

## CASE

# Briquettes from agro-waste and municipal solid waste (Eco-Fuel Africa, Uganda)

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## Supporting case for Business Model 2

Location:	Lugazi Town, Buikwe District, Uganda
Waste input type:	Agro-waste, municipal solid waste
Value offer:	Briquettes (Clean cooking fuel), biochar
Organization type:	Private
Status of organization:	Operational (since 2010)
Scale of businesses:	Small
Major partners:	National Bureau of Standards, Calvert Foundation (equity), Global Catalyst Initiative (grant)

## Executive summary

Eco-Fuel Africa (EFA), located in Lugazi Town, Buikwe District, Uganda, converts farm and municipal waste into briquettes and biochar fertilizer. With good understanding of local fuel usage conditions, EFA ingeniously developed simple, low-cost, easy-to-use technologies – *kilns* for carbonization of waste and *eco-fuel press machine* – to convert it into briquettes, which are cheaper than charcoal and other

## KEY PERFORMANCE INDICATORS (AS OF 2012)

Land use	0.4 ha and 0.8 ha in 2 sites					
Capital investment:	USD 10,500 owner's investment and USD 60,000 from donors; in 2013, USD 372,892 capital required to expand the business					
Labor:	19 full-time and 3 part-time workers					
Total cost of operation in 2012:	USD 98,259 per year					
Output:	200 tons of briquette per year sold for 170 USD/ton					
Potential social and/or environmental impact:	Household savings 200 USD/year, women retailers earn 1,825 USD/year, 1,500 farmers earn 360 USD/year, 43 micro-franchisees earn 1,728 USD/year, job creation, avoidance of GHG emissions and improvement of educational opportunities for women					
Financial viability indicators:	Payback period:	N.A.	Post-tax IRR:	N.A.	Net profit	USD 3,000

briquettes. EFA implements a micro-franchising system whereby it trains its important chain actors (i.e. rural farmers, micro-franchisees and women retailers) to produce and distribute its briquettes to its final customers (i.e. poor households). The project, in addition to combating deforestation and climate change, generates jobs, creates entrepreneurs through its micro-franchising scheme and boosts rural incomes. In addition to the positive effect from the business, a portion of the business' income is donated to tree-planting initiatives to restore destroyed forests.

### Context and background

In Uganda, over 90% of the household energy is derived from biomass, mainly firewood and charcoal. The continuous dependence on firewood and charcoal contributes to deforestation. As forests disappear, gathering of firewood, which is mainly done by women and children, becomes difficult. Inspired by the problem of collection of firewood, and by the problems girl children were going through in missing school to fetch firewood, as well as the rate at which Africa was losing forest cover, EFA set out to find a solution. The enterprise invented a simple technology, which can be used by poor communities to convert farm and municipal waste into briquettes and biochar fertilizers. The briquette made, known as 'green charcoal' is a carbon neutral cooking fuel that is made from renewable biomass waste such as sugarcane waste, coffee husks and rice husks. In Uganda, the institutional setting in waste management and recycling supports innovations in renewable energy. However, at the assessment time, no statutory guidelines were available for carbonization and charring.

### Market environment

The enterprise's target customer segment is households living in villages, who rely on firewood and charcoal for fuel. Uganda has faced rising charcoal prices due to, among other factors, increased levies on charcoal burners by the government of Uganda in recent years. Between 2009 and 2011, the price of charcoal increased from 0.25 USD/kg to 0.60 USD/kg (an increase of 140%) (Ferguson, 2012). With soaring charcoal prices and increased awareness about the problems related to charcoal use, there is increased demand for *cheap* and *clean fuel* for cooking. Briquettes can serve as a direct replacement for firewood and charcoal. This gives EFA the opportunity to tap into the growing market where charcoal prices are rising. It is also planning to tap into other market segments such as small enterprises (restaurants) and institutions (schools) in the near future. Market competition is relatively moderate. Although there are a number of other producers producing briquettes such as Kampala Jellitone Suppliers Ltd. (KJS) and other small informal producers of briquettes, EFA's briquettes are cheaper as it uses mechanical methods with very little electricity input which keeps costs lower than those of competitors (Table 10). EFA business has a great potential as it has a low investment cost while at the same time, the product has a high market demand.

