu Development Association
KENDBIP	Kenya National Domestic Biogas Program
KENFAP	Kenya National Federation of Agricultural Producer
KWFT	Kenya Women Finance Trust
LPG	Liquid Petroleum Gas
MCA-T	Millennium Challenge Account – Tanzania
MFI	Micro Financing Institutions

MPT	The Maasailand Preservation Trust
MUE	Masito-Ugalla Ecosystem
NCDO	Noomayianat Community Development Organization
NGO	Non-Governmental Organization
NRCF	New Rural Children Foundation
PV	Photovoltaic
REA	Rural Energy Agency
REDD	Reducing Emissions from Deforestation and Forest Degradation
ROSCO	Rotating Savings and Credit Organization
SACCO	Savings and Credit Co-operative
SEI	Stockholm Environment Institute
SIDO	Small Industries Development Organization
SMEP	Small and Micro Enterprise Program
SNV	Netherlands Development Organization
TAREA	Tanzania Renewable Energy Association
TaTEDO	Tanzania Traditional Energy Development Organization
TACARE	Lake Tanganyika Catchment Reforestation and Education
TDBP	Tanzania Domestic Biogas Program
ToR	Terms of Reference
TRA	Tanzania Revenue Authority
UN	United Nations
USAID	U.S. Agency for International Development
WW	Wildlife Works
WWF	World Wide Fund for Nature

Exchange Rate Used

1 USD : 84 KES : 1575 TZS

Executive Summary

This learning report documents the findings of a review of household clean energy technologies for lighting, charging and cooking in Kenya and Tanzania. It includes details on energy technology suppliers in Kenya and Tanzania, insights from other stakeholder activities in household energy and findings from surveys conducted at African Wildlife Foundations' site in Imbirikani, Kenya and Jane Goodall Institute's site in Kigoma Tanzania.

The report focuses on the technologies of improved cookstoves, biomass briquettes and eco-charcoal, solar technologies, biogas and wind. A range of product types exist for each technology option including both imported and locally produced products which vary in capacity and price. The energy market in Kenya is slightly more advanced than in neighbouring Tanzania and this report has listed key suppliers of these technologies in both countries. Whilst most are located in the major cities such as Nairobi and Dar-es-Salaam they will supply countrywide and are expanding their activities into rural areas through partnerships and dealer networks.

In addition to suppliers of energy technologies a number of stakeholders are active in promoting and disseminating these technologies, several within conservation contexts, such as Wildlife Works, WWF and African Solar Designs. Lessons can be learnt from the experience of these organizations when planning the introduction of energy technologies.

Promotion of energy technologies such as improved cookstoves and biogas has been on going in Kenya and Tanzania for several decades, yet the uptake of the technology remains relatively low. This report has outlined some of the barriers that have hindered the uptake of these technologies including the lack of available financing for both the consumers and entrepreneurs operating in the sector. Many initiatives initially disseminated energy technologies for free which has left the end user with a sense of entitlement and reluctance to pay for these technologies on a commercial basis. Lessons learnt from past programmes have also been discussed such as the positive effect of peer marketing on the demand for energy products and the importance of having product maintenance available at the local level to maintain confidence in the quality of the product.

A range of financial institutions exist in Kenya and Tanzania from formal banks, to micro finance institutions to informal savings schemes at the village level, all with differing terms and conditions. Financing for energy products is still at infancy, with Kenya slightly ahead of Tanzania. Current options available for payment of energy products include upfront payments and instalment payment with credit provided through financial institutes or product suppliers. Pay as you go schemes are also being piloted. The cost of small products such as improved cookstoves and small solar lanterns are low, and therefore financial institutions often do not include such products into their lending portfolio for customers as transaction costs will be higher. Without key technical experts, financial institutions often face problems with quality assessments, and it is recommended that certified products and guarantees be essential elements for any product financing.

The following conclusions were drawn from site surveys conducted at the Imbirikani Group Ranch in Kenya and the Gombe-Masito-Ugalla Landscape in Kigoma Tanzania;

i. Firewood use within both areas is high, whilst charcoal is limited to the main towns and surrounding areas. The use of the three stone fire is high in both areas and few homes are

using improved stoves. In Kenya many people feel they do not know any other way to cook than with the three stone fire, indicating that switching from this cooking practice represents a significant behaviour change. Awareness and availability of the stoves is also a factor at both sites with many households not knowing where to purchase these items.

ii. Fixed wood stoves with chimneys are suitable for both sites as well as portable charcoal stoves in more urban areas. Existing domestic stove producers around the Imbirikani site could be supported to expand their product range and reach. No domestic stove producers were identified at the Tanzania site although locally made wood stoves had been introduced by JGI. There is scope to develop the market for charcoal stoves in Kigoma town but further assessment of the demand would need to be done and production established locally.

iii. Institutional stoves are also suitable for both areas where schools and restaurants have high wood expenditure. Financing options can be assessed for those that cannot afford the upfront costs, by channelling credit through local financial institutions. There is also potential to work with local schools to set up woodlots for sustainable wood harvesting.

iv. At both sites, charcoal is sold and used mainly within the towns. Whilst targeting the market in urban areas with energy savings stoves and alternatives such as briquettes and LPG could help reduce demand, there is also potential to work with local land owners and charcoal producers to introduce more sustainable production techniques.

v. Access to grid electricity is very low in both sites outside of the main towns and kerosene is the most widely used fuel for lighting. There is potential to increase the availability of solar lanterns through establishing dealers for existing solar businesses and linking with solar initiatives such as that facilitated by Camco in Kigoma.

vi. There is potential to work with businesses with high energy demands to introduce more energy efficient techniques (improved kilns) or establish wood lots to make their fuel wood use more sustainable.

vii. There is potential to establish briquette production with potential feed stocks such as coffee husk and sawdust husk in plentiful supply at the Kigoma site. The economics of production would need to be established to see if the production price could compete with charcoal in the market.

viii. The level of financial activity amongst households and financial institutions varies between the two sites. Most households would opt to pay for energy products in monthly instalments to make payments more affordable. There is potential to further explore consumer financing options through financial institutions, local SACCOs (Kenya & Tanzania) and farming associations (Tanzania) with access to credit facilities.

ix. Existing CBOs and NGOs already working in the area can provide links to the local community in potential energy projects. Existing associations and cooperatives can also be engaged in energy projects since they are well organized, with strong community links and often with distribution and financing capacity (such as the Matyazo coffee cooperative in Kigoma).

1. Introduction

1.1 Background Context

Renewable energy is a priority for sustainable development and is included in the Global Climate Change Initiative and several United Nations (UN) conventions. In developing countries 1.6 billion people still lack access to electricity and 3 billion people rely on traditional biomass fuels for cooking, heating, and other basic household needs[1]. The use of these traditional biomass energy sources results in forest degradation and negatively impacts climate change, through reduced carbon sequestration and increased greenhouse gas (GHG) emissions. Additionally, they present a public health challenge from indoor air pollution. Such negative impacts highlight the need to invest in sustainable and cleaner energy technologies, yet despite investment in research and field testing of energy technologies, uptake remains limited.

The African Wildlife Foundation (AWF) and the Jane Goodall Institute (JGI) are members of the Africa Biodiversity Collaborative Group (ABCG) which aims to tackle complex and changing conservation challenges by catalyzing and strengthening collaboration. ABCG is supported in part by a cooperative agreement with the U.S. Agency for International Development's (USAID) Biodiversity Analysis and Technical Assistance (BATS) program of its Africa Bureau. Under this support, ABCG members AWF and JGI are leading its work on Clean Energy and eco-charcoal. These activities aim to build knowledge on clean energy program and to review existing program to inform on-going conservation efforts to enhance uptake of these technologies at meaningful scales. To achieve this objective there needs to be a better understanding of why the adoption of fuel efficient technologies has been relatively slow given the promotion of such alternatives.

In June 2012, GVEP International was contracted by AWF and JGI to produce an in-depth review and documentation of clean energy technologies used by households in the conservation landscapes of Kenya and Tanzania. As per the terms of reference (ToR), the review identifies the preferences, challenges and scope for scaling up the use and adoption of clean energy technologies in the wider East African region. The review also provides a basis to inform on-going conservation efforts by enhancing uptake of clean energy technologies at meaningful scales.

The main outputs from this study are a learning report outlining the key findings from the analysis (which the body of this document forms). In addition, a toolkit was designed on the appropriate identification and implementation of sustainable energy projects within the context of conservation. The toolkit includes some key issues that may need to be taken into consideration for the adoption and scale up of specific technologies, the economic benefits/opportunities and the mechanisms required for successful implementation. The toolkit and learning report will be shared with various stakeholders.

[1] Igniting Change: A Strategy for Universal Adoption of Clean Cook Stoves and Fuels, Global Alliance for Clean Cookstoves, 2011

1.2 Purpose of this Report

This document forms the learning report outlining the findings from an in-depth analysis of the clean energy technologies used by households in Tanzania and Kenya. The report reviews the technology options available for household cooking, lighting and charging in Kenya and Tanzania and analyses some of the key barriers as well as lessons learnt to uptake of these technologies. The report goes on to summarize key recommendations to the conservation community on future strategies promoting clean energy technologies in East Africa, based on the sites surveyed. As per the ToR, the report also outlines analysis of value chains for the implementing agency, preferably depending on the key technologies that might be used following the results of the field assessments.

The main objectives of this report are as follows;

i. Document the main energy technologies that are available in Kenya and Tanzania for households cooking, lighting and charging, the main suppliers of these technologies, the cost of the technology and product details.
ii. Describe the activities of other organizations that are operating within the household clean energy sector, which are of particular relevance to the conservation sector, including main activities, approach taken and lessons learnt from their experience.
iii. Discuss some of the challenges and drivers to adoption and scaling up of energy technologies and key lessons learnt from existing experience.
iv. Analyze the key findings from field assessments carried out at AWF's site in Kenya and JGI's site in Tanzania, including results from household surveys and community interviews, and their impact on technology options for the areas.
v. Present recommendations for the conservation community to introduce and increase the uptake of energy technologies.

2. Review of Energy Technologies in Kenya and Tanzania

This study focuses on energy technologies for lighting, cooking and charging at the household level and will review five key technologies: Improved Cookstoves, Briquettes & Eco Charcoal, Solar, Biogas and Wind. The following sections give details of these technologies along with the main suppliers in Kenya & Tanzania.

2.1 Improved Cookstoves

An improved cookstove (ICS) is considered more energy efficient compared to traditional cooking methods by using less biomass to cook the same amount of food. Many ICS are also expected to reduce the amount of smoke and harmful emissions given off by the burning biomass.

Throughout East Africa the majority of the population relies on biomass to meet their cooking needs. Traditional cooking methods, as shown below, such as a three stone fire are often used. Most ICS use charcoal or wood, the most commonly used fuels in East Africa.

Figure 1: Traditional three stone fire used for cooking in East Africa (left)

Figure 2: Traditional metal charcoal stove commonly used for cooking in East Africa (right)

2.1.1 Types of Improved Cookstoves

Many different designs of ICS exist in the Kenyan and Tanzanian market. They are often produced in varying shapes and sizes from small domestic stoves to larger institutional stoves. Various ICS are made locally by individual artisans, women's groups and small enterprises, while some ICS in the market are imported from other countries (these can have higher efficiencies but also cost significantly more). A different type of stove, the gasifier, also allows for cleaner cooking compared to a traditional cooking stoves and can accommodate a variety of biomass fuels.

A selection of cookstoves available in the Kenya and Tanzania market are shown in Table 1 below. For the full and detailed list please see Annex A.

Table 1: Cookstoves commonly available in the Kenya & Tanzania market

	Product	Description
Artisan, Portable	 **Kenya Ceramic Jiko**	**Manufacturers**: Various artisan producers. **Key Features:** Charcoal stove. Ceramic liner with metal cladding. Production started in Kenya in the 1980s. **Distribution Channels:** Complete stoves sold through middlemen, retailers, markets & small vendors. **Cost Range**: $4 – 10 **Available**: Kenya, Tanzania (known as Jiko Bora).
Imported, Portable	 **Envirofit G3380**	**Manufacturers**: Factory manufactured in China, imported by Envirofit. **Key Features:** This wood stove is factory made in China. Can save 50% fuel, reduce particulate matter and carbon monoxide emissions. **Distribution Channels:** Distributed through Paradigm Project (a carbon credit company), which sells through network of countrywide dealers. In Tanzania main distributor is L'Solution based in Arusha. **Cost Range**: $27 in Kenya, $12 in Tanzania. **Available:** Kenya, Tanzania.
Institutional, Fixed	 **Institutional Stoves**	**Manufacturers**: Various. **Key Features:** Improved Institutional stoves can have efficiencies over 40% and save up to two thirds on fuel consumption. Most vary in size from 20 liters up to 250 liters. **Distribution Channels:** Mainly made to order and assembled on site. **Cost Range**: Starting from $1000 depending on size / type. **Available:** Kenya, Tanzania (design will differ).

2.1.2 Suppliers and Distributors

Activity in the cookstove sector in Kenya and Tanzania has been ongoing for several decades with support from stakeholders in a number of sectors including government, donors, non-governmental organizations (NGOs), the private sector and academia.

The majority of cookstove production is done locally by micro, small and medium businesses, majority within the informal sector. Some businesses are starting to realize larger production levels and international manufacturers are entering the market. Many different business models exist with some producers making individual components and others assembling and making complete stoves. Retailers and middlemen also exist along the value chain before the stove reaches the end user.

Over the past five years the development of carbon markets for cookstoves has instigated new investment into the sector with many international companies linking with local manufacturers to generate carbon revenue from the sale of stoves.

Within Kenya the value chain is fragmented with some business producing cookstove liners whilst others assemble the complete cookstoves, which are further sold on for retail. Some types of ICS are available in most parts of the country although of varying quality. In Tanzania production of complete cookstoves is much more common with pockets of production centered on urban areas such as Dar-es-Salam, Morogoro, Arusha, Mwanza & Dodoma.

ICS are available in most large urban centers but availability within rural areas and some parts of the country is low. Factory produced ICS products such as the Envirofit stove are also been supplied through Paradigm Project and East Africa Energy in Kenya and L'Solution in Arusha Tanzania. The stoves are linked to carbon credits which allow them to be offered to customers at a subsidized price.

In addition to private sector suppliers many other stakeholders such as NGO, donors and carbon developers have been active in the cookstove sector in Kenya and Tanzania and have trained local artisans on cookstove production, business development and marketing. Annex B gives examples of some of these initiatives in the region.

For a full list of domestic and institutional stove suppliers/distributors in Kenya and Tanzania, please see Annex C.

2.1.3 Technology Challenges

In the past awareness around improved cooking technologies has been low and end users have been unwilling to pay for the technology. This has led to a lot of cheap and poor quality products on the market leaving the end user wondering what is 'improved' about the stoves. For local producers cookstoves is a low margin business and they have struggled with the cost of extensive distribution and expanding production, leading to many regions in East Africa remaining underserved.

2.2 Solar

Solar energy can be used to generate electricity using solar photovoltaic (PV) panels. Solar PV panels convert sunlight directly into electricity. Solar PV can provide a reliable and predictable source of power for a range of uses. Solar PV systems are most appropriate for low power requirements (a few watts up to a few kW), for example lighting, radio, television, mobile phone charging, refrigeration, small appliances or electric water pumps.

It is also possible to use the energy from the sun in a non-electrical form - for cooking and heating water, drying agricultural products, space heating for buildings and greenhouses, and air cooling (through evaporation) – this group is called solar thermal technologies.

Solar technologies are particularly suitable for people in rural areas that do not have grid electricity, or people in urban areas that have an unreliable supply or cannot afford to connect and use the grid. The amount of energy that can be produced is directly dependent on the duration and intensity of the sunshine.

2.2.1 Types of Solar Products

There is a wide range of solar PV products available on the market ranging from large systems that can supply electricity to a large number of households, down to small portable solar lanterns. This review will concentrate on two main product types; solar home systems that can power equipment in a single home and portable solar lanterns.

Solar equipment can be used for powering equipment in the home, and can also provide income generating opportunities through businesses such as phone charging, battery charging and those providing services that can utilize the electricity generated such as hair salons. The price of solar equipment varies depending on the specification and the size of equipment, which is dependent on the amount of power required each day.

Table 2 gives an example of the equipment required to set up a solar system, for charging 20 mobile phones per day and the associated cost. Solar panels from reputable dealers usually come with a warranty of at least 10 years. Solar batteries will need to be regular maintained and replaced every 2 – 5 years, depending on the type used[2].

Table 2: Example investment for mobile charging station with 20 phones / day capacity

Equipment	Rating	Cost ($)
Solar Panel	1 x 30 Watts	130
Battery	1 x 50 AH	100
Inverter	1 x 150 Watts	85
Charge Controller	6 A	33
Electrical Material	Cables, switches etc.	95
Installation		48
	Total	**491**

A few of the main solar lantern and solar home kits available in the Kenya and Tanzania market are given in Table 3 below. For a full detailed list of some more solar equipment available please see Annex D.

[2] Nickel-metal hydride battery used in lanterns lasts roughly 2 years, whereas a more expensive Lithium iron phosphate battery will last a few years longer than this.

Table 3: Example solar products available in the Kenya & Tanzania market

	Product	Description
Solar Light	 **Sun King**	**Manufacturer**: Green Light Planet **Distributor:** Sola Taa, Radbone Clarke, Renewable Energy Ventures (Kenya) **Description**: Can provide 16 hours of light on full charge. **Price:** Approx. $35 **Availability:** Kenya & Tanzania
Solar Light	 **Tough Stuff Products**	**Manufacturer**: Tough Stuff **Distributor:** Tough Stuff (Kenya & Tanzania) **Description**: Module product, flexible solar panel with add on solar lights, rechargeable batteries, phone and radio connectors. **Price:** Panel $10; Light $8; Rechargeable battery power pack $9 **Availability:** Kenya & Tanzania
Solar Home System	 **Barefoot Power Pack**	**Manufacturer**: Barefoot **Distributors:** Smart Solar (Kenya), ARTI (Tanzania) **Description**: Different sizes available, the 5w pack can power 4 lights for 12 hours. Can also charge mobile phone and radio. **Price:** Approx. $140 (5W), $80 (junior 2.5W) **Availability:** Kenya, Tanzania
Solar Home System	 **Bright Box**	**Manufacturer**: One Degree Solar **Distributors**: One Degree Solar, SCODE (Kenya) **Description**: Solar-powered battery kit that powers light bulbs, phones, and virtually any USB device. ODS has integrated after-sales support and mobile-based customer service. **Price:** Approx. $75 **Availability:** Kenya

2.2.2 Suppliers and Distributors

Of all the main manufacturers of solar lanterns and corresponding products in the Kenyan and Tanzania market, none of their products are manufactured in East Africa; most are manufactured in China and are imported into the country. Some manufacturers such as Tough Stuff and Trony have established offices in the region to directly manage the distribution of the product. Other manufacturers such as Barefoot Power work with in country partners such as Smart Solar in Kenya and Appropriate Rural Technology Institute (ARTI) in Tanzania.

In addition these suppliers will link with other organizations and businesses to distribute the products more widely in the country and often have a network of local dealers. For example ARTI (Appropriate Rural Technology Institute) have a network of distributors across Tanzania, D Light have linked with Total to sell through petrol stations in Kenya and several suppliers have linked with Financial Institutions and Savings And Credit Co-operatives (SACCOs) to make products available to their members, such as Kenya Women Finance Trust (KWFT).

Recently solar products tailored to particular activities have been introduced into the market, for example 'business in a box' solutions for mobile phone charging are being offered by companies such as Powerfy and BBoxx. Pay as you go systems have also been recently introduced to the market by companies such as Eight19 (www.eight19.com) with the IndiGo product in Kenya. IndiGo combines solar power and mobile phone technology and allows users to pay as go for power by buying top up scratch cards that are validated through their mobile phones. For a list of some of the main technology suppliers for solar home systems and lanterns in Kenya & Tanzania, please see Annex E.

2.2.3 Technology Challenges

Many people perceive the cost of solar as high and are unwilling to pay for quality products. As a result many cheap products have entered the market which overstate their power capacity and perform poorly for the end user. A lack of knowledge by solar retailers has led to systems been sized wrongly and improper use by consumers can lead to reduce lifetime of the products. The high cost of last mile distribution has led solar suppliers to concentrate in commercial centers, leaving many rural areas with low awareness and availability.

2.3 Briquettes

Briquette making is the process of pressing and compacting biomass waste materials to produce fuel. The main source of raw materials to make briquettes is often charcoal dust that is left to waste as well as other biomass input such as maize cobs, sawdust, coffee husk, groundnut husk, wheat bran or coconut husk among others. The biomass material is combined with a binding agent and extruded under high pressure, often with the use of machinery, to form briquettes. Briquettes are used as cooking or heating fuel in households, institutions such as schools or in industrial boilers.

2.3.1 Types of Biomass Briquettes

One of the most common feedstock currently used in Kenya and Tanzania is char dust (waste charcoal material). Other biomass materials can also be used directly but it is recommended that for the domestic market they are carbonized first to reduce the amount of smoke they will give off. Carbonization involves burning the biomass in a kiln with limited aeration so that it resembles char.

Carbonized briquettes can act as a replacement for charcoal for domestic and institutional cooking and heating, and compared to charcoal, they generally burn for longer and have a more consistent heat output. Non-carbonized briquettes on the other hand serve as a replacement to natural firewood and raw biomass fuel. They offer greater energy per unit weight than wood or raw biomass but release as much smoke. Consequently these are more appropriate for industrial processes and institutions where emissions can be controlled[3].

[3] Briquette Businesses in Uganda, Hamish Ferguson, GVEP International, 2012

Various shapes and size of briquettes exist, mainly depending on the machine that is used in the pressing process. The most basic briquettes are made from hand and packed into round balls as shown in Figure 3 below. Other machines can extrude the briquette into long oblong shapes as shown in Figure 4 and Figure 5 or cylindrical and square blocks.

Figure 3: Briquettes made by hand from charcoal waste (left)

Figure 4: Non carbonized briquette made from straw waste using a piston extruder (middle)

Figure 5: Carbonized briquettes made from coconut waste using a screw extruder (right)

2.3.2 Suppliers and Distributors

Only a handful of briquette businesses operate at scale in East Africa, details of which are given in Figure 4 and Figure 5 below. Larger briquette businesses target industrial and commercial markets such as hotels, restaurants and factories, since orders are made in bulk and the steady burning of briquettes is suited to this application. In addition to the larger suppliers smaller local supplier exist many that have been support by donor funded initiatives, such as DEEP (Developing Energy Enterprises Project) in Kenya, Uganda and Tanzania (GVEP International), the Fuel from Waste initiative[4] in Kenya and Legacy Foundation[5] to provide training on the technology and production processes.

Table 4: Suppliers of Biomass briquettes in Kenya

Supplier	Location	Description
Chardust	Nairobi, Kenya	Produce 2000 tons of briquettes per year mainly for commercial and industrial markets. Briquettes made from charcoal dust. Also sell through supermarkets.
Ecopower Kenya	Thika, Kenya	Small enterprise established in 2011 producing 3-4 tons of briquettes/pellets per day from sawdust and agro-waste.
BICODE	Kaloleni, Kenya	Based in Coastal Region, produce briquettes from recycled coconut waste. Still not reached large production but working on market and initial production.
Alfastar Industries	Nyeri, Kenya	Can produce around 2 tons per week. Briquettes made from charcoal dust.

[4] The 'Fuel from Waste' Network, 2012 [www.fuelfromwaste.wordpress.com]
[5] Legacy Foundation, 2012 [www.legacyfound.org]

Table 5: Suppliers of Biomass briquettes in Tanzania

Supplier	Location	Description
East Africa Briquettes	Various, Tanzania	Factories in Tanga, Northern Serengeti and Ngoronogoro. Briquettes made from carbonized agricultural waste bought from local suppliers. Can sell 60 tons of briquettes per month. The main biomass materials used are coconut husks, cashew nut shells, maize stalks and cobs.
Joint Environmental Techniques (JET) / ARTI	Dar-es-Salaam, Tanzania	Utilize local community members to produce char from coconut waste which is then made into briquettes at factory in Bagamoya.
Nishati Poa Services	Arusha, Tanzania	Based at TEMDO premises in Arusha they have capacity of 1 ton per day. Use fully mechanized process.

2.3.3 Technology Challenges of Briquettes

As a new product on the market briquettes have struggled to compete against charcoal at the household level due to lack of awareness by consumers and unwillingness to switch fuel. Basic machinery and lack of technical capacity by producers have led to some briquettes being of poor quality and smoky making them unsuitable for the household market. Availability of feedstock can be a limiting factor in the production process and a large amount of space is required for drying the briquettes.

2.3.4 Eco Charcoal

Eco charcoal is charcoal that is produced in a sustainable manner and does not result in a net loss of wood resources. Eco charcoal can be produced from woodlots specially grown for charcoal production or by using only the branches from trees in a way that allows them to quickly regenerate. Production often utilizes kilns with improved efficiency to increase the production yield.

Production of eco charcoal on a commercial basis is a relatively new idea within East Africa and currently few suppliers exist. One such supplier Olerai Farm was identified in Kenya which has been supported by Woodlands 2000 Trust and Cookswell Jikos to establish commercial charcoal production. Situated just outside the Maasai Mara, close to Narok the farm plants trees and makes lump charcoal from the branches only in high efficiency kilns. Initial experience shows that eco charcoal is complicated especially for commercialization mainly because of a cumbersome process to sell 'charcoal' as there is not standardization or certification of eco-charcoal that gives it an advantage over normal charcoal. The eco-charcoal processing technology is not yet robust, and processing the wood waste itself seems a bit tedious. Whilst wood resources are depleting in conservation areas many people can still collect wood for free, meaning that price differences between wood and eco-charcoal is also greater.

Another such initiative was identified in Tanzania at Rotian Farm in Simanjiro district. The project which was a joint venture between Rotian Farm Ltd and a Dutch firm Fresh Food Technology receiving funding from the Dutch government to set up an eco charcoal factory. The project was to use sustainable grown wood from the farm to make charcoal in high efficiency kilns to serve markets in Arusha and Moshi. The project started in 2009 but the current production capacity of the project and commercial sustainability are unclear.

In addition to these suppliers several other initiatives have been identified many of which work with local charcoal producers to improved charcoal production efficiency in donor funded projects as outlined in Table 6 below.

Table 6: Projects promoting sustainable charcoal production in Kenya & Tanzania

Project	Location	Description
Dar-es-Salaam Charcoal Project - WWF/ Camco/ Barclays Bank	Kisarawe and Rufiji Districts, Dar-es-Salaam, Tanzania	Work with councils, local government and private sector to improve sustainability of charcoal production and introduce more regulation.
Wildlife Works Eco-Charcoal Production Facility	Voi District, Kenya	Eco charcoal production is part of the Kasigau Corridor REDD Phase II project and involves low impact production harvesting tree branches and using high efficiency kilns.
Transforming Tanzania's Charcoal Sector - Swiss Agency for Development and Cooperation	Kilosa District, Tanzania	Supports improvements to the efficiency and sustainability of the charcoal industry, including improving on branding and marketing and researching demand side information.
Eco-Charcoal - TaTEDO	Chalinze, Tanzania	Reportedly engaged in a project near Chalinze producing sustainable charcoal using improved basic earth kilns. Marketed via the Sustainable Energy and Environment Co. (SEECO).

2.3.5 Technology Challenges of Eco Charcoal

Eco charcoal is a relatively new product in East Africa and it is challenging to prove the economic benefit of producing eco charcoal to charcoal producers and land owners. If both briquettes and eco charcoal are to reach the larger household market it needs to be able to compete with charcoal and woodfuel in terms of price. This is viable in areas where charcoal is expensive such as Dar-es-Salaam but in rural areas where charcoal is cheaper and fuelwood more abundant, it has struggled to match charcoal prices without subsidy. As a result the market has so far been concentrated to high end tourism lodges and households, and industrial applications.

