VOLUNTARY CARBON MARKET MONITORING REPORT FORM

Monitoring Period: 31 August, 2007 – 8 September, 2009

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SECTION A. General project activity information

A.1 Title of the project activity:

Improved Household Charcoal Stoves in Ghana

A.2. GS registration number:

GS 413

A.3. Short description of the project activity:

The project reduces greenhouse emissions by disseminating fuel-efficient charcoal stoves. The project is based on pilot work by Toyola Energy Limited (TEL), Ghana. TEL was established in 2003. It is owned and managed by highly educated and trained entrepreneurs. TEL was part of 50 informal metal artisans selected and trained by EnterpriseWorks Worldwide[1] to fabricate the "GYAPA" charcoal efficient cook stoves. During this reporting period, TEL renamed their product to reflect a slightly different design and the different geographic market in which TEL operates, as well as to help avoid double counting with other carbon finance projects in Ghana. While the stove is very similar to the GYAPA, TEL's stove is marketed and sold under the name "Toyola Coalpot"[2] to avoid confusion between these different products.

Four types of stoves are sold under the auspices of the project:

a. improved fuel-efficient household charcoal stoves (small)
b. improved fuel-efficient household charcoal stoves (medium)
c. improved fuel-efficient commercial charcoal stoves (small)
d. improved fuel-efficient commercial charcoal stoves (large)

The improved charcoal stove (Toyola Coalpot) reduces fuel consumption by introduction of a ceramic liner that increases combustion efficiency and retains heat. The Toyola Coalpot stove consists of hourglass shaped metal cladding with perforated interior ceramic liner that allows ash to fall to the collection chamber at the base. A thin layer of cement is placed between the cladding and the liner to bind the two. During use, a single pot rests at the top of the stove.

While these stoves significantly reduce greenhouse gas emissions, they simultaneously provide co-benefits to users and families in the form of relief from high fuel costs, reduced exposure to health-damaging airborne pollutants, faster cooking (resulting in time-savings), and increased cleanliness and convenience. Finally, they curb deforestation by decreasing demand for charcoal.

Currently, inefficient and polluting cooking regimes are deeply entrenched in Ghanaian culture. Using carbon finance, this project is breaking this trend and moving large populations away from conditions under which GHG emissions are unacceptably high, indoor air pollution is harmful to health and environmental effects from deforestation are significant.

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[1]Enterprise Works Worldwide is a global NGO that fights poverty through business development and market awareness programmes.

[2]For simplicity, the term "Toyola Coalpot" is used to describe any stove similar to the Jico design sold in Ghana by TEL, including before TEL began marketing under this name. The term Gyapa is used to describe any stove similar to the Jico design sold in Ghana by companies other than TEL. The name of TEL's stove changed from Gyapa to Toyola Coalpot in July, 2008.

A.4. Monitoring period:
This report includes VERs generated during the period from 9 September, 2007 – 8 September, 2009 from stoves that were sold between 31 August, 2007 – 8 September, 2009.

(although project start date is prior to 9 September, 2007, Gold Standard only allows up to two years of retroactive credits. In addition, the project database on which ER calculations are based starts on 1 September, 2007 rather than 31 August, 2009. This is because there was no sales data available for 31 August, 2007.)

A.5. Methodology applied to the project activity (incl. version number):

A.5.1. Baseline methodology:
Gold Standard Voluntary Methodology “Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes, Version 1.”

A.5.2. Monitoring methodology:
Gold Standard Voluntary Methodology “Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes, Version 1.”

A.6. Status of implementation including time table for major project parts:
The project activity has disseminated 55,331 stoves during the monitoring period, 31/8/2007 through 8/9//2009 with an estimated GHG offset of 51,230 tons generated during the last two years of the monitoring period.
In parallel with stove sales, a rigorous monitoring of the project activity has been ongoing per schedule below:

Date	Activity	Purpose
November 14, 2006 – to date	Sales recording	Establish sales database to track number of stoves sold and determine clusters for kitchen surveys
May 2008	Baseline Kitchen Performance Tests Baseline Kitchen Surveys	Determine baseline charcoal savings and clusters
June 13-22, 2008	Non-Renewable Biomass Baseline Study	Determine percentage of non-renewable biomass
October 23-25, 2008	Kitchen Surveys	Determine if clusters are still representative
November 13-15, 2008	Kitchen Surveys	Determine if clusters are still representative
April 15-19, 2009	Kitchen Surveys	Determine if clusters are still representative
June 8-10, 2009	Kitchen Surveys	Determine if clusters are still representative

A.7. Intended deviations or revisions to the registered PDD:

None

A.8. Intended deviations or revisions to the registered monitoring plan:

None

A.9. Changes since last verification:

None. This is first verification.

A.10. Person(s) responsible for the preparation and submission of the monitoring report:

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SECTION B. Key monitoring activities according to the monitoring plan for the monitoring period stated in A.4.