**TABLE 10. PRICES OF BRIQUETTES AND ALTERNATIVE FUELS (DEC 2011)**

FUEL TYPE	PRICE (USD/KG)
Eco-Fuel Africa briquettes	0.17
Firewood	0.24
Kampala Jellitone Suppliers Ltd. briquettes	0.28
Informal producers briquettes	0.40
Charcoal	0.60

Source: Ferguson 2012; Personal communication with Eco-Fuel Africa; Personal communication with KJS.

## Macro-economic environment

In Uganda, wood is by far the most important source of energy, even though the importance of petroleum and hydroelectric power is growing. The contribution of firewood and charcoal to Uganda's GDP is estimated at USD 48 million and USD 26.8 million respectively (UNDP, 2011). In terms of employment, biomass production creates nearly 20,000 jobs for Ugandans. The fact that the biomass wood industry represents significant economic activity implies that wood fuel will continue to be the dominant source of energy in Uganda for the foreseeable future. This has implications for briquette business as the success of briquette business depends on its competitiveness to the wood fuel/charcoal.

In September 2002, the Government of Uganda adopted a new energy policy. The main policy goal is to meet energy needs of the Ugandan population for social and economic development in an environmentally sustainable manner by substantially using modern renewable energy. The overall policy goal is "to increase the use of modern renewable energy, from 4% to 61% of the total energy consumption by the year 2017." There is still limited use of efficient wood fuel, charcoal stoves and biogas in households, institutions and industries. To support alternative clean energy initiatives, government strategy on the demand side is dissemination of more energy efficient technologies (Renewable Energy Policy, 2007).

Furthermore, with support from the UNDP, the government is implementing key interventions in charcoal production which includes increasing the charge that the National Forestry Authority levies on charcoal burners. This provides an opportunity for alternative fuels to compete further with charcoal.

## Business model

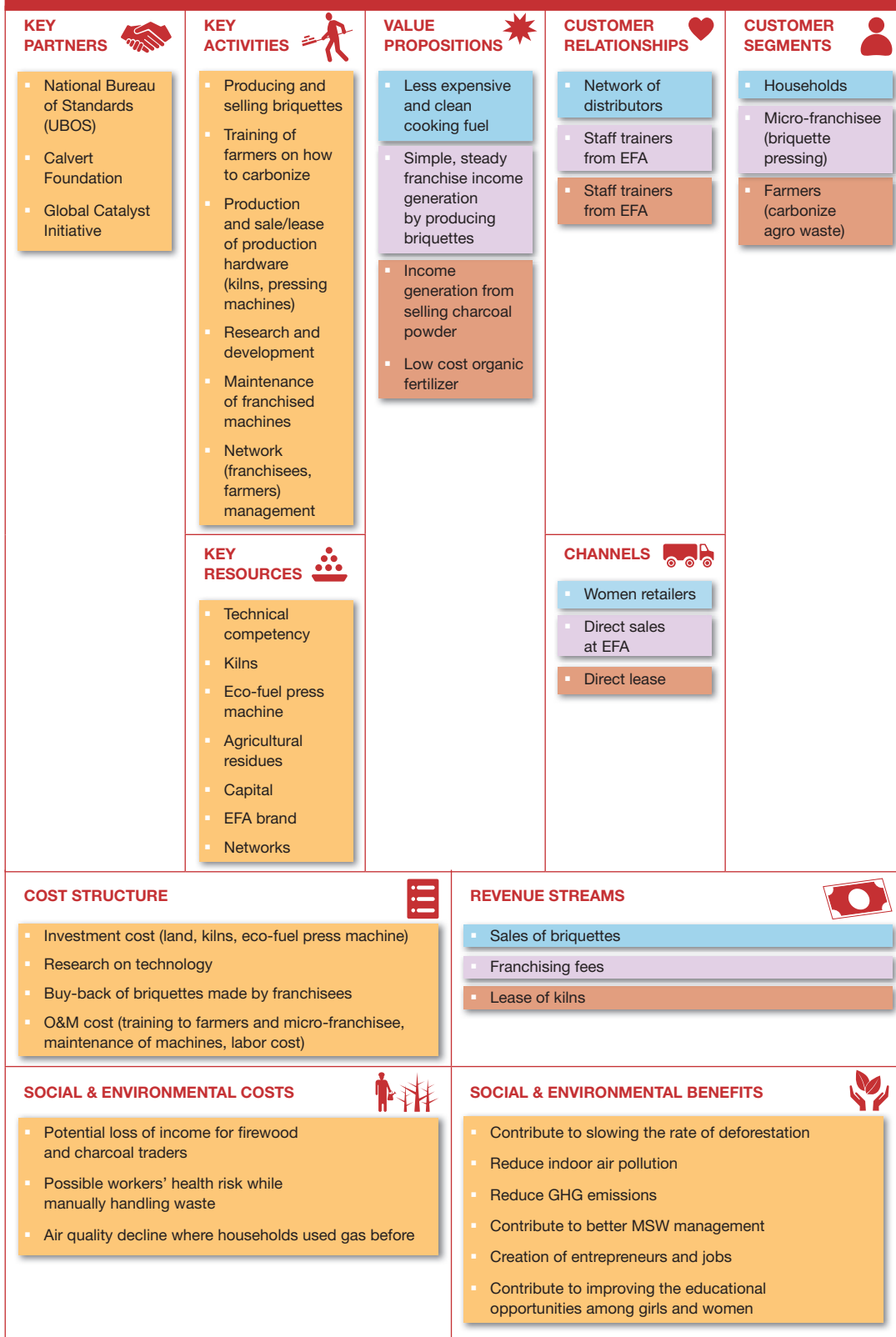
Briquettes are sold to households via women retailers (Figure 20). The business invented two low-cost and energy-efficient technologies, namely low-cost kiln, which carbonize agricultural waste, and briquetting machine, also called eco-fuel press machine. EFA has invented simple tailor-made briquetting technology which does not need electricity to operate and which can be easily used and maintained by people with limited skills. EFA leases the kilns to farmers and provides the farmers training on how to convert their agricultural waste into charcoal powder using the kilns. The eco-fuel press machine is used by the micro-franchisee to convert charcoal powder brought from farmers to clean burning briquettes. The micro-franchisees sell all the briquettes to EFA, which packages and sells them to its network of women retailers.