2.4 Wind

The energy in the wind can be harnessed for generating electricity and producing mechanical power for pumping water or agro-processing. The amount of energy in the wind depends on the speed the air is travelling. Wind speed is very location specific; it depends on macro climatic conditions and local geographic effects and wind is a highly variable resource. An estimate of the average wind speed for a site is needed to assess if a wind turbine generator or wind pump is suitable for a site, and how much energy it could generate.

2.4.1 Types of Wind Technology

There are two main categories of wind turbines; vertical and horizontal, with many variations of design and shape; examples below in figures 5, 6 and 7.

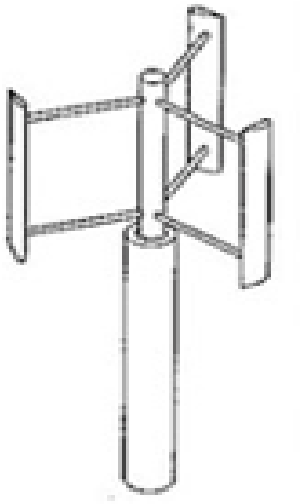

Figure 6: Modern Horizontal Axis Wind Turbine (left)

Figure 7: Savonius Vertical Axis Wind Turbine (Source: www.reuk.co.uk) (middle)

Figure 8: Darrieus Vertical Axis Wind Turbine (Source: www.ecosources.info) (right)

Using wind power for water pumping has a number of uses for the end user; irrigation, water supplies for a village and for livestock. It is important when designing a system to match the rotor design to the pump specifications, which also needs to match demand and available wind speed.

For electricity generation on a small scale, machines with a power rating of up to 60kW are mostly used. In rural or dispersed areas, the electricity can be used to charge a battery in conjunction with powering a light, television or radio.

An example system is the basic starter pack[6] (for a small home) from the East African company WindGen Power. This wind system produces approximately 1,200 watt-hours/day[7], with a DC (direct current) voltage of 12V. The complete cost of this pack is 205,000 KES ($2440) (delivery and installation not included). The main components include; the wind turbine itself, a solar panel, battery, wind controller, solar controller, turbine mounting steel tower, solar mounting roof rack and an inverter.

2.4.2 Suppliers and Distributors

The majority of wind turbines available in East Africa are imported systems with relatively few suppliers manufacturing systems locally. Many of the suppliers of larger solar systems and solar water heaters, listed in Annex E, also supply wind turbines such as Kenital, Davis & Shirtliff, Powerpoint, Dreampower Ricciardi and Solar World in addition to the suppliers given in Table 7 below.

[6] Package Systems, WindGen Power, 2012 [http://windgenpower.com/wp/?page_id=672#SSB]
[7] Daily power production assumes average wind speeds of 4.5 m/s and insolation of 4 kwh/m^2/day.

Table 7: Supplier of wind turbines in East Africa

Supplier	Location	Description
Craftskills East Africa	Nairobi, Kenya www.craftskillseastafrica.com	Manufacture local produced wind turbines for homes and businesses.
Winafrique Technologies	Nairobi, Kenya www.winafrique.com	Suppliers imported wind turbines and solar equipment to meet energy demands
East African Wind Energy Ltd	Mombasa, Kenya	Supplies wind power plants among other renewable technologies
Centre for Alternative Technologies (CAT)	Nairobi, Kenya www.cat.co.ke	Serve East and Central Africa, specializing in the sale of inverters, wind electric turbines and water pumping
Hagi Systems Co, Ltd	Dar Es Salaam, Tanzania	Provides water pumping windmills among other renewable technologies
IB Energy Ltd	Dar Es Salaam, Tanzania	Consultant and service provider for small wind energy systems
Windpower Technics Tanzania	Dar Es Salaam, Tanzania	Designer, consultant and distributor of small horizontal axis turbines

2.4.3 Technology Challenges

Wind is a variable resource and parts of East Africa are unsuitable to this technology due to low wind speed. Back-up is often required alongside wind turbines for continuous power supply. Low awareness around the technology and high upfront costs has led to low adoption at the household level.

2.5 Biogas

Biogas is a combustible mixture of gases produced by bacteria as it breaks down organic matter in the absence of oxygen (anaerobically). The process is known as anaerobic digestion and takes place in an air tight tank called a digester. The gas produced consists mainly of methane (50-80%) and carbon dioxide (20-50%). The mixture of gases is combustible with air and can be used as fuel for cooking and lighting. Livestock or human excrement is the main biodegradable material used in biogas digesters, making it a viable technology for farmers and larger institutions.

2.5.1 Types of Biogas Technology

The most common type of biogas technology used in East Africa is the fixed dome biogas plant. This plant consists of a dome shaped digester chamber, a mixing chamber and an expansion chamber. The gas is stored in the upper part of the digester chamber and as the pressure of the gas increases it pushes the waste slurry into the expansion chamber. Conversely as the gas is used and the pressure decreases the slurry flows back into the digester chamber pushing the gas upwards. A $6m^3$ plant costs approximately $950 with a $16m^3$ plant around $1800. The size of the plant needed depends on the output required and the amount of waste materials available to feed the plant.

A 6m^3 plant for example can run of 3 milking cows or 15 pigs, whereas a 16 m^3 plant can be run of 7 milking cows or 38 pigs. Other types of biogas technology include floating drum plants and tubular plastic biogas plants.

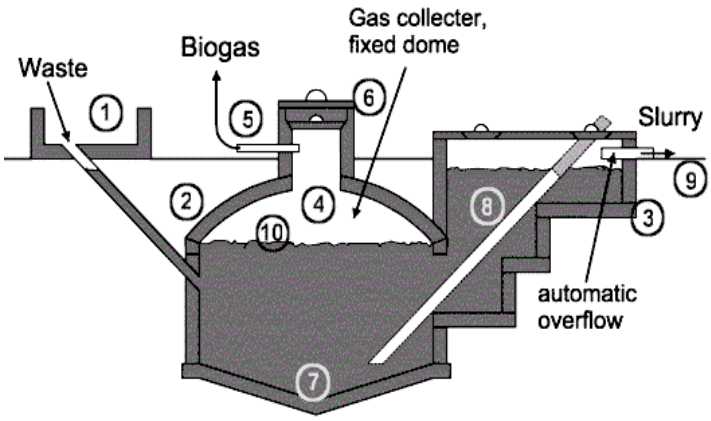

Figure 9: Fixed dome biogas plant (left)

Figure 10: Mason constructing a biogas plant (right)

Table 8 below compares the details for each of the three main biogas reactor technologies[8], floating drum, fixed dome and tubular. It shows that while the oldest design is most prevalent, it requires more cattle and maintenance compared to the newer design which has a simpler construction method.

Table 8: Comparison of three main biogas reactor technologies

Technology	Floating Drum	Fixed Dome	Tubular
Cost ($)	1400 – 1700 (for 16m^3)	800 – 1600 (for 16m^3)	500 (for 9m^3)
Introduced	1950s	1990s	2006
Prevalence (in Kenya)	>1000	300-800	150-200
Ease of installation	Simple to complex	Complex	Simple
Minimum cattle	3-4	2-4	2
Maintenance	Every 3-4 years	Minimal	Unknown
Durability (approx.)	>30 years	>30 years	15 years

[8] Promoting Biogas Systems in Kenya: A Feasibility Study, Biogas for Better Life, 2007

2.5.2 Suppliers and Distributors

The African Biogas Partnership Program (ABPP), financed by the Netherlands' Directorate-General for International Cooperation (DGIS), and developed by the Netherlands Development Organization (SNV) and Humanist Institute for Development Cooperation (Hivos), began in 2008 across 8 African countries including Kenya and Tanzania.[9]

Figure 11: TENDBIP and TDBP Logos

Both National Domestic Biogas Program (KENDBIP and TDBP) are run through local implementing agencies. In Kenya the local implementing agency is Kenya National Federation of Agricultural Producer (KENFAP), whilst in Tanzania it is Centre for Agricultural Mechanization and Rural Technology (CAMARTEC). The National Domestic Biogas Program in each country aims to create a sustainable and commercially viable biogas sector in each country using a private sector strategy. This strategy involves training local masons, involving financial institutes to provide end user loans, providing incentives to investors and ensuring quality manufacturing.

For Kenya, the Association of Biogas Contractors of Kenya (ABC-K) is the umbrella body for biogas enterprises with 30 biogas construction enterprises. About 8,000 – 10,000 plants[10] are planned for construction by the end of 2013.[11]

Tanzania on the other hand has proposed the construction of 12,000 plants in their first 5 year phase ending in 2013.[12] Figure 12 below shows the operating locations of the 10 implementing partners; Karatu Development Association (KDA), Friends In Development (FIDE), Tanzania Traditional Energy Development Organization (TaTEDO), Evangelical Lutheran Church in Tanzania (ELCT), Mbozi District Livestock Office, Caritas, Kama, Istituto Oikos, New Rural Children Foundation (NRCF), and AB. Biogas Enterprise.

[9] Assessment of the Tanzanian Biogas Sector, Bob Jan Schoot Uiterkamp, 2011
[10] http://www.kenfapbiogas.org
[11] http://africabiogas.org/kenya
[12] http://www.biogas-tanzania.org

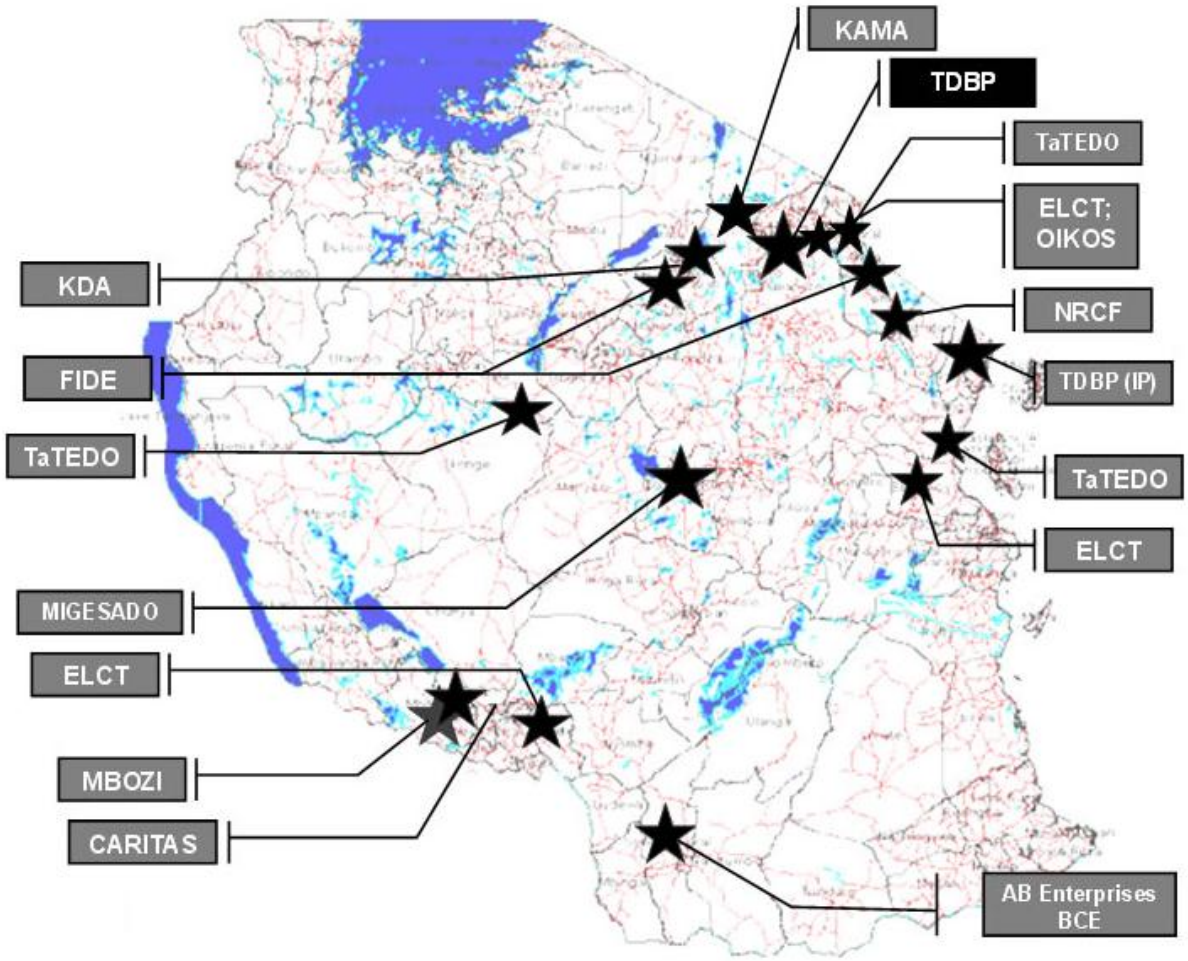

Figure 12: TDBP Implementing Partner Infrastructure (source: www.biogas-tanzania.org)

2.5.3 Technology Challenges

Biogas projects have failed in the past due to poor construction and planning of the plant leading to operational problems such as low gas pressure & oversized plants, which have led users to lose confidence in the technology. Poor maintenance by the end user, often through lack of explanation from suppliers, can lead to digesters falling into disrepair. High upfront costs of the system can also be prohibitive with a lack of finance options available in the past. The market for biogas digester is select and can be prove challenging to develop with extensive market research and promotional activities required.

3. Stakeholder Activities in the Clean Energy Sector

3.1 Activities of Selected Conservation Partners

As part of this review a selection of stakeholders associated with disseminating energy technologies were interviewed. A focus was given to those that have activities in conservation areas and are of particular interest to AWF and JGI. A full list of the stakeholders considered for this review can be found in Annex F, however due to time constraints in the review only a selection of these were interviewed as listed in Table 9. The interviews aimed to understand the approach other stakeholders are taking in energy related activities, some of the challenges and successes experienced in the uptake of clean energy technologies and lessons learnt that could be applied to future energy programs. The section below provides a summary of the interviews with each of the stakeholder involved, focusing on specific activities of interest to AWF and JGI.

Disclaimer: Any views expressed here are those of the interviewee and should not be directly attributed to any of the individuals interviewed or their organizations.

Table 9: Organizations interviewed as part of the review of stakeholder activities

Organization	Activity Location	Key Technology	Website
Cookswell Jiko	Kenya	ICS	www.kenyacharcoal.blogspot.com
Stockholm Environment Institute	Tanzania	Various	www.sei-international.org
Burn Manufacturing	Kenya	ICS	www.burnmanufacturing.com
SNV	Tanzania	ICS, Solar, Briquettes, Biogas	www.snvworld.org
Wonderbag	South Africa / Kenya	Fireless Cooker	www.nb-wonderbag.com
Camco	Tanzania	Solar	www.camcocleanenergy.com
ARTI Tanzania	Tanzania	Solar, Briquettes, ICS	www.arti-africa.org
Africa Conservation Fund	DRC	Briquettes	www.acfvirunga.org
WWF	Regional	Various	www.wwf.panda.org
African Solar Design	Kenya	Solar	www.africansolardesigns.com
Wildlife Works	Kenya	Briquettes / Eco Charcoal	www.wildlifeworks.com

3.1.1 Cookswell Jiko/Woodlands 2000 Trust

Cookswell Jiko produces around 5000 locally made energy efficient cookstoves per month and charcoal baking ovens from its Kitengela factory and supplies to Nakumatt and Uchumi supermarkets. They are also working with Woodlands 2000 Trust on commercial forestry to produce sustainably grown forest by-products (i.e. charcoal, timber etc.). They promote improved barrel kilns that can be used to produce charcoal using only tree branches, hence making the process sustainable.

The Woodlands 2000 Trust has also completed feasibility studies for AWF looking at stove/fuel use and market options to determine if a stove shop would work. In May 2012 Woodlands 2000 Trust set up a stove shop in Kimana town with Cookswell Jiko and funding from AWF. They have also been conducting road shows, distributing stickers and flyers and looking for wholesale buyers for the stoves. At the time of interview, the shop had been running for about 6 weeks and sells about 2 stoves a day. It is expected that sales will increase as marketing activities raise awareness and also as peoples current stoves wear out and they look for replacement.

Cookswell jiko has also been working with Woodlands 2000 Trust to promote commercial forestry and one of the Woodlands first tree growing partners, Olerai Farm in Narok, has been experimenting with supplying camps with eco charcoal.

3.1.2 Stockholm Environment Institute

Stockholm Environment Institute (SEI) conducted a study on household energy in 2009 in Ethiopia, Tanzania and Mozambique. The study covered fuels and stoves and looked at what attributes where preferable to consumers – the attributes given were predetermined and included things such as price and smoke reduction. The project aimed to understand consumer preferences and how to apply this knowledge to scale up technologies. SEI has contributed findings from the study[13] to Project Gaia in Ethiopia[14] to help scale up the uptake of Ethanol stoves there. If the model works well in Ethiopia they will look to extend it to other countries.

SEI has also been involved in other studies in India and Zambia looking at specific attributes of energy technologies people use and why they use them. They have worked with a design company from Sweden to try and learn what people like in energy products as part of the Ezy Stove project[15].

3.1.3 Burn Manufacturing

Burn Manufacturing (BM) is about to introduce a charcoal stove onto the market in Kenya and establish a modern manufacturing facility in the country. They are currently looking at innovative ways to distribute the stove and placing the market for the product - the stove costs approximately $30 to produce. BM's long-term goal is to combine stove sales and reforestation processes that encourage sustainable biomass harvesting. Burn Manufacturing is affiliated with Burn Design Labs

[13] Will African Consumers Buy Cleaner Fuels & Stoves? [www.sei-international.org/publications?pid=1867]

[14] Project Gaia, 2012 [www.projectgaia.com/index.php]

[15] Ezy Stove, 2012 [www.ezystove.com]

(BDL) who designed the Jiko Poa stove that is manufactured by Fine Engineering and distributed through the Paradigm Project in Kenya.

3.1.4 SNV

SNV support the National Domestic Biogas programs in Kenya and Tanzania. Since the beginning of 2012 they have moved into renewable energy beyond biogas and are developing programs looking at biomass sector development and improved cookstoves. In Tanzania they plan to pilot a program of integral renewable energy services in the Lake Zone, working with existing entrepreneurs and trying to address different energy needs and demands. They plan to take a sector based development approach looking at enterprise development, technical skills training and facilitate market linkages.

In addition SNV is working with the Tanzania Renewable Energy Association (TAREA) to facilitate a task force to work with existing organizations in the improved cookstoves sector. There are many programs that are scattered across the country and the task force aims to provide greater connection between agencies and foster linkages with civil society and the private sector.

3.1.5 Wonderbag

Wonderbag is run as a commercial business manufacturing and selling its fireless cooker product. The user cooks food for a short time using their regular stove and then transfers the food to the Wonderbag which acts as a sealed insulator and continues to cook the food. People can save between $30 - 40 a month on fuel using the Wonderbag and it frees up peoples time and reduces exposure to cooking emissions. Approximately 700,000 Wonderbags are now in use globally after the company has been in business for 3 years. The majority has been sold in South Africa but they are currently trialing the product in Nairobi and looking to expand to other countries. They are also considering conservation areas and have a small pilot project in the Mkuze Rhino Reserve in South Africa.

Wonderbag has a blueprint for the product which shows people how the product works, the right way to manufacture the product locally, and how to distribute and promote it. As part of this they conduct cooking demonstrations and product activation where they hold a party for the local community with music and competitions. Manufacturing is done locally, either through cooperatives or in larger production facilities. Extensive testing on the insulation material has been done, with the most common materials used being polystyrene and foam depending on what can be sourced locally in an environmentally friendly manner.

Wonderbag partnered with Unilever in South Africa to open up new distribution channels for the product and continue to expand their partnership with them. Unilever have branded the bag with their Raja curry powder label, to promote this product alongside the Wonderbag. Both sales of Wonderbag and Raja curry powder increased as a result (Unilever had a 200% increase in sales[16]). The partnership has helped overcome distribution challenges initially experienced due to the bulkiness of the Wonderbag and the cost involved in transporting. The product has sold for $12-15 in South Africa and is subsidized depending on the market and subsidy mechanism available. People

[16] Personal communication with Wonderbag, 2012

have been able to pay for it upfront in one go and no consumer financing mechanism have been used.

3.1.6 Camco

Camco has recently embarked on a joint venture partnership with Rex Investments, funded by Millennium Challenge Account – Tanzania (MCA-T) to develop the solar PV market in Kigoma Tanzania[17]. Rex Investment will supply and install the equipment, whilst Camco will focus on household market development. The project involves the following components:

- Installation of 235 solar home systems given to public institutions. Free systems will be installed in secondary schools, health centers, village markets and beach management units on the requirement that they set up a revenue generation activity, to maintain the systems, such as renting solar lanterns. Institutions have been identified and will receive systems from September 2012.
- Developing the household market for solar in rural areas through a cluster model approach and a revolving loan fund for solar lanterns.
- Training end users, retailers and local technicians.
- Rolling out a region-wide marketing campaign to promote solar power products in Kigoma.

The cluster model will work with existing farmers groups and SACCOS, that are already procuring goods and giving loans, and add solar systems to the items they can provide to members on loan. Camco identify groups to work with (ideally with at least 500 members), introduce the project to them and help create awareness for the product. They then collect deposits, either directly or through pay checks, and when the group has a 20% down payment they can make the order and source products. Rex Investments supply the solar systems either directly or through local retailers. The system cost is subsidized 10% by the Rural Energy Agency (REA) and the SACCO takes out a loan from the bank to cover the remaining cost with the loan terms passed on to the group members. The loan is taken out by the group and repaid over three years, at interest rates between 14-20%. The cluster approach is also being implemented in the Lake Zone and Southern Tanzania regions.

The revolving loan funds works with smaller SACCOs promoting the Barefoot power pack & lanterns and the Trony solar lantern. The project provides $1000 of lanterns to SACCOs which are given on credit to their members. The members then repay the loan over 6 months with a small interest fee. Lanterns are currently being sourced by ARTI Tanzania and Rex Investments. In addition the project is conducting marketing campaigns with road shows going through the program areas.

3.1.7 ARTI Tanzania

ARTI Tanzania aims to introduce appropriate renewable energy technologies and introduce them to Tanzania, through both a not-for profit and commercial channel. ARTI imports Barefoot solar products and has set up a dealer network to distribute them throughout the country. ARTI is also

[17] http://www.camcoglobal.com/en/jvwintz.html

partnering with Camco to build up the dealer network in Kigoma through their solar market development initiative.

They will work with existing shop owners, hardware stores, electronic shop and existing solar dealers to develop a specific plan for each of the dealers. Initially the dealers are required to buy minimum stock, after this they are provided with flyers, and an advertising banner. ARTI will also support a radio program for Kigoma and conduct a road show once people have started buying the lanterns. They also train and equip the solar dealer, so they can become a local service center for the lanterns. The activities will concentrate in larger towns, since it is expensive to travel to the rural areas and it doesn't make business sense when only a few lanterns will be sold. However through awareness raising people in rural areas will know where they can buy the lanterns.

ARTI has also established a briquette manufacturing facility near Dar-es-Salaam, producing briquette from coconut waste. They have recently procured two briquetting machines capable of producing 600kg per hour and are trying to establish a dealer network around Dar-es-Salaam.

3.1.8 Africa Conservation Fund

In 2008 African Conservation Fund (ACF) launched a briquette production program in Virunga National Park as an alternative to charcoal sourced from the park, to help fight deforestation and create income for villages and the park. The project distributed briquette machines made through carpentry businesses in the park and targeted those that are involved in charcoal production to encourage them to switch to briquettes. There are currently five locations producing briquettes, with a total capacity of 600 bags per week. Around 2000 jobs have been created through the project. The project identified the best feedstock in each location and uses paper to bind the briquettes. Coffee husk, peanut husk, sawdust, and rice husk are the best ingredients where available.

ACF worked to develop a market for briquettes since there was none existing. They focused on middle income households in Goma that can afford to buy them as well as institutions such as UN and WWF (World Wide Fund for Nature) in Goma. ACF created awareness using radio campaigns, demonstrations, billboards in Goma, opening stalls in charcoal markets and producing a song. A focus has now been given to encourage local consumption since ACF cannot sustain the cost of transport and this reliance on ACF will make distribution unsustainable after the life of the project.

3.1.9 WWF

WWF has a global climate and energy initiative that is aiming to shift energy supply to more sustainable sources. The initiative focuses on several areas including:

- Advocating International climate agreements
- Promoting energy efficiency
- Promoting renewable energy sources
- Preventing greenhouse gas emissions from deforestation

From this WWF developed regional energy strategies that focus on the following:

- Policy Advocacy – analyzing current policy and working with National governments to put in place the relevant energy framework.

- Energy Access – work with partners such as NGOs, civil society and governments to adopt renewable energy at policy level. They also run pilot projects to show the possibilities and impact of renewable technology.

Example of energy initiatives that WWF are involved in include a pilot in the Kasese region of Uganda that has been selected as a district to champion energy technologies, introducing energy technologies to households in the region and engaging private sector partners. WWF have also worked on sustainable charcoal management in collaboration with Camco Advisory Services and Barclays Bank looking at ways to make charcoal production more sustainable. WWF were involved in a similar project in the Democratic Republic of Congo (DRC) where they considered the whole charcoal value chain from planting trees to supply the wood, introducing more efficient production systems and engaging women and youths in producing energy efficient stoves for using the charcoal. These demonstration projects are used to feed back into the policy level and demonstrate the feasibility of the technologies.

3.1.10 African Solar Designs

African Solar Designs (ASD) design and install solar PV mini-grids for tourism lodges in conservancy areas. They currently have three projects in the pipeline in Kenya (Naboisho conservancy, Maasai Mara and Amboseli) and are looking at opportunities in Tanzania. ASD are trying to fill the gap between large scale solar project and Base of Pyramid (BoP) markets by supplying tailored solutions to tourism lodges. They then work with the local communities around the tourist lodges to expand access to solar into these areas.

ASD is currently working on a project with Basecamp Foundation in the Naboisho conservancy in Kenya which includes both the energy supply for a lodge and a community development component. Under the project selected institutions in surrounding communities will be provided with stand-alone PV systems along with the tourist camp. A market will then be developed for the supply and installation of solar home systems and pico-systems (solar lanterns) in the surrounding communities. ASD is involved in the systems design, procurement and installation and training.

3.1.11 Wildlife Works

Wildlife Works (WW) is running an Eco Charcoal Project as part of the Kasigau Corridor REDD (Reducing Emissions from Deforestation and Forest Degradation) project, situated in the Taita Taveta District, Kenya, between the Tsavo East and Tsavo West National Parks. The Eco Charcoal Project harvests branches and trimmings from trees which are then carbonized in specially designed kilns. The resulting char is crushed and mixed with cassava flour and pressed in a machine to make briquettes.

WW has been making the eco charcoal for 2 years and at full capacity can produce around 300kg per day. So far the eco charcoal has been sold to institutions and boutique hotels but Wildlife Works aims to target the household market in future as well. Production has been highly subsidized through carbon revenue and by selling at a higher margin to institutions so eco charcoal can be

subsidized for the household market. The project is also looking to expand with a new production facility to produce 5 tons of eco charcoal per month and open up new retail channels. The project currently employs 14 people in production and aims to increase this to 100 when the new production facility is operating.

The project decided to briquette the eco charcoal rather than convert it directly into charcoal to distinguish the product from bush charcoal in the area and stop other producers imitating the eco charcoal without making it in a sustainable manner. WW use existing natural stock to produce the charcoal and allow the bush to regenerate so it can be harvested again. They also plant trees as part of other activities but not for direct charcoal harvesting. The binding agent cassava flour is not grown in the area and can sometimes be hard to source. Wildlife Works are looking into setting up an out growers scheme to get farmers to produce cassava locally for production. They are working closely with KFS to discuss the issue of taxation on eco charcoal which is currently unclear and register as a charcoal producers association. The project has purposely set up in areas of high charcoal production to try and target existing producers and get them to produce charcoal more sustainably.

3.2 Challenges and Lessons Learnt from Stakeholder Interviews

During the interviews the following challenges and lessons learnt were identified from stakeholder's activities in the clean energy sector;

- Eco charcoal has faced challenges through the negative perception around charcoal and the potential higher cost of production. Eco charcoal is new in the market and the economics are still unproven making it difficult to secure loans for establishing production.

