Project design document form for CDM project activities

(Version 06.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)
Title of the project activity ECO2 Renewable Biomass Fuel Enterprise, Kenya
Version number of the PDD 01.0
Completion date of the PDD 16 May, 2017
Project participant(s) Eco2librium LLC myclimate Foundation
Host Party Kenya
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s) Renewable Energy Supply for Cooking Fuel Switch AMS.I.E – "*Switch from non-renewable biomass for thermal applications by the user*", EB 68.
Estimated amount of annual average GHG emission reductions 13,674

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>The purpose of this project is to replace a non-renewable biomass fuel (charcoal) with a renewable biomass fuel (sugarcane waste briquettes) in western Kenya. In Kenya, charcoal is the primarily fuel in urban households, institutions like hospitals, and restaurants and is the most common secondary fuel in rural areas. Charcoal production, distribution and consumption in Kenya is the second highest in Africa, behind Zambia, the fourth highest in the world, and is increasing, and is the largest component of delivered energy in Kenya. The combination of high consumption and inefficient production of charcoal from wood have highlighted the unsustainability of charcoal and is largely responsible for the UNFCC to estimate the fraction of non-renewable biomass (fNRB) of wood in Kenya at 92% (https://cdm.unfccc.int/DNA/fNRB/index.html).

Sugar production from sugar cane crops is one of the primary agricultural activities in western Kenya, with at least nine sugar factories (Mumias, Muhuroni, West Kenya, Miwani, Chemilili, Nzoia, Busia, Butali, Yala). The production of sugar from cane produces a biomass waste called bagasse. Some of the bagasse is burned for on-site energy, but much of the bagasse is considered waste and dumped or burned. It has been estimated that 1.6 of bagasse is generated annually and only 25% is used. This project will produce, distribute, and sell solid fuel briquettes made from the waste bagasse to households, institutions, and businesses as an alternative to charcoal.

The project will reduce greenhouse gas emissions by switching from a non-renewable fuel to a renewable biomass fuel. The project will contribute to sustainable development by creating jobs producing, distributing, and selling the fuels, transferring technologies involved in the fuels, improving on the disposal of sugar cane waste, reducing forest and dryland degradation, and providing a clean, affordable fuel for residents, businesses, and institutions in western Kenya.

A.2. Location of project activity

A.2.1. Host Party

>>The project activity will occur in Kenya.

A.2.2. Region/State/Province e

>>The project will take place in Rift Valley, Nyanza and Western Provinces of Kenya.

A.2.3. City/Town/Community etc.

>>Eco2librium will base activities out of Kakamega Town.

A.2.4. Physical/Geographical location

>>Activities will take place within rural and urban areas of the three provinces in western Kenya indicated in Figure 1. This is roughly between -4 to 6°N and 34 to 38°E.

