

# Assessment of the Briquette Market in Kenya



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GVEP International is a non-profit organisation that works to increase access to modern energy and reduce poverty in developing countries. To achieve this goal we help small energy businesses to establish and grow.

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## List of Acronyms

|        |   |
|--------|---|
| Afd    | Agence Française de Développement (French Development Agency) |
| CARE2  | Capital Access for Renewable Energy Enterprises               |
| CBO    | Community Based Organisation                                  |
| CDM    | Clean Development Mechanism                                   |
| CO2    | Carbon Dioxide  |
| DEEP   | Developing Energy Enterprises Project                         |
| EEP    | Energy and Environment Partnership                            |
| E-MSME | Energy Micro, Small and Medium-size Enterprises               |
| FAO    | Food and Agriculture Organisation (of the United Nations)     |
| FBO    | Faith Based Organisation                                      |
| GHG    | Greenhouse Gas Emissions                                      |
| GVEP   | Global Village Energy Partnership                             |
| ICRAF  | World Agroforestry Centre                                     |
| ICS    | Improved Cookstoves   |
| IFC    | International Finance Corporation                             |
| KEBS   | Kenya Bureau of Standards                                     |
| KEFRI  | Kenya Forestry Research Institute                             |
| KES    | Kenyan Shillings  |
| KFS    | Kenya Forest Service  |
| kg     | Kilo grams (unit of weight)                                   |
| KIRDI  | Kenya Industrial Research and Development Institute           |
| KTDA   | Kenya Tea Development Agency                                  |
| MJ     | Mega Joules (unit of energy)                                  |
| MOE    | Ministry of Energy  |
| mt     | metric tonne (unit of weight)                                 |
| NGO    | Non-Government Organisation (not for profit)                  |
| PDP    | Pipeline Development Project                                  |
| R&D    | Research and Development                                      |
| REDD+  | Reducing Emissions from Deforestation and Forest Degradation  |
| RTAP   | Regional Technical Assistance Programme                       |
| SHG    | Self Help Group   |
| SNV    | Netherlands Development Organisation                          |
| TBC    | To Be Confirmed   |
| UON    | University of Nairobi   |
| USD    | US Dollars  |

## Executive Summary

In September 2012, GVEP International embarked on a partnership with the Swedish International Development Cooperation Agency (Sida), to manage the Capital Access for Renewable Energy Enterprises (CARE2) project, to improve capital access in the renewable energy markets, across four countries in East Africa. In Kenya the Pipeline Development Project (PDP) under this program aims to work with producers of biomass briquettes (amongst other business) to increase the quality and uptake of this alternative fuel. This assessment was conducted to gain a better understanding of the businesses operating in the biomass briquette sector and the type of interventions that are required to inform the program moving forward. The study also reviewed other initiatives taking place in the sector in Kenya.

Several other initiatives are currently running or have been running in the past such as Practical Action's Briquettes Commercialisation Project. However GVEP's focus of working with existing businesses and offering them scale up support is complementary to these initiatives, which are primarily focusing on introducing the technology to new businesses. There are also several institutions and organisations that are involved in the briquette sector in Kenya offering support services, research facilities and funding amongst other resources.

The survey identified over 70 entrepreneurs who either are, have in the past, or will in the near future, engage in commercial briquetting activity in Kenya, with 35 such enterprises interviewed for this assessment. These operations can be characterised by the following observations;

- Operations can be segmented according to the equipment used to manufacture briquettes, namely handmade, manual machines, locally fabricated electric machines and imported machines. Production capacity across the different types of operation varies, but electric machines allow the largest production volume. Most machines in the market are locally fabricated.
- The majority of producers rely on charcoal dust which is paid for. Lack of high volume carbonisation expertise, and cost effective feedstock collection capacity, appear to be key constraints entrepreneurs will face in trying to incorporate alternative feedstock sources.
- The quality of briquettes is highly variable and largely unmeasured.
- Briquette operations had on average 9 employees, with handmade briquette operations having the largest number of female employees.
- Small commercial and institutional consumers, such as poultry farms and restaurants, form the main markets for briquettes in Kenya. Business-to-business sales form the core of most enterprises transactions and marketing activities.
- The enterprises with the most successful operations and highest level of capacity utilisation often had a combination of management and operations resources to ensure steady production, as well as in house maintenance capacity.

The assessment further considered the main challenges effecting businesses in the briquette sector in Kenya with the following insights;

- Challenges vary for the different categories of operations, as segmented above according to equipment used. The equipment used ultimately creates structural constraints on entrepreneurs in terms of feedstock, production volume, briquette quality and type, and therefore target market.
- Differences between the performance of charcoal and briquettes should be recognised to target the product to the right market and avoid consumer disappointment.



- Technical challenges exist, such as: lack of knowledge on equipment maintenance, lack of drying space, and a need for higher capacity machines.
- Opportunities also exist to diversify feedstock and open up new markets if the right product characteristics and business models can be developed.

Based on an analysis of these challenges the assessment went on to make the following recommendations for the type of intervention the program in Kenya should target;

- Briquette operations can further be segmented into different stages according to the entry level of the business, mainly determined by production type and resources. Different intervention will be required depending on the stage of the business to allow them to progress to the next level.
- Female entrepreneurs face specific challenges; particularly due to physical constraints in operating manual machines, and limitations in their ability to separate home and business obligations. Further research is required to make machines friendlier for use by female entrepreneurs.
- Geographic variations also exist with some challenges specific to different regions of the country and interventions should be tailored accordingly.
- A number of ways in which the program can intervene to support the growth of briquette businesses were identified, and include building technical capacity and focused market development activities. In addition suitable businesses to work with in the program were highlighted.

Following on from the Briquette Market Assessment as detailed in this report GVEP has recruited 25 briquette entrepreneurs to work with in Kenya under the CARE2 program. GVEP intends to build on the recommendations made in this report through the support offered through the program.

# 1. Introduction

## 1.1. Background Context

### *The Biomass Demand*

The demand for energy in East Africa is increasing both for households, businesses and industry. Increasing populations, aggressive deforestation, expanding economies and a lack of regulation have led to increasing fuel prices and shortages, which often hits hardest the households and businesses most in need. In Kenya, approximately 82% of the population cooks with biomass (wood and charcoal). Within urban areas kerosene is the most widely used fuel (44.6% of the population) followed by charcoal (30.2% of the population), whilst in rural areas wood is predominantly used by 88.2% of the population<sup>1</sup>. Biomass fuels are also used for many institutional, commercial, and industrial applications; such as cooking in hotels and restaurants, space heating for poultry farmers, and heating applications in industrial boilers.

Fuel prices have increased steadily throughout East Africa over the last decade. The past year alone has seen significant hikes in the price of fuel and other commodities, increasing the cost of living for many people and increasing running costs for small business and industry. According to Kenya National Bureau of Statistics, the average retail price of a 4kg tin of charcoal in Kenya has increased from 49 KES in June 2011 to 63 KES in June 2012 to 70 KES in June 2013<sup>2</sup>.

With such a high dependence on fuel wood and charcoal for both households and business in Kenya it is not surprising that the country has experienced continued loss of forested areas over the past two decades. According to FAO, only 6% of Kenya's land cover was classified as forest in 2010 after cover declined by 0.3% per year between 2000 and 2010. Although not the sole cause, wood harvested for fuel is a significant driver of deforestation.

Within urban areas, dependence on charcoal for cooking is high and charcoal vendors selling by the bag or tin are a common sight within the residential areas. However much of this charcoal is produced through unregulated and inefficient methods, with production efficiency as low as 8 to 15%<sup>3</sup>. In addition around 10 to 15% of charcoal is wasted as dust which is often discarded<sup>4</sup>.

Biomass briquettes may offer an alternative fuel for many of these applications. Biomass briquettes are a form of solid fuel that can be burned for energy. They are created by compacting loose biomass residues into solid blocks that can replace fossil fuels, charcoal and natural firewood; for domestic and institutional cooking and industrial heating processes. Briquettes can be made from biomass residuals such as charcoal dust (which is waste from the production process), coffee husks, coconut husks, maize cobs and sawdust amongst others. Briquettes have the potential to be a source of renewable energy, if they are made from sustainably harvested biomass or agricultural residues.

## 1.2. GVEP International

GVEP International (Global Village Energy Partnership) is a non-profit organisation that seeks to reduce poverty by bringing energy services to people. They focus their work on renewable energy technology in rural and peri-urban areas of developing countries. GVEP believe that business-led solutions are essential to meet the energy needs of people in these areas. They stimulate the creation of a broad range of micro, small and

<sup>1</sup>UNDP/WHO. *The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa*. 2009.

<sup>2</sup>KNBS, Leading Economic Indicators, July 2012

<sup>3</sup>H Ferguson, *Briquette Businesses in Uganda*, Feb 2012

<sup>4</sup>M Njenga et al, *Making a Living from Dust*, 2011 (accessed at <http://www.worldagroforestrycentre.org/sites/default/files/MITI%20Njenga%20et%20al%20briquette%20%20livelihoods%202011.pdf>)

medium-size enterprises (MSME) in the energy economy, support and nurture these businesses, and help connect them with funders; so they can work towards providing communities with access to energy at affordable prices.

GVEP works across Africa and the Caribbean, with an experienced team operating from regional offices as well as their London head office. Specific programmes and competitions help them meet the needs of energy entrepreneurs providing them with investment, business plan advice and the impetus to develop and improve their businesses.

Recent programs and partnerships include:

- ***The Kenya Climate Innovation Centre (CIC)***, providing business incubation services – including small grant and investment capital, business advice, access to information and workshop resources, as well as laboratory and office facilities - to climate technology start-ups.
- ***Supporting energy SMEs in Sub-Saharan Africa***, a \$30 million programme providing technical and financial assistance to small and medium enterprises in East and West Africa.
- ***Loan guarantee fund***, encouraging the flow of credit by underwriting loans to energy businesses.
- ***Business plan competitions***, to award financial and technical help, such as the IDEAS Energy Innovation Contest and the Access to Clean Energy Challenge East Africa, run in tandem with the BiD Network.
- ***Developing Energy Enterprises Project (DEEP)***, training and supporting over 900 micro entrepreneurs in East Africa with basic business skills, accessing capital, improving their technical knowledge and helping with marketing and distribution plans.

### ***GVEP's Experience with Briquettes***

GVEP has been working with briquette entrepreneurs in East Africa since 2008. Initially through DEEP, approximately 152 small and micro briquette enterprises were supported in Kenya, Uganda and Tanzania with business and technical advisory services as well as market development and financial linkages. GVEP has further supported briquette entrepreneurs in Kenya to access finance through a Rotary grant, enabling briquette entrepreneurs to buy manual and electric machinery to improve production. In addition several medium sized briquette businesses are being supported under the CIC. Building on the work of the DEEP program GVEP is planning to work with more micro briquette businesses in Kenya and Uganda through the CARE2 program, which will help entrepreneurs increase the quality of their products and scale-up production.

