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GVEP International

KENYA BRIQUETTE INDUSTRY STUDY

February 2010

Accelerating Access to Energy

EXECUTIVE SUMMARY

This study into the Kenya Briquette Industry is a component of the **Developing Energy Enterprises Project – East Africa** (DEEP-EA) led by GVEP-International (GVEP-I). Building and documenting knowledge of the industry, it aims to enhance the support DEEP-EA is offering to start-up and existing briquette enterprises.

Biomass accounts for over 80% of energy use in Kenya. Briquettes can provide an alternative and, in some cases more sustainable, **form of biomass energy**. A survey across the briquette industry including producers, consumers and suppliers was undertaken with two objectives:

1. **Identify the supply and demand conditions affecting the success of briquette producers.**
2. **Understand the current and potential impact of micro-scale briquette producers on rural and peri-urban energy access.**

The study investigated the success factors influencing briquette making. Business success was found to **vary considerably**; some enterprises were operating profitably (all of whom use charcoal dust as the primary feedstock) but others were struggling to sell their products.

On the **supply-side** the most crucial factor was arguably the business location with respect to both feedstock and potential points of sale, especially for micro-producers who **rarely have access to private transportation**. Furthermore, some businesses were underperforming; **technical knowledge** was often lacking, for instance of the range of different feedstocks and binders that can be used or how to carbonise feedstocks to achieve a smokeless fuel. Also business skills such as strategic and financial planning were often rudimentary.

Demand for briquettes was also critical to success but varied considerably between regional studies. One of the reasons for this variation in how the **price of briquettes** compared with competing products, critically charcoal. When the unit cost of briquettes was lower than that of charcoal consumers appeared to be increasingly willing to switch to briquettes. Alternatively consumers were convinced to use briquettes when they found out they **burned for longer time** periods, despite being more expensive per unit i.e. if the cost per hour of burn time worked out lower than competitive products. Activities such as product samples and demonstrations were found to be an effective method of raising awareness and impacting positively on consumer perceptions, important in the early stages of business growth.

The **urban or peri-urban** market appears to be the most promising for expanding a business. Here there are sufficient consumers who already pay for fuel and have briquette-compatible heating and cooking equipment. In rural areas, neither is guaranteed. **Low smoke**

production is a requirement for urban users which carbonised briquettes can meet. Non-carbonised briquettes were generally found to be less desirable, except in areas where smoke can easily be dispersed e.g. businesses/schools using a stove with a chimney.

The second aspect of the study was to ascertain how far a briquette industry could impact energy access in the country. This fledgling industry's impact is currently relatively weak; levels of production do not make up even a fraction of the total usage of biomass fuel.

Looking forward, it is foreseeable that existing and new producers will expand operations similar to the current model (production of charcoal dust briquettes) and **briquette use could displace up to 5-10% of present charcoal consumption.** Expansion would be limited by availability of charcoal dust. This scenario would see the briquette industry making a **modest impact** on national energy access and, by recycling a waste product, relieving some pressure on the nation's forestry resources.

A **diversification of feedstock**, from charcoal dust to agricultural wastes like sugar cane bagasse (available in larger quantities) would allow the industry to scale up and have a higher impact on sustainability. It is likely that competitive prices would lead to increased demand from urban areas, displacing a significant fraction of charcoal use in these areas. However, demand from rural areas is likely to remain low unless external factors curb the availability and use of firewood. Knowledge transfer and investment programmes play an important role in accelerating this process; building a financially and environmentally sustainable briquette industry.

CONTENTS

1. INTRODUCTION

This report presents the findings of a study into the briquette industry in Kenya; looking in detail at factors behind the successes and constraints faced by those in the industry. Fieldwork was undertaken during October and November 2009 as part of the Developing Energy Enterprises Project - East Africa (DEEP-EA).

Led by Global Village Energy Partnership International (GVEP-International), DEEP-EA runs for 5 years from March 2008 until 2013. It aims to increase rural and peri-urban energy access in Uganda, Tanzania and Kenya by engaging with micro[1] and small businesses in the energy sector.

Energy access is a key objective for DEEP-EA, and GVEP-International. DEEP-EA aims to increase access to cleaner, more modern forms of energy for disadvantaged parts of society and to also promote sustainable forms of energy, without depleting natural resources.

The production of briquettes for domestic and institutional use is an area of significant interest as briquettes offer an alternative to existing biomass fuel usage practices which are currently leading to severe pressure on forest resources.

In addition to the conventional package of support DEEP-EA offers (technical and business training and mentoring) a focus was placed on linking briquette producers with suppliers of machinery and finance.

However, little was known about how or why briquette producers are beginning to thrive or – perhaps more pertinently – why so many efforts since the 1980s have failed. Nor is it clear how far current briquette activity is scalable on a national level or what impact this would have on energy access. Answering these important questions and formulating a way forward was one of the motivating factors in this study.

1.1 Research Objectives

In this context, two key objectives for the study were developed:

1. To identify key supply and demand conditions, both internal and external to a business, which influence the success of micro-scale briquette producers in Kenya.
2. To understand the current and potential impact of micro-scale briquette producers on rural and peri-urban energy access.

[1] Micro-scale producer was defined as an enterprise that:
- Has a starting capital investment of less than $1,000
- Cannot *significantly* influence external conditions e.g. cooking equipment/ methods, prices of alternative products, consumer awareness beyond a limited area

2. CONTEXT

An introduction to briquettes as a solid fuel is presented, alongside an overview of existing household energy use in Kenya.

2.1 Briquetting Technology

Briquettes are a household and institutional fuel made by compacting/solidifying biomass waste. They can be produced with a range of raw materials including sawdust, bagasse, coffee husks, maize cobs, wheat/beans/barley straws and paper. For an overview of briquetting technology see Grover and Mishra (1996).

Solidification Processes

A key element in the briquette-making process is the method of solidification. The range of methods includes:

- Solidification by mixing raw material with a binding material such as clay and using a simple moulding process, such as by hand.
- Compaction by pressing the raw material into a mould. Various manual machines such as levers, screws can be employed to give mechanical advantage.
- Compaction by continuous extrusion of raw material through a die. Machines to achieve this use piston action or mechanical screw and can be electrically or manually operated.

Carbonisation Processes

Unless burnt in controlled conditions, biomass-based fuels tend to produce appreciable quantities of smoke, problematic if the fuel is to be used in indoor environments. A common way to overcome this in briquetting is to carbonise either feedstock or the finished briquette.

Carbonisation (or partial pyrolysis) drives off volatile compounds to leave more or less pure carbon; the biomass is heated to within a critical temperature band (around 300^{o}C) but with a restricted supply of air so that it does not ignite. Various processes options are available including simple earth kilns to more complex retorts that make use of the volatile compounds in heating the process.

In reality, much of the briquette activity currently taking place in Kenya makes use of waste charcoal fines, or dust, generated by the charcoal industry. In this case carbonisation has been 'done for free' – one of the reasons this works economically.

2.2 Fuel market in Kenya

There are three main sources of energy in Kenya. These are wood fuel, petroleum and electricity, accounting for 70 per cent, 21 per cent, and 9 per cent of total energy use respectively. Renewable energy is also becoming important although it remains insignificant in the country's overall energy mix[1]. This section provides an overview of current *household* energy usage in Kenya. Table 1 presents estimates of consumption of various fuels in Kenya during 2004.

Table 1: Fuel consumption estimates in the household sector for 2004[2]

Fuel	Quantity
Firewood	14,600,000 tonnes
Agricultural Residues	4,940,000 tonnes
Charcoal Consumption	1,600,000 tonnes
Kerosene	305,825,000 litres
LPG	41,884 tonnes

2.2.1 Agricultural residues and Firewood

Wood fuel has remained the most important source of energy in Kenya, meeting over 70 percent of the country's total energy consumption needs. It provides 90 percent of rural households' energy requirements and 85 per cent in urban areas[3]. This state of affairs is unsustainable, it has major adverse implications for East Africa's forest resources and on people's health; burning biomass causes indoor air pollution.

The use of forestry and agricultural residues shows an increase from 1.37 million tonnes in 1997 to 2.9 million tonnes in 2000. Although demand for firewood decreased slightly from 15.42 million tonnes in 1997 to 15.1 million tonnes in 2000, Kenya's annual per capita wood energy consumption was estimated at 627 kg for rural households and 877 kg for urban households[4].