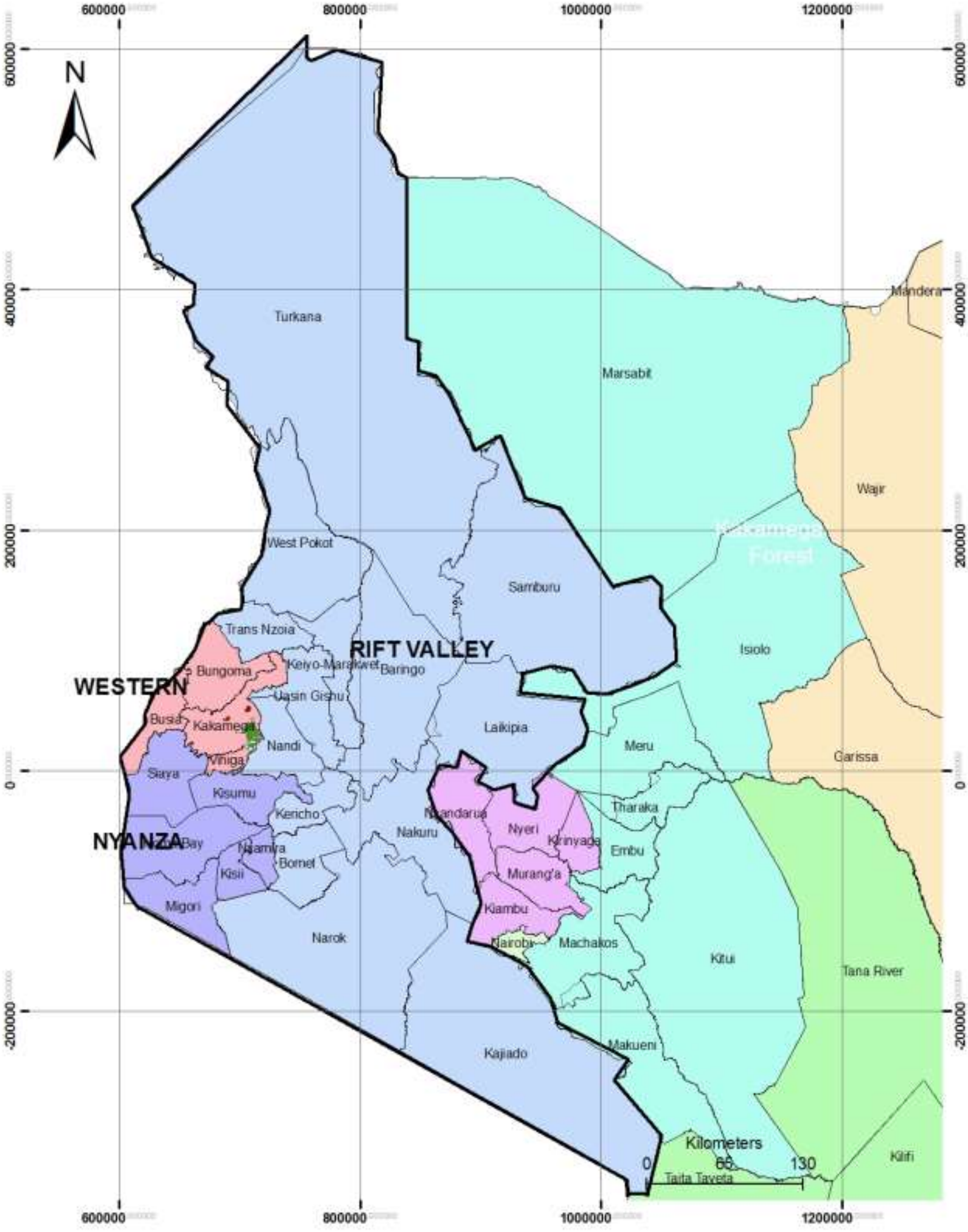

Figure 1: Project area includes Western, Nyanza and Rift Valley Provinces. However, the majority of activities is expected to be within the counties of Kakamega, Vihiga, Busia, and Bungoma in Western Province and Nandi, Uasin Gishu, Keiyo Marakwet and Trans Nzoia in Rift Valley Province, and Kisumu and Siaya counties in Nyanza Province. Activities will be based out of Kakamega town (between 0-1°N and 34-35°E).

A.3. Technologies and/or measures

>>The baseline scenario is the production and burning of charcoal in the charcoal jiko. Charcoal is most commonly produced from dryland and forest trees burned in traditional kilns and transported over long distances to urban centres and towns. The technology of traditional kilns to produce charcoal from wood is considered inefficient. The process, called carbonization, involves burning wood under low oxygen conditions resulting in the production and/or release of gases (CH_4, CO, CO_2, H_2, and O_2), water, and tar (generally hydrocarbons). The remaining fixed carbons and some volatile chemicals is called charcoal. Charcoal is purchased from markets and vendors by households, institutions and businesses and used in various sizes of ceramic or non-ceramic jikos (stoves) to cook food.

Project technologies for cooking will be a new solid biomass fuel source made from bagasse (waste product of sugar production from cane). Technologies engaged to produce the briquettes will be high efficient retort kilns, crusher/mixers, and mechanical presses. Bagasse is delivered by sugar factory lorries to a central production facility near Kakamega town. Here the bagasse is air-dried to reach suitable moisture content, then carbonized in retort kilns (see photo below). In the carbonization process in retort kilns, methane is captured and burned to assist in carbonization, thus reducing emissions of methane in comparison to the baseline. The carbonized bagasse will then be mixed with binders like molasses and water, and pressed into dense solid briquettes by high pressure machines. The briquettes will then be cured and packaged in bags for distribution and sale.

Kilns in the background with carbonized bagasse in foreground.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Party A (host) Kenya	Private entity A – Eco2librium-Kenya LTD Public entity A	yes
Party B	Private entity B Public entity B	
…	…	

A.5. Public funding of project activity

>>There is no public funding of project activity.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

>>The approved methodologies applied are version 06 of AMS.I.E – "*Switch from non-renewable biomass for thermal applications by the user*", EB 68.

B.2. Applicability of methodology and standardized baseline

>>The project is the production and distribution of a renewable solid biomass fuel (sugar cane waste briquettes) which will replace non-renewable charcoal. All applications are for cooking and/or boiling water by end users of the fuel, which are households, institutions (e.g. hospitals), and businesses (e.g. hotels and restaurants). By switching from the burning of non-renewable fuels to the burning of renewable biomass, greenhouse gas emissions are reduced. Therefore the project is a switch from a non-renewable biomass for thermal applications by users.

The thermal capacity of the project is below the limit of 15 MW (thermal) and the project proposes the replacement of non-renewable biomass for thermal energy for individual households, institutions, and small businesses.

The proposed project activity does not save non-renewable biomass accounted for by other registered project activities. There is no similar registered small-scale project in same region.

The IPCC (2006) gives the fraction of non-renewable biomass used in Kenya at 92%. An excerpt from Githiomi and Odour (2012, pg 22) suggest this problem has been in Kenya for at least 30 years: *"Lack of sustainable wood energy production planning has lead to scarcity and over-exploitation of natural resources and environmental degradation as supported by past studies by Akinga (1980) and Ministry of Energy (2002), which despite being two decades apart showed a widening gap between supply and demand in woodfuel. The deficit in woodfuel was due to higher tree cutting rate than replenishment. Strategies need to be put in place to ensure sustainability of wood fuel production."* More recent summaries of Kenya's solid fuel situation shows that the difference between supply and demand is resulting in a growing deficit (see below in B.4.) as charcoal consumption continues to increase (see below in B.4.).

Kenya land cover, biomass, and wood fuel removal data from FAO (2010) support the non-renewable nature of biomass in Kenya. Forest, woodland, and plantation cover has decreased steadily since 1990 (see Table below). In addition, biomass of forests and woodlands has decreased coinciding with a steady increase in wood fuel removal since 1990 (table below).

	1990	**2000**	**2005**	**2010**
Forest (1000 ha)	1,240	1,190		1,140
Woodland (1000 ha)	2,150	2,100		2,050
Plantation (1000 ha)	238	212		197
Forest biomass (million tonnes)	901	863		817
Woodland biomass (million tonnes)	605	600		596
Wood fuel removal (1000 m3)	19,381	22,630	27,359	

*Data from FAO (2010).