### ***The Capital Access for Renewable Energy Enterprises (CARE2) Project***

In September 2012, GVEP International embarked on a partnership with the Swedish International Development Cooperation Agency (Sida), to manage the CARE2 project, a USD 7 million programme to improve capital access in the renewable energy markets, across four countries in East Africa. The project has, among other components, four Pipeline Development Projects (PDPs) which will be implemented in Kenya, Uganda, Tanzania and Rwanda. PDPs target market development activity in specifically defined niches, in order to stimulate the creation and growth of e-MSMEs in those niches, and thereby to build the “pipeline” of potential transactions for investors and lenders.

In Kenya, the project (known as PDP3) will support e-MSMEs in improved cookstove and briquette production. Approximately 20 producers of improved cookstoves, 20 suppliers of ceramic liners and 20 producers of biomass briquettes will be supported in addition to a network of approximately 130 retailers.

This PDP seeks to increase the quality and uptake of locally made domestic biomass stoves and biomass briquettes through improving on product design, marketing and distribution; and scaling up production for high potential local producers. The project aims to generate the following benefits (as they relate to briquettes);

- Creation of further employment in energy enterprises through scaling up of existing producers and development of retail networks
- Increased and improved availability of quality alternative fuels
- A positive benefit to women, as either owners or employees of supported E-MSMEs, or as indirect beneficiaries of increased penetration of briquettes
- Reduction in unsustainable biomass demand and hence a reduction in deforestation
- A material reduction in CO2 emissions

### 1.3. Study Scope

To gain a better understanding of the businesses operating in the biomass briquette sector, and the type of interventions that are required, it was proposed that a briquette market assessment be carried out at the beginning of the project in Kenya. The study focused on the main project regions in Kenya, which are separated into the following clusters; Central & Nairobi, Coast, Kisumu & Kisii.

This study was deemed necessary as existing research provided broad, industry level, overviews dealing with thematic and structural challenges faced by the sector, with individual case studies only used to highlight trends and concepts. As such a study was required to focus in on, and analyse in a more targeted way, the specific challenges faced by individual entrepreneurs. It was to identify company specific challenges as well as sector trends, in order to select producers of biomass briquettes to be supported by PDP3 for enterprise development. To this effect, the study aimed to validate and specify what exactly needed to be done under the proposed areas of intervention. The study also researched the spectrum of businesses operating in the sector, and other participants including product distributors and sector initiatives.

The study set out to analyse the businesses and initiatives that are operating in the biomass briquette sector in Kenya and examine current trends, including the following perspectives:

- Production levels, raw materials used, number of employees, machinery used, main markets for briquettes, and distribution channels
- Understand the main challenges faced by operators to scaling up the production of briquettes
- Identify key opportunities for expanding the briquette market
- Understand what briquette initiatives are already running through other organisations, and how the CARE2 program can complement these initiatives
- Understand how/if any progression is possible from micro to large scale operations

The aim of this analysis is to inform the CARE2 program on the interventions that are required to expand the market and scale up briquette businesses in Kenya, by doing the following:

- Identify realistic targets and specific intervention strategies, reflective of current market conditions, in areas where the CARE2 program can add value in order to expand the market and scale up briquette businesses in Kenya
- Identify the briquetting and distribution businesses CARE2 should be working with, and set realistic growth targets for them under the program

### 1.4. Study Activities

Interviews were conducted with stakeholders in the biomass sector including biomass briquette businesses, organisations that are running briquette initiatives, and distributors of biomass briquettes. The main field study was conducted between 10<sup>th</sup> and 17<sup>th</sup> May, 2013 in Kisumu, Kisii, Coast, Central Kenya, and Nairobi environs. Interviews with initiatives in the sector, alongside additional field work, were conducted in Nairobi between

22<sup>nd</sup> May and 8<sup>th</sup> June 2013. Further information on players in the sector was sourced from desk research and telephone interviews conducted during the study period.

The key activities concluded through the course of the study were as follows:

- Site visits and/or interviews with over 35 briquette producers alongside several distributors of briquettes in the Coast, Kisii, Kisumu Central and Nairobi environs;
- Identification of a range of initiatives that have supported briquette production and marketing, and interviews with key individuals at the organisations concerned;
- Desk research to gather the current body of knowledge on briquetting in Kenya.

## 2. Assessment of Initiatives in the Briquetting Sector

As part of the assessment a review of other initiatives aimed at supporting briquette operations was conducted. This review aimed to understand what briquette initiatives are already running through other organisations, where the initiatives were operating, what they aim to achieve, and how the CARE2 program can complement these initiatives. A summary of the briquette-focused initiatives identified is given in **Table 1** below, whilst further details are provided in the Appendix in section 8.1.

**Table 1:** Summary of existing briquette initiatives operating in Kenya

| Organisation   | Initiative Name / Description  | Location                            | Duration   |
|--|--|-------------------------------------|--|
| Practical Action East Africa                           | Briquette Commercialisation Project  | Nairobi and Nakuru                  | Commercialisation (2011 - 2013), Scale Up (2013 - to 2015) |
| Middlesex University, Kenyatta University, Terra Nuova | Fuel from Waste Network  | Nairobi                             | 2010 - 2012  |
| SNV  | Improved Charcoaling Technologies and Briquetting using Agricultural Waste | West Pokot and Uasin Gishu Counties | Jan to Sept 2013   |

### 2.1. Findings from the review

The focus and aims of the briquette initiatives identified varied with Practical Action and SNV's initiatives having a focus on demonstrating the technology to new businesses and helping them set up operations. The fuel to waste network took a collaborative approach trying to bring producers together to facilitate knowledge sharing, leverage networks, and create awareness of the technology/best practice. Other smaller programs promoting briquettes (see **Table 2**) have had a focus on the environmental and health impacts of cooking fuels. All of the initiatives have a strong focus on training, information sharing and creating awareness of the technology. Lessons learnt from existing initiatives include limitations with current technologies including a lack of high volume drying techniques, and unreliability of briquette presses. They also highlighted the need for more product awareness creation, with briquettes being relatively new in the market, and the need for further networking and information sharing amongst briquette producers.

For the CARE2 programme, the findings of this review highlight that other worthwhile activities and initiatives are supporting the briquette sector in Kenya, thereby allowing for validation of the specific focus and aims of the PDP in Kenya. The PDP in Kenya aims to support briquette businesses that are already producing briquettes at a reasonable scale, and offer them the support to scale up operations whilst improving the products they produce. Other initiatives in the sector focus on demonstrating the technology and creating new briquetting businesses, the CARE2 program can complement these by offering scale-up support to those businesses that have already established themselves. The findings also highlight potential opportunities to collaborate with some of these existing businesses with common overlapping themes such as the provision of suitable and reliable equipment, creating market awareness for briquettes, and encouraging more female entrepreneurs to participate in the sector. As a result it is recommended that such areas of collaboration are further investigated by GVEP to maximise the impact on the sector and avoid duplication of efforts with other initiatives.

## 2.2. Other Organisations in the Briquetting Sector

In addition to specific initiatives operating in the sector, there are also several institutions and organisation that are involved in the briquette sector in Kenya offering support services, research facilities and funding amongst other resources. Such organisations may offer further scope for collaboration with, and support for, the CARE2 program; including testing facilities, training partners, sharing of research, and awareness creation. Institutions and organisations identified are summarised in **Table 2**.

**Table 2:** Other institutions and organisations that are involved in the briquette sector in Kenya

| Organisation  | Area of involvement   |
|---|---|
| <b>Ministry of Energy (Energy Centres)</b>                    | Centres serve as demonstration and training hubs in sustainable energy. Have engaged in training and awareness creation of briquetting technology.  |
| <b>University of Nairobi</b>                                  | Phd candidate Mary Njenga has published research into the technology (collaboration with ICRAF). Both UON and ICRAF have testing facilities for briquettes. The Fablab prototyping and testing laboratory has also piloted briquetting projects.  |
| <b>Kenyatta University</b>                                    | The Centre for Enterprise Development and the Department of Energy Engineering participated in the Fuel from Waste Network, supporting activities in the design and fabrication of more efficient presses.  |
| <b>Jomo Kenyatta University of Agriculture and Technology</b> | Have trialled carbonisation of rice husks and produced briquettes using an internally fabricated, low cost, briquette making machine <sup>5</sup> .   |
| <b>Kenya Bureau of Standards (KEBS)</b>                       | Issue the KEBS “Standardisation Mark”, a mandatory product certification scheme for locally manufactured products. Charcoal briquettes fall under this standard, and the mark must be secured in order to sell through the formal market.   |
| <b>Rotary International</b>                                   | GVEP has collaborated with the Rotary Club of Kenya to offer grants to subsidise briquetting equipment costs for promising entrepreneurs. Rotary also has an initiative named Fuels 4 Schools (F4S) sponsored by Rotary International (UK), promoting briquette making with schools.  |
| <b>Legacy Foundation</b>                                      | A wooden press originating from the foundation has become widely adopted in Kenya and used in several initiatives. The foundation also produced a series of manuals available for sale on their website <sup>6</sup>  |
| <b>Grant to business programs</b>                             | A number of programs to stimulate renewable energy in Africa have provided grants to catalyse the growth of the briquetting sector. These include EEP, which has supported a number of companies to establish and scale up briquetting operations <sup>7</sup> and supported research into the briquette market in East Africa <sup>8</sup> . |

<sup>5</sup> <http://www.farmbizafrica.com/index.php/hopemenu5/22-finance/674-farmers-make-rice-husk-briquettes-with-local-machine>

<sup>6</sup> <http://www.legacyfound.org/>

<sup>7</sup> <http://www.eepafrica.org/index.php/projects/87-kenya-projects>

<sup>8</sup> [http://www.eepafrica.org/images/images/BriquetteStudy/analysisreport\\_briquettemarkets\\_final.pdf](http://www.eepafrica.org/images/images/BriquetteStudy/analysisreport_briquettemarkets_final.pdf)

|  |  |
|--|--|
| <b>Green Africa Foundation</b>   | Offers demonstration training on how to make briquettes and facilitates the acquisition of the briquetting machines by CBO's who in turn assist other groups in the purchase of the same <sup>9</sup> .  |
| <b>AMREF WASH</b>  | Program to train rural communities to produce briquettes using hand presses from non-carbonised leaves (need leaves – Malindi), cow dung (Kajiado) and paper. Goal of preventing deforestation and reducing use of fuel wood.                                  |
| <b>Green Belt Movement</b>   | Partnered with AMREF on project training rural communities to produce briquette in Kajiado. Involved in area of sustainable biomass harvesting.  |
| <b>Youth Agro-Environment Initiative</b>                                 | Conducts regular trainings on making briquettes using hand presses in the Nairobi area.  |
| <b>KIRDI</b>   | Have R&D and briquette testing facilities  |
| <b>KEFRI (Particularly the Forest Products Research Centre – Karura)</b> | Have worked on improved carbonisation methodologies for charcoal production for several years, and have published research on methodologies for charcoal production. They recently published an academic paper on briquetting carbonised bagasse <sup>10</sup> |
| <b>KFS</b>   | Active involvement in the sustainable charcoal sector, are responsible for issuing permits for legal activity in the sector,   |
| <b>KTDA (Kenya Tea Development Agency)</b>                               | A recent tender publicised by KTDA for the supply of briquettes to meet the demand of their tea factories for boiler fuels, shows need for larger scale supply of briquettes to industry.  |
| <b>Tribal Voice Communications Ltd</b>                                   | In 2009, the company utilised presses supplied by the millennium fuel project to train local communities to produce briquettes from cow dung, waste paper and leaves under an initiative in the Masai Mara   |