- One of the briquette projects reviewed faced challenges in finding the market to consume all the briquettes often leaving the producers with surplus supply. Production was also effected by quality, with producers trying to make as many briquettes as possible and therefore compromising on the quality. This led to customer complaints and the briquettes producing too much smoke for customers to use indoors.

- Another challenge faced by a briquette project was the lack of suitable stoves to burn the briquettes properly. The program did not initially consider this but is now looking into introducing a stove to allow the briquettes to be used in households. Projects also need to consider the market they are selling into too. Large size briquettes have a long burn time which suits institutions but for the household market the briquette size may have to be reduced and projects may require different machinery.

- For projects operating in large and sometimes remote landscapes challenges are faced in the large distances between project areas which makes running marketing campaigns and transportation of goods expensive. In such cases there is a need for a strong presence on the ground to mobilize people and keep the project momentum going.

- A stakeholder operating in Tanzania also reported challenges dealing with financial institutions, who often have limited decision making power at the local level and approval through the head office can be a long and frustrating process.

- One of the challenges face by stakeholders selling solar products is price sensitivity of communities. Many people want solar equipment at a low price and don't understand the difference between a quality product and a substandard product. Last mile delivery of such products is also expensive; hence one of the stakeholders interviewed had decided to target the tourist industry first and from there expand into the local community at a lower cost. They had also chosen to focus on larger systems first because they offer more profit margin then pico systems.

- Stakeholders felt that having support from National Government is important for energy projects. For example, in Ethiopia, one of the factors that have helped the Gaia ethanol project is support from the Ethiopian government whom already has kerosene and ethanol initiatives in place. Another stakeholder felt that without backing from National governments and having relevant policy in place, investments into the energy sector and impact on the ground will be limited.

- Findings from one of the stakeholder's research regarding household energy suggested that different factors were important to different groups and results varied with income level. For high income groups, who tended to use electricity and liquid petroleum gas (LPG), reliability and availability of the fuel source was important. Middle income groups, used a mix of stoves and fuels and a range of factors featured. For low income groups affordability and safety were key factors.

- Being able to identify and engage the market segment that is able to use the energy technology is important. Strengthening linkages between organizations and taking advantage of existing dynamics in the energy sector has worked well in stakeholder's programs. It is also important to find out what consumers want and provide them with a choice of technologies to meet different needs & aspirations.

- Being able to tap into existing distribution channels can reduced the cost of transportation and allow the product to reach more communities outside of the local vicinity, as has been the case with Wonderbag linking with Unilever.

- Another factor contributing to the success of The Wonderbag product is that it offers the consumer a very simple cooking solution and a technique that people have been using for years which does not involve a behavior change or fuel switch. It is important for the user to tangibly see the economic and social benefits of the product.

3.3 Financing Options Available for Clean Energy Projects

Energy financing by financial institutions (FIs) is at infancy, with Kenya slightly ahead of Tanzania. It is especially limited in rural or remoter regions. There are 3 main types of financial institutions in both countries:

- Financial institutions directly regulated by the Banks. These FIs are often reluctant to make extended efforts for small loans and while there are notable exceptions, rural and peri urban clients often find that banks have complicated and lengthy procedures to access loans.

- Formal institutions such as micro financing institutions (MFI) and SACCOs. These are not regulated by the Central Bank but registered under various government laws. In Kenya, there has been a tendency for commercial banks down streaming their business to include loans for low income households, micro and small enterprises.

- Informal lending organizations like Rotating Savings and Credit Organizations (ROSCAs). In Tanzania, Community Based Organizations (CBOs) and NGOs that have financial schemes are classified in this category.

Most commercial banks or MFIs do not have a specific energy portfolio but lend as part of the range of working capital and asset finance products. The common end user finance in the energy sector is for solar lanterns or home systems, generally for domestic use. Financing the local players in the market to improving access to renewable energy in rural and semi-rural areas is no easy task and sustainable implementation involves at least three key interventions-financing, capacity building for staff and technicians and awareness creation.

Lack of capital is often quoted as one of the main challenges hindering the uptake of energy technologies for consumers at the household level. It is also a significant challenge to energy businesses, looking to increase their operations, which often lack traditional collateral or credit history. There are several finance options currently being used by energy technology suppliers when selling products to the consumers;

3.3.1 Upfront Payment

This is the preferred method of payment for energy technologies with the consumer paying for the item from the supply/dealer in a single transaction.

3.3.2 Payment through Installments

Realizing that the upfront cost of energy technologies can be a barrier for many consumers, suppliers and dealers may set up arrangements for the product to be paid in installments. Such arrangements may take the following form;

- Credit direct from the supplier or dealer: The energy technology supplier may extend credit to the consumer directly and allow them to pay for the product in installments. For large energy suppliers this is likely to be through formal written agreements with the consumer and interest may be charged. For local dealers credit may be given on a more informal basis, where the dealer knows their consumer closely and their likelihood of repaying.

- However suppliers may not favor this arrangement due to work involved in recovering the credit and dealing with defaulters. For dealers to be able to extend credit to their customers, they often require some sort of credit agreement themselves from the supplier.

- Credit through a financial institute: Larger product suppliers work with financial institutes who can offer loans to their members to purchase energy products. A formal loan agreement is taken out with the FI and responsibility of chasing the credit is given to the FI and not the supplier. However for larger financial institutes the relatively small loan amount required and

unknown field of household energy do not make it an attractive prospect. SACCOS and informal lending organizations are often more suited to dealing with small loans for household purchases.

An example of an agreement, providing institutional stoves to schools on credit, is given in Box 1.

Box 1: Case Study – Kartech Institutional Stove Manufacturer

GVEP International is working with Kartech a manufacturer of improved institutional cookstoves, based in Nairobi, Kenya. Kartech faced financing challenges due to the high upfront cost of their cookstoves for schools and other institutions. Most schools receive revenue from paying of school fees on a term by term basis which restricts their cash flow and limits orders for stoves to certain times of the year. To overcome some of these challenges GVEP International facilitated an agreement through its Loan Guarantee Programme to link schools interested in purchasing Kartech's stoves with Muramati SACCO. Under this agreement Muramati provide credit in kind to the schools by facilitating them to receive an institutional stove. Kartech receive 40% of the stoves cost upfront from Muramati and 60% on completion of the stove. The school repays the credit direct to Muramati SACCO, in 6 installments over a two year period, at an annual interest rate of 9.96% (standard interest rates in Kenya range from 19-25% annually). This agreement not only reduces the upfront cost of the stove to the customer but also gives the onus of credit collection to the SACCO who is better placed to do this.

3.3.3 Pay-as-you-go Arrangements

This is a new payment option been piloted in the East Africa market and is most suited to solar technologies. Under such an arrangement the consumer can pay as they go to access lighting from a solar system in the same way they would buy kerosene in small installments each week. Some schemes eventually give the user the options of owning the solar system when they have paid enough to cover the cost.

3.3.4 Potentials

During the field visits an assessment was carried out regarding the financial institutes in the area and the types of available financing options; specific options for each site will be discussed in more detail in section 4.3.2 Main Findings from Stakeholder Interviews. However the following options have been identified as potential mechanisms for the project sites.

- A rent to own model may work well, especially for solar lanterns, since the initial cost of the systems may be daunting to people in the community who don't have a steady income and have not used credit facilities before. If people had the option to pay installments equal to their existing expenditure on kerosene and phone charging, and eventually own the lantern, it would seem less daunting and they could pay back the cost of the light between 6-9 months and still within the warranty period.

- A community guarantee approach could potentially work well in the project areas to avoid default on credit given out for energy products. Having people from the local community guarantee individual loans creates peer pressure for the loan taker to pay on time.

3.4 Clean Energy Initiatives – Challenges and Lessons Learnt

Clean energy initiatives are gaining ground in East Africa and globally. Some of the key challenges and lessons learnt from overcoming them in energy initiatives are listed below:

i. Lack of available financing for consumers and entrepreneurs

Energy product lending is a very low priority for many financial institutions and the only common products are solar lanterns or solar home systems. There is a lack of awareness of the technologies both for financial institutions as well as consumers. Many field experiences have shown that loans should be available for more than 12 months period. In addition, loans for energy products such as for solar lighting are mainly for consumptive purposes, thus making it more difficult to pay back quickly. During the fieldwork, respondents found it better to take loans for business or income generation activities, and did not equate fuel savings as paying back the loans.

ii. Weak local capacity by product suppliers

A lack of trained and qualified technicians available at the local level is a challenge that needs to be overcome by suppliers. Many companies are based in urban towns or cities and do not have staff based out in rural areas. As a result it can take time to deliver orders and address after sales service and technical problems. In Tanzania, a Project carried out in 2007/2008 by GIZ ''*Promotion of Renewable Energy in Tanzania*' (PRET) found out that local capacity, supply networks, service & maintenance issues were found to be crucial for the success of such a project.

iii. Poor quality of products in the market

The quality of energy products in the market can vary significantly. For example fake solar products often overstate the capacity of systems which can lead to misuse and subsequent breakage - giving solar systems a bad reputation. Many low quality improved cookstoves are available in the cookstove market which often break within a few months and leave the consumer wondering what is improved about the stove. The market for energy products can be highly price sensitive meaning producers often compromise quality over price.

iv. Switching from donor led to commercial approaches

There is often a sense of entitlement from people accustomed to getting things for free from donor organizations, which needs to be overcome to make a more sustainable commercial approach viable. If someone buys the product, they are more likely to take an active interest in the product, use it more and maintain it.

v. High upfront costs of energy technologies

Energy products such as solar or LPG may have high upfront costs and the affordability is often an issue especially for low income rural customers. Thus, the role of FIs and suppliers to provide credit facilities for products is very important.

vi. Last mile delivery of energy products is costly

Conducting marketing campaigns and transporting products to rural areas where perhaps only a few sales will be made does not always make business sense and hence suppliers favor larger commercial centers where sales are more consistent. Transportation can also be a challenge especially with bulky goods like improved cookstoves and in regions with poor road infrastructure.

3.4.1 Successes and Lessons Learnt from Energy Programs

i. Utilize locally available raw materials

Within Tanzania the uptake of fuel efficient stoves has had some success because stoves are made at the local level - creating employment and meaning that raw materials are available locally especially in places such as Dar-es-Salaam, Dodoma and Kahama where series environmentally degradation is happening.

ii. People need to see the tangible benefits of using energy efficient technologies

This is essential for consumers deciding to part with their money. Such benefits that have a direct impact on the consumer's social or economic status can include saving money, freeing time for other economic activities. Stoves programs have had more success in areas where fuel use has a direct impact on people's socioeconomic situation i.e. where people are paying for fuel and it can be a matter of cook or not to cook. In areas where people can access fuel easily and cheaply they often don't see the point in using energy efficient stoves. As a result different marketing approaches should be taken for those that collect and buy fuel. For households that don't pay for fuel marketing campaigns should highlight factors such as time savings and home improvement / smoke reduction. Within more urban areas where fuel is purchased, economical savings should be highlighted.

iii. Effect of peer marketing

Peer marketing can have a strong influence on the uptake of energy technologies. If people see their neighbors using a product and are able to see the advantage of the product with their own eyes they are more likely to adopt it. However many energy technologies require a change in consumer behavior which can take time to happen. People need time to convince themselves on the benefits of such technologies and time to save the money to purchase them and as a result, suppliers may not realize sales for several months.

iv. Maintenance available at the local level

If an energy product is introduced and quickly breaks it needs to be fixed easily at the local level. If not the technology will not be used and people will lose confidence in the product.

v. Households do not prioritize energy products

Rural households may make large purchases or take loans but don't prioritize energy products in this. Households need to understand the potential savings from technologies to put it in line with other income generating activities that often take priority.

vi. The technology needs to be commercially viable

For a product to succeed on a commercial basis the economics of the technology need to be viable in the target market. For example for a technology such as biomass briquettes or eco charcoal to succeed it needs to be able to compete with charcoal in price. In an urban market such as Dar-es-Salaam where charcoal prices are high such technologies can offer a viable alternative and often undercut the price of charcoal. However in more rural areas where charcoal prices are low the technology will be more expensive than charcoal which could hinder uptake.

vii. Many energy programs fail to sustain momentum when program subsidies end

Many energy programs that have trained energy product suppliers offer indirect subsidies through transporting products to market or helping with marketing campaigns. This can produce reliance from entrepreneurs on external support especially in areas of marketing and distribution. When such programs end, entrepreneurs do not have the capacity to cover these costs themselves and fail to sustain the activities.

viii. Sales of energy products can be seasonal

Consumers should be targeted at the right time when they have disposable income available. These could be times of the year that correspond to crop harvesting, selling of livestock and those that do not correspond with payment of other bills such as school fees.

ix. Cultural and social factors have a strong influence

Energy programs need to consider local cultural and social factors that might affect the uptake of technology. For example, traditional cooking practice may favor the taste of smoky food, or smoky stoves may be favored to keep mosquitos away. Another example is with biogas where negative perceptions around gas produced from human waste have hindered the uptake of the technology at institutional level.

4. Results from Site Surveys

4.1 Description of Sites

The 130,000 hectare Imbirikani Group Ranch (IGR) is situated between three National Parks: Amboseli, Tsavo West and Chyullu, which is of critical importance to the ecological integrity and connectivity of the region (map shown below in Figure 13). The group ranch is managed by a democratically elected committee consisting of 15 members, which represent the 9 different zones of the ranch and consult with them on decisions affecting the ranch. AWF has been working with IGR for the last 15 years and has supported several programs including the community ranger network, afforestation and alternative livelihood programs. As part of these programs a high end tourism lodge has been set up on the ranch close to Ol Donyo Waus to generate income for ranch members from tourism.

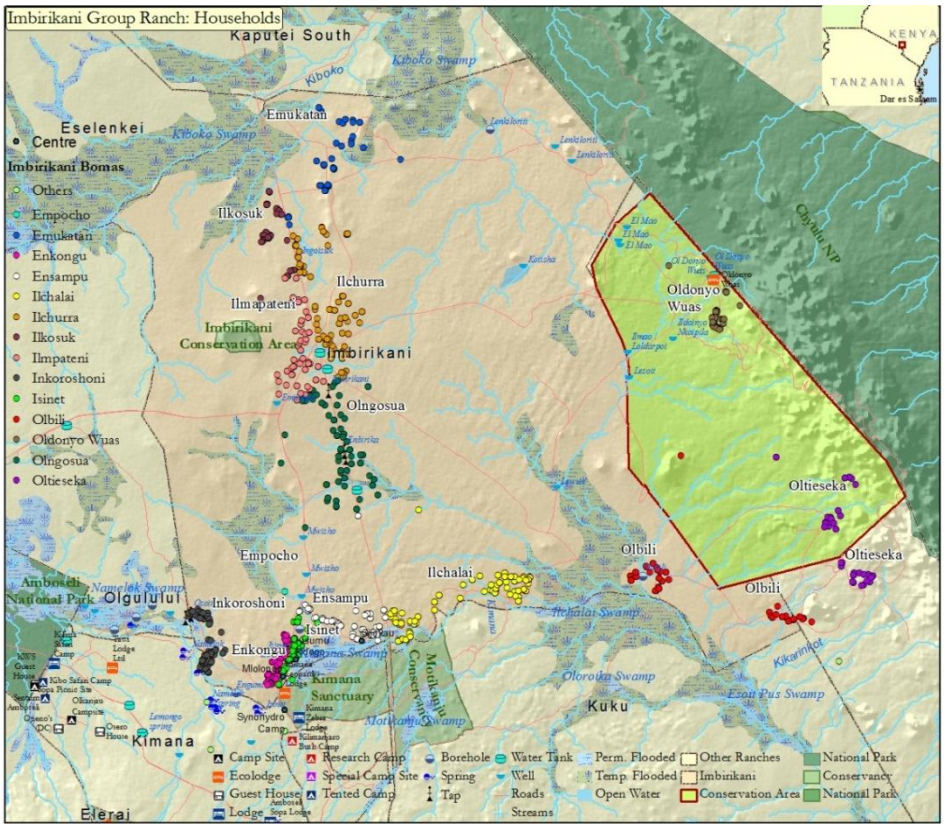

Figure 13: Imbirikani Group Ranch

The majority of the ranch is not connected to grid electricity. The grid has recently been expanded to reach the town of Isinet in the southern part of IGR. In 2011, a tarmac road was constructed through the ranch connecting Email and the Tanzanian border. A Kenya Water pipeline runs through the ranch taking water from the foothills of Kilimanjaro to Nairobi. The pipeline provides a water source for many residents within the ranch and as a result settlements have formed along the pipeline path. Several boreholes also exist within the ranch to provide water for domestic use. Apart from the wetland area in the south east of the ranch, which has been extensively cultivated for agricultural purposes, it is a water scarce environment. There is protected forest area to the East of the ranch bordering the Chyulu National Park.

AWF have previously worked with the Centre for Livelihood Opportunities Unlimited and Technologies (CLOUT) to introduce energy products to the ranch. CLOUT conducted training on improved cookstoves and planned to set up a demonstration unit for the stoves in Imbirikani. They also conducted surveys and product demonstrations within the ranch. However the project experienced delays and was subsequently cancelled. As a result some community members within the ranch have received sensitization to energy products. The project also gave out solar cookers and fireless cookers to some households within the ranch.

Imbirikani is a small commercial center located along the pipeline, at the heart of the ranch. Isinet to the south of the ranch is also a small town, with potential to expand with its recent connection to grid electricity. Kimana is an important commercial center lying outside of the ranch to the south, providing a trading center for agricultural produce and livestock. It is also the closest center for many people on the ranch to buy household essentials such as food stuffs, kerosene for lighting and petrol for generators. Further to the south lies Loitokitok town and to the north Emali is the closest commercial center. Outside of the commercial center most settlements consist of traditional Maasai bomas, with several small households and an animal enclosure making up one boma.

Within the past decade land use inside the ranch and surrounding area has changed with the expansion of settlements and agricultural activity. Africa Wildlife Foundation is working within the Imbirikani and surrounding ranches to protect the wildlife corridor between the Amboseli, Tsavo and Chyulu national parks.

4.1.1 Gombe-Masito-Ugalla Landscape - Tanzania

Jane Goodall arrived in the Gombe region in 1960 and went on to establish the Jane Goodall Institute in 1977. JGI initiated the Lake Tanganyika Catchment Reforestation and Education (TACARE) project in the Kigoma region of Tanzania in 1994. The program aimed to address poverty and support sustainable livelihoods in villages around Lake Tanganyika while combating the degradation of natural resources, in the remaining indigenous forest. The program focuses on community development and offers training and education in sustainable natural resource management[18].

JGI's presence is in the Gombe Masito-Ugalla Ecosystem (GMUE) with an estimated area of 12,000 sq. km with over 83% covered by miombo woodlands[19]. The GMUE consists of the smaller Greater Gombe Ecosystem (GGE) to the North of Kigoma town, which encompasses the Gombe National Park and extends to the Burundi border, and the Masito-Ugalla Ecosystem (MUE) an expansive area to the South East of Gombe town. The area lies along the shores of Lake Tanganyika and covers the Kigoma and Rukwa regions of Tanzania (shown in Figure 14). The area is rich in biodiversity and GMUE is estimated to be home to 540-900 chimpanzees (excluding those protected in Gombe and Mahale National Parks). Between the two areas lies a wildlife corridor, which is highly settled and cultivated and which JGI is working to protect.

[18] Fuel wood consumption in the TACARE villages, Kigoma region Tanzania, How can we make it more sustainable? , Van Hall, Larenstein University of Applied Sciences, 2010

[19] JGI - Social Economic Study Report of Communities Living in the Corridor Area of Gombe Masito Ugalla Ecosystem, Green Tanzania Environmental Consultants Ltd, 2011

Kigoma is the main town in the region, being the district capital, and the only one served by electricity (off grid diesel power station), with an estimate population of 135,234 (2007 census) in 2007, a figure that is likely to have grown since then. The area has seen recent investment in the poor road network with several new tarmac roads currently been built, such as the Kigoma – Uvinze highway which is expected to open up the region further.

JGI introduced fuel efficient stoves to a few villages in the GMU area in 2000. While the uptake of the technology was slow due to some cultural factors, some women's groups modified the fuel efficient stove to meet their local needs. More recently, improvements have been made to fuel efficient stoves through collaboration with Dartmouth University. These rocket stoves have been introduced to villages, with uptake increasing while feedback is received from communities on how they can be enhanced and promoted.

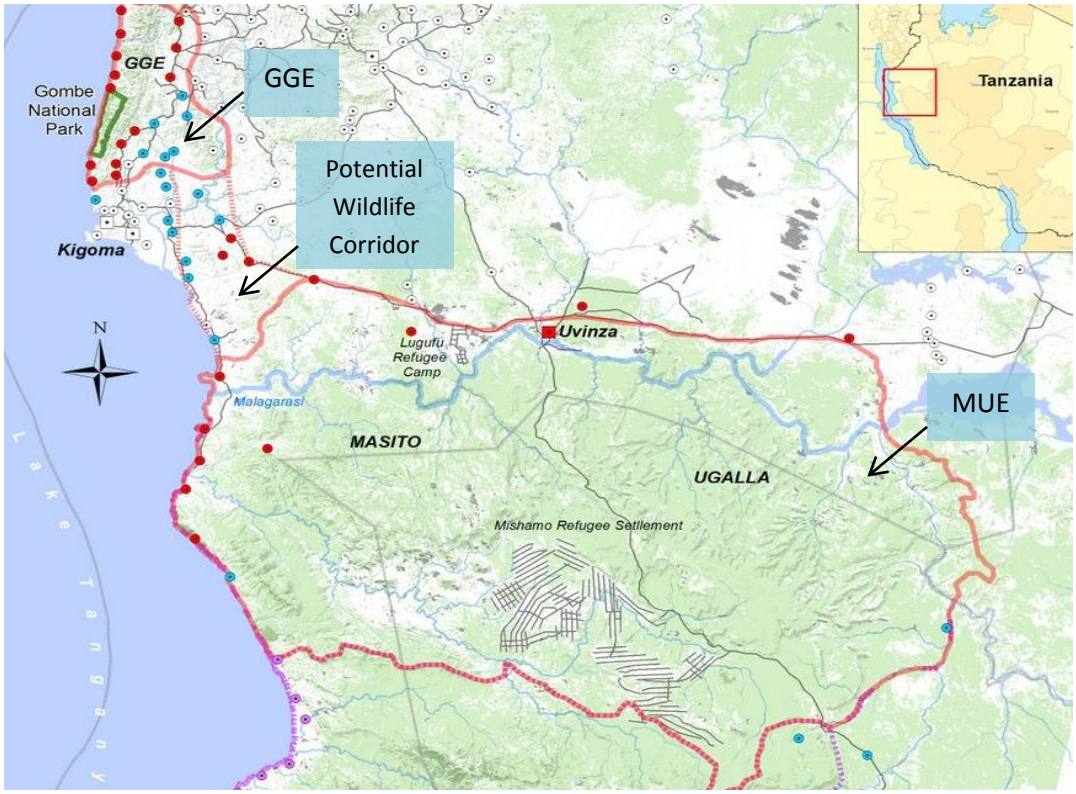

Figure 14: Gombe-Masito-Ugalla Landscape

Within the GGE landscape two main types of settlements exist; villages situated along the Lake and inland villages. Hill ranges separate the lake villages to those inland meaning that no road network can link the two and the lake villages are only accessible by boat from the lake or on foot from inland. A range of settlement types exist in the MUE landscape, with most of the population in settlements along the lake and the town of Uvinza, which is home to several salt mining factories. The Mishamo Refugee Settlement lies in the south of the area and has become a permanent settlement after being established by the UNHCR and Government of Tanzania in the wake of the genocidal war that broke out in Burundi in the early 1970s[20]. More recently, illegal settlements are being established within the general land in the MUE area leading to increased deforestation for

[20] http://www.tcrs.or.tz/index.php/refugee-old-settlements

agriculture, production of charcoal and cattle grazing. JGI is working with the local communities and district to protect critical forests that are also home to chimpanzees within the general lands.

Within the area coffee, maize and tobacco farming is practiced. A range of economic activities and businesses exist in the area, many with substantial energy needs, such as palm oil processing, salt mining and brick burning. The government employs many people in Kigoma through institutions such as the Tanzania Revenue Authority (TRA) and district government offices.

4.2 Survey Methodology

Field assessments were conducted at each site during the following dates:

- **July 2nd – July 7th 2012**
  Assessment at AWF's site, Imbirikani Group Ranch (IGR) situated between three National Parks; Amboseli, Tsavo West and Chyullu in Kenya.

- **July 16th – July 21st 2012**
  Assessment at JGI site within the Gombe-Masito-Ugalla landscape in Kigoma Tanzania.

The aim of the field assessments was to ascertain the energy needs of households within the sites as well as other institutions and businesses, assess the suitability and potential for energy technologies in the sites and potential mechanisms and partners that could be leveraged to provide energy services to the community. The following activities were conducted during the site survey:

4.2.1 Household Surveys

Forty (40) households were surveyed during each of the assessments in areas where AWF and JGI directly work as well as surrounding areas whose energy consumption is impacting on these areas. The full household survey can be found in Annex A and covered the following topics:

- Consumer data
- Economic status of households
- Agro forestry practice
- Household fuel use
- Household stove use
- Household lighting
- Mobile phone charging and other energy requirements
- Purchasing factors and product awareness
- Household conservation activities

The household survey aimed to capture a cross section of the different communities within the project sites. An assistant from the local community was present during the surveys to introduce the team to households and help with any translation. The locations surveyed at each of the project sites are given below.

i. Kenya

- ***Kimana town*** (10 households) - Lying to the south of Imbirikani ranch, Kimana town is a commercial center for the area. The town is served by grid electricity but most residents rely on biomass for cooking which is sourced from wood on the neighboring ranches.
- ***Obili & Oltiseka villages*** (10 households) - Located to the south east of the ranch, these isolated villages lie around 50km from the nearest commercial center and border the protected forest area.
- ***Wetlands area*** (5 households) - This area lies along the southern boundary of the ranch and consists of wetlands, which have been cultivated for agricultural purposes.
- ***Imbirikani and around the pipeline*** (10 households) - Imbirikani is a small commercial center with neighboring settlements stretching along the path of the water pipeline.
- ***Isinet*** (5 households) - Isinet is a small up and coming town to the south of the ranch. Located along the tarmac road the town has recently been connected to grid electricity.

ii. Tanzania

- ***Uvinza*** (10 households) - Uvinza is a small town located on the edge of the Masito-Ugalla landscape. The area is not connected to grid electricity and contains several salt mining factories and other agricultural industries such as tobacco and maize farming.
- ***Kigoma*** (10 households) - Kigoma is the main town in the region situated on the shores of Lake Tanganyika. The town is supplied by electricity from off grid generation. The residential Ujiji area of Kigoma was surveyed.
- ***Matyazo / Kalinzi*** (8 households) - Matyazo and Kalinzi are inland villages located in the Gombe landscape. The area is not served by electricity and JGI has worked with communities to establish several village forest reserves. Improved coffee farming is practiced in the area.
- ***Mwamgongo*** (12 households) - Mwangongo is a fishing village situated alongside the lake in the Gombe landscape just North of Gombe National Park. It is not served by electricity and is only accessible by boat or foot from Kigoma and other villages.

4.2.2 Area Mapping with AWF/JGI Staff

Throughout the assessments, area mapping was done with AWF and JGI staff to understand the background context of the area, identify the types of settlements in the region and their importance to on-going projects. Staff also helped to identify NGOs, CBOs, institutions, energy businesses and financial institutes within the survey area. Previous initiatives, local resources available for prospective businesses and skills prevalent within the community were also discussed during the field assessment.

4.2.3 Meeting with community leaders

Within the Imbirikani ranch in Kenya a meeting was held with local community leaders to discuss energy requirements in the area and get community leaders view's on energy products, through demonstrations of sample products. The situation was slightly different at the Kigoma site and

instead a visit to the local district/ward office was made at each location to inform them of the survey and its aims.