B.3. Project boundary

The project boundary, both the physical/geographical space and the relevant and major emissions, includes the production and distribution of renewable biomass fuel, and the consumption of this fuel by end users, but does not include the source of the waste renewable biomass. Specifically, biomass waste from sugar factories (bagasse) is excluded from project boundary as cultivation would happen with or without use of the waste biomass to produce fuels. The briquette production centre, where waste biomass is carbonized in kilns and pressed into briquettes, involves emissions from petrol and/or electricity consumption running machinery and also emissions from carbonization. Finally the project boundary encompasses all end users.

The targeted population are charcoal users within project boundary.

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from the production of charcoal	CO_2	Yes	Primary emission source
		CH_4	Yes	Major emission source in production of charcoal
		N_2O	No	Minor emission source (ignored for simplicity)
		…		
	Emissions from the consumption of non-renewable charcoal	CO_2	Yes	Primary emission source
		CH_4	Yes	Important emission source
		N_2O	Yes	Important emission source
		…		
	Emissions from the consumption of non-renewable wood fuel	CO_2	Yes	Primary emission source
		CH_4	Yes	Important emission source
		N_2O	Yes	Important emission source
Project scenario	Emissions from the production of renewable biomass solid fuel	CO_2	Yes	Production requires electricity and produces methane, which can be recaptured and burned as fuel source.
		CH_4	Yes	
		N_2O	No	
		…		
	Emissions from consumption of renewable solid biomass fuel	CO_2	No	No emissions since the shift is 100% from non-renewable to renewable source.
		CH_4	No	Minor emission source
		N_2O	No	
	Emissions from shift in pre-project activity	CO_2	No	The renewable biomass source is all waste/residual, therefore not applicable.
		CH_4	No	
		N_2O	No	
	Emissions from biomass generation and/or cultivations	CO_2	No	The renewable biomass source is all waste/residual, therefore not applicable.
		CH_4	No	
		N_2O	No	

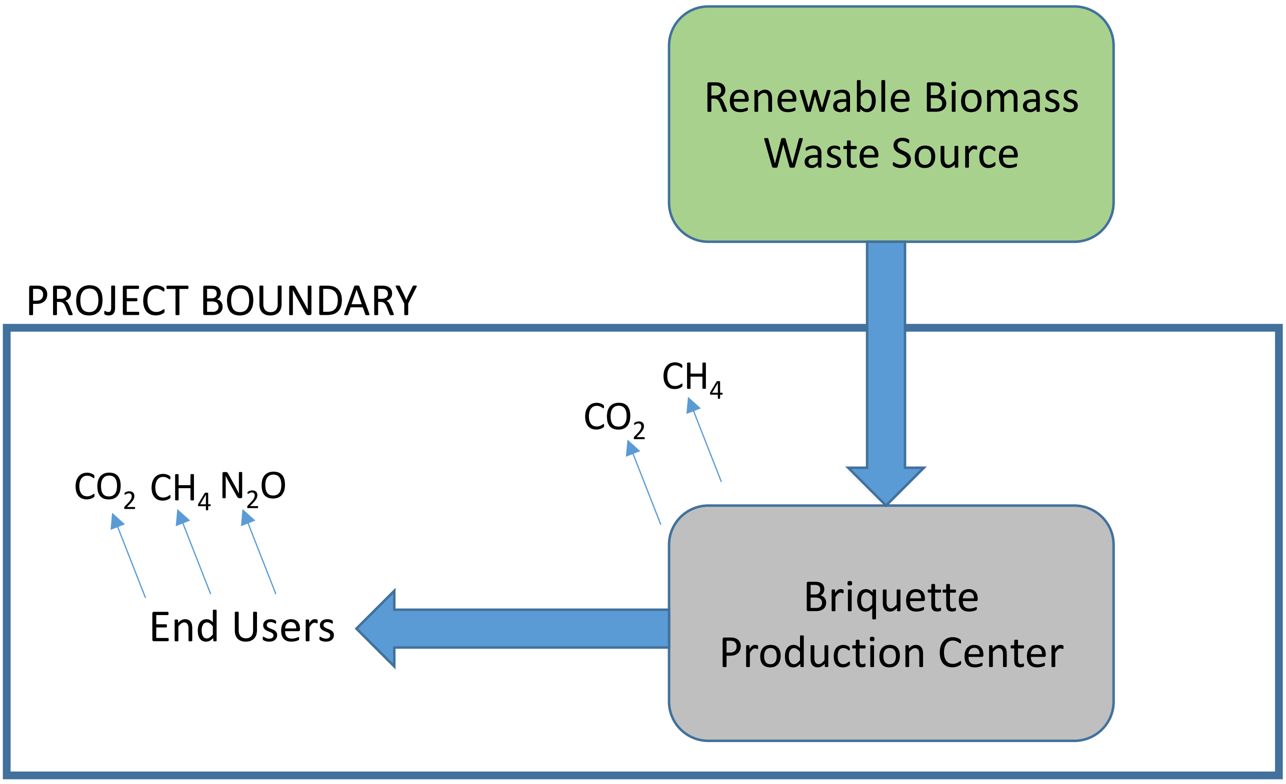

Figure B.3.1: Flow diagram showing energy flow and delineation of project boundary with regards renewable biomass fuel (bagasse briquettes).

