

CASE

Briquettes from municipal solid waste (COOCEN, Kigali, Rwanda)

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Supporting business case for Business Model 2

Location:	Kigali, Rwanda
Waste input type:	Municipal solid waste (MSW)
Value offer:	Briquettes (Clean cooking fuel) and compost
Organization type:	Cooperative/Public-private partnership (PPP)
Status of organization:	Operational since 2002
Scale of businesses:	Medium
Major partners:	Kigali City Council, UNDP, city residents

Executive summary

Coopérative Pour La Conservation De L'Environnement (COOCEN), established in 2002, is a women's cooperative that delivers waste collection and briquette production service in the low-income Nyamirambo District of Kigali, Rwanda through the implementation of a public-private partnership (PPP) with the Kigali City Council. The PPP is based on the delivery of waste collection services by COOCEN, and as a component of the partnership, the Kigali City Council provided 7 ha of land in Nyamirambo District for COOCEN from where the primary waste sorting and briquette production takes place. At the time of the assessment, the cooperative collected waste from more than 4,000 households for a fee, while till now demand for briquettes constantly exceeds production. The reason is that COOCEN is the sole supplier of fuel briquettes to 16 prisons in Rwanda, which has become a sustained market segment. The cooperative provides solutions to various issues related to the environment and to living conditions of communities. COOCEN contributes to cleaning of the city and provides sanitation services to local communities, which benefit from improved health and sanitary conditions. It contributes to reduction of CO₂ emissions and to reduction of deforestation by avoiding the burning of firewood. In addition to these, the cooperative generates employment, mostly to women.

KEY PERFORMANCE INDICATORS (DATA AS OF 2012)

Land use	7 ha					
Capital investment:	USD 162,075					
Labor:	110 workers (90% women)					
O&M cost:	USD 94,875					
Output:	1,500 ton/year (retailed at 0.122 USD/kg)					
Potential social and/or environmental impact:	Job creation and income generation (women members earn 50 USD/month), households benefit from improved sanitary and health conditions, avoided burning of firewood of 1,200 tons/year, CO ₂ emission saving of 297 tons/year					
Financial viability indicators	Payback period:	3	Post-tax IRR:	N.A.	Gross margin:	42%

Context and background

COOCEN initially focused on waste collection in a congested urban area that previously had no waste collection facilities or services. The cooperative expanded its operations and constructed a briquette production plant in the low-income Kimisagara Sector of Nyamirambo District. It collects waste from 4,000 households for a fee, sorts waste, extracts organic fragment and produces briquettes from organic components through the implementation of a strategic PPP with the Kigali City Council. As the component of the partnership, the Kigali City Council provided 7 ha of land to COOCEN. The project obtained further financial assistance from the Global Environmental Facility's Small Grants Programme (GEF-SGP), implemented by the United Nations Development Programme (UNDP). Environmental conservation is a key component of the COOCEN strategy and was an instrumental aspect to securing project grants from the European Union (EU) and UNDP. At the assessment time, the cooperative produced and sold around 1,500 tonnes of briquettes per year to schools, prisons and factories.

Market environment

In the capital of Rwanda, Kigali, wood and charcoal are the primary sources of fuel used for cooking and heating, causing major environmental problems such as deforestation and pollution. Charcoal is the preferred fuel for urban households, serving 51% of households, and demand is pushing up the price. As Rwanda also faces a serious wood fuel deficit, there is a need for alternative sources of fuel. Between 2007 and 2012, the amount of municipal solid waste (MSW) grew almost fourfold. COOCEN's environmentally friendly briquette made from MSW is retailed at 0.122 USD/kg while the price of charcoal in 2014 was 0.20–0.22 USD/kg. However, about 1.6 kg of MSW briquettes will be required to replace 1 kg of charcoal. So far, demand from its customer segments constantly exceeds production particularly as COOCEN is the sole supplier of fuel briquettes to the Rwandan prison service, which has become a long-term customer. COOCEN anticipates an increase in briquette demand as a result of the rising price of charcoal coupled with the government policy to protect the environment and promote alternative sources of energy. COOCEN is aiming to increase production however, there are constraints due to limited production capacity and availability of capital. COOCEN also acknowledges that overtime competition in briquette production will increase and thus it aims to improve the manufacturing process and the quality of the final product.