Studies in western and central Kenya[5] find that all households, regardless of socio-economic status, use woody or high quality crop residues (like maize cobs) before changing to other forms

[2] UNEP 2006
[3] Kituyi, 2002
[4] Government of Kenya, 2002
[5] Mugo, 1997; Mugo, 1999

of biomass energy for cooking. In western Kenya, all the maize cobs were used before the population turned to wood or maize stalks, and in central Kenya, all the coffee and tea prunings and maize cobs were used before the population turned to wood or other lower forms of residues.

2.2.1 Charcoal

About 47 percent of Kenyan households use charcoal. This can be further analysed in terms of rural and urban areas; 82 percent of urban households use charcoal in comparison with 34 per cent of households in rural areas[6]. The most recent national charcoal survey estimated that charcoal consumption is in the region of 1.6 million tonnes, valued at KES 32 billion[7].

Contrary to the popular view that charcoal is a fuel for low income urban dwellers, 83 per cent of high income groups regularly use charcoal, meaning that charcoal is consumed by all categories of urban dwellers.

There is indication of rapidly changing usage patterns for charcoal. Charcoal consumption has dropped from 2.91 million tonnes in 1997[8] to 2.48 million tonnes in 2000[9] and to 1.6 million tonnes in 2004[5].

2.2.2Briquettes

There are no statistics for briquette use in Kenya, however the percentage of the population using briquettes is thought to be very low. Briquettes produced with charcoal dust can be used as a supplement or alternative to firewood and charcoal. In this way they make use of a waste product and reduce some pressure on forestry resources. It is a matter of debate how far charcoal dust briquettes can be considered sustainable, since they rely on the existence of a charcoal industry that most agree is currently operating unsustainably.

Briquettes produced from alternative raw materials which would otherwise have no other use, such as bagasse, coffee and maize residues or saw dust provide a more sustainable alternative to firewood and charcoal.

2.2.3 Kerosene

Kerosene as a cooking and lighting fuel is important in rural and urban areas and in some cases serves as a complete substitute for biomas fuel. The government has used either a reduction or non-increase in tax for kerosene to increase its uptake, primarily as a poverty mitigation

[6] UNEP (2006)
[7] ESDA (2005) National Charcoal Survey
[8] Kituyi, E (2000)
[9] Government of Kenya (2004)

measure. The growing use of kerosene is in part attributable to convenience and competitive pricing especially as charcoal prices rise. The price of kerosene during the study was observed to vary between KES 54 (US$ 0.71) per litre and KES 68 (US$ 0.89) depending on location. Dealers include filling stations, independent pumps and kiosks.

2.2.4 LPG

The use of LPG for cooking continues has grown steadily in both rural and urban markets. Kenya had fewer than 50,000 household LPG cylinders in use in 1995, confined to a few key urban areas. By 2002, over 700,000 cylinders were in use, particularly in urban areas of the country[10].

Studies in India have shown that there is a shift from biomass fuel to kerosene and liquid petroleum gas (LPG) by mid income urban households, and to LPG and electricity by higher income urban households[11]. LPG remains out of reach of most of the Kenyan population due to tariffs and duties and the high up-front cost of filling a bottle (which can last over a month). There is 18 per cent VAT and import duty on LPG, and 18 per cent VAT on cylinders and appliances.

2.2.5 Electricity

About 15 per cent of the Kenyan population has access to electricity, 46 per cent in urban areas but a staggering low 3.8 per cent in rural areas[12]. This is one of the lowest in developing countries. A goal of Kenya Power and Lighting Company (KPLC) is to add an additional 120,000 connections per year to domestic consumers. The target for electricity connection in rural areas currently stands at 20 percent of the population by 2010. KPLC expect the demand for electricity in Kenya to rise from 916 MW in 2006 to 2397 MW in 2025.

2.3 Energy Policy

The Energy Act 2006 sets out the national policies and strategies for short to long-term energy development. It identifies a number of key challenges which are set out below:[13]

- Upgrading and expanding the current energy infrastructure.
- Promoting energy efficiency and conservation.
- Protection of environment.

[10] ESDA (2003)
[11] TERI (1992), Reddy and Reddy (1994)
[12] Kamfor (2002)
[13] GTZ Eastern Africa Energy Resource Base (2009)

- Mobilizing requisite financial resources.
- Ensuring security of supply through diversification of sources and mixes in a cost effective manner.
- Increasing accessibility of energy services - not only electricity - to all segments of the population.
- Institutional corporate governance and accountability.
- Enhancing legal regulatory and institutional frameworks to create consumer and investor confidence.
- Enhancing and achieving economic competitiveness.
- Effectively mainstreaming the rural energy issues – framework unclear on how rural energy will be addressed.

Current trends focus increasingly on the creation of markets, overcoming market barriers and the roles of the various stakeholders; the private sector and NGOs in developing markets as well as the government in providing "supportive policies" as a "fundamental aspect of an enabling environment". An influential programme has been the World Bank / UNDP funded Energy Sector Management Assistance Programme (ESMAP), whose focus has been "...to reduce barriers to the operation of markets for bio-energy and to establish conditions that make it easier for markets to serve communities and groups that currently lack access to energy services" [14].

Since the 1980s the Kenyan government has issued successive official bans on the production and transportation of charcoal in an attempt to curb illegal deforestation however this ban has not been rigorously enforced, policing agents are open to bribery[15]and subsequently charcoal is still widely used.

Briquettes have been produced on a small-scale in Kenya since the 1970's however are not widely used because of the cultural preference for charcoal and lack cooking equipment compatible with the type of briquettes being produced (see FAO report 1990 for a dated but still relevant overview). If Kenya's dependency upon unsustainable charcoal is to be reduced in line with the Energy Act 2006, a paradigm shift in cooking habits is required. Additionally a wider programme of awareness-raising and dissemination of energy-efficient cooking equipment will assist with uptake of briquettes as an alternative or supplementary fuel to charcoal and lead to a reduction in deforestation.

[14] Energy Sector Management Assistance Programme (2005)

[15] World Agroforestry Centre (2005)

3. METHOD

3.1 Selection of study areas

The following areas in Kenya were chosen for the study, based on areas where DEEP-EA is operating or has considered operating in. Areas were chosen on this basis to ensure that specific findings would be of immediate internal relevance.

1. The town of Ranen in Nyanza Province, western Kenya
2. Three towns of Mariakani, Kilifi and Kaloleni in Coast Province
3. Nairobi, Central Province
4. Nyeri, Central Province

There is a significant deal of variety between the sites (see Table 2 below). In the Nyanza Province micro-scale briquette producers were known to be active, whereas there were fewer active producers in the Coast Province. A number of key organisations involved in the Kenyan briquette industry operate in Nairobi and Nyeri - at various scales.

Table 2: Key characteristics of study areas

Study area	Population	Type of area	Economy	Number of producers or potential producers interviewed	Number of machine manufacturers interviewed
Ranen	5-6000**	Peri-urban	Market town in agricultural area	5	1
Kilifi	30,394*	Peri-urban	All sectors including agricultural, service and tourist	1	-
Kaloleni	11,000*	Rural	Subsistence agriculture, small scale commerce	1	-
Mariakani	10,987*	Peri-urban	Market commerce, light industry	1	-
Nairobi	3,000,000*	Urban	All forms of industry across all sectors.	2	3
Nyeri	100,000*	Urban	Market commerce, light industry	2	1

* Data from the Republic of Kenya Central Bureau of Statistics, census figures 1999. In 10 years it is almost certain that the population has grown and is higher than listed above.

** Local testimony where census figures are not available.

3.2. Data collection

Table 3 shows the key stakeholders and user groups and the methods of collecting data about each:

Table 3: Stakeholders and data collection methods

Stakeholders	Data Collection Method
Wider fuel market	• Walkover survey of market place • Semi-structured interview with suppliers • Assessment of producers
Supply of raw materials	• Walkover survey of area • Semi-structured interview with stakeholders • Assessment of producers
Key consumer groups	• Quick market place survey of consumers • Semi-structured interviews with key groups • Trial of briquette products (non-users)
Producers	• Semi-structured interview
Suppliers	• Semi-structured interview
Financial institutions	• Walkover survey of area • Semi-structured interview
Kenya briquette industry	• Interviews with notable producers • Survey of equipment manufacturers

4. CONDITIONS AFFECTING BRIQUETTES SUPPLY

The ability of a given producer to supply briquettes economically was found to depend on a number of critical inputs. These are brought to light and discussed below.