B.4. Establishment and description of baseline scenario

>>According to the methodology AMS 1.E, *"It is assumed that in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs."*

Project activities focus on fuels for cooking and boiling water in three sectors: domestic (households), businesses (e.g. restaurants, hotels) and institutions (e.g. hospitals).

National Fuel Use. Nationally, biomass (primarily wood fuel in the form of firewood and charcoal) provides the largest proportion of Kenya's energy requirements, is the predominant fuel in both rural and urban households, and its total use is increasing (O'Keefe et al. 1984, MoE 2002, KIPPRA 2010, Githiomi and Oduor 2012, Bonjour et al. 2013). Most relevant in this context, the deficit between wood supply and demand is growing. In 1980 wood fuel deficit was estimated at 37% (i.e. total demand was 37% higher than total supply of wood as a fuel) (O'keefe et al. 1984). In 2002, the wood fuel deficit was estimated at 57% (MoE 2002). By 2020, the deficit is expected to be 67.3% (Githiomi and Oduor 2012).

Specifically, charcoal is the primary fuel in Kenya. In terms of total energy delivered in Kenya, charcoal was the highest at 39% (MoE 2002 in ERC report 2005, page 7). It is the most common fuel in urban households at over 80% (MoE 2002 in ERC rport 2005, page 8), is the preferred fuel in the commercial sector (Kituyi 2001), and is used in over 25% of rural households (Bailis 2003, KIPPRA 2010).

There is also evidence that charcoal use is increasing and will continue to do so. Between 1980 and 2000, total charcoal consumption increased in commercial and institutional, urban domestic and rural domestic sectors (Bailis 2003, figure 2). Specifically, the increase in consumption in urban areas was 135%, in rural areas by 308% and in commercial/institutions was 315% (Bailis 2003, Table 2). During this same time period, Kenya was the second largest consumer of charcoal in Africa, second only to Zambia, and the 4th largest charcoal consumer in the world (Bailis 2003). In recent years, with increasing urbanization in Kenya and charcoal being the most affordable fuel, charcoal use in urban areas in increasing and expected to continue (Njenga et al. 2013, pg. 360 paragraph 2). In developing countries as a whole, charcoal consumption is expected to increase 6% per year (Njenga et al. 2013, page 360, paragraph 2). And further evidence suggests that biomass fuel use in Africa will not decrease as in the rest of the world (Bonjour et al. 2011) and that charcoal *"will continue to be the main, and in some cased, the only source of energy for millions of people in the sub-Saharan African for a long time"* (Mugo et al. 2007 in Njenga et al. 2013, page 360, paragraph 2).

As a country, Kenya's population is increasing and poverty rate is hovering around 50% (KNBS 2009), rates of rural electrification is very poor especially in the project area (~ 15% - KIPPRA 2010, page 20, last paragraph), and access to affordable alternative fuels like LPG is not improving (KIPPRA 2010, page 21, paragraph 1), as cost of installation is prohibitive. For example, Njenga et al. (2013, page 362, paragraph 3) said that the cost of charcoal was $150 per household per year, while LPG and electricity was $397 and $750 per household per year, respectively. In contrast, charcoal has many other advantages including ease of transport, long burning time and less smoke (compared to wood) (Njenga et al. 2013).

Project Area Fuel Use. The counties encompassed by our project area and activities lie roughly in two agro-ecological zones (AEZ I and AEZ II – see below) - low to mid elevation moist forest/shrubland. Within these counties, poverty rate averages 50% (KNBS 2009) and electrification is less than 15% (KIPPRA 2010, page 20, last paragraph). Thus, biomass is the most common fuel due to its financial and physical accessibility; over the 9 counties included in our project area, biomass (in the form of wood and charcoal) average 93.3% of household cooking fuels (KNBS 2006, page 216-217). Charcoal as the cooking fuel was found in 14.9 % of households on average in these counties (KNBS 2006, page 216-217). It is assumed that this survey included both rural and urban households. However, in an earlier study, Kituyi (2001) found, in AEZ I and AEZ II, that charcoal was predominant in urban households and restaurants (see table below). Fuel use has been studied extensively by Eco2librium (unpublished data) in Western Province (Kakamega and Vihiga counties). They found that over 90% of rural households use wood as the primary fuel and charcoal was the most common secondary fuel, consistent with findings by Kituyi (2001). The project activities will target charcoal users.

Region	**Rural (kg/person/day)**		**Urban (kg/person/day)**	
	Charcoal	**Biomass Res**	**Charcoal**	**Biomass Res**
AEZ I	0.34	0.50	0.62	0
AEZ II	0.23	0.13	0.30	0.01

Region	**Fuel**	**Households**	**Schools**	**Restaurants**	**Total**
		(million tons)			
AEZ I	Wood	8.3	0.16	0.037	8.52
	Charcoal	9.3	0.014	0.487	9.76
AEZ II	Wood	5.7	0.156	0.034	5.85
	Charcoal	5.4	0.124	0.186	5.85

*from Kituyi (2001)

Baseline Surveys.