4.2.4 Community Focus Groups

During the assessments, four community focus group (CFG) meetings were held in different locations in Kenya and two in Tanzania to discuss energy requirements, views on energy products and some of the barriers that hinder their purchase. A selection of stoves and solar lights were shown to participants to get feedback on the products and indications if participants would be prepared to buy these items and how much they would be willing to pay. The locations for focus groups were decided jointly between GVEP and AWF/JGI staff to try to capture views of a cross section of the community including both male and female residents and different settlement types. Residents within the chosen locations were mobilized by a local community contact to attend the focus group session. An outline of the discussion topics for the CFG is given in Annex G.

Kenya focus groups:

- Community leaders (male)
- Olbili village (female)
- Oltiseka village (mixed)
- Tuinwane savings group, Kimana (female)

Tanzania focus groups:

- Matyazo village (male)
- Matumaini SACCO, Mwangongo (female)

Figure 15: CFG being held in Olbili village at the IGR

During the field assessments, interviews were conducted with various sectors of the community, including local businesses, NGOs, CBOs, charcoal traders and financial institutes as detailed in *Table 10*. Interview participants were selected through discussions with AWF & JGI staff and contacts gained during the surveys. They aimed to include organizations that are important partners to AWF & JGI or work closely with the local community as well as businesses and institutions that have engaged in energy activities or could potentially benefit from energy technologies in the future. The interviews sought to understand activities that are currently on-going within the area, energy needs and uses of organizations and potential partners/beneficiaries for future energy initiatives.

Table 10: Sectors of the community interviewed during field assessments

Stakeholders	Kenya	Tanzania
NGOs/CBOs	- Noomayianat Community Development Organization (NCDO), - The Maasailand Preservation Trust (MPT)	- JGI REDD Project
Financial Institutes	- Kenya Women's Finance Trust - SMEP - Equity Bank - Kadet - Tuiniwane Savings Group	- PRIDE - Bayport - Matumaini SACCO

Energy Businesses	- Cookswell jiko - Sun Transfer - Stove assembler Loitokitok - Solar phone charging businesses - Charcoal traders - Institutional stove dealer - Timber mill	- SIDO (soap manufacturers, palm oil producers, timber mills) - Solar phone charging businesses - Nyanza salt mine - Solar stockists - Charcoal traders
Institutions	- Primary & Secondary schools, Abattoir, Restaurants	- Secondary schools, Restaurants, Matyazo Health Centre
Others	- Community game scouts	- Forest Monitors - Tobacco Farmers - Matyazo Coffee Cooperative

4.3 Imbirikani Ranch - Kenya

4.3.1 Main Findings from Household Surveys and Focus Group Discussions

The following sections describe the main findings from the 40 households surveyed at AWF's Kenya locations within the Imbirikani ranch and surrounding area.

i. Consumer Data

Basic data regarding the household respondents are shown in the following tables & charts. Table 11 shows that more women than men were interviewed during the household survey, mainly due to household roles within the area meaning that women are more likely to stay within the homestead in the day whilst men go elsewhere to tend to cattle and conduct business.

Table 11: Age and Gender of Household Respondents

Age	Male		Female		Totals	
	Number	**%**	**Number**	**%**	**Number**	**%**
18-25	3	7.5	2	5	5	12.5
26-35	5	12.5	9	22.5	14	35
36-45	7	17.5	4	10	11	27.5
Over 45	0	0	10	25	10	25
Totals	**15**	**37.5%**	**25**	**62.5%**	**-**	**-**

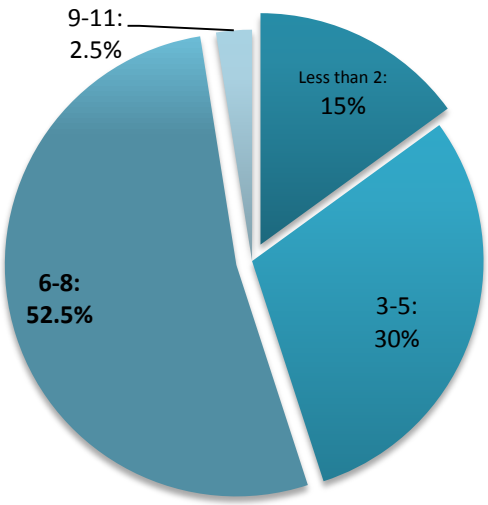

Figure 16: Household Members

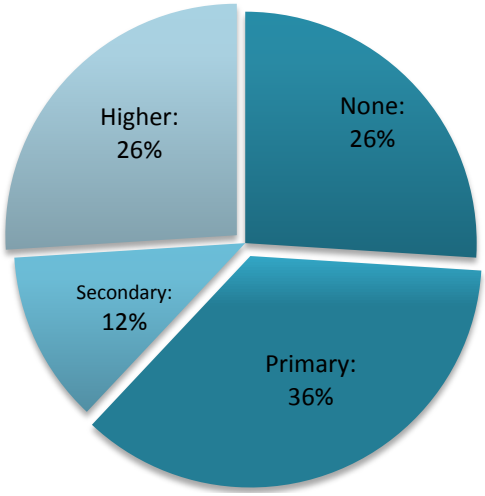

Figure 17: Highest Education Level

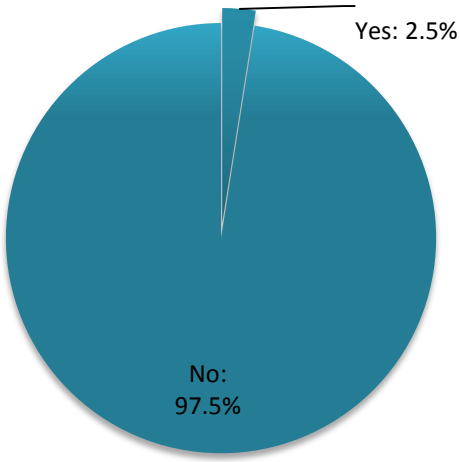

Figure 18: Connection to Grid Electricity

The majority of households (out of the 40) surveyed had between 6-8 people living in them, although this question was sometimes difficult to interpret in the context of the Maasai Boma where family units are spread across several households in the Boma. 26% of the respondents had no formal education whereas a further 26% had studied up to higher education level showing a range of education levels across respondents. Although grid electricity was available in some of the areas surveyed, only one out of the 40 households was connected to grid electricity (all shown in Figure 16, Figure 17 and Figure 18 above).

ii. Economic Status of Households

Fifty percent (50%) of respondents said that two or more people within the household earned an income. The majority of households had 2 or 3 different sources of income with livestock keeping and crop farming the main economic activities practiced as shown in *Figure 6* below. Half of respondents also get income from running their own businesses. The results suggest that most

households do not get their income from a regular wage and instead there may be times of the year when households have more income available, i.e. when crops are harvested and sold or when households sell livestock. This should be taken into account when marketing energy products to the community to try and target households at times of the year when they have more money available.

Households were then asked about their average monthly income from these sources of livelihood (shown in Figure 19) and their average household expenditure per month. The responses are shown in Figure 20 below and show that 8000 – 25,000 KES (approx. $95 – $300) per month is the most common range for household income and expenditure. The results also show that 30% of respondents earned more than 25,000 KES ($300) per month, whilst only 5% had household expenditures above 25,000 KES, indicating that they may have disposable income available that could potentially be utilized for energy products. When analyzing these results it should be noted the many people were unwilling to answer this question and reveal their true income during the survey, especially in the presence of another community member. The findings here should be treated cautiously and may not represent the full extent of household incomes.

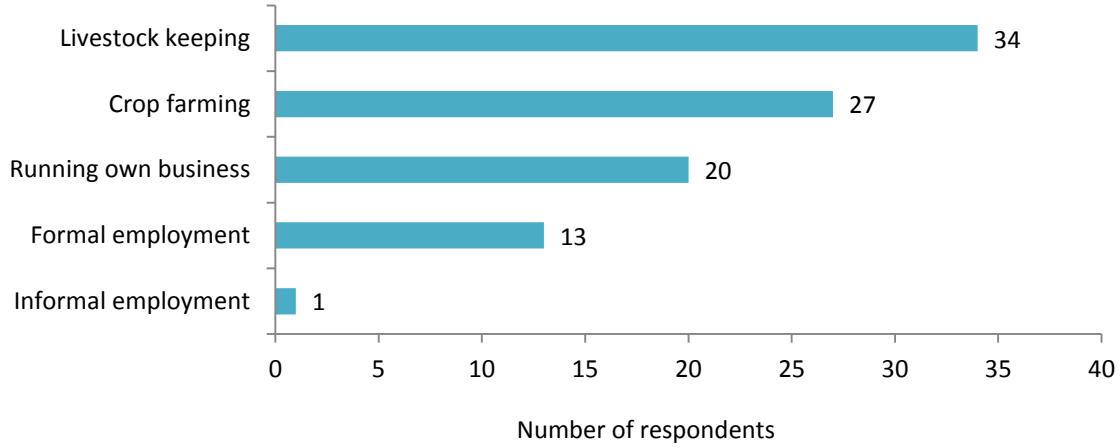

Figure 19: Sources of Income for Survey Respondents

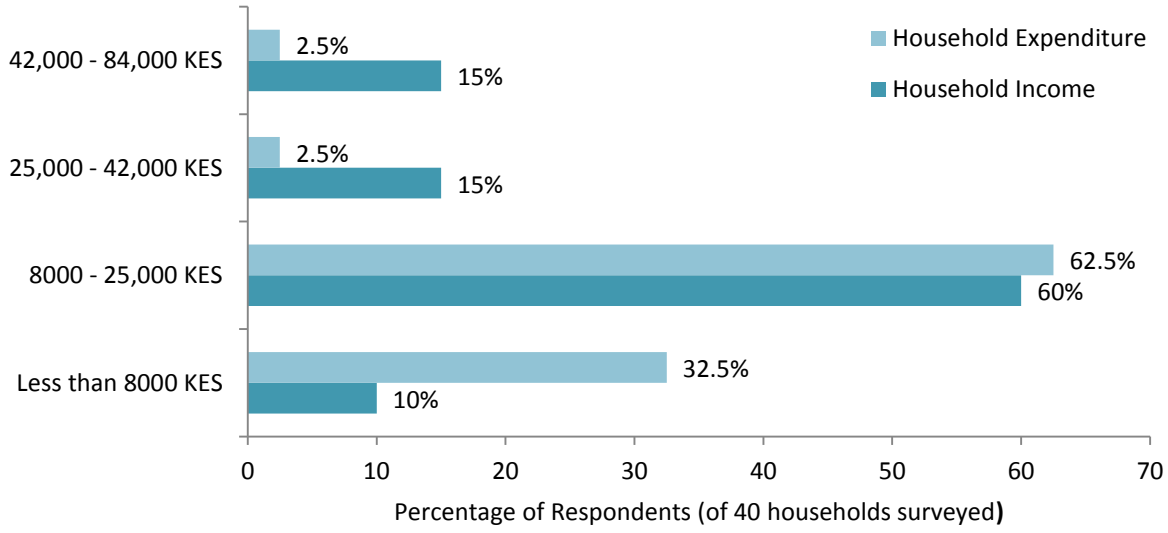

Figure 20: Percentage of Households Falling into Brackets of Household Income and Expenditure

Table 12: What do you people do with savings?

Options	What do you people do with their savings?	
	Number	%
Put savings in the bank	21	52.5%
Buy assets	11	27.5%
Keep savings in the house	6	15%
No savings	2	5%

Many people had bought major item for their house during the year with livestock been the most common purchase (27.5%), followed by other household items (15%), kitchen utensils (12.5%), and building materials (10%). Only 3 households said they had not bought any major items over the past one year. These results are encouraging, indicating a moderate level of financial activity within the respondents with over half of the households' surveyed saving money in the bank and most households purchasing not essential items over the past one year (table 12).

Further to this, 55% of respondents said they have a bank account, with the majority been held with Equity Bank (18 out of the 22 having a bank account). One person also had an account with KWFT, a micro finance institution and two other with Tuinwane Women's Saving Group. Out of the 22 people having bank accounts 12 had borrowed money over the past year, showing that there is willingness within the households to take out loans from financial institutions and the ability to pay them back.

iii. Cooking Practice

All 40 households surveyed were using firewood for cooking with 26 households (65%) collecting the wood for free from surrounding areas, 9 households (22.5%) buying firewood and 5 (12.5%) harvesting firewood from their own trees. Of those that were buying firewood 8 out of 9 were in Kimana town a more urban area outside of Imbirikani ranch.

Table 13: Number of hours spent on fuel wood collection

Hours Spent Collecting Fuel Wood	Household Member (of 26 households surveyed)	
	Number	%
Less than 30 mins.	1	3.8%
30 min – 1 hr	1	3.8%
1-2 hrs	5	19.2%
2-3 hrs	5	19.2%
3-4 hrs	5	19.2%
4-5 hrs	1	3.8%
More than 5 hrs	8	30.7%

The average weekly expenditure was 260 KES ($3.1) per week on fire wood. Out of the 26 households collecting wood, 57.5% (23) said the female head of the household collected the wood, 27.5% (11) outsourced the collection of wood, 2.5% (1) said the wood is collected by the male household head, and 2.5% (1) by a female child (10% did not answer the question).

Table 14: Average household expenditure on fuel

Fuel	Average Weekly Expenditure ($)
Fire wood	3.1
Charcoal	3
Kerosene	1.26

Nineteen (19) of the households surveyed were using more than one fuel for cooking. In addition to firewood, 15 households were using charcoal, 7 were using kerosene, 1 was using briquettes (made by the user) and 1 was using biogas as shown in Figure 21 below. All 10 households surveyed in the urban area of Kimana were using charcoal and the other users of charcoal were located within the vicinity of the main commercial centers, where this fuel is available.

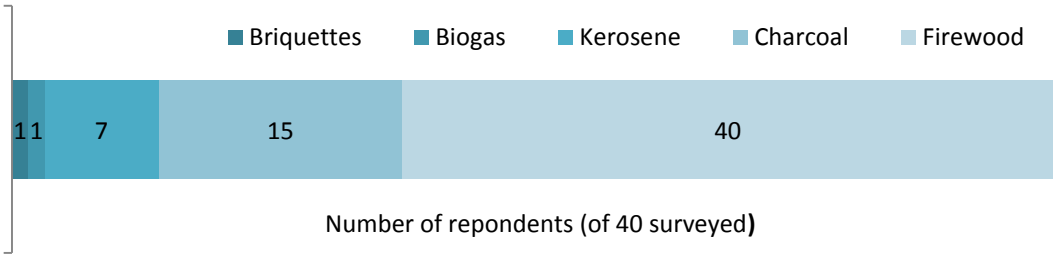

Figure 21: Number of households using different types of fuel

Respondents were asked about problems they encountered sourcing fuels, with the results shown in Figure 22. Households' main concern was related to economic factors such as not having enough money to buy fuel and hence being forced to collect it themselves. The second biggest concern was wild animals within the ranch which made the collection of fuels dangerous especially when collecting firewood. Availability of fuel was not a major concern for people although many spoke about problems with transporting the fuel to their home, especially those collecting firewood themselves.

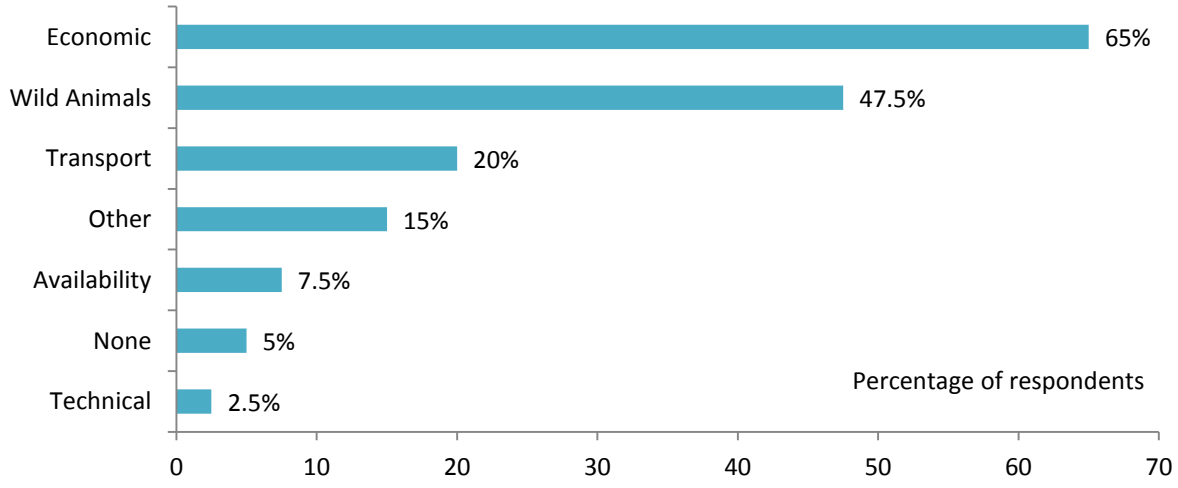

Figure 22: Problems encountered with sourcing fuels

Out of the 40 households surveyed 39 of them (97.5%) were using a three stone fire for cooking and only 6 households (15%) were using an improved stove, as shown in Table 15. Only 19 respondents were using a three stone fire alone and the other 21 respondents were using a combination of stoves. When respondents were asked why they use an open fire the most frequent reason was that people felt they had no alternative and using the three stone fire is the only way they know. This indicates that availability but also cultural factors & cooking habits are strong influences in stove use.

Table 15: Different stoves used for cooking by survey respondents

Stove	Stoves used for cooking by households		Reasons for use
	Number	%	
Open fire	39	97.5	No alternative/availability (10), Only way they know (9), Cheap (5), Easy to use (4)
Traditional metal charcoal stove	19	47.5	Lack of firewood (4), Cheap (2), Available (2), Speed (2), During rains (1)
Kerosene stove	7	17.5	Speed (3), Cheap (1)
Portable improved stove	4	10	Saves money (1), During rains (1)
Fixed improved stove	2	5	Saves money (1), Lack of firewood (1)
Other	1	2.5	-

There was no correlation between household income and the type of stove used, indicating that availability and awareness may be more important factors to stove use. Many of the respondents that had improved stoves were still using them along with an open fire or traditional metal jiko, indicating that people wanted a choice of stove to use depending on the cooking situation and type of food being cooked. All the households surveyed cooked inside indicating that they are being exposed to potentially high levels of indoor air pollution, since most are using a three stone fire and traditional stoves.

These findings corresponded with insights from the community focus groups in Obili and Oltiseka villages where most households use wood for cooking on a three stone fire. Wood is fetched from the bush on average twice per week with distances of 1 -3.5 km covered. Problems encountered collecting the wood includes fear of wild animals, distances travelled, the weight of carrying the wood and the thickness of the bush.

Most people felt they didn't know any other way to cook than with wood on a three stone fire. Many would like to use charcoal but they can't afford to buy it and it is only available within the towns. Many of the participants had seen improved stoves such as the Kenya Ceremic Jiko (KCJ) before, in the papers and in Kimana town.

In addition residents had the following concerns about the stoves demonstrated:

- The improved stoves would not be suitable for roasting meat. People like to use lots of fire too cook the meat quickly which the stoves couldn't do. For large families a food such as Githeri (beans and maize) requires a big pot which might not fit on the stoves.
- People also use the three stone fire for heating their homes and felt that the stoves might not be able to do this.

iv. Lighting

Kerosene is the most widely used type of lighting with both the kerosene lantern and tin lamp been used by 20 and 28 households respectively, as shown in Figure 23. Seven households (17.5%) surveyed were using solar lighting in their house, 4 (10%) using a solar lantern and 3 (7.5%) a solar home system. The 4 households using solar lanterns were using them alongside kerosene lights indicating that one solar lantern on its own is not sufficient to light the whole house.

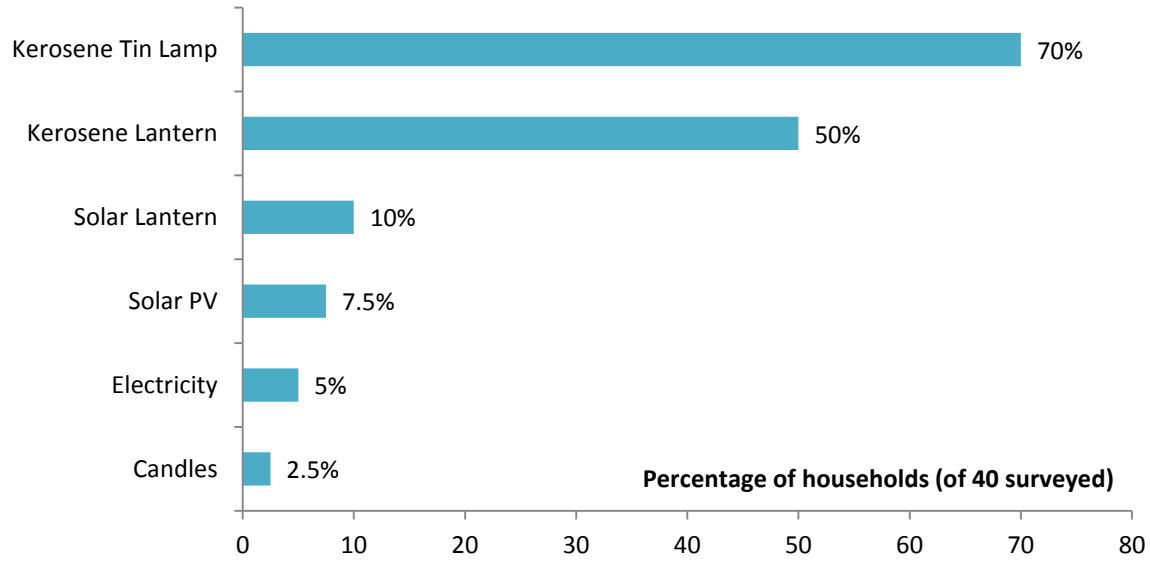

Figure 23: Types of lighting used by households surveyed

Only one household had access to electricity for lighting from the National Grid, despite six of the households surveyed in Kimana saying the grid was less than 1 km away, indicating affordability is an issue. One other household had electricity from a generator. Thirteen (32.5%) of the households surveyed were using two different types of lights with both a kerosene lantern and tin lamp being the most popular combination.

Box 2: Facts on household kerosene use

Average amount of kerosene households use per week for lighting	2.26 litres
Average cost of 1 litre of kerosene	102 KES ($1.21)
Average household weekly expenditure on kerosene for lighting	230 KES ($2.74)

The majority of people surveyed (55%) had to travel more than 7km to purchase kerosene with people in villages such as Oltiseka travelling as far as 50km to purchase kerosene from Kimana, the nearest town. When asked about problems people experience with lighting in their home the most common issues were economic (40%), i.e. the cost of purchasing fuel for lighting, as well as health related (40%), with people complaining about the smoke given off by kerosene and the strain on eyes from using kerosene lights to study.

The focus group discussions also showed that most people used kerosene tin lamps or lanterns for lighting. Kerosene is usually sourced from Kimana town. In the case of Oltiseka village this is a distance of around 50km, which is travelled once a week for the market day in a pickup truck which charges 250 KES ($2.97) to take people there. Most people in Olbili spent around 100 KES ($1.19) a week on kerosene whilst in Oltiseka they spent around 200 KES ($2.38).

Figure 24: Traditional fire and kerosene lamp being used in a Maasia home on Imbirikani Ranch

v. Charging Mobile Phones

67.5% of households (27) surveyed charge their mobile phone in the town, where a combination of grid electricity, generators and solar is the power source. 15% of households (6) charge their phone in the local village with 5 households saying the power source is a generator and the remaining one charged from solar.

The majority of people (55%) charge their phone two times per week, whilst 37.5% charged it once and 5% three times a week. Most phone charging facilities cost 20 - 29 KES ($0.24 - $0.35) per charge (31 respondents), whilst a few cost less at 10-19 KES ($0.12 - $0.23) (2 respondents).

From the focus group discussion in Olbili residents charged their phones either in the local church or in Kimana town, sometimes leaving their phone there for the whole week to charge. In Oltiseka phones were charged either in Kimana or at the Posho mill within the village, that had a generator and can charge around 6-10 phones per day for 25 KES each ($0.3).

vi. Other Energy Requirements

Apart from cooking and lighting energy needs, 85% (34) of respondents also had a radio in their house run from dry cell batteries. In addition 20% (8) of respondents had a TV in their house with 3 running it from solar, 3 from a generator, 1 from a battery and 1 from grid electricity. When asked what energy equipment households would like to buy in the future, the most popular item was a TV (50%) followed by a fridge (25%), solar kit (7.5%) and more lighting (7.5%).

vii. Payment Options

People were questioned about the payment option they would choose to purchase energy products with 77.5% (31) of respondents saying they would choose to pay in monthly installments as shown in Table 16.

Table 16: Payment options households would choose for purchasing energy products

Payment Option	Respondents choose (of 40 households)		Reason given
	Number	%	
Monthly Installments	31	77.5	Spread the cost of payment, more affordable
One full payment	9	22.5	Avoid debt

Respondents were further probed on the amount they would be willing to pay for the option they had chosen. However this was quite a general question in this context and 82.5% of respondents (33) were unable to answer this question saying it depended on the product they were buying or the specific terms of any credit agreements given. For those that did respond willingness to pay varied from 200 KES ($2.38) to over 5000 KES ($59.5). This topic was discussed further in the community focus groups with demonstration products. People cited prices of 200-500 KES ($2.38-$5.95) as affordable for improved stoves demonstrated to them. When asked how much they would be willing to pay in installments to purchase the products, residents in Olbili said around 500 KES ($6) and in Oltiseka between 400-500 KES ($4.8 - $6).

viii. Product Awareness

During the survey respondents were asked if they were aware of the following energy products; briquettes, improved cookstove, solar lanterns, biogas & wind turbines. Pictures were shown of the energy products and explained to clarify the concept to respondents. Figure 25 below shows the number of respondents that were aware of the energy products out of the total 40 surveyed. The figure shows that improved cookstoves had the highest level of awareness at 50% of respondents, followed by solar lanterns (27.5%), biogas (12.5%), briquettes (5%) and wind turbines (5%).

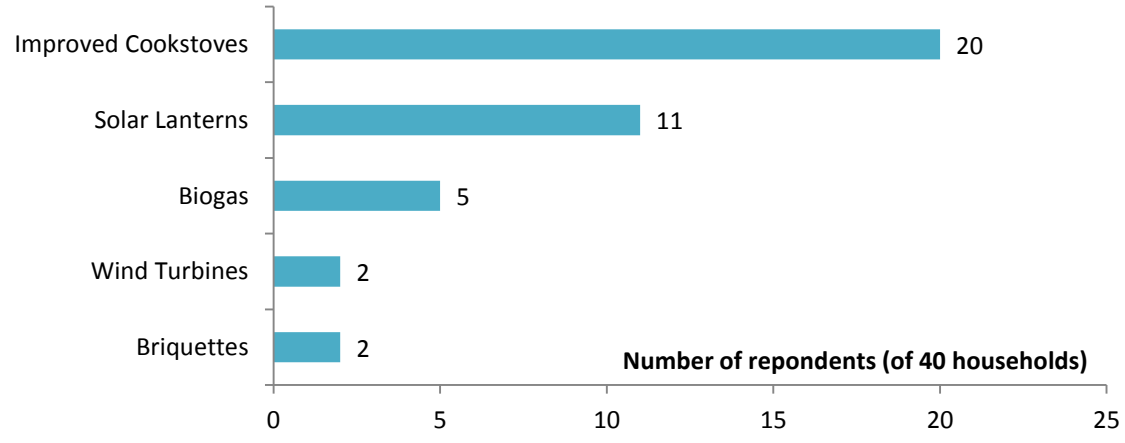

Figure 25: Number of respondents that were aware of the energy products

Awareness however did not seem to be converted to buying the products shown by improved cookstove usage (see Table 15). Respondents were further asked about the positive and negative attributes of these products, barriers to purchasing the products and whether the respondent had seen the products being marketed in the area. The responses to these questions are shown in Table 17, for the three technologies people were most aware of, with the corresponding number of respondents that gave each answer. It should be noted that several people did not respond to all of the questions in this section.