<sup>9</sup> <http://www.greenafricafoundation.org/section.asp?ID=209>

<sup>10</sup> Onchieku, J. M.; Chikamai, B. N.; Rao, M. S, Optimum Parameters for the Formulation of Charcoal Briquettes Using Bagasse and Clay as Binder, European Journal of Sustainable Development (2012) 477 - 492



### 3. Assessment of Existing Briquette Businesses and Market Conditions

#### 3.1. Number and Level of Establishment

The survey identified over 70 entrepreneurs who either are, have in the past, or will in the near future, engage in commercial briquetting activity in Kenya. The consultants had meetings with 35 of these (28 of which were held at the site of production). The geographic spread of the entrepreneurs visited as part of this study is summarised in **Table 3**.

**Table 3:** Count of briquetting operations met as part of this study

| Region       | No. Of Operations Met |
|--------------|-----------------------|
| Kisumu       | 10                    |
| Central      | 8                     |
| Coast        | 8                     |
| Nairobi      | 8                     |
| Kisii        | 1                     |
| <b>Total</b> | <b>35</b>             |

Additional operations in Uasin Gishu, Kajiado and Narok were identified through the course of this research. There is no doubt that there are many more localised operations dotted around the country with similar characteristics. This is especially the case for businesses operating in the informal sector (being the majority). Additional enterprises not visited under this study would require site visits in order to truly understand the extent of their operation and entrepreneurial potential. The types of legal entity under which briquetting operations function are summarised in **Table 4**.

**Table 4:** Count of briquetting operations by type of entity

| Operation Type      | No. Thereof |
|---------------------|-------------|
| Sole Proprietorship | 11          |
| Not registered      | 9           |
| Limited Company     | 8           |
| CBO                 | 4           |
| NGO                 | 2           |
| FBO                 | 1           |
| <b>Total</b>        | <b>35</b>   |

Many operations in the informal sector tend to have a relatively short life span, as the entrepreneur may shift focus to other business if they are unable to overcome the difficulties in making the briquetting business model profitable. On average the entrepreneurs met have 3 years' experience in production of briquettes. A summary of the spread of the age of the operations visited is summarised in **Table 5**.

**Table 5:** Count of age of briquetting operations visited

| Years in Briquette Production | No. of Operations Thereof |
|-------------------------------|---------------------------|
| < 3 years                     | 11                        |
| 3-6 years                     | 8                         |
| > 5 years                     | 6                         |
| N/A                           | 10                        |
| <b>Total</b>                  | <b>35</b>                 |

There are likely to be additional operations in the industrial sector that are unaccounted for by this survey, particularly in the tea processing sector where there is significant interest in sourcing alternative solid fuels to fuel wood. Factories producing waste, and with sufficient funds and technical expertise, could proceed to procure the equipment, and produce and consume the briquettes with relatively little fanfare. This would mean that they have limited need to market the product and as such remain below the radar. Two such operations were visited as part of this study.

### 3.2. Categorisation of Operations

At the most basic level briquetting operations can be segmented according to the equipment used to manufacture briquettes as that ultimately creates structural constraints on entrepreneur in terms of feedstock, production volume, briquette quality and type, and therefore target market as follows.

#### 1. *Hand made*

- Usually produced by women's groups in urban, low-income areas
- Largely for local and internal consumption
- Exclusively use charcoal dust
- No standardisation of binder or fixed ratios of inputs
- Part time operations with irregular production
- Often born out of charitable goals to stimulate employment and create income for people in low income areas



**Figure 1:** Handmade briquette production (left: Operations in Nairobi; centre & right: CBO operations in Kisumu)

## 2. **Manual presses**

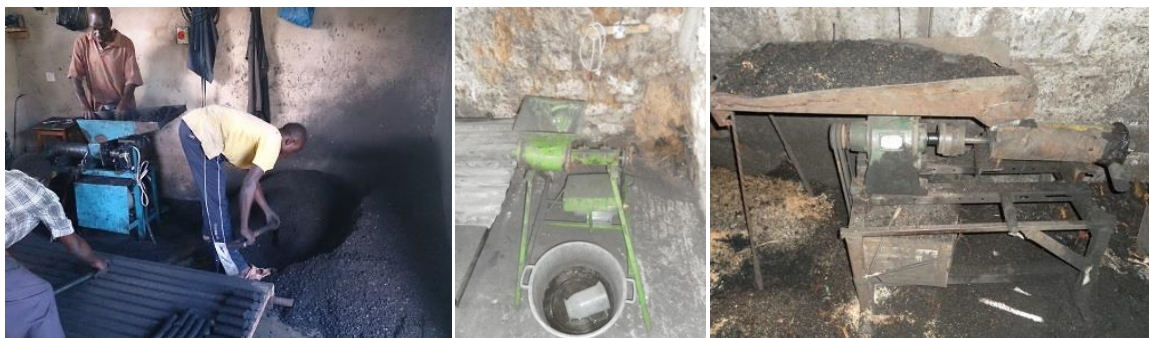
- In urban areas such operations use charcoal dust exclusively
- In rural areas production of uncarbonised briquettes is more common, particularly using the wooden press design shown in Figure 2 below
- Operations are largely dominated by women's groups and individual entrepreneurs, both male and female.
- Often wooden presses are purchased by NGO's and given to the community and/or business models are created in co-operation with said community
- Very wide range of designs - mostly piston, fabricated locally from metal or wood
- Wide range of production capacity and markets targeted, from those selling in supermarkets to those producing for local market stalls
- Relatively balanced mix of men and women
- Often born out of charitable goals to stimulate employment and create income for people in low income areas



**Figure 2:** Different designs of locally fabricated manual presses (left: Millennium Fuel Project, right: Alfastar Industries)

## 3. **Locally fabricated electric machines**

- Dominated by sole traders and small enterprises
- Very few operations adequately resourced to cover technical, operations and marketing needs within the business, largely due to cost constraints and the small scale of the business
- Clear divide between technically competent producers of quality briquettes with less market knowledge, and business minded small-scale manufacturing operations with good marketing ideas but limited technical capacity
- Operating capacity and efficiency severely affected in operations without mechanical maintenance expertise and technical understanding of the characteristics of briquettes
- Operating capacity problems compounded in areas where electricity supply is unreliable, such as coast region.
- Some are able to secure debt financing to cover start up and expansion costs, largely based pre-existing on other assets unrelated to the business that serve as collateral
- Few instances of entrepreneurs benefiting from support provided by organisations with charitable goals. Most use their own money and decide to enter into the business for economic reasons.



**Figure 3:** Locally fabricated electric machines in operation.

#### **4. Medium sized businesses producing carbonised and non-carbonised briquettes using imported machines**

- Larger scale production capacity and high quality standards
- Entrepreneurs usually already have other successful businesses and are self financed, few are looking for financing, and those who are usually require significant amounts only available from a commercial bank rather than a micro finance institution
- Most don't use charcoal dust
- Most don't carbonise the waste
- Non-carbonised production faces an additional challenge resulting from additional electricity cost due to the heating process need to seal briquette on production
- Carbonised production is capacity constrained due to limitations of throughput in the carbonisation process:
- Affordable carbonisation methods are batch based and include a cooling time, not allowing for continual production of carbonised feedstock, thereby resulting in a bottleneck in feedstock supply
- Kilns tend to produce a lot of smoke and smell, making them unsuitable for use in densely populated areas
- A single kiln can only be filled to a certain level and volume, in order to ensure even carbonisation
- Successful cases are dominated by players with a captive feedstock source, either through co-location with producer of feedstock/consumer of the product, or as an internally managed side business of the producer of the waste



**Figure 4:** Imported machines (left: heated screw press, right: pillow press)

The 35 briquetting operations met as part of this study, in terms of the categorisation, are broken down into the different production methods as described in **Table 6**. The majority of operations have electrically powered presses.

**Table 6:** Summary of briquetting operations interviewed by category of production

| Operation Type | No. Thereof |
|----------------|-------------|
| Electric       | 20          |
| Hand           | 10          |
| Manual         | 5           |
| <b>Total</b>   | <b>35</b>   |

### 3.3. Analysis of Operations

#### 3.3.1. Production levels

**Table 7:** Analysis of production levels of briquetting operations interviewed during the study

| Production Category | Min Current Production (mt/month) | Max Current Production (mt/month) | Average Current Production (mt/month) | Average Operational Capacity (kg/hr) | Average Capacity Utilisation |
|---------------------|-----------------------------------|-----------------------------------|---------------------------------------|--------------------------------------|------------------------------|
| Electric            | 1.3                               | 200.0                             | 31.7                                  | 250.1                                | 55%                          |
| Hand                | 0.6                               | 1.5                               | 1.2                                   | 20.0                                 | 31%                          |
| Manual              | 0.7                               | 2.2                               | 1.4                                   | 19.2                                 | 41%                          |

**Table 7** above summarises the study findings on production levels from the 35 briquetting operations interviewed. In this regard the following points can be highlighted:

- Production levels range between 0.6 to 2.2mt per month for those operating hand presses and producing by hand.
- For those with electric machines the production levels range from 1.3 to 200mt per month, although only one operation was producing more than 60mt per month.
- Those with imported machines generally had much greater capacity – 100's of mt per month, though very few were able to achieve such levels of production, either due to the operations being new (several operations have only procured equipment in the past 6-12 months, and are still in the testing and strategy development phase); or due to it not being core business (examples of such instances include agro-processing facilities, where the core business is the production of food, and the waste produced can be used as feedstock for briquetting) - for example in one instance a processor was observed to have put briquette production on hold whilst expanding the agro processing plant's capacity.
- Few companies keep production accounts so it was difficult to reconcile current production figures with historical levels
- On the basis of 8 hours per day, 6 days a week being the full productive capacity, the entrepreneurs visited are working at 50% capacity, on average; although this is higher for electric operations and lower for manual and by-hand operations.