Macro-economic environment

The primary energy supply in Rwanda is dominated by wood, which accounts for about 80% of the supply, of which 57% is direct supply and 23% for charcoal (Ndegwa et al., 2011). There is a combined per capita demand of wood (both for fuelwood and charcoal) of 1.93 kg/person/day, which creates an unsustainable situation because it largely surpasses the production capacity of 0.46 kg/capita/day. Rwanda lost 37% of its forest cover (around 117,000 ha) between 1990 and 2010. Firewood is

associated with environmental, social and health problems, stemming from deforestation and the emissions from wood and charcoal burning respectively. Furthermore, population growth is intensifying deforestation and causing more environmental degradation.

Most of the charcoal is consumed in Kigali, and the main supply areas are the rural areas of Southern and Western Provinces, where charcoal is produced using the traditional earth mound kilns with an efficiency of merely 12%. The chief actors in the supply chain are also poor and unable to invest in the expensive and more efficient biomass conversion technologies – a factor resulting in massive wastage of the wood fuel resource. There are significant health and social benefits of transitioning to charcoal, but it is likely to increase the pressure on the limited wood supplies. The country is taking a ‘green economy’ approach to economic transformation as a priority. Although fuel wood consumption is expected to increase in the short-term, the long-term strategy of the Government of Rwanda is to reduce fuel wood consumption to 50%.

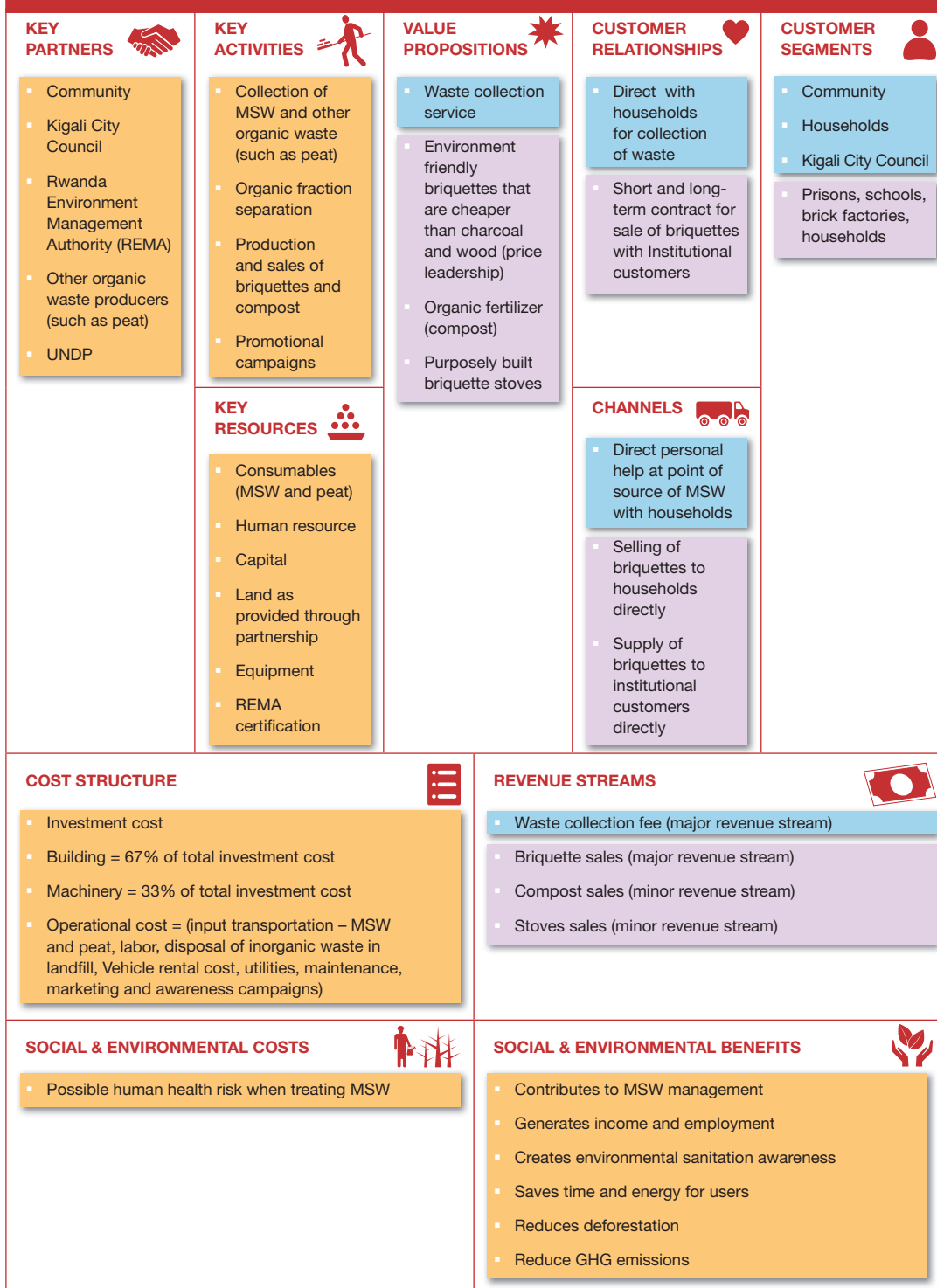
Unlike in many African countries, the demand for wood fuel is met through forest plantations, mostly of eucalyptus, which are owned by the state or districts and by private entities. About 450,000 hectares or 17% of the country is covered by forests, with 46% being natural forests and the rest public and private plantations. Sixty-five percent of the plantations are state and district owned, while institutions and private citizens own 9% and 25% respectively. Thirty percent of the state forests is left for soil protection, which reduces the amount of plantations that can be harvested to 194,000 hectares.