Price and access have been found to be the most important variables influencing fuel choice (KIPPRA 2010, Njenga et al. 2013). As incomes rise, people add fuels like charcoal and LPG to their fuel mixes. In urban areas, charcoal is preferred because access to wood is limited, charcoal burns clean and is more easily stored, and is cheaper than other fuels like LPG and electricity (KIPPRA 2010, Njenga et al. 2013). To compare divergent fuels (e.g. Electricity, LPG, charcoal) we calculated the cost of each fuel per standard energy output. In other words, it is difficult to compare costs of fuels to cook using the units they are sold by (e.g. sacks of charcoal, cylinder of LPG, kilowatt of electricity). We converted each fuel into the amount of energy output using a standard energy unit – MMBTU's (million BTU's). This was done by first obtaining the heat/energy content (i.e. net calorie value) for each fuel (except electricity) from IPCC (2006, Chapter 1, Table 1.2), which is given in terajoules per million tons. We then converted this into MMBTU's per kilogram (using standard energy and mass conversions). We then converted each fuel into a cost per kilogram. Using cost per kilogram and MMBTU's per kilogram we then calculated cost per MMBTU's. See excel file "price per energy content of fuels" for more details.

Table B.4.1

Fuel	[1]Cost of cooker (KES)	[2]Cost of fuel per unit (KES/unit)	[3]Cost of fuel per kilogram (KES)	[4]Cost of fuel (KES) per MMBTU's	Total Cost to Cook
Charcoal	**510**	996/sack	28.9	**1,034**	**1,544**
LPG	**4,293**	943/6kg cylinder	157.0	**3,501**	**7,794**
Electricity	**6,495**	17.2/kwh	NA	**5,041**	**11,536**

1. Based on prices obtained from local supermarket (see pdf: "*nakumatt quotation for stoves*") and known price of Upesi. We obtained quotes (without VAT) from the local Nakumatt store in downtown Kakamega for charcoal and LPF. Electric cooker prices were found online. For clarification in the quotation:
   Clay jikos = charcoal cookers
   Cook and Lite stoves = LPG cookers
   Electric cooker – see Nakumat quotation
2. Sources:
   Charcoal – survey data (and www.allafrica.com/stories/201412051189)
   LPG – average of 3 quotations from local vendors and
   www.businessdailyafrica.com
   Electricity - https://stima.regulusweb.com/historic (April 2017 average over all sectors)
3. Sources:
   Charcoal weight per sack: based on survey data and weighed containers
   LPG – average per quotation for refill of small 6 kg cylinder.
4. Sources: See excel file, "*price per energy content of fuels*"

Limited access to alternative fuels like electricity and LPG (the grid is minimal in western Kenya – KIPPRA 2010 page 20; and LPG is sold primarily in urban centers), high entry (LPG and electric stoves are 8.4 and 12.7 times higher than charcoal cookers) and operating costs (LPG fuel is 3.0 times more than charcoal and electricity is 5 times more), high levels of unemployment and poverty in the project area, and national trends of increasing charcoal consumption (see above), it is reasonable to assume that the current scenario of charcoal use will continue in the future. With increasing population and in the context of cost and access to other fuels, it is also reasonable to assume that the deficit between supply and demand of woody biomass will either stay the same (conservative) or increase in the future. Thus the most plausible baseline scenario is the continued use of unrenewable charcoal in the domestic, commercial and institutional sectors.

B.5. Demonstration of additionality

>> **Step 0: Identification that the project activity is first of its kind.**

The output / service that the project activity is delivering is heat for cooking purposes to households, businesses and institutions who in the baseline scenario cook with charcoal. The applicable geographical area is defined as three Provinces in the western part of Kenya, but most activities will take place in all the counties of Western Province, Nandi, Trans Nzoia, and Uasin Gishu counties of Rift Valley Province, and Kisumu and Siaya counties of Nyanza Province (see figure 1). This specific geographical area is chosen (as opposed to the entire host country) because (1) it is the primary goal of project activities by Eco2librium to apply solutions to slow the rate of forest degradation to threatened forests of the western highlands of Kenya, and (2) the raw materials for production of the renewable biomass come from the dominant sugar cane industry located within this same area.

Below we provide evidence that the proposed project activity is:

(a) the first in the applicable geographical area that applies a technology that is different from technologies that are implemented by any other project, which are able to deliver the same output and have started commercial operation in the applicable geographical area before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of the proposed project activity, whichever is earlier.

The proposed project activity is the production and distribution of a renewable biomass fuel used for cooking and heating water in the residential (i.e. households), small business (e.g. restaurants), and institutional (e.g. hospitals) sectors. The fuel is made from the waste product (bagasse) of sugar production from sugar cane. The raw bagasse is carbonized in retort kilns (kilns which recycle and burn the methane and other gases emitted from heating of biomass) and mixed with water and molasses to press into small briquettes. These briquettes are burned in small to medium sized stoves. Based on government records there are no registered companies, organizations, or businesses that are currently engaged in this activity in the applicable project region (check and provide source). In addition, according to market surveys there are no products similar to this being sold within the project boundary (where are the locations of the other briquette makers?). There are small organizations north (Bungoma region) and south (Kisumu region) which are making biomass fuels from uncarbonized bagasse for industrial outputs, and there are a few small scale operations making briquettes out of charcoal dust (waste of charcoal production from wood) (sources?).

(b) implementing the following two of the four measures:

The proposed project activity is a fuel switch from non-renewable charcoal to renewable biomass. We have provided evidence that charcoal is a non-renewable fuel (see above). The biomass substituted (bagasse) is a waste product of sugar cane production and cultivation would happen with or without use of the waste biomass to produce fuels. In addition, the waste biomass "*is considered an environmental hazard and a probable source of factory fires. . . (and) it is difficult to decompose.*" (Onchieku et al. 2012, page 479). In Onchieku et al. (2012), it is estimated that 1.6 million tons of bagasse are produced annually and that only 25% is used on site. Further, it is suggested that bagasse is an important source for alternative energy as the production is focused in one geographic area with concentrated points of continual production.