Table 17: Attributes people associate with energy technologies and barriers to purchasing

Technology	Positive Attributes	Negative Attributes	Barriers to purchasing	Marketed in the area
Improved cookstove	Saves money/ fuel – **10** Availability – **1** Safety – **1**	Low Durability – **1**	Availability – **6** Economic – **5**	Yes – **8** No – **7**
Solar Lanterns	Saves money – **12** Performance – **1**	Performance during rainy season low – **1**	Economic – **5** Availability – **3** No maintenance services – **1**	No – **6** Yes – **4**
Biogas	Durable technology – **2** Better for health – **1**	Expensive – **2**	No responses	No – **2**

The results show that even though 50% of respondents were aware of improved stove only 20% had seen the stoves marketed in the area, suggesting that availability is a factor hindering uptake of the technology. Those that were aware of the technology also cited the price of the technology as a barrier to purchasing. The results show that awareness of energy products within the area is still low especially for products such as briquettes and wind turbines. Further awareness creation would have to be done in the area in parallel with increasing the availability of the technologies.

From the meeting and focus groups held with the community leaders they were highly welcoming of the energy technologies demonstrated and keen for them to be available in the area. This was also the case for the Tuiniwane women's group in Kimana. Some participants were frustrated that these technologies are demonstrated to them and then taken away without them having the chance to actually purchase them for their homes.

4.3.2 Main Findings from Stakeholder Interviews

The following sections describe the information gathered from stakeholder interviews conducted during the field assessments at Imbirikani Group Ranch, Kenya. Two main organizations that have been working closely with the local community were identified during the field surveys;

i. Noomayianat Community Development Organization (NCDO)

Based in Kimana town NCDO was founded in 2001 and works within the Kimana, Kuku and Imbirikani ranch to tackle issues such as livelihood development, improving water supply and better crop management. NCDO have become involved in the household energy sector through partnering with SNV on the National Biogas Program, since the start of 2012. So far 4 biogas plants have been constructed within the Kimana area, including a plant at the home of the CBO founder, which is used

as a demonstration unit for others interested in the technology. The CBO however does not have a biogas technician and one is sent from Machakos town (165 km away) to construct the biogas plant with local masons. Finance has been a barrier for many households to purchase biogas as well as sufficient levels of livestock.

ii. The Maasailand Preservation Trust (MPT)

Founded in 1991 MPT works closely with the local Maasai community to protect the Amboseli-Tsavo ecosystem and contribute to the success of the Maasai people and their way of life. They do this through wildlife scholarships, supporting local schools, establishing health care centers and a predator compensation scheme. They also run a community games scout network, with almost 200 scouts covering an area of 2 million acres to protect the animals and natural resources from poaching. This includes patrolling for illegal removal of fire wood and charcoal burning. MPT also runs the Ol Donyo Wuas lodge within the Imbirikani ranch. The lodge is run 80% on solar power with a backup generator. They also have a biogas system at the lodge but the system installed was not large enough for their requirements and they have to turn to alternatives.

Figure 26: MPT community game scouts patrol for poaching and illegal harvesting of wood

The organization has promoted afforestation through demonstration plots and distributing seedlings. However this approach proved unsuccessful since grazing livestock destroyed the seedlings. Ideally seedlings need to be planted in a fenced off area but this raises land ownership issues which can be complex. The organization also ran a project promoting briquettes made from cow dung, using simple wooden briquette presses. However the project did not take off because the women using the briquettes found them too smoky. The women were keen to adopt the briquettes since many of them were spending 7 hours on a round trip to collect wood and there is potential for this technology if the briquette composition and technology can be improved.

From discussions with the stakeholders in appears that promotion of improved stoves has taken place in the area, but uptake has been low due to initiatives not been sustained and rarely progressing past pilot phases (such as the CLOUT initiative). Availability and affordability of products is also a barrier. Working with women's groups & household savings groups in the area to increase the availability of technologies and conducting demonstrations could help the technologies take off more commercially.

Stakeholders feel the availability of firewood within the ranch is becoming scarcer with women having to travel 4-5 km to collect wood. Those who have money hire people with bicycles or vehicles to source wood for them from as far as 8-15 km away. Findings from interviews suggest getting wood illegally from the ranches is difficult with the community game scouts in action. People in Kimana also use charcoal for cooking, which is often made from trees poached from the neighboring ranches. In Kimana ranch, next to Imbirikani, the land has been subdivided and sold off. In some cases landowners are giving permission for people to clear trees on the land for making charcoal. Business men will also come and buy trees from local landowners for making charcoal. Within the ranch no one has tried to establish woodlots for sustainable charcoal making on a commercial basis.

Both NCDO and MPT could act as local partners to help facilitate links with the community in energy projects piloted in the area. NCDO have links with the communities in Kimana town and the surrounding area whilst MPT has built a strong relationship with communities within the Imbirikani ranch. Both organizations appear to have a good understanding of the local community dynamics and needs and are enthusiastic about introducing energy technologies to the area.

iii. Financial Institutes and Savings Groups

During the field trip, four FIs were interviewed in Loitokitok in Southeastern Kenya: KWFT, Small and Micro Enterprise Program (SMEP), Kadet & Equity Bank (all based in Loitokitok). All 4 financial institutions except Equity had a specific energy product loan, mostly for solar products as below:

- **KWFT** (an MFI) provides loans for a Sun Transfer solar lantern with phone charger – 5500 KES ($68) and a larger system for three bulbs – 15,000 KES ($188). They also provide loans to their members for purchasing LPG hardware. There are conditions to be met to receive the loans: applicant must be an existing client, already have taken a normal loan with KWFT, and have a credit history. The interest rate is 22% for a group loan and 20% for an individual. Loans need to be repaid over a one year period.

- **SMEP** (an MFI) provides a similar loan for Sun Transfer solar lantern (KES 5800/$69) and additionally, an Envirofit cookstove (2500 KES/$30). SMEP rates may be slightly higher as they take a slightly risky approach of providing loans to groups who may not have taken a loan before. The interest rate varies between 18-25% and repayment is normally over 12 months. The MFI tends to have more male customers as they compete directly with KWFT, exclusively women membership MFI.

- **Equity Bank** does not have a specific energy product loan but can provide loans on specific activities. The Bank has lent for electricity connection costs in the past and can provide loans as little as 1000 KES ($12.50) with interest normally between 18-24%. The Bank also has special loans to target particular groups. For example, the Vijana loan is aimed at the youth with a first loan at 8% interest and the second at 14%. There is a loan for women at 24%.

- **Kadet** (an MFI) offers a solar loan with products from Barefoot Power: the lowest is the Firefly 2820 KES ($35), Power pack junior 2.5 W 6050 KES ($76), the 2 bulb power pack 5W at 9850 KES ($123) and the biggest system the Power pack 15W 18150 KES ($227). The MFI provides loans mostly to people with businesses that are members and have 3 guarantors. The repayment of loans is over 6 months and the interest charged is added to the initial product cost. Due to technical issues with the system, the sales of products had stopped during the field visit

awaiting a technician to come from Nairobi and address the problem.

Discussions with the FIs in the field in Kenya showed no major challenges in loan repayments. The supplier 'Sun Transfer' had already opened up a branch outlet in Loitokitok, thereby allowing more partnerships with the main FIs in the region. With the suppliers present nearer the customers, technical backup, support and maintenance is available at the local level making it more manageable. This is evident as Kadet's supplier is not located in the immediate area of operation and they had to wait for technical support from Nairobi. This has also meant stopping sales of the product to avoid undermining consumer confidence. Thus, FIs are better off if they partner with key suppliers that are present in their operational areas/region.

Slow uptake of the Envirofit stove was reported as it is a new product in the market. However, demand is stimulated once usage by community members increases. It was also important for potential customers to be able to see the products for themselves and see demonstrations of use.

It was also reported that solar is an unfamiliar technology for many women, with sensitization and awareness raising for this technology required.

iv. Schools and Restaurants

During the fieldwork 7 restaurants & hotels were visited in Imbirikani and Isnet to discuss their energy requirements and the current technologies used. As Table 18 shows the majority of restaurants were using some type of improved stove. In some cases the owners had built the stoves themselves from clay and others had been sourced from the Jua Kali (artisan market) in Nairobi. One restaurant in Imbirikani had bought one of the energy saving stoves from the Cookswell Jiko's store in Kimana for 7500 KES ($89). He is now using 2 bags of charcoal per week compared to 4-5 bags previously.

Table 18: Summary of energy use in the restaurants and hotels interviewed

Restaurant	Cooking Fuel	Stove	Lighting	Approx. Energy Cost / Week
Hotel Imbirikani	Wood Charcoal	Improved Stove	Generator	Charcoal: 1200 KES / $14 Wood: 1750 KES / $21 Diesel: 2100 KES / $25
Back to Eden, Imbirikani	Wood Charcoal	3 stone fire, metal charcoal stove, mud wood stove	Solar	Wood: 1500 KES / $18 Charcoal: 1200 KES / $14
Kick Rock Café, Imbirikani	Charcoal	Improved Stove (Cookswell Jiko)	Generator	Charcoal: 1100 KES / $13 Diesel: 1050 KES / $12.5
Njuguna Hotel, Isnet	Charcoal	Improved Stove	Kerosene	Charcoal: 2200 KES / $26
Ukwala Hotel, Isnet	Charcoal	Metal Charcoal Stove	Solar Lantern	Charcoal: 2000 KES / $24
Nono Hotel, Isnet	Charcoal	Unknown	Kerosene	Charcoal: 2000 KES / $24 Kerosene: 375 KES
Nono Butchery	Wood	Improved Stove	Unknown	Wood: 850 KES / $10

During the assessment five schools were visited within the survey area. A summary of their energy uses are given in Table 19. All of the schools in the area were using wood and the majority with an institutional improved stove. All but one of the schools was paying for their wood to be delivered to the school and many complained about the increase of the price of wood. One school reported paying 17,000 KES ($202) for a lorry of wood compared to 4,000 KES ($48) two years ago. Another school said wood was sourced from almost 50 km away to meet their cooking needs. It is difficult to directly compare the difference between those schools using an improved stove and an open fire due to differences in the amount of meals cooked.

Christ Secondary School in Kimana which is not connected to grid electricity had done a cost analysis for connecting to the grid and calculated the total cost of connection and equipment to be approx. 200,000 KES ($2380), a significant financial investment for the school.

Table 19: Summary of energy use in schools interviewed

School	Size	Cooking Fuel	Stove	Lighting	Energy Cost / Month
Imbirikani Secondary School	290 pupils boarding	Wood	Improved Institutional	Solar System	Wood: 30,000 KES/$357
Kimana Secondary School	400 pupils boarding	Wood	Improved Institutional	Electricity & Diesel Generator	Wood: 90,000 KES/$1071 Diesel: 20,000 KES/$238 Elect: 40,000 KES/$476
Olbile Secondary School	130 pupils day	Wood	Improved Institutional	Electricity	Wood: 10,000 KES/$119 Elect: Unknown (new)
Oltiseka Primary School	330 pupils day	Wood	Open Fire	None	Wood: Each pupil brings 2 pieces wood per day
Christ the King Secondary	75 pupils day	Wood	Open Fire	None	Wood: 8000 KES/$95

Figure 27: An institutional stove in use at Olbile Secondary school near Kimana

v. Existing Energy Businesses

Several energy businesses already exist in the area, many of which have established over the past one year:

- An outlet for **Cookswell Jiko** was opened in Kimana town one month ago through a partnership between Cookswell Jiko, Woodlands 2000 Trust and AWF. The shop sells a range of energy efficient charcoal and wood stoves and baking ovens made at Cookswell's Kitengela factory. In addition they have been conducting road shows, distributing stickers/flyers and looking for wholesale buyers for the stoves. The shop has been running for about 6 weeks and currently sells about 2 small jikos a day. It is expected that sales will increase as marketing activities raise awareness and also as peoples current stoves wear out and they look for replacement.

- Another **stove business** exists in Loitokitok assembling energy efficient charcoal cookstoves. The artisan sources the stove liners from the market in Nairobi, makes the metal cladding and assembles the stove. The stoves sell for around 300 KES ($3.57) and he sells around 90 stoves per month, making about 7000 KES ($83) profit per month. People buy for both personal use and on wholesale, selling the stoves further in towns such as Rombo. The business has been running for three years and people are aware of the business. There are not many other tin smiths in the area so his skills are in demand for other services as well, such as repairing household items.

- **Sun Transfer** has had an outlet open in Loitokitok since June 2012. They sell a solar lantern with phone charging capability (6000 KES/ $71) and a larger system with 3 lights (15,000 KES/ $178). They also sell the Envirofit M5000 through Paradigm Project (2500 KES/ $30). In the first month they have sold 8 larger systems, 4 lanterns and 3 stoves. They expect to sell 20 larger systems per month but have had challenges getting information out to communities about the products. They also support existing stockists such as KWFT & SMEP.

- A handful of **solar phone charging businesses** exist in Imbirikani town, running from generators or solar systems. Most of these businesses are not doing phone charging alone but alongside other economic activities such as selling phone accessories, bank agents and hair salons. One such business in Imbirikani has been using solar power for the past four months to expand their business into phone charging. The business charges around 20 phones per day at 20 KES ($0.24) per charge. A 30 Watt solar system is used which cost 18,000 KES ($214) and was bought from Nairobi.

- Across the road **another business** exists charging phones from a generator alongside shaving and cutting hair. The business charges 20-30 phones per day at 20 KES ($0.24) in addition to 20 shaves at 30 KES ($0.36) each bring in around 1200 KES per day ($14). The generator for the business cost 31,000 KES ($369) and uses 2 liters of petrol per day. The business owner decided to invest in a generator rather than solar because he thought it would be more reliable during the rainy season. The fact that it is portable also means he can take it home and use it for lighting in his house at night.

- A number of institutional stoves and solar systems were observed within schools and homes in the region. Most of the institutional stoves were bought from Nairobi and an **institutional stove dealer** exists in the area for an institutional stove manufacturer based in Nairobi. Solar systems observed were also sourced from Nairobi, with several owners saying they had been advised by friends on where to source the equipment, indicating that there is some knowledge within the community.

vi. Charcoal Traders

Several charcoal traders exist within the commercial centers of Imbirikani, Isinet and Kimana. Most are selling charcoal in small quantities, such as buckets or sacks, many in kiosks alongside other commodities and households items. Two such traders were interviewed in Kimana town and found to be selling charcoal in buckets (approx. 5kg) for 30 KES ($0.36) and 90kg sacks for 800 KES ($9.52). The price of charcoal in Kimana is considerably cheaper than in large urban areas such as Nairobi where a small 2kg tin of charcoal can cost 60 KES ($0.71). The traders were not aware of the origin of the charcoal, assuming it had come from the Kuku ranch (neighboring Imbirikani). The charcoal is bought to the market by a middle man three times a week, who sells it to the charcoal traders.

Through discussions with stakeholders and survey participants, it appears that most of the charcoal production done within the ranch is not by residents but by people from outside who come in to make the charcoal for business purposes and sell in other areas. In general, ranch residents are respectful of the wood resources and only collect dry wood that has already fallen, instead of chopping down new trees. However reports suggest that land owners within the local ranches will sell trees to businesses to make charcoal from them. With the dividing of land on neighboring ranches such as Kimana, land owners often give permission for businesses to come on to clear the land, often for agricultural purposes, and use the wood for making charcoal.

Figure 28: Charcoal for sale at a kiosk in Kimana town

4.3.3 Assessment of Suitability of Energy Technologies

i. Improved Cookstoves

Within the ranch many people collect wood for free and hence there is no direct economic benefit for them to switch to an energy saving cookstove. However many women complain about the smoke that fills the house when using the three stone fire and many problems related to the collection of firewood. The marketing message for the stoves would have to focus on other benefits apart from saving money such as saving time on firewood collection and removing smoke from the house.

Within the Maasai Bomas on the ranch women cook in a fixed position inside the house and hence portability of the stove is not a consideration. For these reasons fixed stoves with chimneys would be suitable for the traditional households where cooking is performed inside the home. The stoves would be marketed as a home improvement item, which can relieve smoke from the household and save women time and effort on fuel wood collection.

A stove should try to replicate current cooking practice and be suitable for the types of foods cooked in the area. For example a low to the ground stove with a wide stable base would be suitable, to replicate cooking on a three stone fire and cater for large pots that require vigorous stirring. Lessons could be learnt from The Maasai Stove Project in Northern Tanzania run by International Collaborative for Science, Education and the Environment (ICSEE) which has spent several years designing a fixed household stove with a chimney with local Maasai women. Local capacity to manufacture and install the stoves could be created within the communities. Further research would be required into the exact design of stove and locally available materials that could be used in production and it is recommended that previous stoves introduced by CLOUT are reviewed to build on work that was started.

Another solution that would be suitable is a fireless cooker such as the Wonderbag product. Using this product does not require a change of behavior or fuel switch by introducing a new type of stove. Instead the user would use their traditional fire for a short time before transferring the food to the Wonderbag where it continues to cook. This technology saves firewood and reduces the amount of time cooking on the three stone fire, hence saving time and reducing the amount of smoke in the house.

Within the more urban locations such as Kimana town where charcoal is used, portable improved charcoal stoves would be suitable. During the focus groups the multipurpose stove proved popular, since it is one stove that can use both firewood and charcoal. This product would be suitable for areas like Kimana where both fuels are used and even within the ranch where households aspire to use charcoal.

Several suppliers of energy efficient stoves already exist within the area and in particular the Cookswell energy saving shop in Kimana town could act as a supplier of these technologies. Cookswell could be further supported to increase their marketing activities and increase their product range. Other local producers could be engaged and provided with training to increase the quality of their stoves and their business capacity.

ii. Institutional Cookstoves

Many of the restaurants and schools interviewed were already using improved stove technology and reporting wood fuel savings as a result. These technologies are very suitable for the area where the majority of schools and restaurants are buying fuel wood and it represents a significant part of their monthly budgets. One of the main barriers to uptake is the initial high upfront cost of purchase and financing options could be explored for those schools with limited budgets. One option would be to work with local financial institutions that would finance the upfront cost of the stove and allow the school to repay the loan in installments, similar to the work that GVEP has done through its Loan Guarantee Program (please refer back to Box 1).

iii. Solar

Considering that most homes within the ranch are not connected to grid electricity, solar technology is highly suitable to this area and several households and institutions have already adopted this technology. At the household level, small solar lanterns with phone charging capacity could provide households with economic and time savings that would be tangibly realized. Especially for villages in the interior of the ranch large distances have to be travelled to purchase kerosene and charge mobile phones. If a household is spending 200 KES ($2.38) per week on kerosene and phone charging, a big lantern costing 6000 KES ($71) would be offering cost savings after 30 weeks, well within the warranty period of one year given by most solar lantern suppliers. For smaller lanterns, the payback period would be much shorter.

Larger solar home systems are also suitable but financing mechanism may be required to make the products available to all households within the ranch. It is considered that there are groups within the ranch that can afford the technology, such as community leaders, and these groups could be initially targeted and act as energy champions to demonstrate and promote the products more widely in the community.

At the institutional level solar is also suitable for powering lights, computers and office equipment. Imbirikani Girls School in the area has a large solar system which it has been operating for around 5 years demonstrating the use of the technology at this level. The ability of institutions to afford solar is highly dependent on the funding status of the school. Private schools that are funded by international donors seem more likely to be able to afford such systems compared to those financed by parent's contributions and government. Solar systems for intuitions can be expensive depending on the size of the system and many day schools may not see this technology as a top priority. Similar to the case of institutional cookstoves financing mechanisms with financial institutions could be explored. The Community Development Trust Fund (CDTF) in Kenya is another potential funding channel that could be utilized for such purposes.

Another potential application for solar is to power pumps at community boreholes and other agricultural applications. In such situations however there may be ambiguity over who is responsible for the financing and maintenance of such equipment and ownership of the project would have to be clear. A backup generator would also be required during times of low sunlight.

iv. Briquettes

The suitability of briquettes to the area was explored by assessing the available feedstock for this technology. Biomass briquettes can be made out of char dust (charcoal waste) or other biomass waste such as agricultural residues. At the Imbirikani ranch some of the most common agricultural wastes used in briquette production such as coffee husk and maize cobs are not available. However feedstock could be available in local towns such as Kimana where three timber mills are in operation and charcoal traders exist. There is a limited supply of these feedstocks available that could provide raw materials for a briquette business and further assessments on the estimated quantity and competing uses would need to be assessed. Some timber mills reported people from lodges within the National Parks taking away waste materials possible for the purpose of making briquettes.

Briquettes are most suitable for urban areas, such as Kimana and Loitokitok where people are paying for charcoal and using charcoal stoves that could switch to using briquettes. However within these areas the price of charcoal is relatively low compared to large urban areas such as Nairobi. Further analysis would have to be done to work out the cost price of a unit of briquettes compared to charcoal in the area to determine their economic feasibility.

v. Eco Charcoal and Woodlots

Although tree planting is taking place in the area it is done as a conservation activity and currently not for wood harvesting. There is potential in the area to establish woodlots for sustainable wood harvest to be used directly as fuel or converted into charcoal. Local schools would be ideal areas to start woodlots since many have available land, are paying significant amounts for fuel wood and could incorporate the activity into conservation education. Local corporations such as Equity Bank could be partnered with to donate tree seedlings as part of their corporate social responsibility (CSR) programs. Within the larger ranch, cattle are grazed freely and could easily damage young seedlings preventing them from growing and woodlots would need to be fenced off to protect against this. Land ownership issues may also come into play, within the ranch, depending on where woodlots were established. One possible location would be along the perimeter of the wetlands area bordering the agricultural land. By planting along the perimeter a large number of trees could still be grown without taking encroaching onto agricultural land.

Establishing woodlots is a long term investment as it can take several years before the branches are ready to harvest depending on the species being used. Advice would need to be sought on the appropriate species and location to plant the trees and an assessment of the effect on the local water resources made.

vi. Biogas

Livestock is prevalent within the Imbirikani ranch as many residents practice semi nomadic pastoralism. Cattle are grazed in the day and return back to the boma during the night. Zero grazing techniques are the most suitable for biogas since animal waste can easily be collected, however there may still be potential for biogas technology for households that keep animals enclosed for part of the day. There is also potential for biogas within the surrounding towns such as Kimana where households maintain smaller numbers of cattle but grazing is more restricted.

Examples of biogas were seen within a household in Kimana and also at the Ol Donyo Wuas lodge. However in both instances the users reported problems with the systems resulting in declined use, due to a biogas technician not been available in the local community. If this technology was further pursued it is important that qualified masons are employed to build the systems and technical issues are quickly addressed to avoid consumers losing confidence in the technology. KENDBIP is a potential avenue to disseminate the technology through and NCDO in Kimana has already partnered with the program to promote the technology. If uptake of the technology increased it is advisable to training a technical expert within the local area to provide after sales support. The upfront cost of biogas systems may be prohibitive for many households within the site and partnering with the KENDBIP could also allow access to subsidized prices and credit facilities.

On an institutional level negative perceptions around biogas for cooking, generated from human waste, exist making it difficult to initiate without first doing extensive consultation and sensitization on the technology. However one suitable application of biogas was identified at the Imbirikani Abattoir which is currently under construction. This site could potentially utilize livestock waste to generate biogas which could be used to heat water which is used in the slaughtering process.

vii. Wind Turbines

The suitability of wind turbines is highly dependent on the average wind speeds in the area and this data would need to be accessed to determine the potential for this technology. One small wind turbine was observed within the area, suggesting that there could be potential for this technology. No wind turbine manufacturers exist in the local area and this technology would have to be sourced from Nairobi. The high up front cost of wind turbines may make it unsuitable for many households within the ranch and more suitable for institutions and businesses.

4.4 Gombe-Masito-Ugalla Landscape - Tanzania

4.4.1 Main Findings from Household Surveys and Insights from Community Focus Groups

The following sections describe the main findings from the 40 households surveyed at JGI's Tanzania location within the Gombe-Masito-Ugalla landscape and surrounding area. Due to the complexity of the site and large distances to be covered the survey team split into several groups on most days to cover more ground and several members of the team conducted household surveys. Whilst this allowed the target of 40 households to be met it led to a higher incident of missing data, which will be indicated where necessary in the presentation of results.

i. Consumer Data

Basic data regarding the household respondents are shown in the following tables & charts. Table 20 shows that more women than men were interviewed during the household survey, mainly due to household roles within the area meaning that women are more likely to stay within the homestead in the day whilst men go elsewhere to conduct business.

Table 20: Age and Gender of Household Respondents, Tanzania

Age	Male		Female		No Data		Totals	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
18-25	2	5	0	0	0	0	2	5
26-35	0	0	8	20	1	2.5	9	22.5
36-45	6	15	5	12.5	1	2.5	12	30
Over 45	4	10	8	20	1	2.5	13	32.5
No Data	1	2.5	3	7.5	0	0	4	10
Totals	**13**	**32.5**	**24**	**60**	**3**	**7.5**	**40**	**100**

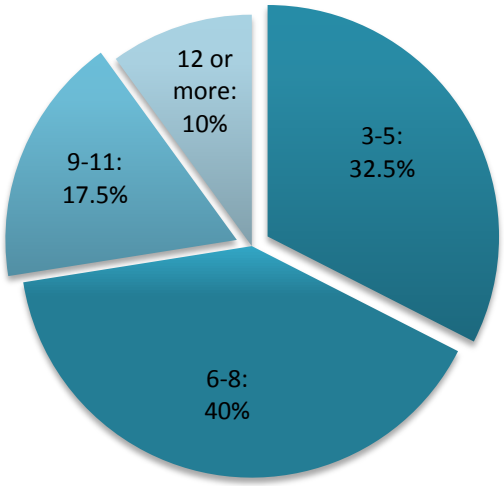

Figure 30: Household Members

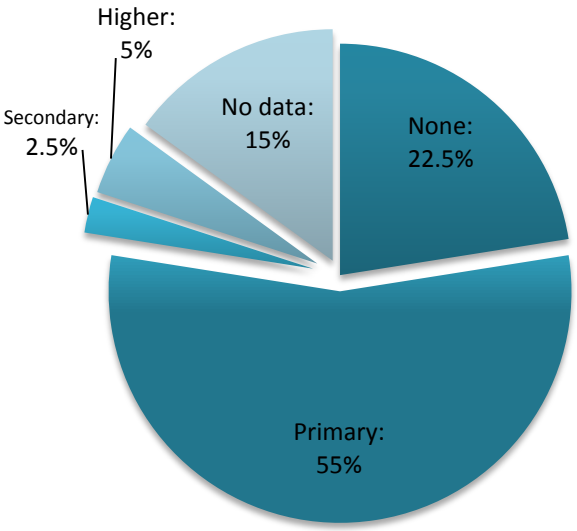

Figure 29: Highest Education

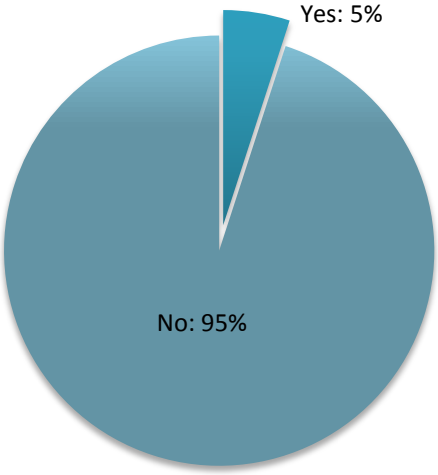

Figure 31: Connection to Grid

The majority of households (of the 40) surveyed had between 6-8 people living in them, with 4 households (10%) having more than 12 people living there and 7 households (17.5%) reporting more than 6 children living there. Only 7.5% of respondents (3) had been educated to secondary level or above indicating a low education level amongst the survey respondents. Grid electricity was only available in one of the survey areas (Ujiji area of Kigoma) and only two households surveyed were connected to grid electricity although another 8 reported the grid being less than 1 km away (all shown in Figure 30, Figure 29 and Figure 31 above).

ii. Economic Status of Households

Sixty-five percent (65%) of respondents said that two or more people within the household earned an income. The majority of households had 1 or 2 different sources of income with crop farming (72.5%) and running a business (37.5%) the main economic activities practiced as shown in *Figure 32* below. Half of respondents also get income from running their own businesses. Only 10% of respondents were in formal employment indicating that most households do not get their income

from a regular wage and instead there may be times of the year when households have more income available, i.e. when crops are harvested.