4.1 Availability of raw materials

The fieldwork showed that the availability of raw materials has a strong influence over producers' success. There were three main dimensions to this; proximity, suitability, and quantity. (Refer also to Annex B for a break-down of raw material availability in each area).

Proximity to raw materials

Like any production business, briquetting relies on good access to raw materials, namely 1) biomass feedstock, 2) binding agent and 3) water. A key finding is that (for micro-scale producers at least) the producer and raw material must be linked by an affordable means of transport. This includes:

- A wheelbarrow
- Bicycle
- Public transport (matatu)
- Borrowed private vehicles (rare)

At micro-scale, experience suggests this can be problematic, particularly for collection of the biomass feedstock. For instance, charcoal dust – the most common feedstock - only tends to be available at larger settlements where charcoal is sold (or sites of charcoal production). This, then, limits viable production sites to places that can access such settlements by one of the above means of transport.. A typical binding agent is clay; a material not available in all parts of the country, in the absence of this, alternatives such as cassava flour must be used. However, access to a binding agent and water are less likely to be problematic in comparison to the issue of feedstock sources.

Quantity and Suitability of Biomass Feedstock

Not only must raw material be within reach, it must be available in large enough quantities. **Charcoal dust** (perhaps 10% of charcoal stock by the time it reaches the point of sale[16]) as a waste product of the charcoal industry is inherently limited. However, in most areas it is still under-utilised and there is scope for more micro-scale producers to make use of this resource. In the Coast Province, for instance, there were no producers found to be using charcoal dust and

[16] FAO 1990

yet it collects in mounds at the point of sale/distribution. Even where three producers were very active in a small Nyanza market town, it could be readily sourced from larger settlements in reach (though supply in the town itself was nearly exhausted). The price that producers in some areas now pay for collecting charcoal dust is evidence that a limit will be reached.

Fibrous **bagasse** waste from sugar processing has long been touted as feedstock with high potential in Kenya. Sugar cane is grown in abundance in the fertile Nyanza and Western Provinces and the amount of bagasse waste available is substantial, yet remains underexploited. One barrier which is likely to be preventing an increase in the use of bagasse is the fact that the raw materials smoke when burnt and micro-scale producers often do not have the skills/equipment to carbonise it. The active promotion of the carbonisation process through the capacity building activites could overcome this problem. In the Nyanza Province potential producers are being supported through DEEP-EA intervention in learning how to successfully carbonise and press bagasse into briquettes.

Another viable alternative is **coconut waste,** widely available in Coast Province in the form of leaves, shells and coir (fibrous husks) of coconuts that are sold at market or spoilt windfall. Used in other ways such as house roofing and direct burning as a fuel the waste has not yet been exploited as a briquette feedstock. One Community Based Organisation in the region, BICODE, has plans and the funding to produce briquettes from cocunut waste and their experience will be of future significance.

Finally, another option is the harvesting of **tree prunings**. One NGO producer in Coast Province set –up an out-grower scheme in which twigs are harvested from fast-growing trees at the rate of re-growth to ensure sustainability. Farmers in the scheme then carbonise the twigs and sell to the NGO who mix it with a binder to make briquettes. Although labour intensive this process has proven potential to provide feedstock in areas where other more commonly used types of feedstock are unavailable. However at present this particular briquette product was not selling well; the NGO had targeted 'high-end' consumers for the product and set a high price for the product (see Appendix A). In light of this it remains unclear whether this model can compete against conventional fuels.

Conditions for Success Identified

		Importance to briquette producers	
Condition affecting success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
A suitable feedstock and binder must be available near to the site of production. Where this is not the case, shared transportation or linking collection with delivery can increase the distance within which it is economical to collect raw material.	External	Very high	Very high
Charcoal dust offers a good potential feedstock for micro briquette producers in peri-urban areas. Availability is contingent upon the levels of charcoal sold in a given area.	External	High	High
Producers must have a regular supply of feed stock. Local competition amongst micro-producers can limit the availability of raw materials.	External	High	High

4.2 Labour and business premises

For micro-scale producers, **space to operate** was sometimes found to be a limiting factor, especially in urban areas where rents / business rates are high. Even where costs was not an issue, many producers seemed reluctant to change locations, despite being constricted by the lack of space.

Sufficient space to work is essential for **drying briquettes**. The drying process can take 2-5 days so there must be enough space to accommodate a minimum of 5 days output. Another factor is that the process needs full-time supervision so that briquettes can be covered in the event of rain and some micro-producers find it difficult to commit resources to this.

Another issue which would need to be addressed if producers move away from charcoal dust towards the use of feedstocks that requires carbonisation is the **air pollution** (e.g. smoke) which arises during the carbonisation process(carbonisation traditionally takes place in isolated areas where the smoke can be dispersed without immediate danger to health. This is a hazard in the populated areas where briquettes producers tend to locate themselves and a solution would require a change of location or diversification between multiple sites.).

Labour makes up a large proportion of a briquette's direct cost. Micro-producers in smaller settlements are able to take advantage of **informal labour rates** – as low as $1.50 per day. This is one of the key reasons why these producers can (potentially) make briquettes that are affordable to the masses, whereas larger (often urban) producers must increase productivity to afford higher labour costs and formal salaries. The application of this rural/urban labour market principle illustrates why capital-intensive formal briquette ventures have failed in the past when competing with an industry (firewood and charcoal) where pay is very low.

Conditions for Success Identified

		Importance to briquette producers	
Condition affecting success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
Unskilled and skilled labour must be available to support the production of briquettes. However availability of labour was not found to limit the profitability of existing micro-scale producers.	External	Low	Low
Sufficient land must available for drying briquettes. Lack of affordable drying space often limits production capacity. Space for covered drying racks is often required during the rainy season otherwise production is limited. This is only for the micro scale production, not for medium/large scale production.	Internal	High	High
If carbonising feedstock to produce briquettes it is necessary to have enough open land to accommodate a kiln. The land must be situated outside of populated areas because the kiln generates a lot of smoke.	External	Medium	Medium

4.3 Machinery and technical knowledge

The use of **machinery** can benefit a briquette business by: 1) adding value to the product by producing a desired shape and/or 2) increasing productivity. The need for machinery is greatest in the compaction process, since high force is required if material is to be compacted and a uniform product generated.

A range of **compaction concepts machines** were found in use around Kenya including manual and powered presses and extruders, (see Annex C for a list of those found during this

study). Of these, some were found to produce briquettes no faster than purely manual techniques and were unlikely to be a wise investment. However, there were others available at affordable prices (some less than $100) which were in commercial use, for example a Nyeri manufacturer has sold over 20 electrically-powered machines.

Nevertheless the study showed that it was possible to start and sustain a briquette business using entirely manual techniques. In fact, a more important requirement for enterprise growth appeared to be **technical skill and understanding**;

- Skills such as carbonisation, sieving, mixing, compaction and drying.
- Understanding of how parameters like size/shape and combinations of feedstock and binding agents influence fuel characteristics (e.g. smoke production, length of burn, compatibility with charcoal stoves etc).

This evidence suggests a major constraint is a basic lack of **knowledge transfer**; many micro-entrepreneurs are currently unable to access technical information. It is clear that enabling agencies such as GVEP-International can play an important role in this space.

Conditions for Success Identified

		Importance to briquette producers	
Condition affecting success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
There must be knowledge of appropriate production techniques, including technical press designs, in order to start and expand a business.	Internal	High	High
Capital must be available to purchase a briquette press if the producer wishes to increase production capacity and produce a bespoke, uniform-shaped product.	Internal	Low if intending to hand roll.	High
		High if intending to use a machine	
There must be access to a briquette press manufacturer to facilitate the growth of existing briquette producers (and allow start ups intending to use a machine). As presses are specialised there may be no press suppliers in the area and awareness of suppliers is often limited.	Internal	Low if intending to hand roll.	High
		High if intending to use a machine	

4.4 Access to Finance

Access to finance is perceived as an important success factor for small-scale briquette producers. However, it is **considered difficult** for a number of reasons:

In many areas, most Micro Finance Institutions (MFIs) and Saving And Credit Co-Operatives (SACCOs) operate using the group lending model, not favourable towards individual entrepreneurs. The model is time intensive given that the groups must save for a minimum of two to six months depending on the institution. As the financial and time implications inherent in the model, entrepreneurs must also find other willing people to set up a group with – an additional barrier. They must pay to register the group with social services and often there is a loan application fee.