The proposed project activity captures and burns methane from the carbonization of bagasse in retort kilns (see photo below). We use retort kilns manufactured using purchased plans from Adams Retort (https://www.biocoal.org/adam-retort/; http://charcoalkiln.com/adam-retort-improved-charcoal-production-system/), which has been shown in published, peer reviewed studies to be more efficient at carbonization and reduce emissions (Adams 2009).

(c) selecting a crediting period for the project activity that is “a maximum of 10 years with no option of renewal”.

Therefore, based upon the guidelines for demonstration of additionality based on first of its kind, it is reasonable to assume that the project is first of its kind and therefore is additional.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

1. Switch from Wood/Charcoal to Renewable Biomass.

According to the methodology AMS 1.E, the emission reductions are derived from the total displaced non-renewable biomass by renewable biomass. To calculate emission reductions from replacing charcoal with renewable biomass we use modifications of equation 1 from the methodology:

$$ER_y = B_y \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected\_fossil\_fuel} - PE_{BC,y}$$ Equation (1)

where:

ER_y = emission reductions during the year y in T CO_{2e}

B_y = quantity of woody biomass that is substituted or displaced in tonnes

$F_{NRB,y}$ = fraction of woody biomass used in the absence of the project activity in year y that can be established as non-renewable biomass using survey methods or government data or approved default country specific fraction of non-renewable woody biomass (fNRB) values on the CDM website

$NCV_{biomass}$ = net calorific value of the non-renewable woody biomass that is substituted (IPCC default value for wood fuel, 0.0156 TJ/tonne)

$EF_{projected\_fossil\_fuel}$ = emission factor for the substitution of non-renewable woody biomass by similar consumers. We used the IPCC value of 112 t CO2/TJ

$PE_{BC,y}$ = Project emissions due to cultivation of biomass

For replacing charcoal:

ER_{ychar} =[emission reductions from the production of charcoal from wood] + [emissions reductions from the burning of charcoal] – $PE_{BC,y}$

$ER_{ychar} = [B_{ychar} \times (f_{NRB,y} \times EF_{CO2ewood} + EF_{nonCO2ewood})] + [M_{ychar} \times (EF_{CO2echar} + EF_{nonCO2echar})] - PE_{BC,y}$

Equation (1)

Where:

B_{ychar} = quantity of wood from charcoal production substituted or displaced in tonnes

M_{ychar} = quantity of charcoal substituted or displaced in tonnes

$EF_{CO2echar}$ = CO2 emission factor for burning of charcoal (tCO2/t fuel) from IPCC 2006 values for NCV and EF pertaining to the burning of charcoal.

$EF_{nonCO2echar}$ = nonCO2 (CH4 and NO2) emissions factors for burning of charcoal (tCO2e/t fuel) from IPCC 2006 values for NCV, EF, and GWP for CH4 and NO2 pertaining to the burning of charcoal

Calculation of B_{ychar}. The methodology provides one of two options to calculate B_y. Project activities centre on the production, distribution, sale, and use of a renewable biomass fuel (bagasse briquettes). This renewable fuel source will be sold to households, businesses, and institutions to substitute or replace non-renewable charcoal. Because these are the primary, and almost always the only, fuel used, we assume that all bagasse briquettes sold will be replacing charcoal. Because there will be no appliances sold or distributed, option (a) is not applicable. Option (b) is also not applicable because there will be no new systems and because the amount of thermal energy generated (HG) in option (b) is equal to the product of the amount of biomass (B_y) and the NCV of that biomass, which are already in the original equation. Therefore we will not be using option (a) or (b) to calculate B_y, but calculate B_y from the following:

$$B_{ychar} = M_{y,char} * CE \qquad \text{Equation (2)}$$

where:

$M_{y,char}$ = amount of charcoal substituted or displaced (tonnes) in year y

CE = the conversion efficiency (M_{wood}/M_{char}) at which a certain amount of wood is turned into charcoal. We use the value of 6.67/1 which is 6.67 tonnes of wood/1 tonne charcoal. This value represents an efficiency of 15%, which is a conservative value given to the production of charcoal in Kenya. While many references (Ferguson 2012, Mutimbo and Barasa 2005, Njenga et al. 2013, Bailis 2003 Kimaryo 1983 in Kammen and Lew 2005, https://energypedia.info/wiki/Charcoal_Production,) give indications of the efficiency of turning wood into charcoal as being very low (2-20%), there is only one published, peer-reviewed study to our knowledge (Okello et al. 2001, page 146). This study found the mean conversion efficiency of 14.2 (+/- 0.9 SE) percent. We therefore use 15% as the conservative value based on this study.

$PE_{BC,y}$. Because project activities will be using only waste/residue (bagasse) from already existing cultivation and production of sugar from sugar cane, the emissions from cultivation are assumed to be 0.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	**$f_{NRB,y}$**
Unit	proportion
Description	the proportion of biomass used in absence of project that is established non-renewable
Source of data	CDM default for Kenya (https://cdm.unfccc.int/DNA/fNRB/index.html)
Value(s) applied	0.92
Choice of data or Measurement methods and procedures	national default value
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**NCV_{wood}**
Unit	TJ/tonne
Description	the net caloric value of wood that is being substituted
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.0156
Choice of data or Measurement methods and procedures	According to methodology, this is the number that should be used.
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**NCV_{char}**
Unit	TJ/tonne
Description	the net caloric value of charcoal that is being substituted
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.0295
Choice of data or Measurement methods and procedures	According to methodology, this is the number that should be used.
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**$EF_{CO2wood}$**
Unit	tCO_{2e}/t fuel