Vision 2010, the Rwanda development strategy has identified a target of increasing the production of wood for fuel and other uses through the expansion of forest and tree cover to 30% of the national land area by 2020. The wood fuel sector is a major economic activity in Rwanda employing about 20,000 people, which in turn support about 300,000 people (Ndegwa et al., 2011). However, Rwanda still faces a serious wood fuel deficit, which directly impacts the availability and affordability of biomass energy including charcoal production. This gives an opportunity for briquette businesses to fill the charcoal supply and demand gap.

Business model

Figure 16 shows the business model for COOCEN. The cooperative collects waste, extracts organic fragment and produces briquettes from organic components and efficient briquettes cook stoves through the implementation of a PPP with the Kigali City Council. As a component of the partnership, the Kigali City Council provides a site (7 ha of land) for COOCEN from where the primary waste sorting and briquette production takes place. Thus, COOCEN’s principle business idea is providing a waste collection service to the local community and then converting the organic waste into fuel briquettes, which are sold to prisons, schools, brick factories and in some cases to households. Initially, the cooperative had difficulties motivating the residents to pay for waste collection services. However, through its awareness campaigns about waste, sanitation and the environment, the cooperative was able to change peoples’ attitude. Therefore, waste collection fee and sales of briquettes are the two major revenue streams while selling compost and improved cooking stoves are minor revenue streams. The compost is supplied to the Kigali City Council and is used for city greening and urban amenities including flowerbeds, parks and green walls on the steep urban roadsides.