Through micro-franchising, EFA have created a decentralized network of village based micro-factories using their already tested technology and business model to convert locally sourced biomass waste into briquettes (green charcoal) and making it easily accessible through women retailers to local people. This eliminates the need to transport biomass waste and green charcoal over very long distances, keeps the cost of green charcoal down which makes it affordable and creates local sustainable jobs.

## Value chain and position

The briquette value chain involves three important actors, namely farmers, micro-franchisee and women retailers (Figure 21). EFA is the focal point in the value chain. It is involved in technology transfer and in training each of the chain actors. It provides training to the farmers to convert their agricultural waste into charcoal powder using kilns invented by EFA. The kilns are made out of old oil drums and provided to farmers on a lease-to-own basis. The farmers sell the powder directly to EFA or to the local micro-franchisee. The charcoal powder is then converted into briquettes using the eco-fuel press machine. The press machine is designed to ensure that it can be operated and maintained by local people with no or little formal education. EFA recently invented a low-cost briquetting machine

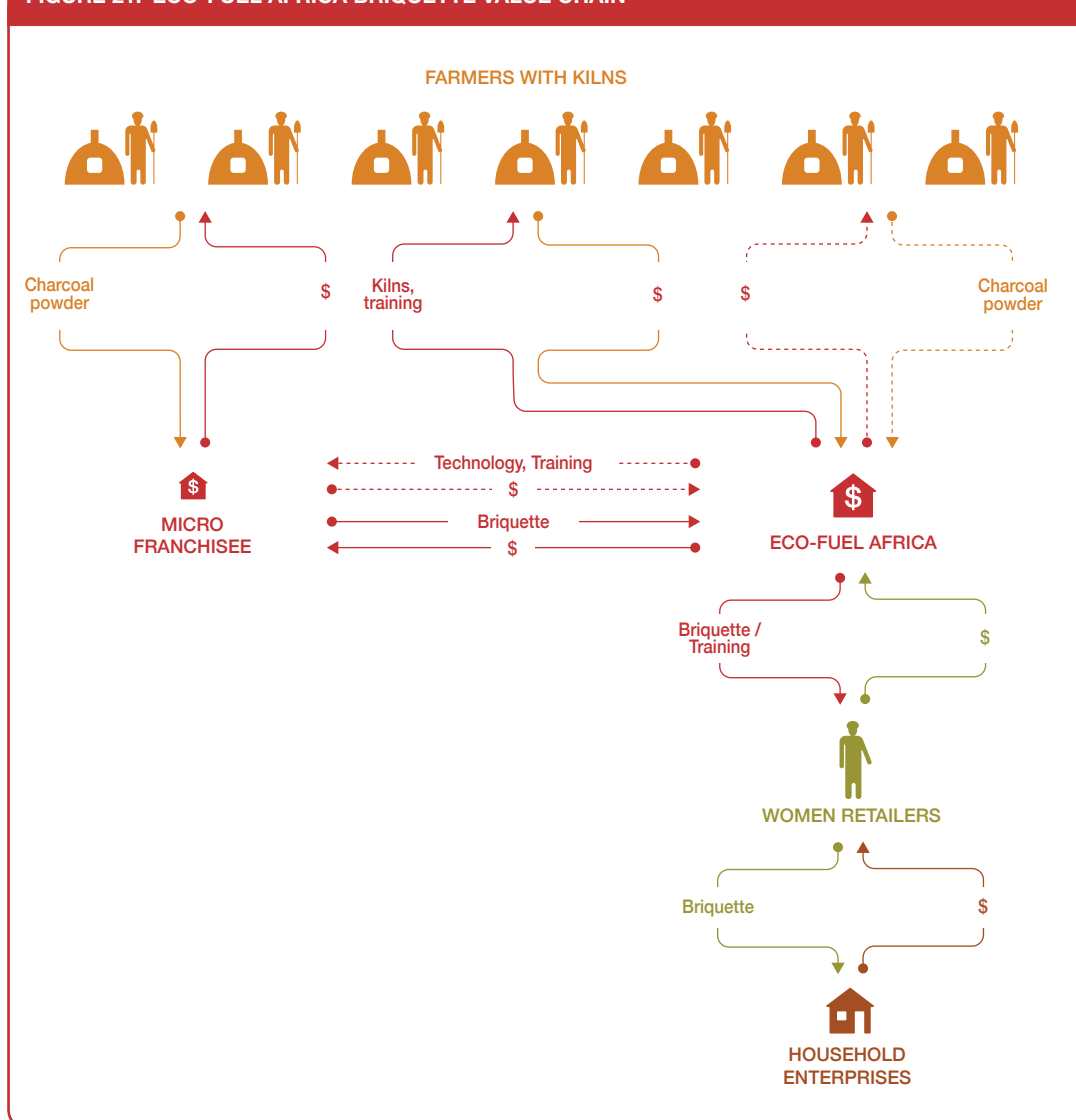
FIGURE 20. EFA BUSINESS MODEL CANVAS



called eco-fuel press which compresses charcoal powder bought from farmers into clean burning fuel briquettes without using electricity.