- Feedstock availability, machine reliability, speed of production and lack of drying space appear to be the key hindrances to reaching capacity.

### 3.3.2. Feedstock's used and their availability

A summary of the feedstocks used by the 35 operations interviewed is given in **Table 8** below, and shows that the vast majority rely on charcoal dust for briquette production currently.

**Table 8:** Feedstock's utilized for current production at the briquetting operators interviewed during this study

| Feedstock Type      | No. Operations Utilising |
|---------------------|--------------------------|
| charcoal dust       | 26                       |
| coconut waste       | 2                        |
| rice husk           | 2                        |
| wild twigs & leaves | 2                        |
| macadamia shells    | 1                        |
| Sawdust             | 1                        |
| TBC                 | 1                        |
| <b>Total</b>        | <b>35</b>                |

Key highlights from the findings are as follows;

- 8 entrepreneurs visited were using (or planned to do so as a core of their business plan) feedstock other than charcoal dust; including corn cobs, rice husks, coconut husks, macadamia shells, sawdust, leaves and twigs from wild plants. Of these 8, only 3 had established regular production capacity. The rest were in the testing stage and were just getting familiar with the briquetting machine.
- Few entrepreneurs had a sense of the technical characteristics of the feedstock they were using in quantitative terms. Many perfected their feedstock pre-processing process through trial and error.
- Of 35 entrepreneurs visited as part of the study; when asked, all expressed a concern for feedstock availability in the medium to long term, and had an interest in exploring alternative sources; with short term concerns on availability in some areas (e.g. Nyeri, Nakuru and Nairobi).

Charcoal dust, the most common feedstock, was purchased in all instances as no charcoal producers were met who were also engaged in briquetting. As summarised in **Table 9**, the by-hand producers in Kisumu appeared to be paying a relatively high price for feedstock, likely due to lack of economies of scale given the volumes they purchased and/or the scarcity of charcoal in the town. Nairobi was the next most expensive as the price of transport of charcoal to Nairobi is factored into the price, whereas in the coast and central regions there is more local charcoal production, and/or charcoal travels less far to reach the market.

With regards to non-charcoal briquetting operations, those that were not able to source feedstock for free appeared to have to pay a relatively high price of up to 1500 KES per 100kg. In Uasin Gishu maize cobs can cost between 120-200 KES per sack (estimated to weigh 20kg) and are already sold as a low-density, non-carbonised household fuel. Non-charcoal dust business models without a captive and cheap feedstock source therefore appear challenged in comparison to charcoal dust.

**Table 9:** Average charcoal dust procurement price by region as reported by briquetting operators interviewed during this study

| Region         | Average Cost of Charcoal Dust (KES/ 100kg) |
|----------------|--|
| Coast          | 173  |
| Central        | 182  |
| Nairobi        | 245  |
| Kisumu         | 321  |
| Kisii          | N/A  |
| <b>Average</b> | <b>210</b>                                 |

Lack of high volume carbonisation expertise, and cost effective feedstock collection capacity, appear to be the key constraints the entrepreneurs will face in trying to incorporate other feedstock sources. At least 10 of the 35 enterprises visited had the intention to use feedstock other than charcoal dust as part of their business plan, however only one had built an operating business model that sources this feedstock from third parties. For most sources of uncarbonised waste, it is likely that feedstock collection economics are not compelling when the briquetting plant is not located in situ, especially when considering the loss of mass that occurs as a result of carbonisation and drying. One model observed had the collector responsible for pre-processing the feedstock (both drying and carbonising), whilst another business produced non carbonised briquettes from a hand press utilising wild leaves. Only one other operation visited was found to have capacity for regular production of briquettes from feedstock other than charcoal dust, as a result of its core business activity in agri-processing generating the necessary feedstock.

**Figure 5:** Examples of feedstocks used for briquette production (left: carbonized coconut husk, right: crushed charcoal dust)

Very few entrepreneurs had ownership of feedstock supply, and this was only observed in the larger businesses that are outside the scope of CARE2. However two conservation-led initiatives briquetting wild plants have established community-based feedstock collection programs that should be further examined. Irrespective of the type, feedstock collection is a major challenge, and key constraint, as it means most businesses have to shoulder both supply chain and product delivery costs and risks, which creates significant operational and financial burden, and prevents businesses from managing production efficiently to meet market demand fluctuations.

### 3.3.3. Quality of the product

The quality of the product was observed to be highly variable and largely unmeasured, with testing limited to burning a sample from a production batch in a stove. Charcoal dust briquettes were observed to suffer from brittleness, especially when transported long distances. Haphazard application of binding agents was also relatively common, with use of soil as a binder raising the ash content further still. In addition, many operations are not crushing the feedstock down to fine material which can result in the briquettes being smoky.

Eight entrepreneurs, out of the 35 visited, had applied for KEBS certification of which 5 have attained the mark and one is pending. Positive feedback on the process from applicants largely depended on whether they had been successful in securing KEBS approval. Those that failed appeared to produce a good quality briquette – sturdy and consistent shape, but did not meet the criteria in terms of the burn characteristics. More research is needed to understand better where the problems are in compliance. Several companies had secured KEBS approval in the past, but were not actively utilising it, due either to it not being critical for their target market or due to not having active production at present.

### 3.3.4. Number of employees in briquette businesses

As shown in **Table 10**, on average each enterprise has 9 employees, with the largest employing up to 80 staff and the smallest being 1 man operations. The number is higher for the larger scale producers and also for community based by-hand operations. These numbers do not account for cases where agents are paid commission for feedstock collection and delivery of product.

**Table 10:** Employee statistics for briquetting operations interviewed as part of this study

| Production Category | No. Operations Visited | Average No. Employees | Min No. Employees | Max No. Employees |
|---------------------|------------------------|-----------------------|-------------------|-------------------|
| Electric            | 20                     | 10                    | 2                 | 80                |
| Hand                | 10                     | 9                     | 1                 | 15                |
| Manual              | 5                      | 5                     | 2                 | 7                 |
| <b>Total</b>        | <b>35</b>              | <b>9</b>              | –                 | –                 |

### 3.3.5. Machinery Used

As indicated in **Table 11**, of the 25 entrepreneurs met who utilised equipment to produce briquettes, most use locally fabricated presses as they are more affordable. Most bought machines direct from fabricators rather than dealers, with typical prices in the ranges below;

- Manual presses sell for 10-15,000 KES (114-171 USD)
- Electrical presses sell for between 30-150,000 KES (343-1715 USD)
- Imported presses typically start from around 1,000,000 KES (11,436 USD) with the total cost depending on the ancillary machines purchased.



**Table 11:** Summary of briquetting press source by category

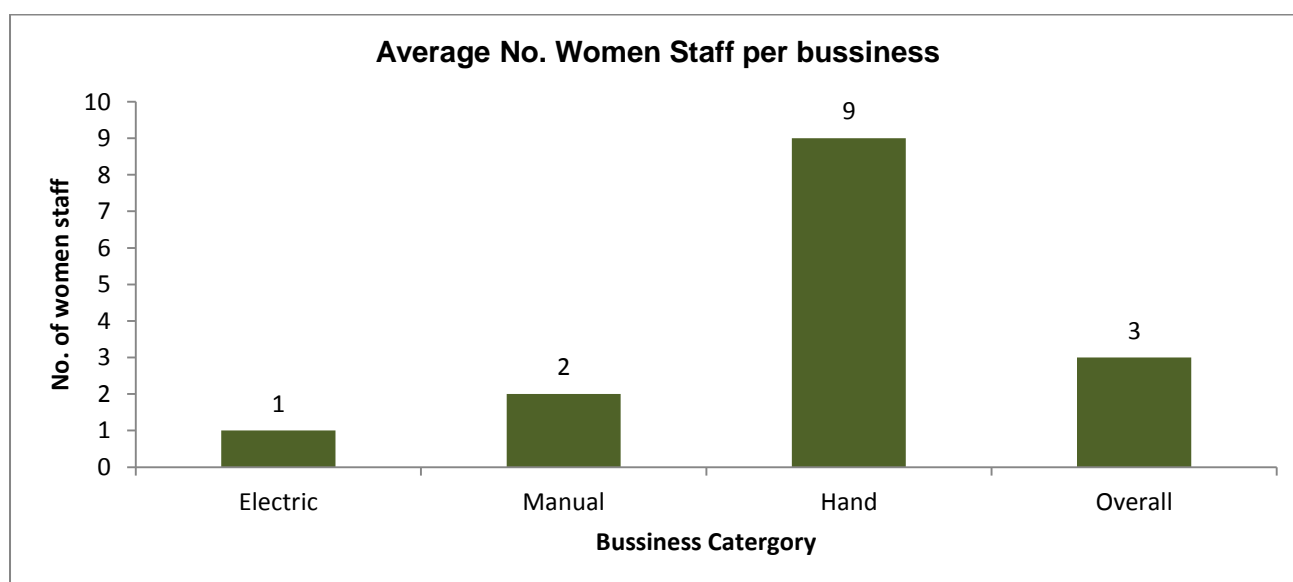
| Equipment (Type / Source) | No. Thereof |
|---------------------------|-------------|
| <b>Electric</b>           | <b>20</b>   |
| imported                  | 6           |
| locally fabricated        | 8           |
| self-fabricated           | 5           |
| TBC                       | 1           |
| <b>Manual</b>             | <b>5</b>    |
| locally fabricated        | 3           |
| self-fabricated           | 2           |
| <b>Total</b>              | <b>25</b>   |

**Figure 6:** Examples of briquette machinery being used. Top left: manual wooden press, Top right: electric machine, Bottom left & right: other manual briquette machines.

In addition the following observations were made;

- Fabricators usually take machines used for other purposes and modify them to produce briquettes - the impact of this on machine quality is subject to further analysis, and largely a function of the quality of the metalwork. However beyond modifications to the extruder and the feeding mechanism there did not appear to be major changes to the functioning of the machines as a result of such modifications.
- Imported equipment was either from China or India.
- Self-fabricated agglomerators were utilised in two instances, producing spherical briquettes.
- The presses from China procured by 5 enterprises appeared to be of identical design, with variations in the motor size and extruder dimensions.
- 10 of the entrepreneurs visited had capacity to fabricate presses in house; of those without such capacity, 4 had machines that were not operational and awaiting repair thereby negatively impacting production volumes.
- Maintenance of screw presses largely focused on re-facing the screw, which requires external servicing unless the machine operator has metalwork expertise.
- Manual presses and imported machines (high pressure) were observed to produce briquettes from non-carbonised feedstock. Locally fabricated electrical machines were only seen to produce briquettes from carbonised material, specifically charcoal dust.