FIGURE 16. COOCEN BUSINESS MODEL CANVAS



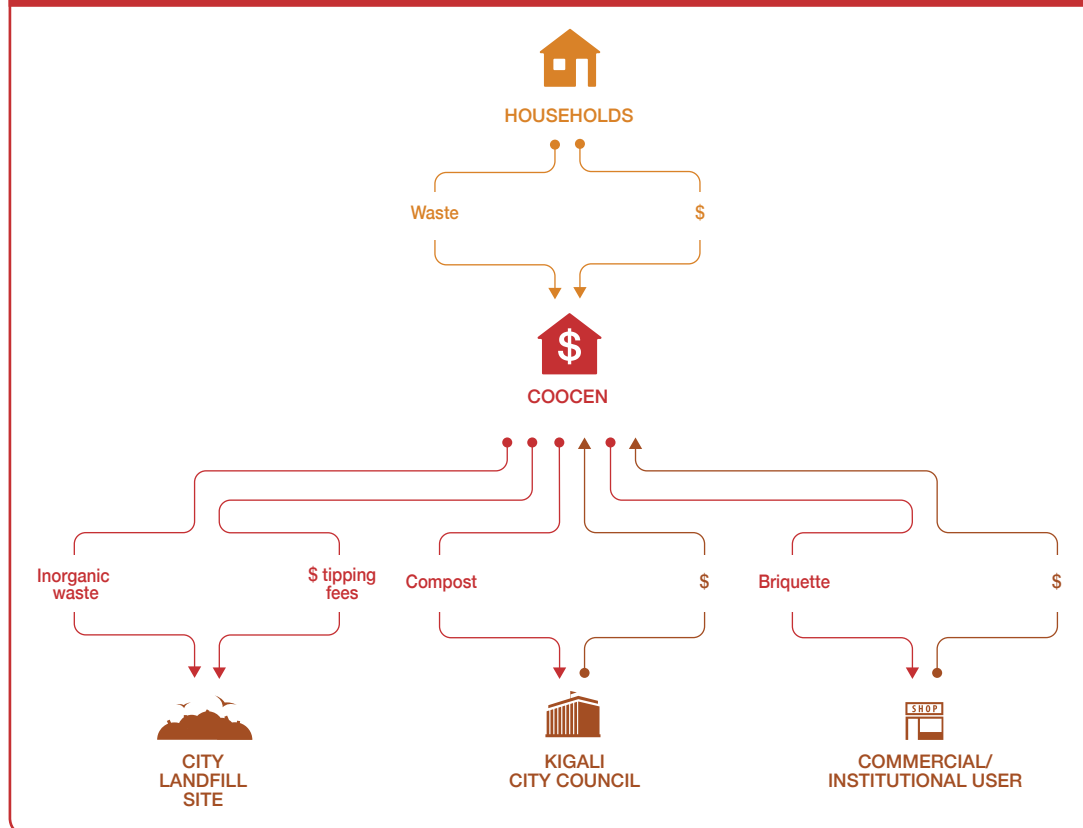
Value chain and position

COOCEN is vertically integrated i.e. it owns the waste collection and briquetting business (Figure 17). As per the recent estimates, about 1.8–2 kg of waste containing 59–65% food waste, is generated per person per day in Kigali (Bazimenyera et al., 2012). Kigali City produces about 100 tons of waste on a daily basis and volume of waste is expected to increase as the population of the city increases.

Currently, the demand for briquettes exceeds supply. COOCEN has a long-term offtake contract with 16 prisons in Rwanda since 2007. The substitute products for briquettes are wood and charcoal. The prices of these substitute products are higher than briquettes, and nowadays, wood is increasingly difficult to get in Rwanda due to government regulations against cutting down trees. With more stringent regulations on cutting down trees and with government policy that promote renewable energy sources, the demand for briquettes from institutions and factories will increase in the future and hence substitute power is low. However, the Rwanda Vision 2010 targets to increase production of wood for fuel through the expansion of forest and tree cover. This may result in more wood available, possibly at a lower price and consequently may dampen briquette market strength.

Moreover, new briquette businesses with more efficient technologies and better product qualities pose a threat to COOCEN due to the fact that its briquette operation is not efficient as it uses mechanical process and heavily relies on uncertain weather conditions to dry its inputs and briquettes. There is

FIGURE 17. COOCEN VALUE CHAIN



also a possibility of installation of bio-digesters at institutions (like prisons) to self-supply biogas for cooking and heating applications. However, it is anticipated that the market for briquettes will grow, which will drive the revenues of briquette business to rise. COOCEN is also looking at the possibility of recycling plastics as an additional income generating activity.

Institutional environment

The main policy objective of the government of Rwanda for the biomass sub-sector is to improve the sustainability of biomass by improving efficiency of use of wood, improving charcoal production methods, facilitate fuel switching from traditional biomass energy carriers toward modern biomass energy technologies, including modern carriers, and cleaner fuel alternatives. The proposal is to decentralize implementation of biomass programmes to the local government levels to improve the impact on the end users, streamline implementation and speed up dissemination. The government has put in place very strict tree harvesting regulations and only licensed persons with tree harvesting permits are allowed to cut trees, including those from private lands.

The Rwandan government initiated an Improved Cook Stove (ICS) programme in the late 1980s or 1990s to combat deforestation. Various programmes have been implemented since, which has led to a penetration rate of “improved” stoves of over 60% in 2012. However, the World Health Organization (WHO) suggests that some “improved” cook stoves still have emissions 20 times above safe air quality levels and there is a need to provide standards for further improvements. Given that around 85% of all energy in the country is in the form of biomass used for cooking, such an intervention on improving cook stove standards could be one of the most significant interventions in the energy sector.

The Ministry of Infrastructure (MININFRA) is the lead Ministry responsible for developing energy policy and strategy, monitoring and evaluation of projects and programmes implementation. The Department of Energy within MININFRA governs energy policy in Rwanda. The government is targeting to ensure that 80% of households have access to improved cook stoves by 2017 and 100% of households by 2020. The government supports sensitization workshops and training seminars on the economic use of improved cook stoves. This will boost demand for modern and improved cooking technologies, increasing private sector motivation to invest in this business and reduce the use of inefficient and traditional three-stone wood stoves.