Each micro-franchisee can make enough fuel briquettes to meet energy needs of at least 250 local households. EFA mainly makes money from micro-franchising through leasing the technology. Micro-franchisees also pay EFA for training and business support. The micro-franchisees sell all the briquettes to EFA which are packaged and sold to its network of women retailers. Most of these women are illiterate. EFA trains these women thoroughly in areas such as basic book keeping, marketing and customer service. EFA builds a kiosk for each of the selected women after 3 days training, which they use as a retail shop to sell EFA's briquettes to final users. EFA's women retailers sell other items like fruits and vegetables in addition to EFA's briquettes at the kiosks.

FIGURE 21. ECO-FUEL AFRICA BRIQUETTE VALUE CHAIN



Each community-based briquetting micro-factory needs 10 farmers with kilns who supply the char needed by the factory to make fuel briquettes, five local retailers to sell briquettes to the final consumers in the local community and five employees to run the machines, handle the packaging and distribution of the fuel briquettes. Each of these farmers can earn up to 30 USD/month in extra income. These farmers are also able to use these kilns to make organic fertilizers called biochar which helps them to increase their farm yields by over 50%. Each of these micro-franchises will earn at least 1,728 USD/year. Each of these micro-retailers can earn up to 152 USD/month in extra income. These people are from local community with limited skills.