Additional barrier include a lack of savings or assets, a lack of record keeping or a robust business plan, loan application fees, high interest rates often around 20 percent or more and a requirement by some institutions for evidence of banking for at least one year. Enterprises that expand must overcome perceived hurdles such as a reluctance to make long terms commitments and a fear of failure. For individuals, collateral is a common problem that limits the amount of money that can be borrowed. However if an entrepreneur has a loan guarantor or collateral to guarantee the loan s/he is able to apply for an individual loan. This type of loan provides capital more readily than a group saving model thus enabling the entrepreneur to invest the capital and yield results faster.

Financial institutions including banks, SACCOS and MFIs were present in all study areas. Accessing an institution is not considered a limit to accessing funds. However, the financial institutions in each area did vary. Access to the most suitable or attractive financial product could therefore be limited by the location of the business. It also requires time and effort to investigate the financial products on offer. Not all entrepreneurs may be literate and therefore may struggle to understand terms and conditions.

Despite all this, the micro-briquette industry stands a chance of taking off for one key reason; evidence suggests that entrepreneurs can build a track record ***without getting financing***. Financing for business expansion could be sought on the back of this record. In fact, most of the barriers identified suggest the issue for micro-entrepreneurs is a lack of knowledge and confidence rather than a set of intractable barriers. This highlights again the role of enabling agencies such as GVEP-I.

Conditions for Success Identified

		Importance to briquette producers	
Condition affecting success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
A track record in business will help a briquettes entrepreneur access investment financing and expand the business faster.	Internal	Low for manual production High if intending to use a machine	High
It is helpful to be located near to a range of financial institutions in order to access the best financial products.	External	Low	Medium
Producers require confidence in the business to take a loan in order to expand their business.	Internal	Low for manual production High if intending to use a machine	Medium

4.5 Distribution

For production on a micro-scale, evidence suggests that sales are most often made 1) from the business premises, 2) by taking the product to a market place or 3) directly delivering to clients – particularly larger consumers like schools or hotels. Again, the existence of such selling points **within reach by foot, or public transport** is a critical success factor, yet one found to be overlooked by some potential entrepreneurs.

For larger-scale producers, **private transport** is used to make deliveries; the radius within which sales remain profitable is an important factor determining the available market. A Nairobi producer suggested that deliveries beyond a radius of 200km or just 60km on poor quality roads become uneconomical.

Retailing through **supermarkets** tends to require certification by Kenya Bureau of Standards (KEBS), the costs of which must be incurred by the producer. New products are normally sold on a consignment basis, which means the supplier would need to supply a large stock to the supermarket on credit. A micro-scale producer is unlikely to be able to provide this quantity of stock on credit and furthermore would be unable to afford the costs of KEBS certification.

Conditions for Success Identified

		Importance to briquette producers	
Condition affecting success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
The site of production must be situated close enough to the market, or point or sale, for the cost to be competitive with other fuels such as firewood	Internal	Medium	Medium
If the site of production is situated close to the target market it's presence is more likely to generate local awareness of the business and therefore help to market the product.	External	Medium	Medium
Briquettes must be visible to consumers and well presented or made? to be successful.	Internal	Medium	Medium

4.6 Business strategy, management and marketing

Good business strategy, management and product marketing is as important in briquette supply as any industry. At a micro-scale it is interesting how this plays out: locally, producers tend to be well connected and have an intuitive understanding of their market. However, **mentoring** from external experts appears to be important in developing structured processes (e.g. record-keeping) and concrete plans for business expansion.

Knowledge sharing between producers can provide an important stimulus to supply. For example in the Nyanza market town, producers discussed ratios of feedstock and sometimes refer clients to each other (e.g. if one producer has no briquettes remaining) a group of briquette producers, providing advice and encouragement. Also, in Coast Province a medium sized producer provides technical advice on production techniques to potential briquette producers.

Strategic mistakes can be made; for instance a Coast Province producer targeted a very small market in 'ethically-motivated' consumers whilst pricing at a level local household markets, hotels or other institutions cannot afford; therefore sales were not good. Another Nairobi producer was relying on consumers to purchase expensive specialised jikos (a type of stove), instead of designing the product around conventional charcoal jikos.

Active marketing has been an important factor in the initial stages of enterprise growth. This included measures such as giving away free samples, product demonstrations and speaking to

potential customers at markets about the benefits of briquettes. After similar types of activities were undertaken in the Nyanza market town, levels of **awareness increased** amongst household consumers and demand grew steadily. This method has been a crucial factor contributing to the success of producers in generating a market for briquettes in areas where none existed previously.

Finally, the producer must be motivated to **earn a livelihood** from briquettes. It was apparent that the most successful producers were willing to invest much of their own time and effort into the production and promotion of the product.

Conditions for Success Identified

		Importance to briquette producers	
Condition affecting success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
Producers and potential producers should share knowledge to grow their own businesses and the industry	External	High	Medium
Awareness raising is important. Successful techniques include giving away free samples of briquettes and lively personal promotion.	Internal	High	Medium
Producers must be entrepreneurial and have high levels of motivation and commitment if the business is to succeed.	Internal	High	High
Research and development of shape, size and feedstock is required to ensure the product is best suited to the target market.	Internal	Low	Medium

5. CONDITIONS AFFECTING THE DEMAND FOR BRIQUETTES

The potential market for briquettes as a solid fuel Kenya is clearly very large. This section considers the current conditions affecting the demand for briquettes, and how the potential demand can be realised.

5.1 Competition analysis

In a competitive market place the success of briquettes is linked to its performance compared to the competition. This study uncovered a number of key performance features upon which choices of fuel appeared to be being made: energy content, price, heat intensity, length of burn, extinguishability and levels of smoke production.

Table 4 compares these features and details the energy content constant across each fuel. It shows that per unit of energy delivered, briquettes were competitive on price with all fuels, and sometimes sold at a lower price. Energy conservation laws dictate that longer burn time must be traded off against lower heat intensity: **briquettes tend to burn for longer, but produce a less intense heat**. This is a key selling point (and for some a drawback), as discussed below.

Table 4: A comparison of the characteristics of domestic energy fuels

	Briquette	Kerosene	Charcoal	Firewood
Quantity considered (constant Energy)	1.4 kg = 30 MJ	0.78 kg = 30 MJ	1.0 kg = 30 MJ	2.7 kg = 30 MJ
Price	Highest: KES 138 Lowest: KES 23	Highest: KES 51 Lowest: KES 47	Highest: KES 25 Lowest: KES 10	Highest: KES 11 Lowest: Free
Relative Heat Intensity	Low	Variable	Moderate	High
Relative Length of Burn	High	Variable	Moderate	Low
Extinguishable	No	Yes – Easy	Yes - Difficult	Yes – Moderate
Amount of Smoke Produced	Low	None	Low	High

Source: Field study 2009

Who might actually buy briquettes then? To answer this, the pool of potential consumers was divided into user groups, based on those encountered in the study. An overall idea of the entire market was gained by examining each user group.

5.2 Urban and peri-urban households

Urban and peri-urban households account for a large section of Kenya's demand for cooking and heating fuel and are very important target markets for briquettes.

Existing Practices & Potential for Briquettes

The majority of households in urban and peri urban areas use charcoal to cook in a jiko. The percentage using an improved jiko[17] varies by area. For most applications charcoal provides the cheapest fuel. Kerosene is also used by many able-to-pay householders and restaurants. The benefit of kerosene is the speed with which it can cook food but a separate stove is required. It is relatively expensive when compared with charcoal. Firewood is rarely used, mainly due to the smoke produced and also because it is less easily available.