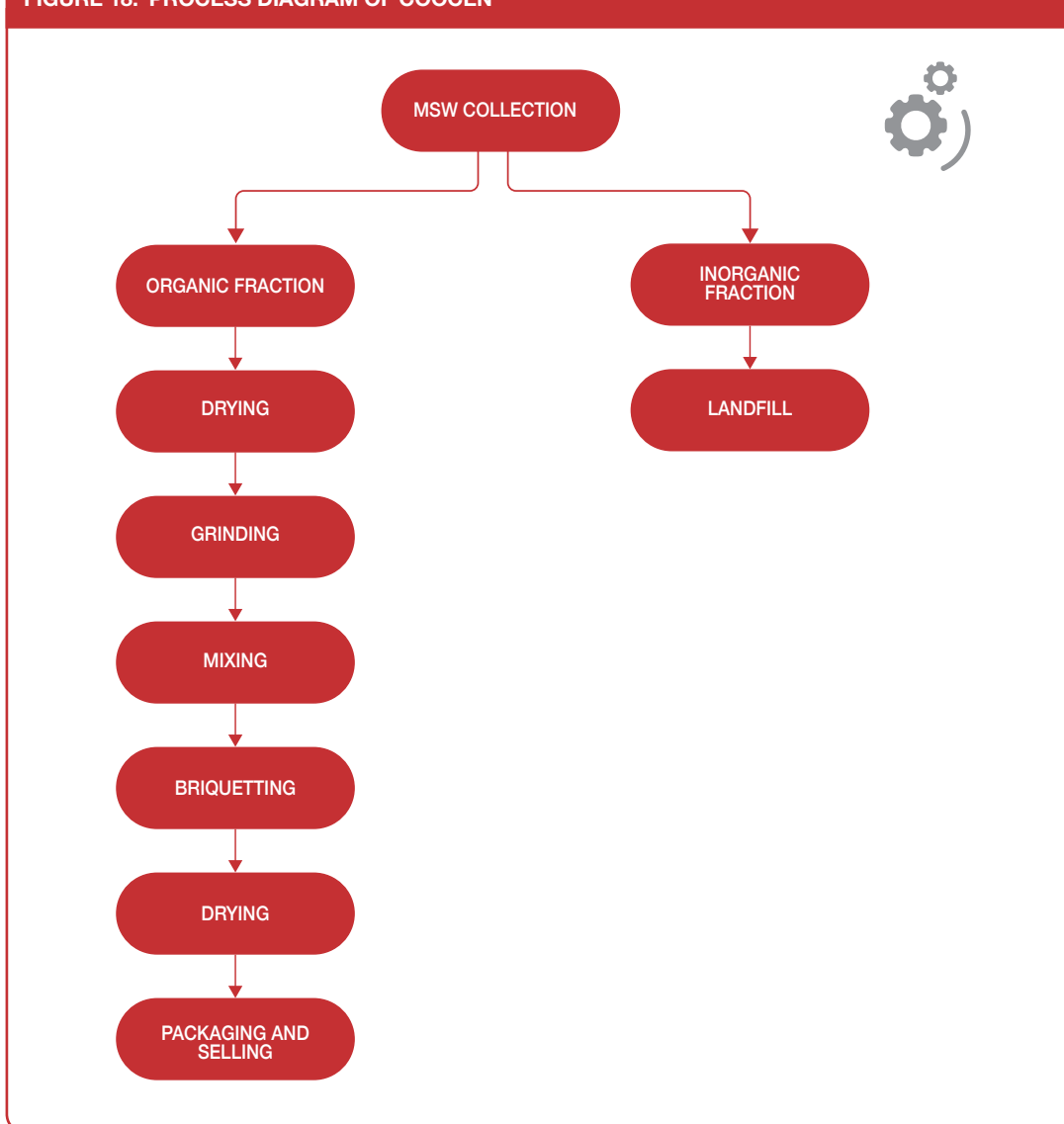
COOCEN has received institutional support in the form of two grants and the provision of land from the Kigali City Council. COOCEN has also been licensed to carry out waste collection services and the project has been certified by the Rwanda Environment Management Authority (REMA) although no specific laws, regulations or policies are in place for briquette production. Rwanda Environment Management Authority (REMA) has the mandate to coordinate, oversee and implement environmental policy. Kigali City has partnered with UNDP for support in areas of technical, financial and maintenance techniques on waste management.