EFA is making profits and has plans to scale up its business and to serve other customer segment such as small enterprises. EFA has a challenge of attracting funding, which has slowed down their expansion plans. They are growing the business slowly, utilizing internally generated funds. As a long-term strategy, EFA intends to construct a training centre in Lugazi, Buikwe District, Uganda. Investment is already made on two acres of land in this area valued at USD 13,000 where the training centre will be constructed. This centre will enable the enterprise to adequately train its micro-franchisees, farmers with kilns, women retailers and other stakeholders.

Looking at the supply side of the value chain, EFA sources its input from various farmers. It relies on their farm productivity and the resulting farm residue to produce the briquettes. Supplier power is weak as the reuse of farm residue and MSW is very limited in Uganda and thus the farm residues have low market value. But in the future, with the emergence of more briquettes, compost and other reuse businesses, supplier power is expected to be higher. Furthermore, new businesses with more automated and efficient technology and a resultant low-priced briquette pose a threat to EFA whose operations are mechanical and less efficient. On the demand side, EFA targets households who previously relied on firewood for cooking. Experience has shown that, even where cleaner fuels are available, households often continue to use simple biomass fuel as they are more familiar with it. EFA must maintain a price that is lower than firewood/charcoal as households will easily shift to firewood. Buyer power thus plays an important role. There is also the threat of substitutes which exists when the demand for the product is affected by a change in price of a substitute product. Market competition from existing briquette businesses is low. There are few briquette businesses (less than 10) which are operating at the same scale of operation as EFA and only one business operating at a larger scale (about 2,000 tons/year). Most of the briquette businesses are small scale and informal. So far, EFA has a competitive advantage over other producers since it is retailing the briquettes at a lower price and demand is constantly outstripping supply. Briquetting industry is in its infancy in Uganda and even with the emergence of more businesses, the increase in market growth (expanding market) would result in increased revenues. The market for briquettes can grow based on households, institutions and industrial sectors shifting to briquettes for their fuel demand.

### **Institutional environment**

The body charged with the duty to oversee and regulate activities in waste management is the National Environment Management Authority (NEMA). It is responsible for ensuring that waste management activities, e.g. recycling, is carried out in a sustainable manner and do not pollute the environment. Others institutional agencies include the Ministry of Energy and Mineral Development (MEMD). The MEMD produced an energy policy for Uganda in 2002 and a renewable energy policy for Uganda in 2007. This was reinforced in the first National Development Plan (NDP) 2010, and in the current NDP II, 2015–2020.

The Renewable Energy Policy 2007 called for innovations and research in waste management and recycling. To promote the conversion of municipal and industrial waste to energy, the government will

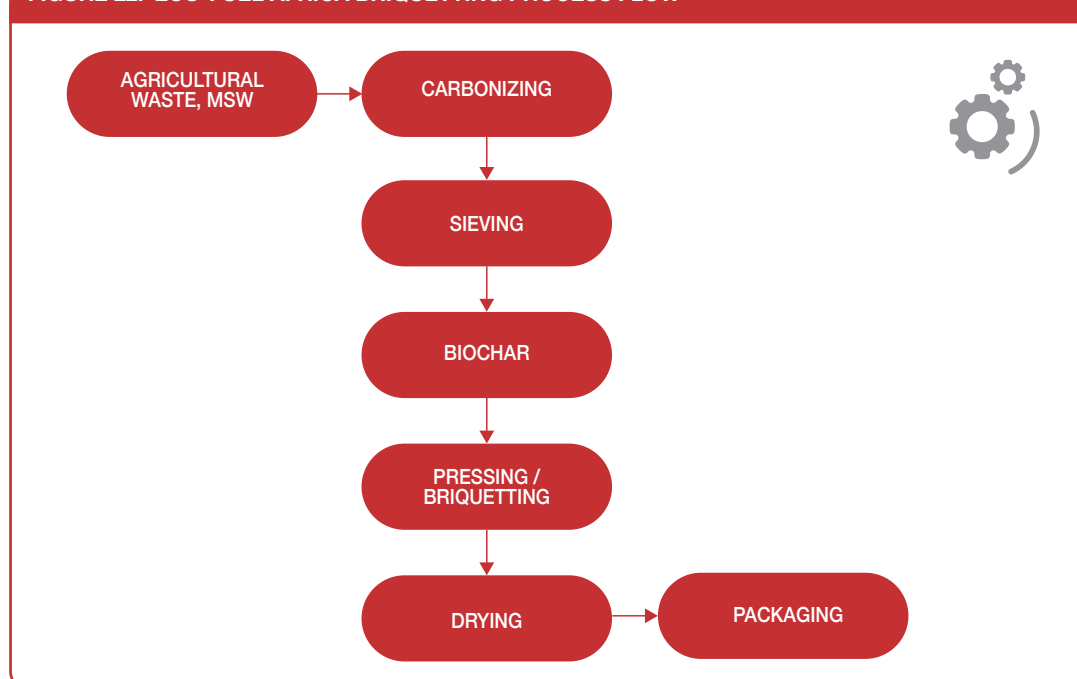
provide incentives for the conversion of wastes to energy and put in place fiscal measures that will discourage open burning or disposal of wastes without extracting their energy content. This will cover the conversion of waste to energy through direct combustion, gasification or biological conversion to biogas and therefore wastes will become part of the energy resource base. To foster this development, MEMD will work with municipal authorities and industries that generate lots of waste in developing this potential. Appropriate incentives shall be put in place to promote the conversion of waste to energy. This could be through the Credit Support Facility (CSF), tax waivers and other incentives.