There is the potential for briquettes to compete with and replace a significant proportion of charcoal usage. Household consumers using briquettes reported saving money on fuel because of the longer burn duration of briquettes compared with charcoal. A common response was "*I liked that it burns for a longer time and heat remains for longer*". For this reason briquettes can be popular with consumers who wish to cook dishes requiring a long cooking time such as maize, beans and rice. Briquettes however, were only ever observed to form *part* of a fuel mix; charcoal and other fuels are still purchased for certain purposes, albeit in lesser volumes.

Briquettes are less able to compete with kerosene as they take longer to light and provide a lower and consistent heat. The use of briquettes alongside kerosene and lesser quantities of charcoal is the most likely scenario. A Nyanza consumer sums this up:

> *"I use kerosene in the morning when rushing. I use the improved jiko in the evening because it saves money in the long run"*

Observed Drivers & Barriers

The drivers and barriers to urban uptake of briquettes in line with the above scenario are now considered. That is, reasons why consumers may demand more briquettes (drivers) and reasons that could prevent further demand (barrier).

Table 5 below presents a summary of the key drivers and barriers found in the study areas. Clearly, both external conditions (e.g. price of competing fuels) and qualities of the briquettes (e.g. burn-time, price) varied from place to place.

[17] An improved jiko refers to a stove designed to retain heat with a clay liner to insulate the coals – this make the stove more efficient than traditional jikos.

Table 5: Observed drivers and barriers to peri-urban and urban household use of briquettes

PERI URBAN AND URBAN HOUSEHOLDS **Strength of demand: Mixed (Very high – Low)** **Size of market: Very Large**		
	Observed drivers for briquette demand	**Observed barriers to briquette demand**
Price Factors	• The price of competing fuels (charcoal) per unit energy is higher than briquettes. • The burn time of briquettes is higher than competing fuels (charcoal).	• The price of competing fuels (charcoal) per unit energy is lower than briquettes.
Non-Price Factors	• Most urban consumers desire a smokeless fuel, and briquettes can meet this need. • Most urban consumers have compatible cooking equipment (charcoal jikos). • Awareness of briquettes is high. • A limited number of households are willing to pay.	• Consumers do not own compatible jikos for burning briquettes. • Competing products (kerosene) heat more quickly and were preferred for certain applications e.g. for making tea. • Competing products are available at more convenient locations, and often on credit. • Competing products are often easier to light and extinguish than briquettes. • Awareness of briquettes is very low.

The findings strongly suggest that for urban and peri-urban consumers to demand briquettes there must be a **clear advantage on price** over the main competing fuel, charcoal. This can be based upon either a lower cost per unit of energy or lower cost per hour of burn time. In the areas studied the price of briquettes was not always cheaper; a fact that goes a long way to explaining success or failure of the briquettes enterprises encountered. When existing cooking practices with charcoal are so ingrained it is difficult for an unconventional fuel to compete unless the price is lower.

The concept of a fuel being cheaper than charcoal per hour of burn time, is difficult for consumers to comprehend. It is important therefore, that the **advantages of long-burn duration are promoted by briquette producers** to differentiate briquettes from charcoal.

Compatibility of briquettes with existing cooking equipment was also a crucial factor. Briquettes can be burned in a traditional or improved jiko, however this assumes that consumers own such a stove. Requiring consumers to first buy a specially designed stove hugely restricts demand and makes little commercial sense when fuels can be easily designed to work in conventional equipment.

As discussed above, briquettes are unlikely to ever take a full share of the fuel market. For certain applications, like making tea in the morning, many want a quick source of heat. Briquettes – as they are conventionally made - do not provide this; not only do they produce less intense heat, they tend to be more difficult to light and almost impossible to extinguish and re-light.

Two more factors emerged which although barriers are temporary in nature. Firstly, in order to generate demand, awareness must first be built, requiring active marketing. Successful examples include giving selected users free product samples and offering demonstrations on how to use them. In Ranen, where this form of promotion has taken place, awareness of briquettes was high amongst local people. In a random sample of 36 people interviewed, 27 had heard of briquettes (75%) and 13 had tried using briquettes (36%) – uptake mostly limited by supply. Secondly, a related factor is that in most urban areas there is an established and widespread network of charcoal sellers and distributors. A new fuel product must overcome (or harness) the inertia of consumer loyalty, habits and convenience, possibly by utilising existing networks of fuel suppliers.

Firewood

Why don't urban consumers use firewood as much as in rural areas? One of the reasons consumers stated was that living in a densely populated area, they could not use fuels that produce a lot of smoke and contribute to air pollution. The fact that - if material is first carbonised - they can be smokeless gives briquettes (and charcoal) an advantage over firewood. Firewood also requires dry storage space, which is often limited in urban dwellings.

5.3 Rural households

Rural households make up a large proportion of Kenya's demand for cooking fuel. In such areas briquettes face a struggle to become established.

Existing Practices & Space for Briquettes

The majority of rural householders with a low income use three-stone fireplaces or firewood jikos. Firewood is collected for free in the surrounding areas or bought cheaply in the nearest

town or village. A number of householders also use a charcoal jiko occasionally if no firewood is available. Kerosene use is less common in rural areas.

A likely scenario is that demand for briquettes in rural areas of Kenya will remain relatively low for some time to come. They could provide an alternative to purchasing charcoal when firewood is unavailable but only if compatible equipment is owned. A more optimistic scenario would see some consumers changing towards briquettes - if priced attractively - for the increased convenience over collecting and storing firewood and the increased burn duration. The situation is dynamic and forces such as deforestation and government regulation could lead to more active promotion of alternative fuels.

Observed Drivers and Barriers

Demand for briquettes in the rural areas that have been assessed was generally low. Firewood or agricultural residues were often available for free or at a very low cost. In isolated areas the smoke from burning firewood can be dispersed and does not present a significant issue for householders. Furthermore a large proportion of rural householders do not own alternative cooking equipment (e.g. a charcoal jiko, or kerosene stove), presumably owing to lower levels of income - a further barrier to changing fuels. There appeared to be few immediate incentives to move away from this practice towards briquettes or other fuels, despite possible long-term or society-wide benefits.

Although demand from rural areas is generally low, one interesting case of a rural producer selling 'hand-made' briquettes from sawdust and charcoal dust bucked the trend. The producer (village of Kakwara, South Nyanza) explained that his customers were finding it more convenient than collecting and storing firewood and were able to afford his price of KES 300 per sack. The price is less than half of what is usually paid for an equivalent sack of charcoal in the area. It demonstrates the potential for economical local production of alternative energy sources from available waste products.

Actual drivers and barriers observed in the study are examined here. Table 6 below summarises these.

Table 6: Observed drivers and barriers to rural household use of briquettes

RURAL HOUSEHOLDS **Strength of demand: Mixed (Moderate – Low)** **Size of market: Very Large**		
	Observed Drivers for briquette	***Observed Barriers to briquette***

	demand	*demand*
Price Factors	• Collecting and storing firewood is an inconvenience people are willing to pay for • Charcoal can be more expensive than briquettes so briquettes preferred if firewood unavailable	• Firewood or other primary biomass is often a free resource
Non-Price Factors	• Sometimes firewood is not available • Some consumers feel safer cooking indoors at night • Some consumers have compatible equipment	• Consumers in isolated areas can put up with smoke from burning firewood. • Awareness is very low, and more difficult to build efficiently • Some consumers do not have compatible equipment

5.4 Restaurants, schools & other uses

Outside of household use, data from other countries suggests that the demand for fuel from institutions and industries across Kenya could be very large. A micro-scale producer could focus on supplying just a handful of consumers like large schools or hospitals, since individually their fuel usage is so large. Indeed, for the country's biggest producer (Chardust) this sector makes up the majority of its sales.

Restaurants and Eating Places

Most restaurants are located in urban or peri-urban areas and drivers and barriers to briquette uptake were found to be similar to that of urban and peri-urban households. It was particularly evident from interviews held with a number of establishments that they will need a mix of fuels – not just briquettes - for example, kerosene or other quicker burning fuel are needed for certain applications.

Those establishments that were given a sample of briquettes to try out were impressed with its performance on the whole. Many indicated a strong interest in using briquettes if they were available locally at a price competitive with charcoal. Briquettes would primarily be used for keeping food warm, or for food with a predictable demand that requires longer time to cook.