Households were then asked about their average monthly income from these sources of livelihood (shown in Figure 32) and their average household expenditure per month. The responses are shown in Figure 33 below and show that less than 150,000 TZS (less than $95) per month is the most common range for household income and expenditure. Only 12.5% of respondents earned more than 470,000 TZS ($300) per month, significantly lower than at the Kenya site (30% of respondents earned more than $300 a month) indicating that disposable income in the region is low and consumers ability to pay for energy products is a potential barrier. Again it should be noted that people are often unwilling to reveal their true income during a survey, and may underestimate their income to encourage subsidies to be offered. The findings here should be treated cautiously and may not represent the full extent of household incomes.

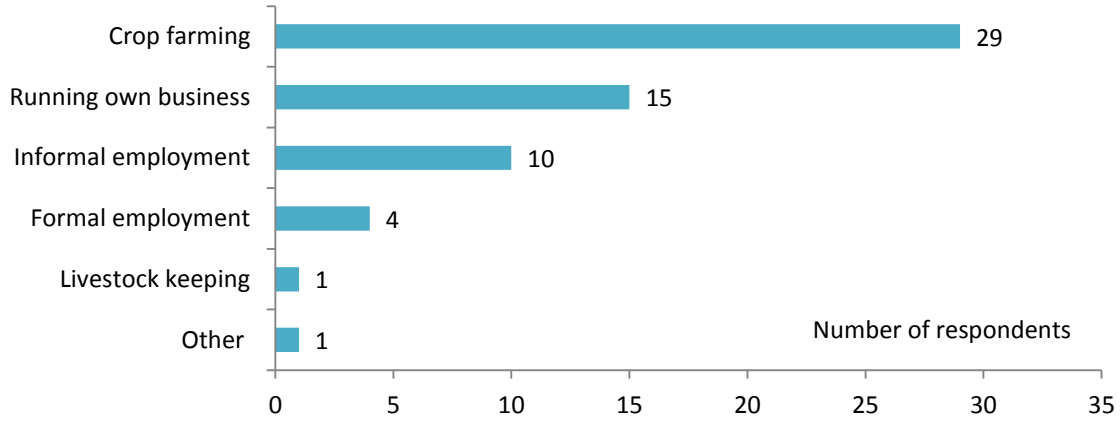

Figure 32: Sources of Income for Survey Respondents, Tanzania

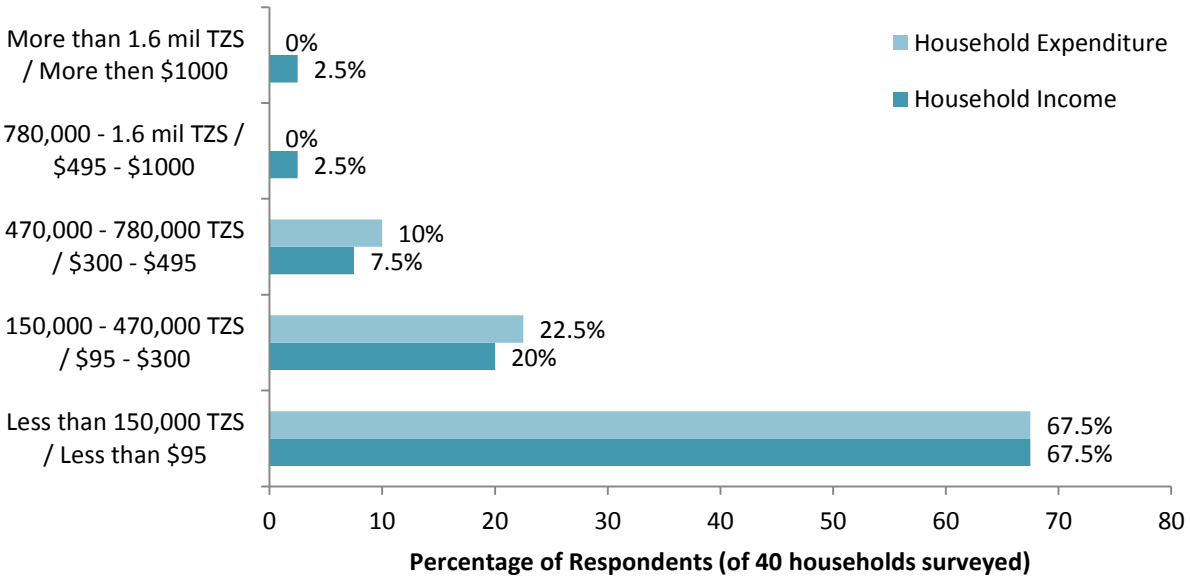

Figure 33: Percentage of Households Falling into Brackets of Household Income and Expenditure, Tanzania

Table 21: What do household do with savings?

Options	What do you people do with their savings?	
	Number	**%**
Keep savings in the house	24	60%
No savings	8	20%
Put savings in the bank / SACCO	3	7.5%
Buy assets	3	7.5%
No data	4	10%
Other	3	7.5%

Only 14 respondents had bought a major item for their house during the year, with household items being the most common purchase (9), followed by building material (7) and livestock (3). Table 21 also shows that the majority of household (60%) keep savings they have in the house with only 7.5% saving money in a bank or SACCO.

In addition, only 10% of respondents (4) said they have a bank account, with all of these being held with National Microfinance Bank (NMB). However despite this low number 25% of respondents (10) had taken loans over the past year with the majority (4) taking loans from relatives. Only one respondent had taken a loan from the bank and the remaining 4 from a variety of sources (SACCO, coffee cooperative, VICOBA and in kind loan from shop). These results indicate that the level of financial activity in the area is low, especially for formal financial institutions such as banks. This could be due to the remoteness of many of the areas sampled which, apart from Kigoma, lacked formal financial institutions meaning that informal sources and community level credit schemes become more important.

iii. Cooking Practice

Out of the 40 households surveyed 36 (90%) were using firewood for cooking with 32 households (89%) collecting the wood for free from surrounding areas and 4 households (11%) buying firewood. On average households were using 3 bundles of firewood per week although the exact size of bundles can vary significantly.

Table 22: Number of hours spent on fuel wood collection, Tanzania

Time Interval	Average hours spent collecting wood (of 32 households collecting wood)	
	Number	**%**
Less than 30 mins.	1	3%
30 min – 1 hr	0	0%
1-2 hrs	2	6%
2-3 hrs	1	3%
3-4 hrs	7	22%
4-5 hrs	6	19%
More than 5 hrs	9	28%
No Data	6	19%

For those that were paying for their wood the average weekly expenditure was 4025 TZS ($2.55). Out of the 32 households collecting wood, 91% (29) said the female head of the household collected the wood, 6% (2) by a female child and 3% (1) gave no data. Sixty-nine percent (69%) of households spent more than 3 hours a week collecting wood (Table 22).

Table 23: Average Household Expenditure on Fuel

Fuel	Average Weekly Expenditure ($)
Firewood	2.55
Charcoal	2.97
Kerosene	2.38

Twenty-six (26) of the households surveyed were using more than one fuel for cooking, with firewood and charcoal the most popular combination. In addition to firewood, 28 households were using charcoal, and 2 were using kerosene, as shown in Figure 34 below. Charcoal use was higher compared to the Kenya site with the average charcoal consumption 23 kg per week. A lot of charcoal production was witnessed within the Tanzania site, indicating the fuel is available and reasonably cheap.

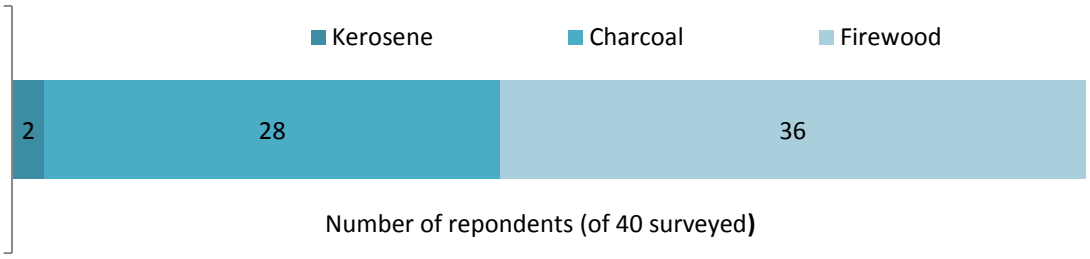

Figure 34: Number of households using different types of fuel

Respondents were asked about problems they encountered sourcing fuels, with the results shown in Figure 36. For those using wood the main concerns related to transport and availability, with people complaining about difficulties carrying the wood over large distances and having to climb hills to collect firewood. The price of the fuel (economic) was the main concern for households using charcoal.

Figure 35: Women carrying wood in Mwamgongo Village, Kigoma

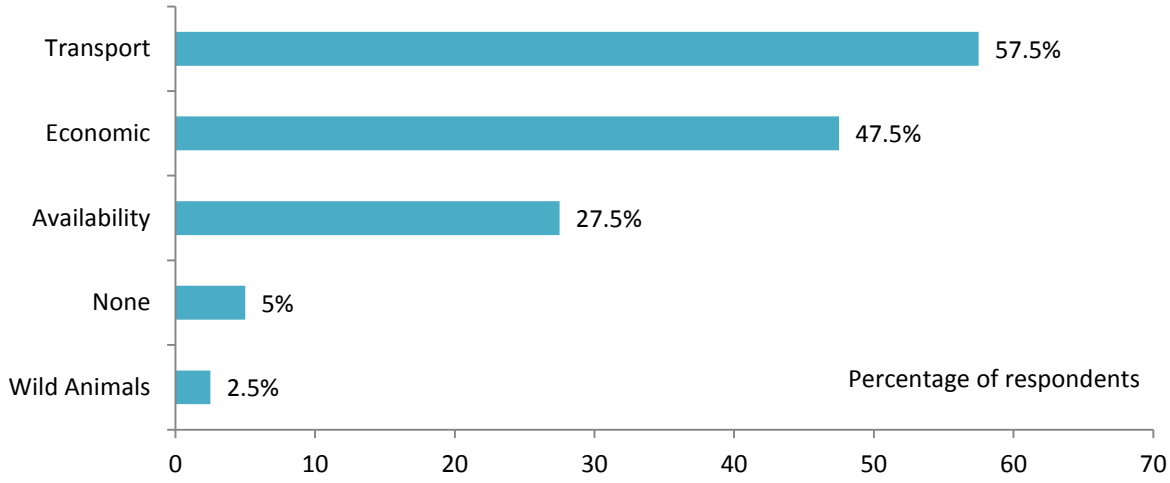

Figure 36: Problems encountered with sourcing fuels

Out of the 40 households surveyed 29 of them (72.5%) were using a three stone fire for cooking, 19 (47.5%) were using a metal stove and 17 (42.5%) were using a fixed improved stove (for both wood and charcoal) as shown in Table 24. None of the households surveyed were using a portable improved stove, consistent with observations that the stove is not available in the area. The majority of household (62.5%) were using more than one stove for cooking in the house, reinforcing the idea that one stove cannot cater for all cooking needs and the different fuels being used. It is encouraging to see households using fixed improved stoves, even if they are of basic design. Although household were realizing fuel savings with these stoves only two household were using them alone with the rest using them alongside open fires and metal stoves, indicating they may not be suitable for all cooking tasks.

Table 24: Different stoves used for cooking by survey respondents

Stove	Stoves used for cooking by households		Reasons for use
	Number	%	
Open fire	29	72.5	Cheap (12), Easy to use (7), What they know (6), No alternative (1)
Traditional metal charcoal stove	19	47.5	Easy to use (8), Available (7), Cheap (2), Speed (1).
Fixed Improved	17	42.5	Cheap / saves money (15), Easy to use (1)
Kerosene Stove	2	5	Cheap (1), Easy to use (1)
Other	1	2.5	-
Portable Improved	0	0	-

No clear correlation between household income and the type of stove used could be concluded, indicating that awareness of the different types of stoves and their availability may be more important factors. The majority of households were cooking inside including all those using metal stoves, indicating that cooks are being exposed to potentially high levels of carbon monoxide and smoke. 18 households were using either the open fire or a fixed improved stove outside, which would reduce their exposure.

Insights from the community focus groups in Matyazo and Mwangongo villages indicate that most people are using wood for cooking. A few people are also using charcoal but households find it expensive compared to wood. Wood is fetched from the surrounding area but sometimes there is not enough trees and people have to travel elsewhere or buy wood from other people. People have noticed a decline in the amount of trees surrounding the villages over the past years.

In both areas households were also using fixed improved clay stoves, which they had made themselves. In Mwamgongo village the women said they received training on how to make the stoves and then they showed other people in the village (this was part of the JGI energy efficient stoves project which introduced the stoves in early 2000/2002). The idea was to install the stoves for other people at a fee of 12,000 TZS ($7.6) but people were unwilling to pay for the stoves and wanted them for free. The women like the stoves because they are easy to cook with, clean and use less wood, however they complained that the stoves burn their pans and require regular maintenance. In Matyazo the men said they are aware of improved stove but they don't perform as well as they expect them to and they want to see new technologies made available.

iv. Lighting

Kerosene is the most widely used type of lighting with both the kerosene lantern and tin lamp been used by 16 and 21 households respectively, as shown in Figure 37. Four households (10%) were using electricity for lighting, two from the grid electricity in Kigoma town and the other two from a diesel generator with an average weekly expenditure on diesel of 30,750 TZS ($19.5). Two households were using solar home systems but no households were using solar lanterns.

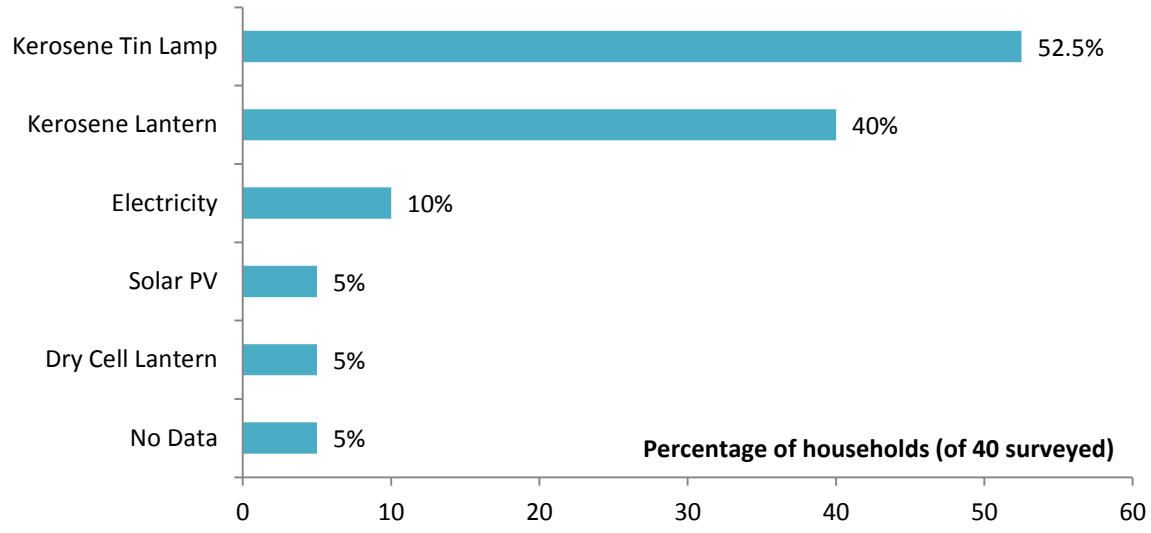

Figure 37: Types of lighting used by households surveyed

Seven (17.5%) of the households surveyed were using two different types of lights; either a kerosene lantern and tin lamp or a kerosene light and a dry cell lantern.

Box 3: Facts on household kerosene use, Kigoma

Average amount of kerosene households use per week for lighting	1.22 litres
Average cost of 1 litre of kerosene	2831 TZS ($1.80)
Average household weekly expenditure on kerosene for lighting	3453 TZS ($2.20)

The majority of people surveyed (72.5%) traveled less than 1 km to purchase kerosene, with no households travelling more than 2km. This is contrary to the Kenya site where some households travelled as far as 50km to purchase kerosene indicating that the fuel is readily available at the local level. The average price of kerosene however is higher in the Tanzania site at $1.80 per liter compared to $1.21 in Kenya, which could be due to the increased costs in transporting it into the villages. When asked about problems people experience with lighting in their home the most common problems were health related (50%), as well as economic (22.5%) and performance (20%).

The focus group discussions also showed that most people used kerosene tin lamps or lanterns for lighting. Kerosene can be sourced from within the villages and in Matyazo the men estimated households use about 2 liters per week. In Mwamgongo the women said households can spend up to 12,000 TZS ($7.62) a week on kerosene. People thought that kerosene was expensive but they had no other alternatives. They were also concerned about the smoke given off by the lamps and the risk of fire and explosions.

v. Charging Mobile Phones

Fifty-five percent (55%) of households (22) surveyed charge their mobile phone in the town, and a further 17.5% at a kiosk in the village. Respondents however were unsure what source of power was used at the phone charging stations. In addition 6 people charged their phones at home using a combination of solar, electricity and generators as the power source.

The majority of people (45%) charge their phone two times per week, whilst a further 30% charged it three times a week and 12.5% once. All phone charging facilities were charging between 181- 342 TZS ($0.11 - $0.22) with 300 TZS ($0.19) the standard price per charge.

From the focus group in Matyazo most people charged their phones in the village where kiosks used small generators and charged 300-500 TZS per charge.

vi. Other Energy Requirements

Apart from cooking and lighting energy needs, 85% (34) of respondents also had a radio in their house with the majority run from dry cell batteries. In addition 17.5% (7) of respondents had a TV in their house and 17.5% had other energy equipment including a fan, fridge and an iron.

When asked what energy equipment households would like to buy in the future, the most popular item was more lighting for the house (75%) indicating that lack of lighting is an issue for many households. Other energy items desired included a fridge (12.5%), TV (10%) and a solar kit (7.5%).

vii. Payment Options

People were questioned about the payment option they would choose to purchase energy products with 60% (24) of respondents choosing to pay in monthly installments as shown in Table 25.

Table 25: Payment options households would choose for purchasing energy products, Tanzania

Payment Option	Respondents choose (of 40 households)		Reason given	Amount Willing to Pay
	Number	%		
Monthly Installments	24	60%	Spread the cost of payment, more affordable	$2-$6 (13) , $6-$18 (8), $18-$57 (1), more than $57 (1)
One full payment	14	35%	Avoid debt	$9-$18 (4), $23 - $57 (3), more than $57 (7).
Quarterly Payments	2	5%	More affordable	Less than $2 (2)

Respondents were further probed on the amount they would be willing to pay for the option they had chosen. This was quite a general question in this context, since a particular product was not been offered and the results showed varying levels of willingness to pay. However some of those preferring one full payment were willing to pay more than $57 for a product whilst those preferring monthly installment were willing to pay less with $2-$6 the most popular option. This topic was discussed further in the community focus groups and an example of a solar light was demonstrated. In Mwamgongo people cited 50,000 – 60,000 TZS ($31 - $38) as an affordable price for a solar lantern; whereas in Matyazo they thought 20,000 TZS ($12.7) was affordable.

viii. Product Awareness

During the survey respondents were asked if they were aware of the following energy products; briquettes, improved cookstove, solar lanterns, biogas & wind turbines. Pictures were shown of the energy products and explained to clarify the concept to respondents. Figure 38 below shows the number of respondents that were aware of the energy products out of the total 40 surveyed. The figure shows that improved cookstoves had the highest level of awareness at 75% of respondents, followed by solar lanterns (52.5%), briquettes (27.5%), biogas (22.5%), and wind turbines (5%).

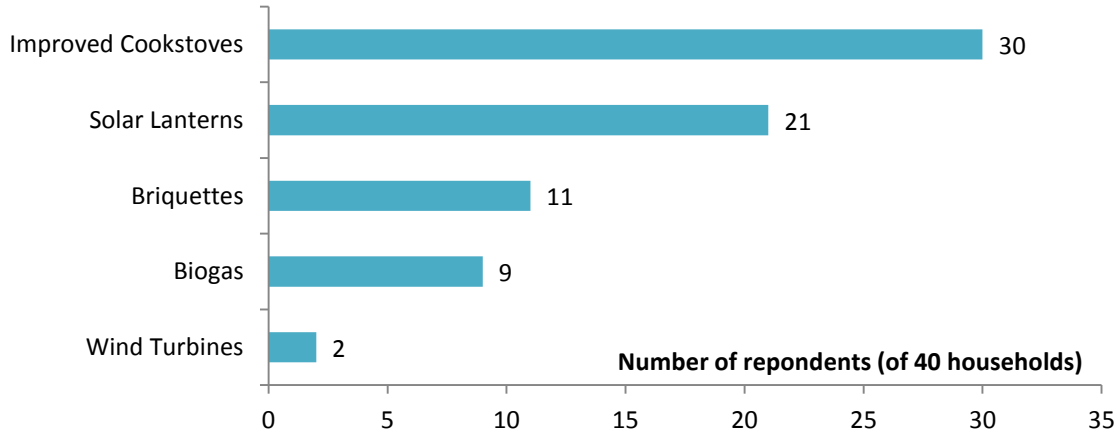

Figure 38: Number of respondents that were aware of the energy products

Awareness however did not seem to be converted to buying the products particularly for solar lanterns since no households surveyed were using one (see Figure 37). Respondents were further asked about the positive and negative attributes of these products, barriers to purchasing the products and whether the respondent had seen the products being marketed in the area. The responses to these questions are shown in Table 26, for the three technologies people were most aware of, with the corresponding number of respondents that gave each answer.

Table 26: Attributes people associate with energy technologies and barriers to purchasing

Technology	Positive Attributes	Negative Attributes	Barriers to purchasing	Marketed in the area
Improved cookstove	Saves money/ fuel – **21** Performance – **1** Can make yourself – **1**	Low Durability – **9** Poor performance - **1**	Economic - **10** Availability – **10** Building skills - **1**	Yes – **6** No – **23**
Solar Lanterns	Saves money/ fuel – **10** Performance – **4** Safety - **1**	Expensive – **3** Low durability - **1**	Economic – **11** Availability – **6** No maintenance services – **1**	No – **18** Yes – **2**
Briquettes	Save money – **3** Environmental – **3** Last longer - **2**	Low durability - **1**	Availability – **8** Economic - **2**	No – **10** Yes - **1**
Biogas	Performance – **3** Saves money/fuel – **1** Safety - **1**	Safety– **1**	Availability-**3** Economic – **2** Maintenance - **1**	No – **8** Yes - **1**

The results show that even though 75% of respondents were aware of improved stove only 15% had seen the stoves marketed in the area, suggesting that availability is a factor hindering uptake of the technology. Although many people were aware that the stoves could save fuel and money they also had a reputation with some people of low durability. Awareness of energy products is higher than expected particularly for briquettes and solar lanterns considering that no households were using these technologies and few suppliers were observed. Through focus group discussions it is felt that people are only aware of a limited range of these technologies, for example fixed clay cookstove that are used in the area and are not aware of more advance or portable options. Further awareness creation is still needed to sensitize people on the full range of energy products available and their benefits.

4.4.2 Main Findings from Community Interviews

The Tanzanian Civil Society Organization Directory lists 153 organizations working in the Kigoma region with 57 listed as working in the sector of environmental conservation[21]. Many of these NGOs work in the refugee camps and focus on health related issues and there are few operating energy programs. The Lake Tanganyika Biodiversity Project funded under UNDP/GEF has installed institutional energy efficient cookstoves at several schools in the area under its project. However during the time of the survey a representative from the project was unavailable for interview. Details of energy related activities undertaken by JGI are given below;

[21] http://www.csodirectory.or.tz/main.php

i. JGI REDD Project

The JGI REDD project area is 70,000 ha and crosses the Kigoma and Mpanda district in the Masito Ecosystem. The project aims to reduce deforestation in the area through education and creating awareness about protecting the forest, enforcing regulations and monitoring the forest stock and has been running for two and a half years. Although the project does not have an energy component they are looking at introducing solar lanterns into the community and have demonstrated the barefoot lights which they bought from ARTI-TZ. They have also provided solar powered equipment such as GPS devices to the forest monitors they work with.

One of the challenges the project tries to tackle is charcoal making in the forest. Most of the time this is not done by local people but by people coming from outside, making the charcoal and transporting it to towns in the region. To make charcoal legally, a permit from the village authorities and a license from the district are needed. The project has tried to work with the district authorities to enforce charcoal regulations but this is difficult since they lack manpower and people continue to make charcoal illegally.

ii. JGI Promotion of Fuel Efficient Stoves

JGI has introduced around 12,000 fuel efficient stoves across 30 of the villages it works with and is working in collaboration with Dartmouth University to introduce an improved rocket stove design and increase uptake of these stoves. The stoves are made from clay soil bricks (inner lining) and mud bricks outer support structure, which are available locally in the area. The 12,000 stoves were given out for free under the promotional stage of the project, but after promotion are sold between 1,000 TZS ($0.63) to 5,000 TZS ($3.2).

A survey done in 2010[22] showed that the TACARE stove had the capacity to reduce fuel wood consumption by 1/3rd and the improved rocket stoves by a further 22%. The study found that most people were still using the three stone fire alongside the TACARE stove, possible to get additional benefits from the fire such as lighting the house or to cook multiple foods at once. It also found that a few of the stove had been spontaneously adopted by families outside of the project area by people who had seen the stoves elsewhere.

During the survey a household that had adopted the JGI rocket stove was visited. Overall the recipient of the stove was happy with its performance saying that it cooks food faster compared to other stoves like the metal stove, it uses less fire wood and the heat from the stove lasts for a long time. On the negative side they reported the stove taking longer to start, producing a lot of smoke and requiring monthly maintenance. It is suggested that the stove could be improved by adding a chimney to the design to remove the smoke. Improving on the quality of the design and materials could help the stove to last longer as well as training local artisans to maintain the stove at the local level. Introducing a design with can cook multiple pots would allow the user to cook different foods in tandem and reduce the need for another traditional cooking device.

[22] Fuel wood consumption in the TACARE villages, Kigoma region Tanzania. How can we make it more sustainable? Van Hall, Larenstein University of Applied Sciences, 2012

Figure 39: Rocket stove promoted by JGI observed in user's home

iii. Financial Institutes and Savings Groups

Several financial institutes were identified in Kigoma town included banks - National Microfinance Bank (NMB), National Bank of Commerce (NBC Bank) CRDB Bank and several Financial Institutions including Promotion of Rural Initiative and Development Enterprises Limited (PRIDE Tanzania), Blue Financial Services Limited & Bayport Financial Services. In addition Village Community Banks (VICOBA) and other traditional savings schemes exist in the region. Due to time constraints in the field work only a selection of financial institutes could be interviewed. These were Bayport, PRIDE and Matumaini SACCO in Mwangongo village (a village level SACCO supported by JGI).

- **Bayport Financial Services** targets government employees for their loan services, and enters into a contract with employers to deduct loan repayments through salary. Interest rates differ from 2- 6% monthly, depending on the loan size and repayment period. Bayport give loans from 500,000 TZS ($317) to 10 million TZS ($6350). Most loans are taken for household items, businesses, vehicles and home improvements.

- **PRIDE** offers loans to individuals through registered groups with 5-50 members. The responsibility of repaying the loan is shared with the rest of the group. Loan sizes are normally from 200,000 ($127) up to 100 million TZS ($63,500) with businesses building their way up to larger loan sizes. Most loans are repaid on a weekly basis and sometimes monthly, with interest rates varying from 22-30% annually.

  Since 2009 PRIDE established PRIDE NGO which operates in rural areas with the aim of providing financial services to assist rural people with issues such as health, safe water and residential improvements[23]. They generally give loans with longer repayment periods but currently do not operate in Kigoma.

- **Mutumaini SACCO** in Mwangongo village consists of 40 women and 20 men, with members able to take a loan from the group once per year. Loan sizes range from 300,000 ($190) – 600,000 TZS ($380) depending on the member's savings and interest is charged at 15% annually. Most loans are taken out for paying school fees or small business activities. Members have to pay 20,000 TZS ($13) to join and put an application forward for due diligence.