### 3.3.6. Gender



**Figure 7:** Average number of women working in briquetting operations under the different categories

As shown in **Figure 7**, by-hand production had the highest number of women employee's per operation. Overall approximately half (15) of the companies met were either owned by women, had significant number of women in their workforce, or had women in senior positions. Out of these, 7 women owned enterprises were identified. Two enterprises were found to have a specific focus on utilising the trading and networking skills of women in low income areas to sell briquettes.

### 3.3.7. Main customers

Findings from the interviews show that stable markets for carbonised briquettes include: chicken farms (space heating), restaurants (space heating and cooking), hotels and safari camps (water heating and cooking), schools and hospitals (heating and cooking). In other markets, distribution models and stable supply chains are yet to be formed at any widespread scale, although some enterprises are successfully selling to industrial consumers and through high end supermarkets. Business buyers usually expect credit on a 30-day basis. This demand for credit creates working capital constraints for smaller enterprises, which cannot finance enough production to maintain sufficient inventory to supply demand year round.

### **3.3.8.Distribution channels**

A small number of wholesale operations interested in selling briquettes were identified, although they do not have significant operations at present. In most instances the producer takes on delivery risk and responsibility to the consumer, whether that is a commercial consumer or a retail outlet (supermarket / market stall). In low income areas door to door sales by members of the community group or agents engaged by the entrepreneur are used. The cost of transport and economically viable radius of distribution has not been determined by most entrepreneurs. The need and difficulty to secure market (demand is greatest in Nairobi) has lead most to sell wherever they can, and incur the costs thereof for the sake of sales. The experience of entrepreneurs who have tried to sell through retail outlets is that the product is not fast moving due to lack of familiarity, and in some instances bad previous experiences, with briquettes.

### **3.3.9.Level of business and technical skills**

The following observations were made relating to the level of business and technical skills possessed by the enterprises;

- Few businesses had gone beyond registering a trading name (only 3 within scope of CARE2 had a limited liability company)
- The enterprises with the most successful operations and highest level of capacity utilisation often had a combination of management/operations resources to ensure steady production, as well as in house maintenance capacity
- Many entrepreneurially minded managers had been undermined by a lack of technical capacity, leading to purchases of machines that did not work and production practices that exacerbated maintenance and reliability issues
- Many technically minded entrepreneurs had not managed to retain within their team production and marketing equals; thereby holding back their capacity to mass produce and manage wide scale distribution

## **3.4. Level of financial activity**

In relation to the level of financial activity amongst the interviewed enterprises the following observations were made;

- Most run cash businesses
- At least half have bank accounts
- 6 operations have secured loans to finance briquetting activities
- The majority kept some records, covering to varying degrees: cost of production, production volumes and sales
- Records were usually not well organised and seemed largely to be more as a result of training they received, rather than due to any particular need/benefit they got from keeping them.

#### **3.4.1. Use of marketing and branding**

Due to the lack of penetration in retail markets, only 6 entrepreneurs were observed to have branded their product. Examples of branding observed include packing in bags, and in some instances boxes onto which a company name and logo is printed. Packaging materials are often recycled from other industries to reduce costs. Business to business sales form the core of most enterprise's transaction and marketing activities. This requires minimal branding and packaging, with sales in non-branded sacks of 70kg or thereabouts.

## 4. Assessment of the main challenges faced to up scaling the production of briquettes

### 4.1 Main challenges to scale production and market reach

#### 4.1.1 Equipment

Challenges to scale can be separated into the 4 groupings of briquetting operations, as each represents a different cap on productive capacity. It should also be noted that each involves a different business model and attracts a different profile of entrepreneur with varying strengths and weaknesses. **Table 12** below summarises the main equipment related challenges for the different types of operations.

**Table 12:** Main equipment related challenges for different types of operations

| Operation Type             | Main Equipment Challenges  |
|----------------------------|--|
| Hand made                  | <ul style="list-style-type: none"> <li>• Low volume makes it difficult to justify full time production</li> <li>• Non-standard dimensions and inputs mean that quality is variable</li> </ul>  |
| Manual press               | <ul style="list-style-type: none"> <li>• Can be tiring to operate – several entrepreneurs were found to own a press but prefer production by hand (particularly women)</li> <li>• Quality is also highly variable and more testing needs to be done</li> <li>• Production volumes are limited but could be high enough to supply a local area or a small number of medium sized commercial clients</li> </ul>  |
| Locally fabricated machine | <ul style="list-style-type: none"> <li>• Lack of in-house maintenance capacity, and unreliability of support services from equipment manufacturer</li> <li>• Unreliability of power</li> <li>• Limitations of carbonisation capacity to meet press capacity when utilising non-carbonised feedstock</li> <li>• Maintenance requirements - Re-facing of screw: charcoal dust impurities (coins, sand etc) wear down the component, some chose not to sieve the feedstock for these impurities; preferring to incur the cost and time delay of re-facing, over the time it takes to sieve the waste</li> </ul> |
| Imported machines          | <ul style="list-style-type: none"> <li>• Feedstock pre-processing requirements (drying)</li> <li>• Technical understanding and maintenance capacity</li> <li>• Cost of power</li> <li>• Cost of equipment</li> </ul>   |

#### 4.1.2 Product

Charcoal (from wood) performs differently to briquettes; charcoal has less ash and higher energy content. This means that the best uses for carbonised briquettes are space and water/food heating (chicken farms, restaurant heating, water heating in safari camps, heating slow cooked containerized food). High ash content means that the ash can get onto the food when cooked on a grill. This is also an issue where a grill cooks continuously and needs constant stoking and addition of fuel. Awareness of the characteristics, and pros and cons, of briquettes compared to cooking with other fuels need to be made transparent to the mass market in order to avoid disappointment by consumers. Non-carbonised briquettes are generally too smoky to be consumed in commercial or residential settings and as such are only really suitable for industrial wood furnaces.

Table 13 below from Mwampamba et al. (2013)<sup>11</sup> summarises the key differences between charcoal and briquettes, these differences play a key role in aiding better segmentation of the markets most suitable for briquettes. Further research in this regard is recommended in the interventions section later in this report.

**Table 13:** Similarities and differences between conventional wood charcoal and charcoal briquettes (Mwampamba et al. 2013)

| Characteristic   | Wood Charcoal   | Charcoal Briquettes  |
|--|---|--|
| Raw material   | Wood  | Sawdust, coffee husk, nut shells, bagasse, crop residues, dust and fines of coal or charcoal (char-dust)   |
| Source of raw material   | Tree plantations or natural forests / woodlands   | Agri-businesses, crop processing industries, smallholdings, urban charcoal traders, coal mines   |
| Location of production process   | Almost exclusively rural  | Largely rural or peri-urban although charcoal dust usually salvaged from urban traders; urban when raw material obtained from urban biomass waste (e.g. saw dust from carpentry centres) |
| Production process   | Ranges from traditional earth mounds and pits, to metal and brick batch kilns, to continuous rotary kilns and microwave systems. In Africa the earth kiln dominates | Ranges from small scale production using steel drums as kilns and modified meat mincers as extruders to large scale factory set up with densify-first or carbonize-first options         |
| Efficiency of production   | Traditional earth mounds and pits: 15–25% metal and brick kilns: 25–25%; continuous rotary kilns and microwave systems: up to 40%                                   | 15–25% if carbonization is required. >90% if material is already carbonized.   |
| Energy value   | 31–33 MJ/kg   | 22–29 MJ/kg  |
| Ash content  | <5%   | 10–30%   |
| Price(a)   | \$100 to \$300 per tonne(b)   | Varies widely depending on intended market, but generally \$150 to \$250 per tonne   |
| Stove type   | All-metal stove with grate, or metal cladding with ceramic insert, square or round  | As for wood charcoal, but may require more ventilation   |
| Ease of lighting   | Easy to light   | Harder to light, due to higher ash content   |
| Length of burn   | Fast burning due to high energy and low ash   | Slow burning, due to lower energy and higher ash   |
| Extinguishability(c)   | Can be put out for later re-use   | Generally crumbles if put out, and cannot be re-used   |
| Principal applications   | Limited use, usually cooking and barbequing   | Variable uses including space heating, water heating, slow cooking   |
| <p><b>a</b> Based on purchase of 30–50 kg sacks from retailers in major SSA cities. Prices may be considerably higher for smaller retail sizes such as tins or plastic bags</p> <p><b>b</b> USD 100 in cities where supply is not severely constrained (e.g., Lusaka, Kampala), USD 200/t where supply is moderately constrained (e.g., Nairobi, Addis Ababa) USD300/t in Sahel cities where shortage is acute (e.g., Bamako, Ndjamena).</p> <p><b>c</b> Refers to ability to put out fuel for later re-use.</p> |   |  |

<sup>11</sup> T.H. Mwampamba, M. Owen, M. Pigaht, Opportunities, challenges and way forward for the charcoal briquette industry in Sub-Saharan Africa, Energy for Sustainable Development, 17 (2013) 158–170



### 4.1.3 Product Distribution

Virtually all briquetting operations managing to sell steady volumes to their customers, manage their distribution chain to the end client. This places the sector at a key competitive disadvantage to the charcoal sector, which has developed organically a network of producers, wholesale traders and several layers of retail distribution, without any real investment in marketing and branding. The companies interviewed as part of this study who were involved with distribution of briquettes cited the following key problems:

- ⇒ Lack of steady supply
- ⇒ Lack of product consistency in terms of quality
- ⇒ Packaged weight inconsistent with market demand
- ⇒ Producer price is too high to make it competitive with charcoal and other cook stove fuels

Resolving these problems will require effective market research, to calibrate the target market to production (quality and quantity) and logistics capabilities. A number of companies, whose sole focus is the distribution of briquettes, were interviewed as part of this research and identified as potential partners with whom to develop distribution capacity and insight into the nature of market demand.

### 4.1.4 Costs of Business Formalisation

Bringing a business into the formal sector creates compliance costs which impact profit margins. Analysis is required in the case of each entrepreneur to determine how to manage this, as the companies move from the informal sector to become formal enterprises.