Schools

A number of schools were visited and it became clear that since they predominantly use firewood their demand has some similarities to rural households. Schools typically pay for

firewood in bulk e.g. by the truck-load. It is likely that the briquettes industry would find competing on cost a huge challenge given how cheap firewood is. Furthermore, micro-scale producers may not be able to cater for the volume of briquettes required in bulk-batches. The uptake of energy efficient stoves is increasing and is another important factor, since many such stoves are actually incompatible or would need to be modified to use briquettes. The best chance for briquette producers appears to be supplying to schools currently using charcoal.

Industrial Uses

Charcoal is currently in use by a number of industries in Kenya, especially where a longer or cleaner burning fuel than firewood is required. In such instances the scope for briquettes as a substitute is large.

For example, poultry farmers in the highlands are known to be taking up the use of briquettes to heat cages overnight when temperatures are low. This application is suited to briquettes since a longer burning fuel is desirable to avoid the need to add extra fuel. Another application observed was that of a blacksmith who would mix briquettes with conventional charcoal. Charcoal was still needed to provide sufficient heat intensity, whilst the briquettes retained heat and allowed the blacksmith to significantly cut down total use of fuel.

Ethical Value-Added

There was a small number of consumers found (both domestic and commercial consumers) who were willing to pay an additional price for a fuel from a more sustainable source. One producer has been specifically targeting this market and has had limited success selling to wealthier consumers/ expatriates and direct to high-end restaurants. Currently, the demand for such a value-added fuel may not large enough to support a profitable enterprise.

5.5 Summary of demand conditions

The demand conditions affecting the success of micro-briquette producers are summarized below, in a similar format to factors affecting supply. Although demand is potentially very large, the fieldwork strongly suggests **it should not be taken for granted** and certain key conditions should be met.

Of those conditions observed in the study, the most important ones were split into 3 sub-groups and are presented in Table 7 below 1) compatibility and awareness, 2) price and 3) other fuel attributes.

Table 7: A summary of demand conditions and their importance to the success of briquette producers

		Importance to briquette producers	
Condition identified for success	**Internal or External to business**	**Starting up a new business**	**Growth of established businesses**
COMPATABILITY & AWARENESS			
There must be sufficient numbers of consumers nearby with compatible cooking or heating equipment.	External	High	High
It must be common for general cooking or heating practices to require long cooking times that lend themselves to using briquettes. e.g. it must be common for people to cook meals for a long period of time (not quick frying, or making tea)	External	Medium	Medium
Awareness of briquettes as longer-burning alternative fuel must first be generated through marketing activities	Internal	High	Low
PRICE			
FOR URBAN & RURAL AREAS, briquettes sold must work out cheaper than charcoal, either per unit or per hour of burn	External	Very high	Very high
AND ALSO FOR RURAL AREAS: The benefits of briquette use must outweigh the additional cost in areas where firewood can be collected for free.			
OR ETHICAL CONSUMERS: Price must be right given willingness to spend a little extra on getting a 'sustainable' fuel [Much smaller market]			

OTHER FUEL ATTRIBUTES			
Smoke Levels of smoke produced in burning must be less than that tolerated by the consumers targeted (often virtually zero, except for rural areas.)	Internal	High	High
Ease of lighting The briquette produced should be easy to light. Or effort must be put into teaching people how to light it.	Internal	Low	Low
Extinguishability There would be more demand if the briquette were extinguishable and re-lightable.	Internal	Low	Low

6. RURAL AND PERI-URBAN ENERGY ACCESS

Briquettes uptake over the next 10-15 years could have a significant impact on access to modern energy in Kenya. This section discusses both current and projected impact of the industry.

Discussion of Terms Used

Improved energy access is understood as having three components:

1. access to a more modern form of energy;
2. access to a more sustainable form of energy; and
3. access to an additional form of energy which diversifies the range of fuel options available.

6.1 Access to modern energy

Carbonised briquettes could be considered a 'modern' form of energy than both firewood and charcoal because they are smokeless and can be designed to offer particular burn characteristics. For instance, the burn time of a briquette can be determined by varying the ratio of clay and the type of raw material.

Current

Current levels of supply/usage of charcoal-dust based briquettes are in a small proportion increasing access to modern energy. This is particularly true in certain areas of the country (e.g. parts of Central and Nyanza Provinces), but the scale of this impact is inherently limited by the supply of feedstock.

For the most part briquette use is displacing demand for charcoal by householders, restaurants/eating places and certain industrial uses, concentrated in urban / peri-urban settlements. Penetration into rural areas is low, since briquettes cannot easily compete with freely collected firewood.

Projected

Assessed optimistically, briquettes have the potenetial to become a major source of cooking and heating fuel in urban centres, especially those areas close to abundant sources of raw material such as sugar cane bagasse. For this to occur it would require existing producers to dramatically expand operations or for there to be an emergence of new enterprises backed by large capital investment. Another factor would (probably) be the engagement of the existing charcoal industry / distribution system in these changes. In this scenario briquettes could substitute a non-trivial proportion of current demand for charcoal.

It is foreseeable that micro, small and medium scale producers in peri-urban and urban areas will expand operations to almost fully utilise charcoal dust resources, selling into similar markets as presently. Some of these producers may begin to diversify into locally available feedstocks such as coconut, sugar cane, coffee husks and sawdust. Knowledge/skill transfer initiatives such as DEEP-EA could accelerate the process of diversification.

However, for briquette production to impact energy access for the large rural population who predominantly use firewood, external conditions need to change. There may not be enough incentives for such consumers change away from freely collected firewood, unless general income levels rise or subsidy/regulation changes the market conditions.

6.3 Access to sustainable energy

The impact of increased briquette production/consumption on environmental sustainability is dependent feedstock and type of fuel substituted. For example, briquettes from agriculture wastes such as bagasse will have benefits over consumption it displaces (e.g. charcoal use) since production of such briquettes would not directly lead to issues such as deforestation. On the hand, charcoal dust-based briquettes have limited potential to benefit the environment since they will always rely on the production of charcoal in large volumes - derived from wood, usually felled unsustainably.

Current

It has been observed that the majority of briquette producers operating use charcoal dust to make briquettes. Though this does displace the same amount of charcoal production, the benefit is limited for the reasons given above. Two models show more promise: sustainable felling of energy crops (Coast Province), use of carbonized bagasse (Nyanza Province). Both, however, operate on a very small scale.

Projected

As discussed above, it is foreseeable that producers will expand to fully utilise charcoal dust resources; displacing an appreciable level of charcoal production. If a trend towards use of diversified feedstocks continues/occurs, then briquette production/use could have a fairly signficant impact, especially on deforestation in Kenya. Having said that, barriers to rural uptake will need to be overcome for country-wide benefits to be seen.

6.3 Diversification of energy access

Again, the impact of briquette consumption on diversity of supply is dependent on the biomass feedstock used. For example, briquettes produced from agricultural wastes like bagasse certainly

increases diversity. However, charcoal dust-based briquettes do not; only offering a different *form* but derived from the same original source as charcoal. The discussion of current and projected impact plays out along similar lines to section 6.2 above and will not be repeated.

An issue to consider is how far a country would wish to be reliant on waste agricultural products for its household fuel; for example the worldwide sugar industry is sensitive to changes in import tariffs etc. and production between years may fluctuate.

7. CONCLUSIONS

7.1 Success Factors

Objective: To identify key supply and demand conditions, both internal and external to the business, that influence the success of micro-scale briquette producers in Kenya.

Supply and demand conditions of highest importance are brought out from the previous discussion (see Section 4 and Table 7), from which the following conclusions can be drawn:

Supply

- *Availability of a suitable raw material.* Proximity to the raw material is of high importance for any briquette producer; the further away the raw material is from the site of production, the greater the difficulty and expense of transportation. Though a range of suitable materials are available, the only commercially successful producers encountered (i.e. those earning a livelihood out of profits from briquettes) use charcoal dust. Reliant on the industry it displaces, there is an absolute limit on levels of production from charcoal dust, though nation-wide this has not yet been reached. **The industry needs to identify alternative sources of feedstock to ensure its long-term survival.**
- *Drying space for briquettes.* Many now cite this as a problem and this is considered to be of high importance to both start up and existing producers. The cost of land can be prohibitive in some areas, or may simply not be available if adjacent lots are already taken. When carbonising material for feedstock, open space is also needed. **Many producers overlook this factor when choosing a site of production**, and these lessons learnt need to be transferred in order to prevent an inability to scale up production.