In pursuant of Law no. 39/2001 of 13 September 2001, Rwanda Utilities Regulatory Agency (RURA) was established with a mandate to regulate sanitation services. RURA principal mandate is to ensure consumer protections from uncompetitive practices while ensuring that such utilities operate in an efficient, sustainable and reliable manner. RURA gives consent to any city or town, company, or sector cell, public/private, to acquire and operate a dump site. It is responsible for improvement in the delivery of sanitation services including waste disposal and management. The Rwanda Development Board (RDB) also plays the lead role in investment mobilization and promotion for the energy sector, acting as a gateway and facilitator. RDB is developing briquette standards for minimum performance and energy requirements.

Technology and processes

COOCEN collects waste from households and brings it to the local COOCEN station where sorting teams separate the organic and inorganic fractions. The organic fraction is solar-dried and then mechanically ground into smaller particles which are then pressed into cylinder compact briquettes (Figure 18). The mechanical technologies that are used for shedding and briquette pressing are based on locally manufactured electricity-driven machines that are easy to operate, maintain and repair. COOCEN also investigated methods of improving the energy efficiency of the briquette through blending of different organic inputs. Consequently, peat is now added as it increases the conformity of the crude materials and also improves the briquette energy efficiency. Peat is a heterogeneous mixture of more or less decomposed plant (humus) material that has accumulated in a water-saturated

FIGURE 18. PROCESS DIAGRAM OF COOCEN



environment and in the absence of oxygen. Peat is sedentarily accumulated material consisting of at least 30% (dry mass) of dead organic material. Peat is also less compactable than organic waste and thus it provides density to the briquette. However, peat increases production costs due to the extraction and transportation costs.

COOCEN is regularly facing technical constraints due to seasonal changes in the weather pattern and due to the limited processing capacity of the briquette pressing machines. In the rainy season, it takes longer to dry the organic matter which can take up to one week to dry before the organic waste is ready for shredding and mixing with other organic fractions. With respect to the processing capacity, COOCEN is equipped with two manually-operated mechanical briquette-pressing machines which have the capacity to produce 10 tons of briquettes per day, but with automated machines this could be increased to 30 tons per day. However, funds to invest in this technology are hard to get.

Funding and financial outlook

The total capital investment of COOCEN is USD 162,075 comprising of building which accounts for 67% of the total investment and machinery accounting for 33% of the total investment (Table 9). The project secured funding of USD 162,075 from an EU grant during its establishment phase in 2002. In 2007, 7 ha of land was provided by the Kigali City Council for the briquette production plant in Nyamirambo District. In the same year, COOCEN received further financial assistance with a grant of USD 43,760 from the UNDP GEF Small Grant Programme and a bank loan to the value of USD 24,311 was also secured.

TABLE 9. COOCEN INVESTMENT, OPERATIONAL AND MARKETING COST

ITEM	AMOUNT (USD)
<i>Investment cost (USD):</i>	
Land	Free
Buildings	108,590
Machinery / equipment	53,485
Total investment cost (USD)	162,075
<i>Operational costs (USD/year):</i>	
Waste transportation and collection	42,788
Electricity	49
Water	175
Wages and salaries	38,898
Repairs and maintenance	9,724
Marketing	3,241
Depreciation	10,805
Total operational costs	105,680
<i>Revenue (USD/year)</i>	
Sales of briquettes (1,500 ton at 122 USD/ton)	183,000
Sales of compost (50 ton at 5.67 USD/ton)	284
Total revenue from briquette and compost sales	183,284
Revenue from waste collection service	144,000
Profit before tax (PBT) – briquette business	77,604
Profit before tax (PBT) – waste collection and briquette business	221,604

Socio-economic, health and environmental impact

COOCEN provides waste collection service to communities, contributes to cleaning of the city and provides sanitation services to local communities (more than 4,000 households) which benefit from improved health and sanitary conditions. Emissions from wood fuel stoves without proper ventilation contain poisonous fumes that can cause respiratory and other human health impacts on women and children, who are traditionally charged with the duty of cooking in Africa. Many more suffer respiratory illnesses resulting in reduced productivity, quality of life and exert an additional burden to the community. The improper waste management can result into bad odor, methane gas explosions, risks of garbage landslides and groundwater pollution. However, from an air quality perspective, also dry fuel can result in net negative health impacts if households do not use safer cooking stoves, or switch from gas to briquettes (Winkler et al., 2017).