[23] http://goo.gl/ZDpge

The SACCO has been operating since 1998, although not efficiently for several years and is now been supported by JGI to build its capacity. The SACCO is restricted by the small capital available to the scheme making it difficult for its members to move forward. They have only had a few instances of people not repaying loans and in such instances the defaulter can be sent to court to repay.

- **Small Industries Development Organization (SIDO)** has an office in Kigoma and offers loans and grants to businesses amongst their activities. Applicants need to have some collateral but loan conditions are not as strict as banks and other financial institutes. SIDO offers loans ranging from 500,000 TZS ($317) to 2.5 million ($1587) with interest rates varying for 18-21% annually. Repayment is normally over 12 months and the business receives training on business management and marketing before they are accepted for a loan.

None of the FIs interviewed had given out energy loans, indicating that it is a new area for them to lend into. All of them expressed an interest to explore this area but further sensitization and training would be required. Some of the FIs stated that decision making happens at the head office level which can slow down the process when building new partnership and loan types. The FIs had quite stringent terms for taking out loans and operated mainly in Kigoma town, which may restrict their access to rural households. It is recommended that SACCOs and savings schemes at the village level are further explored for offering credit for energy products, worth smaller amounts, within rural areas. Within Kigoma town loans for accessing LPG or electricity through financial institutes may be more appropriate, targeting higher income groups such as government employees, since these fuels may have more appeal and will reduce reliance on charcoal.

iv. Schools and Restaurants

Kigoma Secondary school has benefited from an institutional stove provided by the Lake Tanganyika Project. The stove cost 3 million TZS ($1900) to manufacture and install and was built by a company in the Arusha area of Tanzania (due to lack of capacity in the local area). The school also has four other institutional stoves that were donated by DANIDA in the 80's. The school uses around 25 x $1m^3$ of firewood per month (approx. 12.5 tons) with 2/3 of the wood bought and the rest collected from the local forest. One cubic meter of wood costs around 15,000 – 22,000 TZS ($9.5 - $14). The new stove has only been in use for two months, so fuel wood savings are still unclear.

Table 27: Energy used by Kigoma Secondary School

School	Size	Cooking Fuel	Stove	Lighting	Energy Cost / Month
Kigoma Secondary School	400 pupils day	Wood (2/3 bought, 1/3 collected)	Improved Institutional	Electricity	Wood: 300,000 TZS/$190

Figure 40: Energy efficient stove constructed under Lake Tanganyika Project, Kigoma Secondary

A number of restaurants where visited in Uvinza and Kalinzi to discuss their cooking practice as summarized below. Only one of the restaurants visited was using an improved stove for charcoal. For wood all of the restaurants were using an open fire, resulting in significant expenditure on fuel wood and charcoal. Many restaurant owners also complain about the shortage of firewood in the local area and the smoke given off by the open fire but said they didn't know where to get improved stoves in the area. Some of the restaurants had heard about solar but thought the initial investment was too high.

School	Cooking Fuel	Stove	Lighting	Approx. Energy Cost / Week
Mwai Peak Hotel, Uvinza	Charcoal – 2 x 50kg per day Wood – 1 bundle per day	Metal Charcoal Stove 3 stone fire	Candles	Charcoal: 30,000 TZS / $19 Wood: 14,000 TZS / $9
Samunge Hotel, Uvinza	Charcoal – 1 x 50 kg bag/ day @3000 KES ($36)	Improved Charcoal stove, 3 stone fire	Village generator (3 hrs / day)	Charcoal: 21,000 TZS / $13 Electricity: 20,000 TZS / $12.7
Min Hotel, Kalinzi	Wood: 5 bundles per day @ 1200 KES ($14) Charcoal: ½ bucket per day @ 3000 KES ($36)	3 stone fire x 2 Metal Charcoal stove	-	Charcoal: 10,500 TZS / $6.7 Wood: 42,000 TZS / $26.7
Amani Resteraunt, Kalinzi	Wood: 4 bundles per day @ 1200 KES Charcoal: 1 bucket per day @ 3000 KES ($36)	3 stone fire Metal charcoal stove	-	Wood: 33,600 TZS / $21 Charcoal:21,000 TZS / $13

v. Existing Energy Businesses

- **Nyanza Salt Mine, Uvinza**

The salt mine in Uvinza has been in operation since 1926. They pump brine to the surface, evaporate it and crystallize the salt. They use firewood to boil the brine to produce the salt and have 12 kilns in operation. They are also using solar drying to produce salt. The mine uses approximately 1500 x $1m^3$ of firewood per month (approximately 750 tons of wood per month). The wood is sourced from the surrounding forest covering a radius of 50 km from the factory. The mine pays people with the necessary permits to collect the wood for them. Whilst the exact cost of this wood could not be verified by the mine it represents a significant monthly expenditure for the business.

The salt mine has tried several options to reduce their reliance on fuelwood. They now process 1/3 of the salt through solar drying but this can only be done for 3-4 months of the year during the dry season. They also looked at using coal in the furnaces but it had to be transported from 600km away which was not economical. The company has asked a technician in India to look at a new and more efficient kiln design for them. The kilns they are using were designed in 1926 and require a lot of maintenance. They are waiting for feedback from management on this. They also tried planting trees to generate their own firewood but they received bad advice on the trees to plant and they didn't grow very well.

Figure 41: Firewood stacked up at Nyanza Salt Mine in Uvinza

The salt mines in the region have an extremely high demand for firewood which is been sourced from the local forests and represents a large expenditure for the businesses. There is real potential for the salt mines to establish wood lots to generate some of the firewood sustainably and implement more energy efficient kilns. It is recommend they are given professional advice on the right type of trees and correct planting location to set up woodlots successfully. Local businesses, such as Nyanza Salt mine, which also have a high expenditure on generator diesel, could meet some of this power demand with solar power.

- **Small Industries Development Organization (SIDO)**

The organization supports several small businesses at its site in Kigoma where it rents manufacturing space to local businesses. SIDO also offers financing for businesses, business training and technical support through its technology center. They also manufacture machinery for local businesses. Some

of the businesses SIDO supports include soap manufacturers, furniture makers and palm oil processing. SIDO does not currently support any energy businesses in Kigoma, although they have done training on constructing energy efficient stoves in the past.

Many sawmills visited at SIDO produced bags of waste sawdust (ranging from 5 -20 bags daily), that could potentially be used for briquette making. Some of the sawdust is sold to people who use it for cooking at 1000 TZS per bag ($0.63). One such lady who uses it for this purpose says she compacts the sawdust into a basic clay stove to burn it. The palm oil processing businesses visited were using firewood to boil the oil. One business visited estimated their usage to be 2-5 bundles per week at a cost of around 10,000 TZS ($6.3).

From the interviews one of the major challenges identified for local businesses is the lack of access to finance from traditional sources. This lack of capital makes it difficult for these businesses to compete in the market especially when it comes to packaging and marketing. It also hinders their ability to access economies of scale.

- **Solar Stockists**

Two solar stockists were identified and interviewed in Kigoma town, sourcing solar products from Nairobi and Dar-es-Salaam. One of the major challenges the stockists face is transportation of the equipment from the suppliers which is costly and can result in breakages, due to the poor road infrastructure. Awareness amongst customers is also low especially around issues of quality. Many customers are not willing to spend money on larger systems and have low purchasing power. The stockists interviewed were reluctant to give credit to their customers because they felt it too risky in terms of customers not paying. One of the stockists also complained about the poor quality of the batteries which are not able to last for long. The solar stockist sold approximately 14 panels of different sizes per month.

- **Oryx LPG Stockist**

A stockist of Oryx LPG gas was interviewed within Kigoma town. The stockist currently sells around 110 cylinders of gas per month. However customers are increasing with 150 customers during June and a target to reach 250 customers per month by December. The transportation of the gas is expensive and the price is prohibitive to many people in Kigoma that are low income earners. The supplier does not give credit to customers because people do not pay it back. Another challenge is the low awareness around the use and benefits of LPG. Most of the indigenous people of Kigoma do not us LPG, the main customers are those that have moved from other areas.

Box 4: Liquid Petroleum Gas Prices

LPG	Cost
38 kg	300,000 TZS ($190) with cylinder, 150,000 TZS ($95) refill
15kg	140,000 TZS ($89) with cylinder, 64,000 TZS ($40) refill
6kg	60,000 TZS ($38) with cylinder , 30,000 TZS ($19) refill

- **Charcoal Trader**

A charcoal trader was also interviewed in Kigoma town. The trader sold on average 1 – 3 bags of charcoal per day at 16,000 TZS ($10), five 10 kg buckets per day at 2000 TZS ($1.3) each and 10-13

plastic bags at 500 TZS ($0.32) each, mainly to households and local hotels. The trader has to buy the charcoal on credit due to low working capital which means he has to buy it at a higher price. He also faces challenges not having anywhere to store the charcoal which leaves the business open to theft. Taxation from the government on the charcoal is very high. He pays approx. 250,000 TZS ($158) per year in taxes. He buys the charcoal for 6000 TZS ($3.8) per bag and pays 4000 TZS ($2.5) in tax for each bag per trip.

- **Solar Phone Charging Businesses**

Several were observed in towns such as Uvinza and Kalinzi outside of Kigoma. Details of two businesses interviewed are given in Table 28.

Table 28: Details of solar phone charging businesses interviewed

Location	Equipment	Capacity	Challenges
Kalinzi	2 x 60W panels. Bought from Kigoma	40 phones per day at 200 TZS ($0.13)	- Battery doesn't last long - High competition - Lack of knowledge on solar maintenance
Kalinzi	2 x 50W panels. Bought from Dar-es-Salaam	25 phones a day at 300 TZS ($0.19)	- Not enough power to meet demand - Battery doesn't last long - Wants to expand into solar lanterns but lacking capital.

vi. Others

- **Tobacco Farmers Association**

There are around 1200 members under the association which represents tobacco and maize farmers. The association helps organize farmers involved in cultivation and oversees land use planning and assignment of resources. The main energy requirement of the tobacco framers is in the curing process, where tobacco is laid out in large barn like kilns which are heated from channels below. The channels are heated by firewood. The curing process can take about 10 days and is done once a year.

Last year 48,000 kg of tobacco were produced by 80 farmers under the association with a potential requirement of 20 tons of wood for curing. Most farmers collect the wood from their farms or save the wood that is cleared when creating farm land. The association also requires that members plant 100 trees per season to replace the firewood they use. Most of the farmers use kilns made from mud and grass which costs around 500,000 TZS ($317). Modern kilns made from burnt bricks are also available and cost around 700,000 TZS ($445). The kiln made from burnt brick is an improvement to that which they had before and can save some energy. Thermal energy is generated and flows through a burnt brick tunnel underneath the drying racks, on which tobacco leaves are placed for curing. This system is new in the area and tobacco farmers appreciate it as it saves energy.

Figure 42 below shows a kiln made from burnt bricks where tobacco is cured. Firewood is burnt in the opening at the bottom of the wall, which heats channels that run along the kiln floor.

Figure 42: Burnt Brick Kiln

The association has finance services available to member through CRDB Bank who will give loans to members to purchase kilns and other equipment. Loans up to 700,000 TZS ($445) can be taken and are repaid over 2 years, with payments made after the tobacco is sold. Farmers can make between 3 million – 6 million TZS ($1900 - $3800) annually from the tobacco they grow.

From the maize farming a large amount of maize cobs is generated, which could potentially be used for briquette making. Currently the farmers destroy the maize cobs and are not utilizing them for any other activities.

There is potential to work with associations such as the tobacco farmers association to introduce energy efficient equipment (kilns) into their processes to save on firewood. Working through the associations has the benefit of reaching many farmers through an already organized system. The association already has access to finance services which could help provide loans to purchase the equipment. There is also potential to utilize the maize cobs that are been destroyed by the farmers either to make biomass briquettes or use directly as fuel for the tobacco curing process.

- **Matyazo Coffee Cooperative**

The cooperative was formed in 1994 from 12 smaller cooperatives to process coffee for export and direct sale in Kigoma. The cooperatives joined together to buy equipment and reduce the cost in transporting the coffee. JGI have worked closely with them to help address issues of quality and accessing new markets. The cooperative uses a diesel generator at its production site which can use 120 liters per day at full production capacity. One of the byproducts of the coffee production is coffee husk and the cooperative estimates that they produce around 160,000 tons of husks per year. Currently they donate some of the husks to the local hospital where it is used directly for cooking, but a lot of husk remains unused.

There is potential to work with the coffee cooperative to utilize the waste coffee husks for making briquettes. The cooperative are already organized with distribution and marketing capacity.

- **Forest Monitors**

There are 61 forest monitors that patrol the village forests reserves for illegal activities and destruction of trees and animals. The village forest reserves were set up through local land use planning initiatives, facilitated by the Kigoma district council and JGI. If forest monitors find people taking firewood or people burning trees for charcoal in the first instance they provide them with advice and counseling on the alternatives to cutting down the trees. They direct local communities to village nurseries run by Village Nursery Attendants (VINA's) to obtain information on establishing their own woodlots to act as an alternative source of firewood and timber to that illegally obtained in the forest reserves. Forest monitors report that people caught cutting the trees often do so because they are poor; they have no money to buy fuel and they are not afraid of the fine because they can't' afford to pay it.

The forest monitors are well suited to provide advice and information on energy products and alternatives to the local communities. At the moment they are trying to stop people taking the wood but they are not in a position to offer an immediate alternative. If alternatives were promoted in the area such as briquettes, alongside other energy technologies, they would be able to advise the local community on these products and where they can purchase them. At the moment most forest monitors work as volunteers and although passionate about the work, it can take a lot of their time. Although a small allowance is given, it is advised that compensation is provided to the community monitors to further motivate them, which could be channeled through the management of the community forest reserves and funded through fines and permit payments.

- **Matyazo Health Centre and Orphanage**

The orphanage is home to 63 children and lies next door to the local hospital and health center. The center has more than 40 solar panels for electrical needs, such as lighting and refrigerators, and also has solar water heaters. The systems were donated by a German donor who imported the equipment from Germany. The orphanage also uses a diesel generator for washing clothes and pumping water using about 25 liters of diesel per day. For cooking they use coffee husk sourced from the local coffee association, burnt directly in metal stoves, as well as some firewood. The center also has a small 24 V wind turbine, although there is not always enough wind to generate electricity from it.

vii. Other Observations

- Engaging the local district and ward offices in activities that are conducted in the region is very important. The local ward and district offices were visited at the start of each day to explain the activities that were taking place and help arrange logistics. Local government involvement should be considered in any future projects.

- Another activity that was observed in the area with high energy requirements is the burning of bricks. Unfortunately due to time constraints no brick burning businesses were interviewed. However these are a further sector that could be assessed and engaged in improving the efficiency of their production techniques.

- During the fieldwork several forest fires were witnessed in different parts of the survey area. Although JGI are already engaging local communities on this issue and several information poster addressing the issue were observed, it stills seems to be a problem in the area causing destruction to the local forest.

4.4.3 Assessment of Suitability of Energy Technologies

The Gombe-Masito-Ugalla landscape was a large site to survey and more challenging than in Kenya in terms of accessibility and transport networks. As a result it was more difficult to build up a detailed picture of one particular area and instead a snapshot of the whole landscape was gained. The technology assessments below are based on the interviews conducted and towns and villages visited. However it is recommended that the local conditions are considered in more detail if any of the technologies are to be implemented and the opportunity for these ideas to be transferred to other areas not visited as part of this survey.

i. Improved Cookstoves

Charcoal and firewood is used for cooking within Kigoma town where most people pay for fuel and hence an energy saving stove could have direct social and economic benefit to the user. However no existing stockists or producers of portable improved cookstoves were identified in the area. There is scope to introduce these technologies in Kigoma town but the market is currently underdeveloped and demand has yet to be established. It is recommended that a small amount of stoves be introduced to test the market before full production is established locally. Sourcing stoves from neighboring regions may be an option in the first instance, but would be challenging in the long-term due to distances to be covered and poor road infrastructure.

Another cooking option for higher income households in Kigoma such as government workers would be Liquefied Petroleum Gas (LPG), which is a clean cooking fuel that could potentially switch some users away from charcoal. Stockists of LPG exist within the town but the high upfront cost of LPG hardware is prohibitive for some consumer and LPG suppliers are reluctant to give credit to their customers.

Financing options could be explored either working through financial institutions or directly with employees to set up credit schemes to purchase LPG equipment. Awareness creation around the benefits of LPG use would also have to be conducted to stimulate more demand.

As at the Kenya site most households outside of Kigoma collect wood for free and cook on a three stone fire and hence there is no direct economic incentive to use energy saving stoves. Some households within the areas are using basic improved stoves made from locally available materials and JGI has promoted an improved rocket stove within the area. There is scope to build on this by introducing improved designs that could give additional fuel savings and more durability, incorporating features such as chimneys and multiple pots. The commercial distribution of these products can be built up by training local artisans in the area to install and maintain the stoves and provide them with training on marketing and promotion.

Another solution that may be suitable is a fireless cooker such as the Wonderbag product. Using this product does not require a change of behavior or fuel switch by introducing a new type of stove. Instead the user would use their traditional fire/stove for a short time before transferring the food to the Wonderbag where it continues to cook, hence saving fuel and reducing emissions. Further research into the feasibility of establishing production in the area would have to be conducted. It is

recommended that Kigoma town could be initially targeted with the product, whilst the market in more rural areas is assessed.

ii. Institutional Cookstoves

Some schools within the area are already using institutional cookstoves. Most of these stoves have been provided through donor support and the commercial market for these products is under developed. No local institutional stove businesses were identified. There is scope to further develop local capacity by establishing a local dealer for an already established institutional stove provider who can conduct sales and marketing activities within the area. The dealer could also supply larger stoves to hotels and restaurants.

Most restaurants in the area were not using improved stoves and were paying significant amounts on fuel. There is potential to introduce these restaurants to larger energy savings stoves that can cook multiple pots. It is envisaged that the price of the stove would soon be covered through the fuel savings gained. However availability of these stoves is a challenge and no suppliers were identified in the region. Another option would be to promote a fixed stove that can be made with locally available material (similar to the household situation) large enough to cater for multiple pots. This stove can be promoted on a commercial basis through training an artisan to install and promote the product.

iii. Solar

Small solar systems and lanterns would be suitable in this area but at the moment awareness and availability of the product is low. Camco Tanzania is running a program in the region to further develop the solar market which could help to combat this (found in section 4.3.2 of this report). As part of this Camco are working with local groups and SACCOs to facilitate access to solar products and groups that JGI work with could potentially be introduced to the scheme. Under this scheme the solar home market will be further developed in the region through establishing dealer networks for lanterns and systems and advertising campaigns and it is envisaged that this will improve the supply of products and awareness in the area. It is recommended that JGI meet with Camco who are coordinating the project to discuss ways in which they can collaborate to maximize the project benefits in areas where JGI work, perhaps through hosting promotional events in JGI areas or helping disseminate information on suppliers and products.

iv. Briquettes

Briquettes are currently not available in the area but there is potential to establish production with raw materials such as coffee husk (Matyazo), maize cobs (Uvinza) and saw dust (Kigoma) plentiful. Existing associations such as coffee and farming cooperatives would be potential channels to establish production through, since they already have established distribution networks and marketing capacity. Through these cooperatives local households could be engaged to produce and use the briquettes.

However the economics of making the briquettes need to be considered to establish if it could feasible compete with the price of charcoal. Outside of Kigoma charcoal prices are low, for example a 50 kg bag in Uvinza costs around 3000 TZS ($1.90), approx. 60 TZS (0.04) per kg. In Kigoma town a 10 kg bucket sells for 2000 TZS ($1.27), approx. 200 TZS ($0.13) per kg. In Dar-es-Salaam charcoal sells for around 800 TZS ($0.51) per kg and briquettes which are sold at 600 TZS ($0.39) per kg can easily compete with this price. However in the Kigoma market briquettes may not be able to compete unless they are highly subsidized.

Another consideration is the type of stove that households are using and whether it would be suitable for users to switch to briquettes. Outside of Kigoma most households are using the three stone fires and would need to also purchase a stove to use the briquettes in.

v. Eco Charcoal and Woodlots

Although woodlots were not visited during the survey it is understood that JGI has facilitated the establishment of woodlots mainly for construction and firewood with individual farmers. Over 1500 ha of woodlots have been established especially in villages in the northern part of the ecosystem. In corridor villages heading to Uvinza, the uptake of woodlots seems to be slow due to the availability of existing natural forests around target villages where they can easily access firewood close to home for free or at a much reduced cost.

There is potential to establish further woodlots particular with businesses and institutions that have high energy demands and are buying fuel such as Nyanza Salt Mine and schools. Establishing woodlots is a long term investment as it can take several years before the branches are ready to harvest depending on the species being used. Advice would need to be sought on the appropriate species and location to plant the trees and an assessment of the effect on the local water resources made.

Most charcoal producers do not have the capacity or resources to establish woodlots to harvest wood and are likely to continue harvesting the wood off local land (legally or illegally). Whilst woodlots have been established on a small scale, to introduce this technology at a larger scale would require significant production of wood biomass. Land owners and businesses could be targeted to establish woodlots (potentially for charcoal production) with the economic benefits and business opportunities advertised to them. To maximize the output from woodlots trees with high calorific values and high efficiency production techniques should be focused on. Local charcoal producers should be exposed to improved production techniques to encourage them to switch from unsuitable to sustainable sources. They could potentially be employed by land owners who establish woodlots to make the eco-charcoal.

Currently charcoal production is done through the use of basic pit and earth kilns and there is potential to introduce improved kilns and production techniques to increase the efficiency of the process and produce higher yields. This would reduce the amount of wood that is needed to produce the same amount of charcoal.

vi. Biogas

Livestock was not frequently observed within the survey area, although discussions with local stakeholders suggest that many people keep livestock but often graze them elsewhere. There may be some limited potential for biogas, particularly around the towns where animal grazing is more

restricted, however the high up front cost of the technology could also be prohibitive. The Tanzania National Domestic Biogas Program based in Arusha is a potential avenue to disseminate the technology through and could be contacted further to establish if trained masons exist in the area. On an institutional level negative perceptions around biogas for cooking, generated from human waste, exist making it difficult to initiate without first doing extensive consultation and sensitization on the technology.

vii. Wind Turbines

The suitability of wind turbines is highly dependent on the average wind speeds in the area and this data would need to be accessed to determine the potential for this technology. One small wind turbine was observed within the area (at Matyazo Health Centre), suggesting that there could be potential for this technology. No wind turbine manufacturers exist in the local area and this technology would have to be sourced from elsewhere. The high up front cost of wind turbines may make it unsuitable for many households within the ranch and more suitable for institutions and businesses.

viii. Other

There are a range of economic activities and businesses in the area that have high energy demands currently been met by wood fuel such as palm oil processing, salt mining and brick burning. Whilst many of these businesses are small scale, for some of the medium scale businesses and large salt mines firewood represents a large financial expenditure. In addition to charcoal production, there is potential to work with some of these sectors to introduce more energy efficient technologies in their production process as well as establishing wood lots. For example more energy efficient kilns used in brick burning and tobacco curing processes could reduce the amount of firewood used. Working through associations such as the tobacco farmers association could help the promotion of these technologies and utilize existing credit facilities for members.

5. Conclusions

5.1 Main Conclusions from the Study

5.1.1 Background

Household energy is a crucial issue for organizations such as Africa Wildlife Foundation (AWF) and Jane Goodall Institute (JGI) who are working to conserve local environments that are coming under pressure from increasing human populations and the use of unsustainable sources of energy. In areas of ecological importance energy services, such as connection to grid electricity, are often scarce and households and local institutions rely on natural resources such as firewood and non-renewable sources such as diesel to meet their cooking, lighting and charging needs. These activities are putting further pressure on depleting forest resources. Energy products such as improved cookstoves, solar lighting, biomass briquettes, biogas and wind turbines are available in the East Africa market. Such products can help to reduce household's reliance on unsustainable sources of fuel as well as improving living conditions and creating livelihood generating opportunities.

5.1.2 The Energy Technology Landscape

A range of product types exist for each technology option for example both imported and locally made cookstoves are available and a range of solar lights of varying capacity and price exist. The energy market in Kenya is slightly more advanced than in neighboring Tanzania and this report has listed key suppliers of these technologies in both countries. Whilst most are located in the major cities such as Nairobi and Dar-es-Salaam many will supply countrywide and are expanding their activities into rural areas through partnerships and dealer networks.

In addition to suppliers of energy technologies a number of stakeholders are active in promoting and disseminating these technologies, several within conservation contexts. For example, Wildlife Works is promoting eco charcoal as part of their REDD project in the Taita Taveta District Kenya, WWF is promoting the use of energy technologies at the policy level and African Solar Design are promoting community energy solutions through linking with the tourism industry.

Promotion of energy technologies such as improved cookstoves and biogas has been on going in Kenya and Tanzania for several decades, yet the uptake of the technology remains relatively low. This report has outlined some of the barriers that have hindered the uptake of these technologies including the lack of available financing for both the consumers and entrepreneurs operating in the sector. Many initiatives initially disseminated energy technologies for free which has left the end user with a sense of entitlement and reluctance to pay for these technologies on a commercial basis. Lessons learnt from past program have also been discussed such as the positive effect of peer marketing on the demand for energy products and the importance of having product maintenance available at the local level to maintain confident in the quality of the product.

A range of financial institutes exist in Kenya and Tanzania from formal banks, to micro finance institutes to informal savings schemes at the village level, all with differing terms and conditions. Financing for energy products is still at infancy, with Kenya slightly ahead of Tanzania. Current options available for payment of energy products include upfront payments and installment payment with credit provided through financial institutes or product suppliers. Pay as you go schemes are also being piloted in Kenya. The cost of small products such as improved cookstoves

and small solar lanterns are low, and therefore financial institutions often do not include such products into their lending portfolio for customers as transaction costs will be higher. Without key technical experts, financial institutions often face problems with quality assessments, and therefore it is always suggested that certified products and guarantees be essential elements for any product financing.