- *Awareness of production techniques and press/extruder designs*. Start-up producers are often unaware of the business potential of hand-produced briquettes and are often unable to get off the ground. Many producers are also limited by a lack of knowledge of where to obtain a briquette press or appropriate press designs. This is of high importance for micro-enterprises (e.g. those beginning with hand-produced briquettes) to expand. Government of Kenya **Renewable Energy Centres and other institutions could play a role in accelerating the transfer of this knowledge**
- *Access to finance* is an important condition for the growth of micro-enterprises. Machinery to increase briquette production with a press or start carbonising feedstock with a kiln requires capital and is a major step in the transition from micro to small-scale producer. Briquettes enterprises are potentially profitable and more could be done to **facilitate linkages between producers and a range of existing financial institutes**, e.g. tailoring financial products to the needs and likely business growth pattern of briquette producers (c.f. milk loans offered by SACCOs)
- *Entrepreneurship*. This is a new and growing industry coming up against new challenges and needing to develop new techniques and knowledge. A key characteristic of successful producers was commitment to such engage in processes. Without these characteristics a business is likely to stagnate.

Demand

- *Saving consumers money*. In some areas where charcoal prices are high briquette producers were able to undercut the price, kilogram for kilogram, of this key competing product. The long-burn characteristics of briquettes are valued by consumers, since this saves them money in the long-run. **This alone can stimulate a very large demand.**
- *Presence of consumer groups*. There must be consumers within reach of a producer who both 1) currently pay for fuel (in rural areas, not all do) and 2) have compatible heating and cooking equipment. Domestic consumers in urban areas, and restaurants/eating places and certain industries are key groups to target. Domestic consumers in rural areas are considerably harder to sell to due to low income and availability of biomass, often at no-cost. **The proximity of a ready market is often overlooked by producers**.
- *Building awareness*. A new briquette producer must put effort into raising awareness of their novel fuel. This has been achieved by providing free samples and promotion at the production site and the market place by word of mouth, emphasising benefits such as long

burn duration. **Producers can have confidence that such efforts will yield good results.**

- *Acceptable smoke production*. For many urban consumers, low or zero smoke production is a necessity. Uncarbonised briquettes are unlikely to be desirable by householders but they may be suitable for businesses using a stove with a chimney.

Should I start up? (External Factors)

Of the above factors, a number could be considered external to a producer. These should form the basis of a decision to start-up in a given location:

- The availability of a suitable raw material (e.g. quantity available and proximity)
- Proximity of consumers (e.g. with compatible practices and financial incentives to change)
- The price of charcoal (or other fuels) compared to local rates for casual labour

What can I control to make a difference? (Internal Factors)

Having chosen to start-up, a number of factors are now under a producers control. These will determine how far the business can reach its full potential! The following are highlighted:

- Knowledge is fundamental to start-ups and also producers that want to grow. Areas where knowledge is required include production techniques and technologies and marketing, for instance so that product characteristics is matched to the needs of consumers
- Access to finance is a condition that producers have some control over. It is not quick or easy to secure a loan, however with perseverance and saving and/or as part of a motivated group, it can be achieved.
- Motivation and commitment is a characteristic that defines the most successful producers.

7.2 Impact on Energy Access

Objective: To understand the current and potential impact of micro-scale briquette producers on rural and peri-urban energy.

Urban& Peri-urban areas

- Currently, the briquette industry is making an impact on energy access in certain regions of the country such as Central, Nairobi and Nyanza provinces. The scale of usage remains a small fraction (<2%) of overall energy consumption.
- It is foreseeable that the scale of operations will expand until current resources (e.g. charcoal dust) are used up i.e. briquette production could equate to about 10-15% of total charcoal consumption
- Optimistically, if producers can exploit alternative biomass feedstocks briquette use could displace a substantial fraction of charcoal usage in urban/peri-urban areas. A key benefit of this would be to reduce pressure on forestry resources.

Rural areas

- In rural areas, the briquette industry has had little penetration; incentives for consumers to change from often freely collected biomass are few.
- Looking forward, it is difficult to foresee widespread uptake in such areas until wider changes occur such as better transport networks or tighter government regulation on use of firewood are put into place.

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ANNEX A – BRIQUETTE SPECIFICATION

Currency Exchange Rates (11-Feb-2010 – http:// http://www.xe.com/ucc)
$1 = KES 76.4
£1 = KES 119.5

<table>
<tr><th>Location</th><th colspan="3">Specification</th></tr>
<tr><td colspan="4">Wild Living Kilifi</td></tr>
<tr><td rowspan="5">  </td><td></td><td>Circular briquette</td><td>Square briquette</td></tr>
<tr><td>Feedstock</td><td colspan="2">Carbonised twigs (87%)
Coconut coir (6%)
Cassava/clay (7%)</td></tr>
<tr><td>Equipment used</td><td>Wooden vice press, cost KES 12,000. Produced on spec by a local fabricator in Kilifi.</td><td>Steel brick press with mould, cost approx KES 50,000. Produced on spec by a local fabricator in Kilifi.</td></tr>
<tr><td>Production cost</td><td>KES 20-25/kg</td><td>Under KES 20-25/kg</td></tr>
<tr><td>Retail cost</td><td>KES 100/kg</td><td>KES 40/kg</td></tr>
<tr><td colspan="4">Dagoretti Corner, Nairobi</td></tr>
<tr><td rowspan="4">  </td><td>Feedstock</td><td colspan="2">Various ratios of:

Waste Paper
Saw dust
Charcoal Dust</td></tr>
<tr><td>Equipment used</td><td colspan="2">Manual press</td></tr>
<tr><td>Production cost</td><td colspan="2">KES 9.5 / kg</td></tr>
<tr><td>Retail cost</td><td colspan="2">KES 12.5 / kg</td></tr>
</table>

Ranen Market, Rongo District		
	**Feedstock**	Charcoal Dust (75%) Clay (25%) Water
	Equipment used	Hand moulded
	Production cost	KES 5 / kg
	Retail cost	KES 15 / kg
Kakwara Market, Rongo District		
	**Feedstock**	Carbonised sawdust Clay Water
	Equipment used	Hand moulded
	Production cost	unknown
	Retail cost	KES 6 /kg
Nyeri		
	**Feedstock**	Charcoal dust
	Equipment used	Electrical extruder
	Production cost	Unknown
	Retail Cost	KES 15 / kg

ANNEX B – RAW MATERIALS

THE TABLES BELOW INDICATES THE AVAILABILITY OF RAW MATERIAL IN EACH AREA. THE LAST COLUMN DESCRIBES THE POTENTIAL IMPACT OF EACH RAW MATERIAL UPON INCREASING CONSUMER'S ACCESS TO ENERGY.

Table B1: Availability of raw materials for briquette production in Ranen Market, Nyanza Province

Raw Material	Potential Volume Available	Ease of Processing	Potential impact upon energy access
Charcoal Dust/Fines	Approx 10-20% of charcoal sold. Moderate quantities available at Ranen Market. Larger quantities available from neighbouring towns	Easy: can be mixed with a binder such as clay and used without further processing.	Moderate: in long-run could probably only ever supplement use of charcoal – unless imported in bulk from elsewhere
Bagasse	Very large quantities (over 1,000 tonnes / week) at Sony sugar factory. Moderate quantities available from local cane processors.	Moderate: Would need to be carbonised to reduce smoke to acceptable levels.	High: could serve a much larger population than Ranen (e.g. up to 500,000 people)
Sawdust	Small volumes from furniture workshops in town – e.g. lathe turning in town.	Moderate: Would need to be carbonised to reduce smoke to acceptable levels.	Low: could only serve a small population, but maybe worth utilizing.
Paper	Very small volumes from shops/ offices / schools	Moderate: Would need to be carbonised to reduce smoke to acceptable levels.	Very low
Cow Dung	Moderate amounts from approx 50-100 cows around outskirts of town (e.g. up to 2,000kg of dung per week)	Easy: Could be mixed with other raw materials and used directly.	Moderate: as a supplement to other feedstocks e.g. charcoal dust / sawdust
Clay	Difficult to quantify	Easy: can be mixed directly with feedstock	Very low