Description	the emission factor for wood
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.7472
Choice of data or Measurement methods and procedures	As per the methodology, we used NCV*EF NCV = 112 TJ/t fuel EF = 0.0156 tco2/TJ
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**$EF_{CO2charcoal}$**
Unit	tCO_{2e}/t fuel
Description	the emission factor for the substituted non-renewable biomass by similar customers = NCV x EF (below)
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	3.304
Choice of data or Measurement methods and procedures	As per the methodology, this value represents the emission factor of the fuel(s) most likely to be used and is the product of NCV and EF: NCV = 112 t CO2/TJ EF = 0.295 TJ/t fuel
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**$EF_{nonCO2wood}$**
Unit	tCO2e/t fuel
Description	the emission factor for CH4 and NO2 for wood
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1356
Choice of data or Measurement methods and procedures	As per the methodology, this value represents the emission factor of the fuel(s) most likely to be used and is the sum of the products of NCV, EF, and GWP for CH4 and NO2: CH4: NCV = .0156 TJ/t fuel; EF = 0.300 tCO2/TJ; GWP = 25 NO2: NCV = .0156 TJ/t fuel: EF = 0.001 tCO2/TJ: GWP = 298
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**$EF_{nonCO2char}$**
Unit	tCO_{2e}/t fuel
Description	the emission factor for the substituted non-renewable biomass by similar customers
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories

Value(s) applied	0.2292
Choice of data or Measurement methods and procedures	As per the methodology, this value represents the emission factor of the fuel(s) most likely to be used and is the sum of the products of NCV, EF, and GWP for CH4 and NO2: CH4: NCV = .0295 TJ/t fuel; EF = 0.200 tCO2/TJ; GWP = 25 NO2: NCV = .0295 TJ/t fuel: EF = 0.001 tCO2/TJ: GWP = 298
Purpose of data	applied to emission reduction calculations
Additional comment	

Data / Parameter	**CE**
Unit	no units
Description	this number is the amount of wood needed to make one tonne of charcoal in kilns that are estimated at 15% efficient.
Source of data	Okello et al. 2001
Value(s) applied	6.67
Choice of data or Measurement methods and procedures	Most kilns used to make charcoal are traditional earth kilns with a calculated efficiency of 15%. Therefore to make 1 tonne of charcoal, then one consumes 1/0.15 tonnes of wood = 6.67
Purpose of data	applied to baseline biomass consumption calculations
Additional comment	

B.6.3. Ex ante calculation of emission reductions

**Calculations based on one year with assumed usage rate of 1 and 365 project technology days.*

$ER_{ychar} = B_{ychar}$ x $(f_{NRB,y}$ x $EF_{CO2ewood} + EF_{nonCO2ewood}) + (EF_{CO2echar} + EF_{nonCO2echar}) - PE_{BC,y}$

= 6.67 x (0.92 x 1.7472 + 0.1356) + (3.304 + 0.2292) – 0

= 11.626 + 3.533

= *15.159 tCO_{2e}

**for every tonne of charcoal substituted or displaced by the renewable biomass*

B.6.4. Summary of ex ante estimates of emission reductions

Estimated new fuels over 10 years

Year	Estimated renewable biomass sold (tonnes)
1	20
2	100
3	200
4	300
5	600
6	600
7	1200
8	1200
9	2400
10	2400

Estimated emission reductions over 10 years.

Year	Renewable Biomass ER's ($t\ CO_2e$)
Year 1	303
Year 2	1,516
Year 3	3,032
Year 4	4,548
Year 5	9,096
Year 6	9,096
Year 7	18,192
Year 8	18,192
Year 9	36,384
Year 10	36,384
Total	**136,743**

B.7. Monitoring plan

Monitoring will conform to the methodology AMS 1.E in which the following specifications are relevant to this project:

1. Monitoring of appliances – not applicable as no appliances are distributed.

2. Monitoring for leakage – there is no evidence of use of renewable biomass in this area and thus it is reasonable to assume that non-project users will not switch to non-renewable charcoal saved from project activities as this is already what is being used. In others words, almost all fuel used in this area is charcoal. Therefore leakage is assumed to be "0."

3. **<u>Monitoring for displacement/substitution of non-renewable charcoal – this is the major role of monitoring is this project.</u>**

4. Monitoring for thermal energy generated in case of option (b) chosen – not applicable as option (b) was not chosen.

5. Monitoring regarding water treatment – not applicable

Monitoring Plan to confirm and quantify displacement/substitution of non-renewable charcoal –

Monitoring will be carried out by Eco2librium-Kenya's Monitoring Department. Monitoring will include two main strategies:

1. Sales Record – renewable biomass briquettes will be sold to vendors (wholesale) and users (retail). For each transaction a record of sales will be kept (i.e. Purchase and Sales – PS). This record will include quantity (kg) of briquettes, date of transaction, and contact information of buyer. Buyers will also receive a receipt for each purchase. Hard copy sales records will be gathered by territory managers who will send the records to Eco2librium headquarters. Here, the sales records will be digitized and added to a spread sheet.

   Annual sales records will be used:

   - to calculate total quantity (tonnes) of bagasse briquettes sold for each year that went to displace charcoal.

   - to provide the population for annual sampling

2. Regular Sampling – Regular random sampling will be carried out to assess:

   a. Accuracy of briquette quantity that went to replace charcoal.

   b. Monitoring of sustainability indicators.