## 4.2 Macro Level View of Sector Challenges & Opportunities

The high level view of the sector recently conducted by Mwampamba et al. (2013) summarises the challenges and opportunities in the sector from a top down perspective, as shown in the table below:

**Table 14:** Summary of factors affecting the charcoal briquette industry in Sub-Saharan Africa (Mwampamba et al. 2013)

| Factors                  | Supporting Conditions  | Opposing Conditions   |
|--------------------------|--|---|
| Technological            | <ul style="list-style-type: none"> <li>Many technological options available for all scales of production</li> <li>Machines can deal with most types of biomass waste (single producer could handle multiple type of raw material)</li> <li>Potential to co-generate electricity and gas</li> </ul>                                   | <ul style="list-style-type: none"> <li>For large scale production, machinery (and parts) must be imported (often from India or China)</li> <li>A highly skilled technician needed to adjust machine settings to local conditions</li> <li>May require design of stoves more appropriate for briquettes</li> </ul> |
| Economic                 | <ul style="list-style-type: none"> <li>Voluntary carbon market or clean development mechanism: potential to earn carbon credits from avoided emissions</li> <li>Cheap (in some cases free) biomass waste</li> <li>Place value on waste and creation of new product</li> <li>Diversification of national energy portfolios</li> </ul> | <ul style="list-style-type: none"> <li>Marketing of new product is expensive and benefits the competition</li> <li>High capital costs for medium to large scale production</li> <li>In some cases (for agricultural waste), only seasonal supply of biomass</li> </ul>  |
| Environmental and Health | <ul style="list-style-type: none"> <li>Climate change mitigation requires implementation of all viable methods for decreasing GHG emissions</li> <li>Use of waste that otherwise is unused, or disposed of in rivers, or burned, especially in</li> </ul>  | <ul style="list-style-type: none"> <li>Requires consistent supply of nearby biomass waste</li> <li>Indoor pollution improvement advantage over lump wood charcoal not sufficiently large to shift lump wood consumer to briquettes</li> </ul>   |

|                     |   |   |
|---------------------|---|---|
|                     | urban areas <ul style="list-style-type: none"> <li>• Briquette industry still viable under sustainable forestry policies</li> <li>• Briquettes could replace unsustainable charcoal and firewood production systems</li> <li>• Decrease air pollution indoors and outdoors</li> </ul>   | <ul style="list-style-type: none"> <li>• Closed indoor cooking with briquettes still not viable — carbon monoxide poisoning</li> </ul>  |
| Political and Legal | <ul style="list-style-type: none"> <li>• International climate change policies such as REDD+ and CDM for avoided deforestation and clean development technologies;</li> <li>• Increased national interest in diversification of the energy portfolio;</li> <li>• Availability of funds to conduct National Biomass Energy Strategies (BEST);</li> <li>• International Year of Sustainable energy for all (opportunity to explore future energy options);</li> <li>• Global tendency among developed nations towards substitution of fossil fuels with biomass</li> </ul>  | <ul style="list-style-type: none"> <li>• Contradicting policies on the role of biomass energy in national energy portfolios (unclear which policies and ministries would address briquettes)</li> <li>• Lack of cohesion among producers (e.g., to share cost of marketing or to lobby for more favourable policy conditions)</li> <li>• Absence of products standards — it is easy to put on the market low-quality briquettes that can completely destroy user's trust of all similar products [especially when it is a new product on the market]</li> </ul>   |
| Social & Cultural   | <ul style="list-style-type: none"> <li>• Desire for cheap, reliable, and clean energy — particularly in urban areas</li> <li>• Important similarities with charcoal such that shifting to briquettes requires least 'dramatic' behavioural adjustments</li> <li>• Some awareness and desire for sustainable/forest-friendly charcoal alternative</li> <li>• Energy crisis in many Sub-Saharan countries — increased realization there is need to expand energy options and to include biomass in national energy portfolios;</li> <li>• Provide employment and labour in production areas and along the supply chain</li> </ul> | <ul style="list-style-type: none"> <li>• Inherent unwillingness to change cooking practices;</li> <li>• Power relations: final user (the cook) may not have decision making power to determine which fuels are utilized at household level ("maid culture theory")</li> <li>• Upgrading to electricity and gas are more desirable improvements (in urban households) that shift from wood charcoal to briquettes</li> <li>• Improving energy options in the household not a priority: contentment with existing conditions</li> <li>• Few marketing studies exist to fully understand consumer preferences</li> </ul> |

### 4.3 Main Development Needs of Small and Medium Sized Briquette Businesses

The most frequently cited requests from the interviews were as follows:

1. Equipment maintenance expertise to increase machine reliability
2. Research on improved briquette binder (existing binder not effective in holding the briquette together and/or makes the ash content very high)
3. Lack of adequate space to dry briquettes
4. Need for higher capacity machines

### 4.4 Main Opportunities Identified by Businesses for Expansion

The main opportunities identified by businesses for expansion include the following:

- ⇒ Diversify feedstock supply from charcoal dust, in order to reduce cost of supplies and increase volume, largely from locally available agricultural wastes. Perception of ample availability, yet few models for its purchase and collection exist, on which to base a collection and processing strategy.
- ⇒ Increased uptake in retail markets based on improved market awareness,



#### 4.5 Potential for Utilizing Different Types of Feedstock



**Figure 8:** Left: Example of briquettes made from charcoal dust (carbonised), Right: Example of briquettes made from rice husk (uncarbonised)

In rural areas, where non-charcoal based feedstock is abundant due to agricultural activities, fuel wood is also plentiful and as such there is a challenge to market the product to the local population. As such, appropriate location of the briquetting plant must be determined in order to find the sweet spot between proximity to market and feedstock source. Depending on the capacity of the entrepreneur to co-locate with feedstock source, business models that have significant costs relating to both collection of feedstock and delivery of product to market remain challenged.

No comprehensive studies have been undertaken to accurately estimate the volume of unused agricultural waste in Kenya. Data is available for researchers to work backwards from crop production volume records estimating the amount of non-crop organic matter produced for a certain type of crop, based on agricultural statistics (e.g. maize stover and cobs for a certain tonnage of maize seed). However, competing uses and weight losses from processing (e.g. drying, carbonisation) need to be taken into account to accurately estimate the amount of feedstock available in the country, and the true cost and supply characteristics. There is abundance of agricultural waste in some areas, but a lack of demonstrated viable business models with a pre or post briquette production carbonisation process, producing a briquette which is suitable for domestic and commercial consumption.

Impurities and lack of sorting and crushing of the feedstock before briquetting affect briquette quality and characteristics. For carbonised feedstock, at its present level of sophistication (mostly using simple drum kilns that wear out relatively quickly), the scale of production of briquettes is not matched to the production capacity of kilns, when considering the lack of work space challenge faced by many entrepreneurs. To overcome this challenge the entrepreneur would either need the feedstock supplier to carbonise the feedstock, or develop a higher capacity carboniser. Higher capacity would require a design that allows for continuous production of carbonised material, and affordable fabrication of such equipment. No such technology exists in the market at present.

#### 4.6 Potential for New Markets

Potential markets exist for briquettes in the commercial, industrial, domestic and export market segments as outlined below;

|                   |  |
|-------------------|--|
| <b>Commercial</b> | Depends on the food prepared (e.g. on grill the high ash content can affect food quality)  |
|                   | Higher demand in a cold area (space heating)   |
|                   | Definite potential to scale up in tourism industry if transport costs can be managed through only delivering to those in close proximity or selling to traders who supply tourist lodges   |
| <b>Industrial</b> | Market for supply to chicken farms around Nairobi is highly competitive and well served. Depth of related demand in other locations subject to further research  |
|                   | Supply to industrial consumers of non carbonised briquettes for boiler consumption is not well developed and presents a significant opportunity due to the scarcity of fuel wood and high cost of fossil fuels   |
|                   | Industrial consumers require much higher volumes than currently produced (5,000mt/yr sum total of production capacity of all plants visited as part of this study). Some may need to change their boilers, and to be willing to do so must be assured of briquette quality and supply (it cannot be done on a gradual basis). As such this market is likely to be served by a different category of entrepreneur outside the scope of the CARE2 program. |
| <b>Domestic</b>   | Smokeless characteristics are a key advantage, however variable quality of briquettes in the market undermines consumer confidence   |
|                   | Burn characteristics make briquettes only suitable for some foods (e.g. beans (central staple) suitable Vs rice (coast staple) not suitable), this needs to be clearly communicated in the marketing of the product  |
| <b>Export</b>     | Significant demand from the Middle East due to popularity of barbecuing  |
|                   | Charcoal dust briquette enterprises constrained by KFS requirements for traceability of exported products to a sustainable source  |
|                   | Significant potential for operations consuming feedstock from traceable, sustainable sources   |

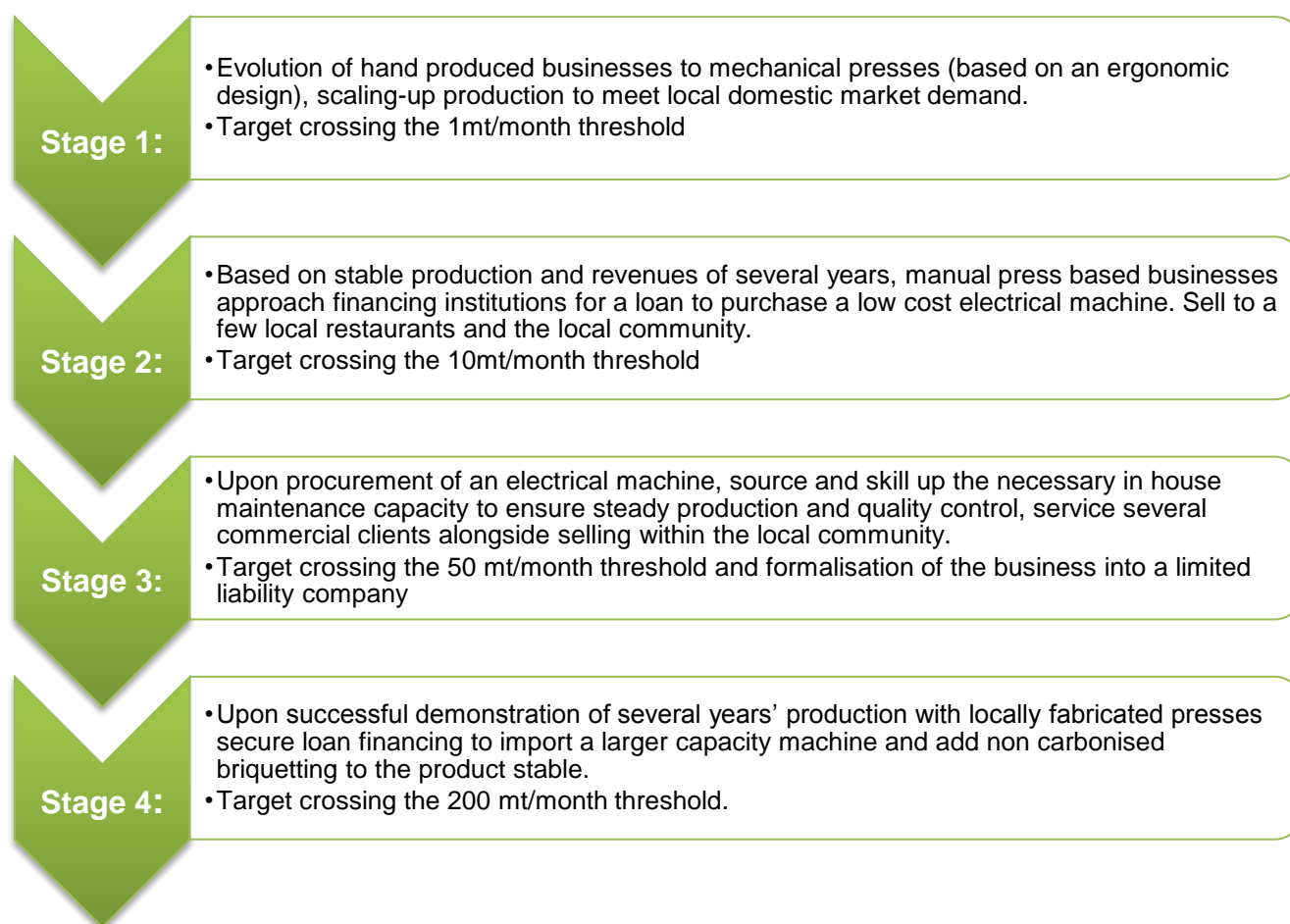
#### 4.7 Gaps in the current market

In addition the followings gaps have been identified in the current market for briquettes;