Table B2: Availability of raw materials for briquette production in Kilifi, Coast Province

Raw Material	Availability	Ease of Processing	Importance to energy access
Charcoal dust	Given a population of 30,394 consuming 156 kg of charcoal per year per person [18], this equates to a total of 4,741,464 kg of charcoal used in Kilifi each year. If it is assumed that 10 percent of this total is collectable charcoal dust [19] which could be used to manufacture briquettes, this gives a volume of 474,146 kg of raw material.	Moderate: Could be collected from charcoal suppliers in Kilifi for free or low price. It would take time to collect and transport, at a cost.	Moderate: in long-run could probably only ever supplement use of charcoal – unless imported in bulk from elsewhere. Ultimately it is not sustainable.
Coconut coir	The fibrous husk of coconuts (coir) is a waste product of coconuts sold at market or spoilt wind-fall. Coconut trees grow wild or are planted by farmers. The availability is limited by the number of coconuts harvested. Ultimately the coconut crop could be limited by seasons or disease but this is unlikely. However coconut coir could be sourced from further afield.	Easy: Coir is shed when coconuts are prepared for market. It requires no preparation before being mixed.	Moderate: Coir makes up a small proportion of the briquette mix however it is available in relative abundance in Kilifi and can therefore serve a small population. In the long term coconuts may not be harvested in sufficient quantities to meet demand.
Carbonised tree prunings	Produced by local farmers who have been trained locally by Wild Living (footnote who they are) to prune fast-growing trees. Twigs, no more than finger thick, are carbonised in a drum kiln. Wild Living purchases at least 50kg of twigs per farmer per month. The availability is constrained by the number of farmers who are trained. Up to 80 farmers have been trained to date.	Intensive: requires extensive training and quality control to ensure that the material is sustainably harvested. These are time and capital intensive processes.	Moderate/High: Carbonised tree prunings offer a sustainable alternative to charcoal dust, and can serve a large population. The rate of regrowth of tree twigs could limit the volume but to counter this more trees could be pruned or grown for this purpose.
Cassava flour	Brought from general stores at low cost	Easy: No processing required	Low: Is commonly available however if production levels were to increase significantly its use in briquettes may compete with its use as food
Clay	Available locally. Volume is difficult to quantify	Easy: can be mixed directly with feedstock	Very low

[18] Kenyan Ministry of Energy (2000)
[19] FAO (1991)

Table B3: Availability of raw materials for briquette production in Mariakani, Coast Province

Raw Material	Potential volume available	Ease of Processing	Importance to energy access
Charcoal Dust/Fines	Given a population of 10,987[20] consuming 156 kg of charcoal per year per person [21], this equates to a total of 1,713,972 kg of charcoal used in Mariakani each year. If it is assumed that 10 percent of this total is collectable charcoal dust [22] which could be used to manufacture briquettes, this gives a volume of 171,397 kg of raw material. This is a low estimate given that the population of Mariakani is thought to have increased significantly since 1999 and that the town serves surrounding wards.	Easy: can be mixed with a binder and used without further processing.	Moderate: in long-run could probably only ever supplement use of charcoal – unless imported in bulk from elsewhere
Sawdust	Produced as a waste product by furniture workshops – e.g. from lathe turning. Available in relatively small quantities. Would need to be carbonised to reduce smoke to acceptable levels.	Moderate: Would need to be carbonised to reduce smoke to acceptable levels.	Low: could only serve a small population, but maybe worth utilizing.
Paper	A limited number of shops/ offices / schools are likely to produce waste paper. Might need to be carbonised to reduce smoke to acceptable levels.	Easy/Moderate: Might need to be carbonised to reduce smoke to acceptable levels.	Very low
Cow Dung	Uncertain	Easy: Could be mixed with other raw materials and used directly.	Moderate: as a supplement to other feedstocks e.g. charcoal dust / sawdust
Clay	Available locally but quality for use in briquettes in not known. Volume is difficult to quantify	Easy: can be mixed directly with feedstock	Very low

[20] 1999 census
[21] Kenyan Ministry of Energy (2000)
[22] FAO (1991)

Table B4: Availability of raw materials for briquette production in Kaloleni, Coast Province

Raw Material	Potential volume available	Ease of Processing	Importance to energy access
Charcoal Dust/Fines	Produced as a by-product by street sellers/ Market (approx 10-20% of charcoal sold). Given a population of 11,000[23] consuming 156 kg of charcoal per year per person [24], this equates to an estimated total of 1,716,000 kg of charcoal used in Kaloleni each year. If it is assumed that 10 percent of this total is collectable charcoal dust [25] which could be used to manufacture briquettes, this gives a volume of 171,600 kg of potential raw material.	Easy: can be mixed with a binder and used without further processing.	Moderate: in long-run could probably only ever supplement use of charcoal – unless imported in bulk from elsewhere
Coconut tree waste (husks, shells, leaves, coir)	Uncertain. Would require knowing the number of trees available for harvest and the volume of material available from one tree.	Moderate: would require to be carbonised.	High: the supply could be supplemented by planting additional trees. Could become a sustainable source.
Sawdust	Produced as a waste product by furniture workshops – e.g. from lathe turning. Available in relatively small quantities. Would need to be carbonised to reduce smoke to acceptable levels.	Moderate: Would need to be carbonised to reduce smoke to acceptable levels.	Low: could only serve a small population, but maybe worth using.
Paper	A limited number of shops/ offices / schools are likely to produce waste paper. Might need to be carbonised to reduce smoke to acceptable levels.	Easy/Moderate: Might need to be carbonised to reduce smoke to acceptable levels.	Very low
Cow Dung	Uncertain	Easy: Could be mixed with other raw materials and used directly.	Moderate: as a supplement to other feedstocks e.g. charcoal dust / sawdust
Clay	Available locally but quality for use in briquettes is not yet known. Volume is difficult to quantify	Easy: can be mixed directly with feedstock	Very low

[23] 1999 census
[24] Kenyan Ministry of Energy (2000)
[25] FAO (1991)

ANNEX C – BRIQUETTE PRESSES AND KILNS

BRIQUETTES MACHINES	
	<u>Manual Extruder – Produced at Nyeri</u> Cost: KES 6,000 Produces about 2 sacks per day – charcoal dust briquettes
	<u>Electrical extruder – Produced at Nyeri</u> Cost: KES 80,000 Either single-phase or 3-phase Produces about 20 sacks per day – charcoal dust briquettes

	<u>Manual Screw press – produced at Kariobangi, Nairobi</u> Cost: KES 55,000 Can produce 10 briquettes per press – 10 presses per hour – 800 per day
	<u>Manual Extruder – also produced at Kariobangi Light Industries, Nairobi</u> Cost – KES 90,000 Capacity is 2,000 pieces per day

CARBONISERS	
	Drum kiln Photo taken at Nyeri renewable energy centre
	'Charcoal' Kiln Cost about KES 6,000

ANNEX D – FINANCIAL INSTITUTIONS

Table D1: Indicative Financing Options for Micro-Enterprises

Conditions	**SACCO (Kilifi Teachers SACCO, Mariakani)**	**MFI (First MFI, Mariakani)**	**Bank (KCB, Rongo)**
Relevant Loans	• Business loan • Group micro-finance loan	• Asset loan • Business loan	• 'Boresha' Micro-Loan Boresha
Conditions of the business loan	Savings account for at least 6 months. Minimum deposit of KES 1000	Savings account for at least 2 months. Savings must be 20% of the loan amount.	Evidence of banking, and running business for at least 1 year
Loan application fee	KES 300-500 on sliding scale	2% of loan amount (e.g. KES 300 for a KES 15,000 loan)	Zero
Minimum loan amount	KES 500	KES 500	KES 5,000
Maximum loan amount (to first-time borrowers)	2 x amount of savings, no limit	5 x amount of savings, up to KES 40,000	KES 500,000
Period of repayment and interest rates	24 to 48 months @ 12% p.a	3 to 12 months. Business loan @ 2% - 2.5% per month. or Asset loan @ 1.25% per month.	up to 12 months @ 1.5% per month

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