Management of Monitoring Activities:

Monitoring will occur through a Monitoring/Research Coordinator (with staff) hired full time by project. This person and staff will receive oversight and guidance from the Field Director. This person and staff, in collaboration with Senior Manager, will coordinate all data collection specifically regarding continuous measures (e.g. total sales records). This person and staff will also coordinate independently the collection of all annual and periodic measures. All data will be gathered in hard copy in the field by the Monitoring Coordinator and staff. MC will then input data into digital files. This will be checked for QC/QA by the Field Director with "spot" checks using hard copies in comparison with digital. All data will be archived as hard copies in ECO2-Kenya field office and in digital achives in ECO2 Headquarters Executive Director and with ECO2-Kenya Field Director.

Data and parameters to be monitored

Data / Parameter	M_{ychar}
Unit	tonnes
Description	the amount of charcoal that is displaced by renewable biomass
Source of data	calculated from sales record
Value(s) applied	
Choice of data or Measurement methods and procedures	Based on methodology.
Purpose of data	applied to emission reduction calculations
Monitoring frequency	collected on a regular basis and calculated every year
QC/QA methods	Transparent data analysis and reporting in sales record
Additional comment	

B.7.1. Sampling, Analysis and Reporting Plan

>>

Sales Record. OC collects sales information from territory managers via text messaging or written hard copies on a daily/weekly basis. OC collates all hard copy PS and delivers once per week to MC. MC inputs data digitally and sends to OC and FD monthly. A monthly report is written. All sales are summarized annually at end of year (monitoring period).

Regular Sampling. Organized and carried out by MC with assistants in field. Hard data from field digitized then checks by FD. Sent to ED for analysis.

Sustainability Indicators. Will be part of Regular sampling.

B.7.2. Other elements of monitoring plan (QC/QA)

A) >> Regular Monitoring (Data from Purchase and Sales): All Purchase and Sales (PSs) received by the office go through 4 levels of checks prior to being submitted as final entries into the Sales Record database that is used for verification. These steps are as follows:

1. *Operations team:*
   i. The operations team conducts checks at 2 levels;
   ii. The 1st check is through the **Database** that tracks briquettes from purchase through delivery and PS submission to the office;
   iii. The 2nd series of checks follows submission of the PS to the office;
   iv. Once submitted, all PSs are matched to the buyers Personal sheets;
   v. Numbers on PSs are matched to delivery records;
   vi. PSs are checked for errors, inconsistencies and gaps (if incomplete) prior to being entered into a database;
   vii. Any faulty PSs detected at these stages are rejected and returned to buyers;
   viii. Once checks are completed, PSAs and the matching database are submitted to the Monitoring team.

2. *Monitoring team:*
   i. The monitoring team checks PSAs for completeness, accuracy, plausibility and for the actual existence of the sales;
   ii. To check for completeness and accuracy, the monitors recheck everything;
   iii. If any issues are noted, monitors are dispatched to visit the specific locations that have raised questions. At the same time, such PSAs are rejected and returned for correction;
   iv. Once all checks are completed, a database of the latest PSA entries is emailed by the Monitoring Coordinator to the Field Director and the Finance Department.

3. *Finance department:*
   i. Once the database is completed, the finance department processes the database for payment;
   ii. Processed payment records are matched to briquettes purchased and delivered.

4. *Field director:*
   i. The field director receives the final database and conducts a final quick check prior to adding to the **PSA Master Database (MDB);**
   ii. At this stage, all entries are copied into the **PSA Master Database (MDB)**;
   iii. The field director then shares the database with the Executive Director who maintains the final **Sales Record** as used in the verification process;
   iv. At this stage, 3 copies of the database are made – 1). With the Executive Director; 2). With the Field Director; 3). With the Monitoring Coordinator. These copies act as a back-up of the main database.

All hard copies are stored in ECO2 Kenya Office. All digital data is stored initially on Field Director's computer. Every month or so an updated copy of the digital data is sent to Executive Director at ECO2 headquarters. Every six (6) months digital data is updated and transferred onto a CD/flash drive for storage.

An independent auditor will check, intermittently and if necessary, the sales record against financial records (e.g. invoice, pay stubs, ledgers).

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

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SECTION C. Duration and crediting period

C.1. Duration of project activity

>>Unknown

C.1.1. Start date of project activity

>>mid 2017

C.1.2. Expected operational lifetime of project activity

>>Unknown

C.2. Crediting period of project activity

>>

C.2.1. Type of crediting period

>>Single

C.2.2. Start date of crediting period

>>January 1, 2018

C.2.3. Length of crediting period

>>10 years, 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>> NA

D.2. Environmental impact assessment

>> NA

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>> See GS Passport

E.2. Summary of comments received

>> See GS Passport

E.3. Report on consideration of comments received

>> See GS Passport

SECTION F. Approval and authorization

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☐ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Eco2librium LLC
Street/P.O. Box	106 N. 6th, #204
Building	Pioneer
City	Boise
State/Region	Idaho
Postcode	83702
Country	U.S.A.
Telephone	01-208-921-0243
Fax	
E-mail	mark.lung@eco2librium.com
Website	www.eco2librium.net
Contact person	Dr. Mark Lung
Title	Executive Director
Salutation	
Last name	
Middle name	
First name	
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Appendix 2. Affirmation regarding public funding

There is no public funding for project. See Gold Passport for ODA declaration

Appendix 3. Applicability of methodology and standardized baseline

Appendix 4. Further background information on ex ante calculation of emission reductions

Appendix 5. Further background information on monitoring plan

Appendix 6. Summary of post registration changes

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