5.1.3 Findings from Site Assessments

The two sites surveyed – Imbirikani Group Ranch in Kenya and the Gombe-Masito-Ugalla Landscape in Kigoma, Tanzania – were different in term of accessibility, size, and existing activities. The Imbirikani Ranch was a more compact site to survey, with better road access, being only 3 hours from Nairobi and had several energy businesses already operating in the area. Kigoma on the other hand was a larger site to survey, with accessibility a big challenge and, apart from solar, limited commercial energy activity.

i. Firewood use within both areas is high, whilst charcoal is limited to the main towns and surrounding areas. Many households collect wood from the ranch (Kenya) or nearby forest (Tanzania) which is a laborious and sometimes dangerous task for mainly female household members. The use of the three stone fire is high in both areas and few homes are using improved stoves. In Kenya many people feel they do not know any other way to cook than with the three stone fire, indicating that switching from this cooking practice represents a significant behavior change. Awareness and availability of the stoves is also a factor at both sites with many households not knowing where to purchase these items.

ii. Two domestic stove producers were identified at the Kenya site and there is potential to further develop the capacity of these businesses to expand their product range and reach within the ranch. There is also potential to introduce fixed wood stoves with chimneys into the Maasai bomas within the ranch to elevate smoke and reduce the time spent on fuel wood collection. No domestic stove producers were identified at the Tanzania site although locally made wood stoves had been introduced by JGI and also adopted by other communities. There is scope to further develop these stoves by improving the design, for example adding chimneys and developing them commercially by training local artisans to install and market the stoves. There is scope to develop the market for charcoal stoves in Kigoma town but further assessment of the demand would need to be done and production established locally.

iii. Institutional stoves are also suitable for both areas where schools and restaurants have high wood expenditure. There is potential for further marketing of these products at both sites, through linking to existing suppliers or developing a local dealer for an established supply. In Kigoma, where access and transportation is challenging there is scope to introduce of a locally made multi pot stove for restaurants. For institutional stoves financing options can be assessed for those that cannot afford the upfront costs, especially in Kenya where this is already happening with credit channeled through local financial institutions. There is also potential to work with local schools to set up woodlots for sustainable wood harvesting.

iv. At both sites, charcoal is sold and used mainly within the towns, such as Kimana and Isnet. In Kenya, production of charcoal remains furtive, with traders buying from middlemen in the market and unclear where the charcoal comes from. In both sites general perceptions are

that charcoal production is done by outside businesses people who are given permission to clear land by landowners (Kenya) or receive licenses from the local authorities (Tanzania) and use the wood to make charcoal. Whilst targeting the market in urban area with energy savings stoves and alternatives such as briquettes and LPG could help reduce demand, there is also potential to work with local land owners and charcoal producers to introduce more sustainable production techniques.

v. Access to grid electricity is very low in both sites outside of the main towns and kerosene is the most widely used fuel for lighting, with a few households starting to adopt solar technology at the Kenya site. In Kenya, for villages in the interior of the ranch, large distances must be covered to purchase kerosene. Awareness of solar lanterns is still relatively low and people perceive the cost of solar technology as prohibitive to purchasing. Most mobile phones are charged at kiosks in the towns, which can also represent a large distance to travel.

vi. In Kenya, Sun Transfer has recently opened a branch within Loitokitok town selling solar lanterns and home systems that could be supported to expand marketing activities further within the ranch. Further dealers of solar products could be established in the area through other existing businesses. In Tanzania, a few stockists of solar equipment already exist in Kigoma town and Camco Tanzania, a consulting company, is working with Rex Investments and ARTI Tanzania to further strengthen the supply of solar products in the region and develop the household market in Kigoma. There is potential for collaboration with this project through introducing groups JGI works with to financing schemes for energy products through the project or utilizing marketing activities taking place in areas where JGI works.

vii. A lot of business activity is taking place within the Tanzania site often with high energy demands, such as salt mining and brick burning. There is potential to work with these businesses to introduce more energy efficient techniques (improved kilns) or establish wood lots to make their fuel wood use more sustainable. There was also potential in the Tanzania site to establish briquette production with potential feedstock such as coffee husk and sawdust husk in plentiful supply. The economics of production would need to be established to see if the production price could compete with charcoal in the market. Within the Kenya site limited feedstock was available (sawdust and charcoal dust in Kimana town) which could potentially be utilized.

viii. At both sites, most households do not have a steady income but instead earn money through selling crops and livestock. There are households that potentially have disposable income that could be utilized for energy products and in Kenya a moderate level of financial activity with regards to saving money in financial institutions and taking out loans.

ix. Most households would opt to pay for energy products in monthly installments to make payments more affordable with $6 per month an amount that people found to be affordable in Kenya. With the Kenya site financial institutes and energy suppliers were already exploring the options to provide energy products on credit to consumers, although high interest rates (18-25%) are charged terms and conditions exist. Product suppliers were also piloting schemes to sell products on credit. Within the Tanzania site financial institutions are new to

lending in the energy sector and would require sensitization and training in this area. Product suppliers were reluctant to provide credit to consumer through fear of not getting it back. Another avenue for consumer financing exists through local SACCOs (Kenya & Tanzania) and farming associations (Tanzania) with access to credit facilities.

Existing CBOs and NGOs already working in the area can provide links to the local community and have a good understanding of local community dynamics. Within the Kenya site organization such as Noomayianat Community Development Organization (NCDO) and Maasailand Preservation Trust (MPT) would provide potential partners to work with community groups on energy projects. Other donor funded projects already running in the region can also be leveraged such as the Camco Solar Project and Lake Tanganyika Project in Kigoma. Existing associations and cooperatives can also be engaged in energy projects since they are well organized, with strong community links and often with distribution and financing capacity (such as the Matyazo coffee cooperative in Kigoma).

5.2 Areas for Further Work

i. The review has suggested technology options that would be suitable to the sites reviewed in Kenya and Tanzania. If AWF or JGI decided to implement a particular technology further work should be done looking at the specific type and design of the technology and costing as well as testing the product further in the market. For example the application of wind technology is very site specific and further assessments could be done at a potential site to assess the wind resources and type of system that would be needed.

ii. If JGI or AWF staff choose to pilot an energy technology it is recommended that they do an exchange visit to a project site that is already implementing the technology such as a briquette production facility or a cookstove project like The Maasai Stove Project installing fixed stoves in Maasai Bomas in Northern Tanzania.

iii. Use of charcoal in urban areas is having an impact on forest resources at both AWF's and JGI's site. Despite the high demand of charcoal in urban areas such as Kigoma town in Tanzania the extent of the need is not quantitatively known. A further study could be conducted to determine the amount of charcoal used and project future needs. This would help to calculate the opportunity cost for using charcoal to alternative fuels such as briquettes and LPG. In addition, a survey assessing fuel wood consumption could also be conducted.

6. Annexes

Annex A: Cookstoves commonly available in the Kenya & Tanzania market

Product	Description
 **Kenya Ceramic Jiko**	**Manufacturers**: Various artisan producers. Liner and cladding often made separately and assembled by third party. **Key Features:** Charcoal stove. Ceramic liner with metal cladding. Production started in Kenya in the 1980s and has been sustained on commercial basis in Kenya. **Distribution Channels:** Complete stoves sold through middlemen, retailers, markets & small vendors. **Cost Range**: $4 – 10 **Available**: Kenya, Tanzania (known as Jiko Bora)
 **Uhai Stove**	**Manufacturers**: Various artisan producers, Keyo Pottery Enterprise **Key Features:** Charcoal stove. Improvement on the KCJ with clay rim to retain and direct heat. Recent innovation in the market and is not yet extensively produced. **Distribution Channels:** Sold through middlemen, retailers, markets & small vendors. **Cost Range**: $10- 18 **Available:** Kenya
 **Multi-purpose Stove**	**Manufacturers**: Various artisan producers, SCODE (Sustainable Community Development Services), around Kiria **Key Features:** Ceramic liner and metal cladding with removable charcoal grate so it can be used with both wood and charcoal. Recent innovation in the market and is not yet extensively produced. **Distribution Channels:** Sold through middlemen, retailers, markets & small vendors. **Cost Range**: Approx. $9 **Available:** Kenya
 **Kuni Mbili Stove**	**Manufacturers**: Various artisan producers **Key Features:** Wood stove. Consists of a ceramic liner with a metal cladding. In Tanzania often made solely from clay. **Distribution Channels:** Sold through middlemen, retailers, markets & small vendors. **Cost Range**: $8 - 14 **Available:** Kenya, Tanzania

 **Maendeleo Stove**	**Manufacturers**: Various artisan producers, many trained by non-governmental organizations GIZ and Practical Action (Kenya) **Key Features:** Wood stove constructed in the kitchen with a specially made ceramic liner surrounded by mud or concrete. An artisan can construct the stove in your kitchen. **Distribution Channels:** Constructed by trained artisans in the user home. The user often contributes the building materials and pays an installation fee. **Cost Range**: $5 -15 depending on design and materials **Available:** Kenya, Tanzania (maybe known by other names)
 **Fixed Brick Rocket Stove**	**Manufacturers**: Various artisan producers, many trained by GIZ. **Key Features:** Fixed wood stove made from fired clay bricks held together with mortar. Based on rocket stove design principles. **Distribution Channels:** Constructed my trained artisans. The user often contributes the building materials and pays an installation fee. **Cost Range**: Starting at $15 depending on design and materials **Available:** Kenya, Tanzania
 **Fireless Cooker**	**Manufacturers**: Various producers, women's groups **Key Features:** The fireless cooker is used with an alternate form of cooking to heat food to boiling point. The food is then placed in the fireless cooker where it continues to cook. **Distribution Channels:** Sold through retailers, markets & small vendors. **Cost Range**: $10 - 23 **Available:** Kenya
 **Jiko Poa**	**Manufacturers**: Fine Engineering exclusively for Paradigm Project **Key Features:** Ceramic liner inside metal cladding with pot skirt. Based on rocket stove design principles. **Distribution Channels:** Distributed through Paradigm Project, which sells through network of countrywide dealers. **Cost Range**: $14 (subsidized by carbon credits) **Available:** Kenya, other portable rocket stoves and available in Tanzania.

 **Envirofit G3380**	**Manufacturers**: Factory manufactured in China, imported by Envirofit. **Key Features:** The Envirofit wood stove is factory made in China. It can save around 50% fuel and reduce PM (particulate matter) and CO (carbon monoxide) emissions. **Distribution Channels:** Distributed through Paradigm Project (a carbon credit company), which sells through network of countrywide dealers. In Tanzania main distributor is L'Solution based in Arusha. **Cost Range**: $27 in Kenya, $12 in Tanzania. **Available:** Kenya, Tanzania
 **Envirofit CH2200 stove**	**Manufacturers**: Factory manufactured in China, imported by Envirofit. **Key Features:** The Envirofit charcoal stove is factory made in China. It can save around 49% fuel and reduce CO emissions compared to traditional stoves. **Distribution Channels:** Distributed through East Africa Energy in Kenya, who have linked with Unilever to sell alongside Royco products. **Cost Range**: $20 **Available:** Kenya
 **Gasifier Stoves**	**Manufacturers**: Various, Kiwia and Laustsen in Arusha. **Key Features:** Metallic biomass fuelled stove that first converts fuel into combustible gases through intense heating which burns with clean flame. **Distribution Channels:** Sold through retailers, markets & small vendors. **Cost Range**: Starting at $15 depending on size and type **Available:** Kenya, Tanzania (design will differ)
 **Institutional Stoves**	**Manufacturers**: Various **Key Features:** Improved Institutional stoves can have efficiencies over 40% and save up to two thirds on fuel consumption. Most vary in size from 20 liters up to 250 liters **Distribution Channels:** Mainly made to order and assembled on site. **Cost Range**: Starting from $1000 depending on size / type **Available:** Kenya, Tanzania (design will differ)

Annex B: Other Cookstove Initiatives in the Region

Initiative	Country	Description
Developing Energy Enterprises Project (DEEP) – (2008-2013)	Kenya & Tanzania	Implemented by GVEP International with technical support from IT Power. The program provides business and technical support to existing micro energy enterprises through training, mentoring, and market linkages.
The Improved Cook Stoves for Households and Institutions Project (2011-2015)	Kenya	Run by HIVOS the program aims to build the capacity of SCODE a local NGO and stove assembler so that they can go on to further support small scale producers, end users and institutions with the aim of scaling up the commercialization of the technology.
Improved Cookstove for East Africa	Kenya & Tanzania	Collaboration between Uganda Carbon Bureau, Care International and the Nordic Climate Facility The project aims to provide sustainable access to affordable and efficient cook stoves by the setting up of a CDM Program of Activities (registered 2011) that will provide stove suppliers with access to revenue from the CDM carbon market.
Improved Stoves and Portable Solar Lighting Programme	Kenya	Since 2011 SNV have expanded their activities into the cookstove sector. They are working with various partners including GIZ and ISAK and Envirofit distributors to build capacity, create market linkages, strengthen distribution and improve access to finance.
Kenyan Stoves Project (Energizing Development, EnDev) (2005 – 2012)	Kenya	Implemented by GIZ the project supports access to modern cooking energy by promoting the sustainable production, marketing, installation and use of improved cooking stoves.
Improved Cookstove Project – CO2Balance	Kenya & Tanzania	CO2Balance have several projects focusing on communities with high biomass use. They distribute stoves virtually free of charge subsidized by carbon revenue. Communities are also educated on stove use.
Programme for Basic Energy and Conservation (ProBEC) (2005-2010)	Tanzania	A SADC program implemented by GIZ. Promote improved cookstoves through training on stove construction (rocket, clay & charcoal stoves), and assisting in marketing activities. Since the program ended activities have been taken over by the Rural Energy Agency (REA).
Maasai Stove Project	Tanzania	ICSEE have worked with local Maasai women to develop a fixed wood stove that reduces smoke within the household. The stove is locally manufactured and installed by trained local women. On purchasing a stove women get access to a buyers club and other home improvement items.

Annex C: Summary of some of the main cookstove suppliers in Kenya and Tanzania

Domestic stove suppliers in Kenya

Name of suppliers / distributor	Location	Description
Paradigm Project	Nairobi	Distribute the Envirofit wood stove and Jiko Poa stove through a network of stove vendors on a commercial basis and through NGOs.
East Africa Energy	Nairobi	Distribute the charcoal Envirofit stove in urban areas of Kenya through development of a network of vendors. Linked with Unilever to sell alongside Royco products.
Musaki Enterprises / Cookswell Jiko	Kitengela	Produce artisan made stoves at Kitengela factory, distribute through supermarkets and direct orders.
Improved Cookstove Association of Kenya	Various	Association of local stove producer many that have been trained under GIZ programm.
Keyo Pottery Enterprises	Keyo, Kisumu	Women's group that supply local manufactured stoves such as the KCJ, Uhai and Kuni Mbili and stove liners.
SCODE (Sustainable Community Development Services)	Nakura	Assemble and retail range of wood and charcoal local made stoves through branches in Central and Rift Valley.
Kiria Group	Kiria, Maragua	Several large producers based in the Muragua region making local stoves and liners. These include Sospeter Muriuki & Joseph Muriuki,
Riumbani Energy Saving Stoves	Muranga	Ceramic liner producer in Muranga.
Ekero	Mumias	Stove manufacturer, distributor and retailer located in Mumias.

Institutional stove suppliers in Kenya

Name of suppliers / distributor	Location	Description
Kartech	Nairobi / Mombasa	Manufacture, supply and install institutional stoves
Rural Technology Enterprise	Nairobi	Manufacture, supply and install institutional stoves based in Nairobi
Technotech Energy Systems	Nairobi	Manufacture, supply and install institutional stoves
Botto Solar	Nakuru	Manufacture and supply institutional stoves, based in Nakuru.

Domestic stove suppliers in Tanzania

Name of suppliers / distributor	Location	Description
L's solution	Arusha	Supplier of Envirofit wood stoves and solar lanterns based in Arusha.
SEECO (Sustainable Energy Enterprises Company)	Dar-es-Salaam	Supplier of locally manufactured ICS in Dar-es-Salaam, established by TaTEDO.
Alternative Energy Tanzania Ltd	Kibaha	Suppliers of energy efficient products including cookstoves and solar PV.
M&R Appropriate Technology Engineering	Dar-es-Salaam	Manufacture cookstoves mainly wood burning and rocket stoves for households and institutions.
Morogore metal clusters	Morogoro	Cluster of artisan cookstove producers based in Morogoro.
Envotech	Dar-es-Salaam	Manufacture domestic and institutional stoves
Kiwia & Lausten	Arusha	Manufacturer gasifier stoves in Arusha, which are distributed through Partners for Development

Institutional stove suppliers in Tanzania

Name of suppliers / distributor	Location	Description
CAMARTEC (Centre for Agricultural Mechanisation and Rural Technology)	Arusha	Produce domestic and institutional stoves based in Arusha.
ProBEC (Programme for Basic Energy and Conservation) trained entrepreneurs	Dar-es-Salaam	GIZ supported program that trained several institutional stove producers. Can be contacted through REA
SIDO (Small Industries Development Organisation) supported entrepreneurs	Arusha	Several institutional stove producers that are based at SIDO premises in Arusha
Sunseed Tanzania	Dodoma	Run a domestic Energy program in Dodoma region supplying institutional stoves to schools

Annex D: Example solar products available in the Kenya & Tanzania market

Product	Description
 **Dlight Nova/ S250**	**Manufacturer**: D Light **Distributor:** Sollatek (Kenya) **Description**: Light with four different intensity settings with mobile phone charging capacity. Can provide light for 12 hours. **Price:** Approx. $50 **Availability:** Kenya
 **Dlight Kiran**	**Manufacturer**: D Light **Distributor:** Sollatek (Kenya) **Description**: Light provides 8 hours of light on full battery and incorporates an integrated solar panel. **Price:** Approx. $18 **Availability:** Kenya
 **Barefoot Firefly**	**Manufacturer**: Barefoot **Distributor:** Smart Solar (Kenya), ARTI (Tanzania) **Description**: Light with 3 settings and 1.5W solar panels. Can provide light for 4 hours on high setting. Mobile phone charging capability. **Price:** Approx. $30 **Availability:** Kenya, Tanzania
 **Philips Uday Mini**	**Manufacturer**: Philips **Distributor:** Nabico Enterprises Limited (Kenya) **Description**: 5W panel and light lasting 5 hours. **Price:** Approx. $22 **Availability:** Kenya
 **Sun King**	**Manufacturer**: Green Light Planet **Distributor:** Sola Taa, Radbone Clarke, Renewable Energy Ventures (Kenya) **Description**: Can provide 16 hours of light on full charge. **Price:** Approx. $35 **Availability:** Kenya & Tanzania

 **Sun Transfer**	**Manufacturer**: Sun Transfer **Distributor:** Sun Transfer Kenya (Kenya) **Description**: Light with 3 settings and 2W solar panel. Highest setting provides light for 6 hours. Phone charging capacity. **Price:** Approx. $70 **Availability:** Kenya
 **Sun dial TSL 01**	**Manufacturer**: Trony Solar Holdings **Distributor:** Trony Kenya (Kenya) **Description**: Light with 2 settings mobile phone and USB charging capacity. **Price:** Approx. $47 **Availability:** Kenya.
 **Tough Stuff Products**	**Manufacturer**: Tough Stuff **Distributor:** Tough Stuff (Kenya & Tanzania) **Description**: Module product, flexible solar panel with add on solar lights, rechargeable batteries, phone and radio connectors. **Price:** Panel $10 Light $8 Rechargeable battery power pack $9 **Availability:** Kenya & Tanzania
 **Sunlite**	**Manufacturer**: Sunlite **Distributor:** Sunlite (Kenya) **Description**: 2.5W panel, light can last for 7 hours. Phone charging capacity. **Price: $**46 **Availability:** Kenya, Tanzania
 **Solux Basic**	**Manufacturer**: Solux **Distributor:** Hensolex Limited (Kenya) **Description**: 5W panel with light **Price: $**95 **Availability:** Kenya

 **Barefoot Power Pack**	**Manufacturer**: Barefoot **Distributors:** Smart Solar (Kenya), ARTI (Tanzania) **Description**: Different sizes available, the 5w pack can power 4 lights for 12 hours. Can also charge mobile phone and radio. **Price:** Approx. $140 (5W), $80 (junior 2.5W) **Availability:** Kenya, Tanzania
 **Bright Box**	**Manufacturer**: One Degree Solar **Distributors**: One Degree Solar, SCODE (Kenya) **Description**: Solar-powered battery kit that powers light bulbs, phones, and virtually any USB device. ODS has integrated after-sales support and mobile-based customer service. **Price:** Approx. $75 **Availability:** Kenya
 **Sun Transfer 10**	**Manufacturer**: Sun Transfer **Distributors:** Sun Transfer (Kenya) **Description**: 10W solar panel & solar box with 12V/18Ah which can power up to 4 LED bulbs & charge a mobile phone. **Price:** Approx. $178 **Availability:** Kenya

Annex E: Main suppliers of solar products in Kenya & Tanzania

Solar Panels, Water heaters and Larger Systems

Supplier	Country	Website
Solar Teknowledge	Kenya	www.solarteknowledge.com
Davis & Shirtliff	Kenya & Tanzania	www.dayliff.com
Solar World	Kenya	www.solarworldea.com
Chloride Exide	Kenya, Tanzania	www.cekl.com
Climacento	Kenya	www.climacento.co.ke
Dreampower Ricciardi	Kenya	www.dp.co.ke
Kenital Solar	Kenya	www.kenital.com
Africa Solar Design	Kenya	www.africansolardesigns.com
Sollatek	Kenya & Tanzania	www.sollatek.co.ke
ZARA Solar	Tanzania	www.zara-solar.com
REX Investment	Tanzania	www.rexsolarenergy.com
Voltzan	Tanzania	www.voltzon.com
Renerg	Tanzania	www.renerg-tanzania.de
Redcot	Tanzania	www.redcot.co.tz
Aqua solar	Tanzania	www.aquasolartz.com
Ensol	Tanzania	www.ensol.co.tz

Solar Lanterns and Small Home Systems

Supplier	Country	Website
Renewable Energy Ventures	Kenya	www.africarenewables.com/page/solar
Smart Solar	Kenya	www.barefootpower.com/subsidiaries
Hensolex Limited	Kenya	www.solux.org/Hensolex
SunTransfer	Kenya	www.suntransfer.com
Tough Stuff	Kenya, Tanzania	www.toughstuffonline.com
Sunlite Solar	Kenya	www.sunlite.co.ke
One Degree Solar	Kenya	www.onedegreesolar.com
Trony	Kenya	www.trony.com
ARTI Tanzania	Kenya, Tanzania	www.arti-africa.org
Sunny Money	Kenya, Tanzania	www.sunnymoney.org
Powerfy	Kenya	www.powerfy.se
BBoxx	Kenya	www.bboxx.co.uk

Annex F: Stakeholders considered for stakeholder activity review

Organization	Website	Technology	Location	Description
Africa Conservation Foundation	www.acfvirunga.org	Briquettes	Virunga National Park, DRC	http://acfvirunga.org/activities/energy Running two programs in the park focusing on briquettes from organic matter and from char dust.
TaTEDO	www.tatedo.org energy@tatedo.org	Various	Dar-es-Salaam, Tanzania	TaTEDO have worked in the energy sector for over 20 years implementing sustainable energy projects. Currently running a Community Based REDD Mechanism for Sustainable Forest Management in Shinyanga and Kahama districts.
Kambi Mpya Campsite	Kambimpyacampsite@yahoo.com	Institutional Stoves	Mwanga, Kilimanjaro, Tanzania	Kambi Mpya is a local NGO based in Kilimanjaro that promotes fuel efficient stoves for institutions like prisons and boarding schools. The NGO is currently installing stoves in some of the prisons and schools in Kigoma and Rukwa regions.
ARTI Energy – Appropriate Rural Technology Institute (ARTI-TZ)	www.arti-africa.org info@arti-africa.org arti.tanzania@gmail.com	Briquettes, Solar	Dar-es-Salaam, Tanzania	ARTI Energy Limited is a commercial enterprise established in 2011 with the mission to identify quality renewable energy products and market them to the Tanzanian consumers with the support of quality sales and service.
Wonderbag	www.nb-wonderbag.com uksales@nb-wonderbag.com	Fireless Cooker	South Africa	Website: www.nb-wonderbag.com Distributed around 500,000 wonderbags. Successful projects in S.Africa, Partnering with Unilever.
Zara Solar	www.zara-solar.com zarasolar@yahoo.com	Solar, Improved Stoves	Mwanza, Tanzania	Sell solar products in Tanzania lake zone. Have experience in selling improved cookstoves.
Rex Investments	www.rexsolarenergy.com info@rexsolarenergy.com	Solar	Tanzania	Supplier of solar products. Have been awarded large solar product in Kigoma with CAMCO and opening up office there.

Cookswell Jiko / Woodland Trust	kenyacharcoal.blogspot.com cookswelljikos@gmail.com,	Improved Stoves, Eco Charcoal	Kenya	Supplier of locally manufactured stoves. Promoted eco charcoal, working with Woodlands trust on this. Has opened up a cookstove shop in Kimana town with funding from AWF. Has conducted baseline surveys in Imbirikani ranch.
WWF	www.wwf.panda.org	Various (Improved Stoves, Eco Charcoal)	Kenya/ Tanzania / Virunga	Running Dar Charcoal Project.
Oikos Institute	www.istituto-oikos.org info@istituto-oikos.org		Tanzania	Istituto Oikos promotes renewable energy, clean technologies and sustainable lifestyle as bridge strategy between North and South, to improve energy efficiency and to reduce and compensate the gas emission and the greenhouse effect.
Kenfap	www.kenfapbiogas.org info@biogaskenfap.org	Biogas	Kenya	National implementing partner for the domestic biogas program.
East Africa Briquettes	www.eabcl.com Nicholas@mkaabora.com	Briquettes	Tanga, Tanzania	Large scale production of biomass briquettes
Wildlife Works	www.wildlifeworks.com info@wildlifeworks.com	Briquettes, eco charcoal	Kenya	Promoting briquettes and eco charcoal under the Kasigau Corridor REDD Project
Stockholm Environment Institute	www.sei-international.org stacey.noel@sei-international.org,	Various	Tanzania	Running programs in renewable energy. Have opened an office in Dar-es-Sallam.
Rural Technology Enterprise	info@energy-kenya.com	Institutional Stoves	Kenya	Private company involved in marketing and selling of improved domestic and institutional stoves
Renewable Energy Ventures	www.africarenewables.com	Solar	Kenya	Distributors of Sun King Products. Running Solar Lanterns initiative.
SNV	www.snvworld.org kenya@snvworld.org	Various	Kenya & Tanzania	Involved in several projects including national biogas program, and building markets for solar and cookstoves.
Camco	www.camcocleanenergy.com	Various	Kenya & Tanzania	Camco is going to operationalize a solar program for the EU in Lake zone, Mara, Shingyanga, Kagera and Kigoma. Also involved in Dar Charcaol Project and developing biomass energy strategy.

Other Organizations to consider

Eco Ventures	www.eco-ventures.org	Briquettes	Lushoto, Tanzania	Future Fuels program exploring enterprise opportunities for women and caregivers in alternative, environmentally-sound fuel production and sales
Greater Virunga Transboundary Collaboration	www.greatervirunga.org/		Virunga National Park	Produced a DVD on the alternatives to firewood called The Burning Solution.
Swiss Development Corporation (SDC)	www.deza.admin.ch info@deza.admin.ch	Eco Charcoal	Tanzania	Started a big initiative on charcoal with TaTedo, Tanzania Forest Conservation Group and some Swiss based groups like EMPA, looking at supporting improvements in the efficiency and environmental sustainability of the charcoal industry and research into baseline data & policy to support sector.
TAREA	Web: www.tarea-tz.org info@tarea-tz.org	Solar, Improved Stoves	Tanzania	Encouraging the use of renewable energy sources through research, policy advocacy and developing networks.
Inyenyeri	www.inyenyeri.org eric.reynolds@inyenyeri.org	Biomass Pellets	Rwanda	Manufacture and distribute pellets made from biomass that undercut price of charcoal. Households get a free Phillips stove, on condition they buy fuel from Inyenyeri, with the cost repaid by fuel revenue.

Stakeholders Interviewed

We would like to thank the following individuals who gave up their time to talk to us during the stakeholder interviews;

Organization	Interviewee
Cookswell Jiko	Teddy Kinyanjui
Stockholm Environment Institute	Jacqueline Senyagwa - Research Associate
Burn Manufactoring	Eoin Flinn - Startup Operations Manager
SNV	Josh Sebastian – Advisor, Renewable Energy
Wonderbag	Sarah Collin -, Founder, Cathy Menees
Camco	Inga Brill - Senior Consultant
ARTI Tanzania	Dennis Tessier – Programme Director
Africa Conservation Fund	Balemba Balagize – Program Manager
WWF	Taye Teferi - Regional Conservation Programme Director
African Solar Design	Mark Hankins - CEO
Wildlife Works	Bryan Adkins - Conservation Landscape Manager

Annex G: Discussion topics for community focus groups

Attendees: Members of local households, local business owners, JGI/AWF local staff, member of local CBO and community groups, representative from FI.

Around 15-20 attendees, 1-2 hours

i. Introductions and explanation of the aims of the focus group.

ii. Hold an open discussion with the work shop participants to cover a range of topics.

- What do people currently use for lighting, cooking and charging? Discuss fuels and products being used.
- What are the main driving factors when deciding what products / fuels to use for lighting, cooking and charging?
- What are some of the problems with the current methods being used?
- What would people like to use for lighting, cooking and charging and why? (Do people aspire to gas, electricity)
- What are the barriers to purchasing energy products?
- How might some of these barriers be overcome?

iii. Take down samples of energy products (improved cookstoves, solar lanterns, larger solar system, briquettes)

iv. Attendees given opportunity to look at products, demonstrations of the stoves and briquettes.

v. Attendees asked to say how much they would pay for the product. Rate the products on a number of factors given.

vi. Open discussion about what people like and don't like about the products and what would enable and hinder people for purchasing the products?

Annex H: Questionnaire for technology suppliers

Please see accompanying document