However, no statutory guidelines are available for carbonization and charring. The government is implementing key interventions in charcoal production and is increasing levies on charcoal burners. The Uganda National Bureau of Standards (UNBS) is a key institution, charged with ensuring that products on the market including packaged charcoal meet certain quality standards. However, all charcoal in the market in Uganda is produced and sold by the informal sector and is therefore not certified.

### Technology and processes

One of the most common variables of the biomass briquette production process is the way the biomass is dried out. Manufacturers can use torrefaction or carbonization, based on increasing degrees (temperatures, oxygen) of pyrolysis. Researchers concluded that torrefaction and carbonization are the most efficient forms of drying out biomass, but the use of the briquette determines which method should be used but all of them involve heating biomass with little or no oxygen to drive off volatile gasses, leaving carbon behind. The EFA invented a low-cost kiln made out of old oil drums. The kiln carbonizes agricultural waste to produce charcoal powder through pyrolysis. The charcoal powder is sieved and converted into briquettes and the remaining coarse material is mixed with compost and used as organic fertilizer or as biochar (Figure 22).

FIGURE 22. ECO-FUEL AFRICA BRIQUETTING PROCESS FLOW



Compaction is another factor affecting production. Some materials burn more efficiently if compacted at low pressures, such as corn stover grind. Other materials such as wheat and barley straw require high amounts of pressure to produce heat. There are also different press technologies that can be used. A piston press is used to create solid briquettes for a wide array of purposes. EFA has also invented a low-cost briquetting machine called eco-fuel press, which compresses charcoal powder bought from farmers into clean burning fuel briquettes. The eco-fuel press requires no electricity and is easy to use. Previously, the machines used by the enterprise were powered by electric motors which required constant monitoring and expensive repairs. With the prevailing unreliable electricity grid, production stoppage was a major problem. The new machine makes much denser briquettes which are more resistant to transport than briquettes produced using the old machine. There are no binders involved in this process. The natural lignin in the wood binds the particles of wood together to form a solid briquette.

The finished briquettes are dried through sun drying which can take up to three to four days. The briquettes are finally packaged in clear plastic bags printed with the enterprise's logo. The technologies invented and used by EFA are simple and low-cost, require no specialized skills and are suitable for the local conditions. EFA provides the workers with hand gloves.

### **Funding and financial outlook**

EFA started with a capital of USD 500 from personal equity. It received a grant of USD 10,000 from the Ugandan government. In 2011, EFA received a grant of USD 20,000 from Calvert Foundation and USD 40,000 from Global Catalyst Foundation. Part of the revenues generated by the business and the grants received are invested to expand the business. With support from the Unreasonable Institute (<https://unreasonablegroup.com>), EFA was able to raise more than USD 3 million in funding and to be profitable, earning USD 1.2 million in revenue (<https://vimeo.com/146802104>).

### **Socio-economic, health and environmental impact**

Use of EFA's cooking briquettes reduces the rate of deforestation, avoids GHG emissions, reduces indoor air pollution and improves educational opportunities among girls and women by eliminating the need for collecting wood.