COOCEN improves both the efficiency of cook stoves in order to close the gap between supply and demand of fuelwood and charcoal. Harvesting of trees for fuel wood and making charcoal contribute to pressures on forests. Briquettes are more efficient and burn more cleanly, preventing release of excess greenhouse gases that are contributing to climate change. COOCEN's briquetting project contributes to reduction of deforestation by avoiding the burning of 1,800 tons of firewood per year or the cutting of at least 9,000 trees per year, which represents around 9 ha of forest plantation (GEF, 2012). The project has also contributed to reduction of 297 tons of CO₂ emissions per year.

The project not only prevents pollution by implementing better waste management, it also recycles materials that would otherwise go to waste. In addition to these, the cooperative employs 110 persons, mostly women, who earn at least 50 USD per month. In Rwanda, nearly 60% of the population lives below the poverty line, with almost 40% living in extreme poverty on less than USD 0.90 per day (<http://www.feedthefuture.gov/country/rwanda>). In terms of employees' safety and health, employees are equipped with gloves, protective masks and boots to protect them from injuries and respiratory diseases while manipulating garbage.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Strong partnership with city municipality.
- Regulations against cutting down trees.
- Government policy that promote renewable energy sources.
- Rising prices of fuel wood and charcoal.

The briquette making project by COOCEN has shown the importance of empowering community based organizations as key actors in environmental protection. It also demonstrated that socio-economic benefits are key for project sustainability. Kigali City of Rwanda is making progress towards solid waste management partly because of the house-to-house collection system and a franchise system which involved collection, treatment, recycling and disposal of residues. This system in Kigali City is worthy of emulation by cities in other developing countries. High charcoal price is a pre-requisite for the business to be up-scaled and replicated in other regions. There are already on-going projects which demonstrate the replicability of COOCEN in Kigali. For example, a larger-scale project supported by UNIDO, where the biggest garbage collection company in Kigali started to make and promote use of briquettes at the start of 2011 is evidence that this business can be scaled-out and replicated in other cities. Since the enterprise requires procuring municipal solid waste, developing strong partnership ties with city municipalities is important for reliable supply of input.

Summary assessment – SWOT analysis

The strength of the cooperative business emanates from the fact that it is vertically integrated coupled with a strong marketing strategy and securing of offtake contracts with its customers (Figure 19). Government support for alternative sources of energy and rising prices of wood and charcoal are seen as key opportunities for the business. However, the cooperative is facing technical constraints due to limited drying capacity particularly during rainy season and processing capacity of the briquette pressing machines, limited human and institutional capacity, and limited availability of capital which hinder expansion of the business. It is also anticipated that overtime competition in briquette production will increase. COOCEN has a strategy to improve its manufacturing process and the quality of the final product. The major threats to the business are power shortages, lack of a well-coordinated institutional framework to manage existing and prospective investments, lack of clear technology standards and regulations, as well as unclear processes for approving investments.

FIGURE 19. SWOT ANALYSIS FOR COOCEN

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	STRENGTHS <ul style="list-style-type: none"> Vertically integrated cooperative with abundant availability of organic waste and long term contract with customers Diversified revenue streams from waste collection and briquette sales Strong marketing strategy effectively created market 	WEAKNESSES <ul style="list-style-type: none"> Limited drying capacity particularly during rainy season Limited processing capacity of the mechanical briquette machines Part of the collected MSW is still dumped to landfill sites Lack of finance to invest in more automated machines and to expand business Limited human and institutional capacity
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	OPPORTUNITIES <ul style="list-style-type: none"> Government support for alternative source of energy Rising prices of wood and charcoal Briquette market growth Possibility of recycling plastics as an additional income generating activity 	THREATS <ul style="list-style-type: none"> Competition from other briquette manufacturing businesses Seasonal changes in the weather pattern affects production 2010 Rwanda development strategy includes developing the wood fuel production, is a counter-force to briquette market growth Power shortages Lack of a well-coordinated institutional framework to manage existing and prospective investments Lack of clear technology standards and regulations

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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 2012/13. As business operations are dynamic data can be subject to change.