- High volume carbonization technologies
- High volume supply of briquettes to industry and export markets
- Substitution of middle class urban demand for charcoal with briquettes
- Decentralised pre-briquetting processing capacity for feedstock to make it more economical to transport

#### 4.8 Realistic Growth for small and medium sized businesses

There is no real continuum of business model progression in the biomass briquetting sector. Briquetting operations are started (and in many cases stagnate) at different levels based on the circumstances, location, resources (marketing, supply, financial and technical), and opportunities; which dictate the entry level into the sector. Also, different types of entrepreneur are attracted to different levels of production, in direct proportion to the start-up costs. However realistic production growth targets could be set as follows:



#### 4.9 Inputs necessary to achieve growth

To achieve growth within the briquette businesses and encourage progression within the various business stages the following inputs are necessary;

- ⇒ Training to develop in house equipment maintenance capability.
- ⇒ Training on which markets their briquettes are most suitable for, and why, so as to improve their sales and marketing efforts.
- ⇒ Training on book keeping focused on the use of the data collected from well managed accounts in business decision making, and the advantages it provides in providing the transparency necessary for financial institutions to lend money.
- ⇒ Greater controls and enforcement in the illegal charcoal industry, in order to improve the competitive environment for legitimate briquetting businesses.
- ⇒ Determination of cost effective collection and delivery radius for each entrepreneur in order to rationalise production location and sales strategy.

#### 4.10 Financial requirements of small and medium briquette businesses

In addition small and medium briquette businesses have the following financial requirements;

- ⇒ Working capital to procure feedstock and meet operating costs (including quality assurance and maintenance), in order to generate sufficient inventory to manage demand fluctuations, and bridge the gap until payment from commercial clients who demand credit. The size of such facilities at the various stages of enterprise development identified in the briquetting sector earlier, are subject to more detailed financial analysis of individual entrepreneur's operations.
- ⇒ Capital expenditure financing to support cost of stepping up the equipment ladder
- ⇒ Capital expenditure to establish and expand operations – mostly for drying space and secure storage

#### 4.11 Gender

The following research questions were added to the study to explore further how women participate in the briquette sector and any gender specific challenges:

- Are male and female entrepreneurs facing different challenges?
- Are there any specific barriers that hinder female led businesses in the sector?
- Assess the general participation of women in the sector as both owners of businesses but also as employees of briquette businesses. Are there things that can be done to enable more female led businesses and employees?
- In what parts of the value chain and production process are women most present?
- For the potential interventions, do female led businesses require any specific interventions or considerations?

The study findings showed that female entrepreneurs are more prominent in hand made and manual operations, largely due to internal and external initiatives to improve their livelihoods, as well as their close involvement in the preparation of food and collection of cooking fuels. Their obligations to care for and feed the family, and tend to the home, usually mean that most such operations are run from the homestead thereby creating an immediate, non-business related limitation on operating space and transport considerations.

Female entrepreneurs face more challenges with regards to physically operating manual press. Several own a press, but prefer to produce by hand for this reason. Designs of such presses need to be modified to better suit women. In addition, no female maintenance experts or briquetting equipment fabricators were encountered during the course of the study and it is suggested the program could proactively seek to train such to ensure female led businesses have adequate technical and maintenance capacity. The businesses with electric machines that had the greatest problems with maintenance were mostly run or owned by women and lacked in house technical expertise. Some businesses also commented that the work is dirty and women are less inclined to enjoy it as a result. Actions such as record keeping, counting, packing, and door to door sales were perceived to be more suited to women; whilst operations of the briquetting plant, collecting charcoal dust and delivering product to clients was largely dominated by men.

## 5. Intervention plan for PDP3 in Kenya

GVEP International has proposed the following interventions in order to support briquette enterprises achieve their market development goals:

- Technology and business coaching and mentorship through GVEP's regional specialists
- Business development services including business management skills training and business plan development
- Assistance with identifying new markets, branding and creating consumer demand (events, marketing materials)
- Support in identifying investment needs for scale up and linkages to loan facilities
- Technology and innovation support, including product testing and advice on improving designs and techniques used in manufacturing

### 5.1 Specific aim of the Program

Because of the geographic variations in manufacturing capacity, aims focused on raising production capacity and market penetration are proposed at a regional level as follows, as per the stages identified in section 4.8:

|                                     |  |
|-------------------------------------|--|
| <b><i>Kisumu &amp; Kisii</i></b>    | <ul style="list-style-type: none"> <li>• Largely focus on stage 1 and stage 2 entrepreneurs with a small number of stage 3, consider expansion of Kisii coverage to include Eldoret, where the sector is also beginning to emerge</li> </ul> |
| <b><i>Nairobi &amp; Central</i></b> | <ul style="list-style-type: none"> <li>• Largely focus on stage 3 entrepreneurs and test some potential wholesale distribution models, with a small number of stage 4 businesses also included</li> </ul>                                    |
| <b><i>Coast</i></b>                 | <ul style="list-style-type: none"> <li>• Largely focus on stage 2 and stage 3 entrepreneurs and focus on solving the power reliability problem through solar and other potential solutions</li> </ul>  |

### 5.2 Type of business to be worked with

In order to secure activities across the regions it is proposed that the program engages at all four of the aforementioned stages of development. Within the stages it is proposed that an additional set of criteria be considered as follows, to ensure the right candidates are selected:

- The entrepreneur is focused on briquetting with the majority of their time and looks to it to generate the majority of their income.
- Exclude side businesses of larger scale industrial operations. Industrial producers would be better supported through other GVEP led initiatives such as the Climate Innovation Centre (CIC) and the Enterprises Support Team (EST), as they are likely to have capital and technical requirements beyond the scope of CARE2 activities
- Handmade operations are suggested for support in urban low income areas, despite low production levels, as an opportunity to test various methods of distribution within the local community.

### 5.3 Specific program activities to meet business needs / gaps in the market

The following key activities are proposed for the program:

1. Produce training materials which segment and correlate scale and type of production, to optimal quality under each production method, to the most suitable end market. Conduct trainings at Ministry of Energy Centres for briquetting entrepreneurs in this regard and make materials freely available to those included in the program.
2. Research the network of equipment suppliers to identify those with good practices and quality of machines.
3. Compile a directory of accredited equipment suppliers and equipment maintenance experts.
4. Explore potential for locally fabricated mass production with the producers of the most reliable equipment.
5. Support the development of service agreement based revenue models for equipment fabricators, to ensure after sales support is provided in a more structured manner and adequately incentivises the equipment manufacturer to do so.
6. Increase product standards and production consistency through training on equipment maintenance and feedstock preparation methods for entrepreneurs brought into the program.
7. Research product demand characteristics in terms of quality and quantity, packaging and pricing of household (cook stove friendly) and commercial use in heating and cooking (restaurants, hotels, schools, chicken farms).
8. Focus on markets/distributors in the immediate vicinity of the entrepreneurs joining the program to aid in minimizing transport costs and delivery risk.
9. Combine market research with identification of key standards and permits etc required to serve each market segment (e.g. KEBS for formal retail, KFS for export etc).
10. Form association of producers and accredit those who meet the standards (review the IFC Lighting Africa Program for solar lanterns by way of comparison) to produce a marque for packaged products that explain and guarantee key characteristics of the product to consumers (consider this as a separate, later stage program as costs will be significant and currently it is unlikely that there will be sufficient demand from the producers to join such a scheme due to focus on local markets that do not demand the KEBS standard).
11. Subject to meeting quality standards consistently, experiment in developing a marketing network in collaboration with select wholesalers, with capacity to manage large numbers of outlets and distribution points at a retail level in the informal sector, so as to facilitate mass market demand generation.

In addition, interventions in the following areas would be of benefit to the sector:

| Intervention                                      | Details   |
|---|---|
| <i>Further research on structural challenges:</i> | <ul style="list-style-type: none"> <li>Wholesale market price of charcoal and availability of firewood create structural constraint to the adoption of briquettes and investment in higher quality machines – as briquettes are typically seen as a replacement product for charcoal, the price of charcoal is a key benchmark against which briquettes are measured. If a briquette manufacturer decided to produce briquettes with comparable characteristics to charcoal (especially with respect to ash content), they would have to utilise premium priced, market leading, sophisticated technology in briquette production. The resulting cost and therefore payback period would not</li> </ul> |



|   |  |
|---|--|
|   | <p>provide adequate incentive to do this, as the producer could not raise the price of the briquettes above that of charcoal, which is produced much more simply and without the need for sophisticated equipment. Further research is needed to understand the dynamics of the charcoal sector, and the short to medium term horizon goals for current policy development and sector reform initiatives.</p> <ul style="list-style-type: none"> <li>• Export potential constrained by KFS regulations of sustainable charcoal requiring certification that the source is sustainably managed</li> <li>• Small scale producers currently run informally and by transforming to the formal sector will have to absorb regulatory compliance costs of running a business legitimately in this sector, which will impact profitability – is there enough margin to absorb this?</li> <li>• Research into the potential for the establishment of non-carbonised waste collection and pre-processing hubs and/or other potential solutions and partnerships to resolve the aggregation and drying challenges of non-carbonised waste, in a similar vein to recycling schemes in urban areas – likely to require county government level engagement and support.</li> </ul>  |
| <i>Partnerships with local fabricators and technical experts to explore innovations in low cost equipment capable of:</i> | <ul style="list-style-type: none"> <li>• Continuous carbonisation to enable larger scale processing.</li> <li>• Briquetting at a faster rate allowing for less water to be used as a binding agent, thereby reducing drying time.</li> <li>• Reducing product drying time through developing best practice with regards to design and layout of racks.</li> <li>• Reducing energy costs and mitigating the impact of grid outages through cost effective back up power systems.</li> <li>• Preparing high grade feedstock – sieving, crushing and removal of impurities in an efficient low cost manner.</li> <li>• Developing more efficient binding agents which enhance the combustion characteristics of the briquette.</li> </ul>   |
| <i>Research on marketing strategy:</i>  | <ul style="list-style-type: none"> <li>• For each entrepreneur - based on sizing of facility, an economically viable radius of delivery should be determined. Several producers from outside Nairobi were looking to sell within the city but will continue to struggle against local producers.</li> <li>• Nairobi is the main market due to high altitude creating a need for heating, and the urban environment constraining the availability of wood fuel, market needs in other parts of the country are likely to be different.</li> <li>• Manage transport costs – determine market potential in local towns and whether existing location of the entrepreneurs operations are economically viable.</li> <li>• Identify potential buyers who would prefer the characteristics of briquettes the entrepreneur has the capacity to produce.</li> <li>• Market awareness created through public events to create retail product awareness in areas where a critical mass of producers have been identified who can produce at the necessary standard and volume.</li> <li>• Potential for smaller chains of supermarkets outside the top nationwide brands needs to be scoped, and analysis of the demand from the growing middle class segment needs to be analysed, for producers to begin targeting this segment where their product is appropriate.</li> </ul> |

#### **5.4 Additional support / resources needed to carry out proposed activities**

To implement these activities there is potential need for further support to the GVEP International team within the following areas;

- ⇒ Additional technical consultancy services to engage individual entrepreneurs and assess needs
- ⇒ Market research services provided by third party specialist firms
- ⇒ Partnerships with technical resource providers (local and international universities, industrial design institutions and related government entities).