In 2015 and after receiving attention by different investors, EFA was able to claim the following impact:

- Brought clean cooking fuel to over 105,000 households served daily. These households are now able to save up to half of the money they previously spent on charcoal from wood, and with these cost savings, they are able to improve their household living conditions like cooking more consistent meals. Over 57,500 marginalized girls enabled to enrol, stay and study in school. Some of these girls could not previously attend school because they had to walk arduous distances to gather wood for their households.
- Increased incomes and food harvests of 3,500 farmers, about 40% of which are women, who use EFA technology to convert farm waste into organic fertilizers (biochar). Farmers earn on average 360 USD/year in extra income as a result of EFA's project.
- Turned 2,300 local women into micro-retailers of clean cooking fuel. All these women had no jobs before they started retailing for EFA. These women now earn about 1,825 USD/year from clean energy retail businesses.
- 500,000 acres of forests saved in averted deforestation.
- About 127,650 tons of CO<sub>2</sub> mitigated every year.



## Scalability and replicability considerations

The key drivers for the success of this business are:

- Regulations against cutting down trees.
- Increased charge that the National Forestry Authority levies on charcoal burners.
- Rising prices of charcoal.
- Government policy that promote renewable energy sources.
- Access to both sufficiently dense community networks and rural markets without electricity.
- Charismatic leader with a business plan gaining international attention.

EFA's business model is based on low-cost and simple technologies that can easily be used by local communities. Within Uganda, EFA was planning to expand to all regions of Uganda by 2015 and to up-scale its operations by building a bigger factory near industrial sources of sugarcane waste to meet growing demand. This business model is highly replicable in other low-income countries where firewood is predominantly used, where wood is scarce and where agricultural waste or municipal solid waste is abundant. With raising more capital to improve its technology and with the franchise model, the business could be out-scaled to other regions in sub-Saharan Africa, latest by 2010. For this business to be out-scaled to or replicated in other regions, high charcoal prices and presence of regulatory frameworks on use of firewood are required.

FIGURE 23. SWOT ANALYSIS FOR EFA

	<b>HELPFUL</b> TO ACHIEVING THE OBJECTIVES	<b>HARMFUL</b> TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>▪ Low-cost technology</li> <li>▪ Dynamic and skilled entrepreneur</li> <li>▪ Well distributed production and micro-franchising system</li> <li>▪ Access to rural markets with no electricity</li> <li>▪ Good relationship with chain actors and investors</li> </ul>	<b>WEAKNESSES</b> <ul style="list-style-type: none"> <li>▪ Poor logistics in transporting briquettes to retailers</li> <li>▪ Lack of local technical and institutional capacity and finance to improve technology</li> <li>▪ Lack of standardization of the briquettes</li> <li>▪ The low-margin, high-volume nature of the business with insufficient profit margins for green charcoal producers</li> </ul>
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	<b>OPPORTUNITIES</b> <ul style="list-style-type: none"> <li>▪ Possible patenting of technology (IP)</li> <li>▪ Good opportunity for up-scaling through franchising</li> <li>▪ Good image through its tree-planting initiatives</li> <li>▪ Increasing prices of substitute products (charcoal)</li> <li>▪ Increasing demand and market growth of briquettes</li> <li>▪ Supportive local community</li> </ul>	<b>THREATS</b> <ul style="list-style-type: none"> <li>▪ Competition for input may raise prices of inputs</li> <li>▪ Low farm productivity (harvest fail) may lead to shortage of supply of farm waste</li> <li>▪ Lack of finance may slow down expansion and limit research efforts</li> <li>▪ Competition from other similar products and technologies</li> <li>▪ Inadequate policy, regulatory and institutional framework and lack of product quality and standards</li> </ul>

## Summary assessment – SWOT analysis

The key strengths of the business are its application of low-cost technology coupled with a well distributed production and franchising system which contributed to the competitive advantage that EFA has over its competitors (Figure 23). The franchise scheme presents EFA a good opportunity to expand its business. However, lack of finance may slow down expansion and limit research efforts to improve technology.

## Contributors

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 Josiane Nikiema, IWMI

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*Case descriptions are based on primary and secondary data provided by case operators, insiders, or other stakeholders, and reflect our best knowledge at the time of the assessments 2012–2015. As business operations are dynamic, data can be subject to change.*