#### **5.5 Size of loan required by program participants**

The survey suggested that most entrepreneurs were unwilling to consider taking on any debt until they had some level of visibility as to the level of market security. On that basis there was interest for funding in the 100,000 – 500,000 KES (~1141 – 5707 USD) range for the purposes of procurement of machinery, securing more production space, warehousing, and meeting working capital needs. These figures should be subject to greater scrutiny through the work of the business development mentors, to prepare each entrepreneur on the program in making a bank financing application.

#### **5.6 Businesses suitable for the program and growth targets**

The study went on to give a summary of the companies who met most of the initial criteria set out by GVEP (as stated in the appendix to this document) and covered the interventions these businesses need and proposals on how the program could be structured to meet those needs, as well as the targeted outcomes of those interventions. These details have been omitted from this report to maintain business confidentiality.

However it was found that there is a continuum of briquetting entrepreneurs from those that are more technically minded to those that are more business focused. Those with technical skills are able to maintain and operate the machines and have a good understanding of the characteristics of a good quality briquette, but rarely do they have a good understanding of business development, marketing, and how to build a team that delivers results. The study separated those entrepreneurs who had the best fit with the scope and activities of the program (suitable candidates), those who would require some additional research to identify suitability (potential candidates), those whose strengths lie mainly in their technical capacity and potential for collaboration with the program therein, and those who would be strong candidates for piloting various distribution models. Also identified were briquetting operations deemed beyond the scope of the program.



## 6. Conclusions

### *Traits of Successful Business Models*

Businesses experiencing the least challenges were observed to:

- Focus on a few clients with capacity to absorb most of the production
- Have in house equipment fabrication and maintenance capacity, and therefore understanding of optimal inputs to produce quality briquettes
- Retain in house feedstock collection and product delivery capacity
- Be strategically located, in close proximity to the feedstock source and/or a major client
- Have largely been self-funded, due to a lack of viable and financing options

As such interventions towards supporting the enterprises incorporated into the CARE2 program should aim to build these capabilities within the companies.

### *Key Structural Challenges*

In terms of research and development in the sector, the following key constraints were seen to be holding companies back from scaling up operations:

- Lack of equipment supplier support and other technical service providers, as well as established standards of practice, constraining scale up planning and product quality development
- High costs (and impact on profit margins) of business formalisation
- Fears of more direct exposure to regulatory risk as a result of formalisation, due to a regulatory environment which is not supportive of briquetting enterprises
- Price and performance cap placed on briquettes through perception of the product as a charcoal replacement
- Lack of affordable, higher capacity carbonisation techniques challenge the replacement of charcoal dust as briquette feedstock

These challenges make it difficult to scale up production and result in the proliferation of unstable operations and a transient, opportunistic trader-based business culture; rather than a long-term value creating approach to building a business through formal market channels.

### *Gender Related Challenges and Solutions*

Success of women in the briquetting sector is largely restricted by equipment operation and maintenance capacity;

- For larger scale production (locally fabricated electrically powered machines), women entrepreneurs require training to develop in house capacity to maintain and enhance their presses. Community based operations in low income areas typically have a large number of participants relative to larger scale briquetting operations.
- For smaller scale production, to enable the transition of women's groups to manual, mechanised production; presses need to be designed that are ergonomically suited to women's needs. None of the presses seen in the market so far appear to have taken this into their design consideration. It would be necessary to work more closely with women to understand what sort of operating function they prefer.

## 7. Moving Forward

Following on from the Briquette Market Assessment as detailed in this report GVEP has recruited 25 briquette entrepreneurs into PDP3 under the CARE2 program. These businesses were recruited following on from recommendations made in this study and further assessments from the project team. The recommendations outlined in this report have provided valuable insight into the type of interventions that should be targeted by the program. GVEP International intends to build these recommendation into the support offered through the PDP3 program, including in the following areas;

- Provision of in house technical capacity for machine maintenance & use to increase the productivity of equipment.
- Research into how manual briquette machines can be made easier to use for female entrepreneurs.
- Further research into the different market segments, to understand the needs and expectations of consumers to provide vital feedback to entrepreneurs targeting these markets.
- Assisting businesses in marketing their products and developing new market linkages, including linkages to retailers where appropriate.
- Optimising the quality of the briquettes based on type and target market.
- Linking entrepreneurs to finance where required, allowing them to partake in expansion activities and scale up their business (for example purchasing a new machine).

## 8. Appendix

### 8.1 Appendix 1: Details of other briquette initiatives in Kenya

| Organisation   | Initiative Name  | Details   |
|--|--|---|
| Practical Action East Africa                           | Briquette Commercialisation Project  | Two projects: Briquette commercialisation (2011 to February 2013) and scale up (2013 - 2015). First program trained 100 small scale start up briquetting entrepreneurs, making briquettes by hand and with a manual press; second program (commencing this year) targets another 200 at a similar scale of production, starting up new businesses. Working in Nairobi and Nakuru urban and peri-urban low income areas. Funded by EEP. Focus on building up entrepreneurial activity from the bottom up.  |
| Middlesex University, Kenyatta University, Terra Nuova | Fuel from Waste Network  | Network of briquetting manufacturers. Implementation partners: Kenyatta University's Department of Energy Engineering, Terra Nuova. Funded by UK Department for Business, Innovation and Skills. Focused on the "jua kali" informal manufacturing sector. Aimed to utilise design expertise at the universities to support entrepreneurs to develop improved presses and products. Focused on meeting domestic energy use market needs using low cost technology. Implemented between July 2010 and June 2011, continued to mid-2012 as a blog. Program culminated in a conference of 75 briquette entrepreneurs. |
| SNV  | Improved Charcoaling Technologies and Briquetting using Agricultural Waste | Demonstration project running January to September 2013 in Eldoret aimed at introducing briquetting to charcoal entrepreneurs (i.e. train them to use dust). Also strove to organise community groups to make briquettes from carbonised saw dust and maize cobs. Funded by EEP.  |

**8.2 Appendix 2: Inception Report Summary of Findings / Recommendations for Interventions –  
21<sup>st</sup> May 2013**

| Cluster                   | Summary of Findings / Recommendations   |
|---------------------------|---|
| <i>Western</i>            | <ul style="list-style-type: none"> <li>• Make briquettes by hand</li> <li>• Predominantly women led/staffed, community groups and CBO's</li> <li>• Suggest purchase of hand presses and training in the correct use of, is first level of intervention, with a view to registering business operations there after</li> <li>• Supply is focused on the local community and internal subsistence requirements</li> <li>• Primary income generating activity for groups involved</li> </ul>   |
| <i>Coast</i>              | <ul style="list-style-type: none"> <li>• Lack of technical expertise in maintenance of briquetting machines is the biggest challenge to those operating electric machines</li> <li>• Power shortages and unreliability is also a major constraint</li> <li>• Feedstock appears to have been politicized in some cases constraining the capacity of some operators (coconut waste)</li> <li>• One example of effective community involvement in feedstock supply has been demonstrated and needs additional resources to scale up</li> <li>• Good technical expertise in quality manual press briquette manufacturing should be supported further</li> <li>• MoE Energy centre could serve as a focal point for GVEP trainings and events in the coastal region, outreach should be co-ordinated with the centre</li> </ul>  |
| <i>Central</i>            | <ul style="list-style-type: none"> <li>• Technical expertise in machine fabrication and maintenance readily available</li> <li>• Distance from market is a challenge and eats into profit margins. Charcoal is readily available and affordable so most manufacturers have to seek out buyers further afield or those who require a smokeless burning and low carbon monoxide emissions (e.g. chicken farmers)</li> <li>• Abundance of charcoal manufacturing means feedstock is plentiful, this has created many small enterprises in charcoal briquetting resulting in excessive competition for feedstock</li> <li>• Alternative feedstock readily available (rice husks, maize cobs, coffee husks, maize stover, sawdust) but power costs deter operation of equipment that could utilize such feedstock (machines producing uncarbonised, heated briquettes), and carbonization practices are not widespread outside of ordinary charcoal production</li> <li>• Major problem with space due to long drying time in cold season, when demand is greatest</li> </ul>  |
| <i>Nairobi</i>            | <ul style="list-style-type: none"> <li>• Ready supply of charcoal dust and large market to serve</li> <li>• Lack of space is a key issue, particularly in low income areas, due to high cost of land and cold seasons resulting in longer drying time</li> </ul>  |
| <i>General Challenges</i> | <ul style="list-style-type: none"> <li>• For those without technical expertise machine breakdowns and maintenance are a serious hindrance to increased production capacity</li> <li>• Issues with binding agent reducing briquette quality - almost all entrepreneurs wanted technical assistance on improving binding agent quality and reducing ash content/brittleness</li> <li>• Impurities in charcoal dust collected from the earth (bits of metal, coarse soil/sand) damage the machine. Most producers found it more straightforward to fix the machine when it broke rather than sieve the feedstock of coarse materials and impurities</li> <li>• A low cost mechanized sieving technique would greatly enhance briquette quality and reduce breakdowns</li> <li>• Knowledge in the hands of relatively few individuals on how to make a quality briquettes and how to maintain an electric machine</li> <li>• GVEP should incentivise knowledgeable individuals to share knowledge and best practice where possible, especially in the formation of standards for equipment, feedstock and briquettes</li> </ul> |