B.1. Monitoring equipment:

B.1.1. Table providing information on the equipment used

The following instrument is used to weigh the amount of charcoal used by households before and after acquiring a Toyola Coalpot stove:

Equipment	Manufacturer	Type	Uncertainty
Accu-Weigh scales	Accu Weigh	(ACCUT-50) Accu-Weigh T-50 Tubular (ACCUT-20) Accu-Weigh T-20 Tubular	ACCUT-50: 25 kg scale uncertainty is equal to +/- 250 g ACCUT-20: 10 kg -- uncertainty is equal to +/- 100 g

B.1.2. Involvement of Third Parties:

Monitoring is being performed by Berkeley Air Monitoring Group

B.2. Data collection (accumulated data for the whole monitoring period):

B.2.1. List of fixed default values:

Data	Description	Value	Source
$EF_{bl.bio,co2}$	CO2 emission factor arising from use of wood-fuel in baseline scenario	1.747 tCO2/t_biomass	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
$EF_{pj.bio,co2}$	CO2 emission factor arising from use of wood-fuel in project scenario	1.747 tCO2/t_biomass	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
$EF_{bl.bio,non-co2}$	Non-CO2 emission factor arising from use of wood-fuel in baseline scenario	0.455 tCO2/t_biomass	CH4 and N2O: IPCC 2006 GL for emission factors and NCVs, IPCC SAR 1996 for GWPs.
$EF_{bl.bio,non-co2}$	Non-CO2 emission factor arising from use of wood-fuel in project scenario	0.455 tCO2/t_biomass	CH4 and N2O: IPCC 2006 GL for emission factors and NCVs, IPCC SAR 1996 for GWPs.
$EF_{ch,prod,co2}$	CO2 emission factor arising from production of charcoal	1.802 tCO2/t_ch	Emissions of greenhouse gases and other airborne pollutants from charcoal making in Kenya and Brazil, David M. Pennise, Kirk R. Smith, Environmental Health Sciences, University of California, Berkeley, California. Journal of Geophysical Research Vol 106 October 27 2001.
$EF_{ch,prod,non-co2}$	Non-CO2 emission factor arising from production of charcoal	0.983 tCO2/t_ch	CO2, CH4, N2O GWPs from (IPCC SAR 1996).
$EF_{ch,use,co2}$	CO2 emission factor arising from consumption of charcoal	3.304 tCO2/t_ch	Product of NCVch (IPCC 2006 GL default 29.5 MJ/kg) and Emission factor (energy basis) for charcoal (IPCCC 2006 GL default 112 tCO2/TJ) x 10^-3

$EF_{ch,use,non-co2}$	Non-CO2 emission factor arising from consumption of charcoal	0.255 tCO2/t_ch	CH4 and N2O: IPCC 2006 GL for emission factors and NCVs, IPCC SAR 1996 for GWPs

B.2.2. List of variables:

Data	Description	Source of data	Monitoring Frequency
Xnrb,bl,y	Non-renewability status of woody biomass fuel in year y in baseline scenario	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual (every two years as outlined in methodology)
Xnrb,pj,y	Non-renewability of woody biomass fuel in year y in project scenario	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual
Xre,bl,y	Woody biomass combustion avoided due to renewable energy form in year y in baseline	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual
Xre,pj,y	Woody biomass combustion avoided due to renewable energy form in year y in project	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual
Leakage	Potential GHG emissions outside project boundary caused by project activity	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual
Bbl,y	Mass of woody biomass combusted in the baseline in year y	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual
Bpj,,y	Mass of woody biomass combusted in the project in year y	Berkeley Air Baseline and Project Scenario Study (annex 6 in PDD)	Bi-annual
Usage in year y	Percentage of stoves of age x remaining in use in year y	Survey	Bi-annual
Age	Adjustment to values of $B_{pj,,y}$ and $AF_{pj,i,y}$ for stoves of age x	Survey	Bi-annual
New Stove	Adjustment to values of $B_{pj,,y}$ and $AF_{pj,i,y}$ for new stove models	Measurements of sample or whole of cluster population	Bi-annual
Stove Sales	Number of stoves sold by project activity	Record keeping by Toyola	Quarterly
Eligibility of Project database for KPT sampling (KS)	analysis of kitchen surveys results to determine whether new clusters (and therefore new KPTs) are required	Survey	Quarterly

Sustainable Development Variables (Gold Standard Requirement)

Sustainable Development Indicator	Data type	Data variable	Data unit

Air Quality	*Self-reported IAP reduction, and/or ambient CO & PM concentrations*	*Reduced indoor air pollution (IAP)*	*Ambient IAP concentration*
Livelihood of the Poor	*Survey results*	*Household fuel cost savings*	*$ saved/year*
Employment	*New employment*	*Job creation*	*Jobs/Year*
Employment quality	*Periodic assessment of conditions*	*Employment quality*	*Qualitative assessment*
Access to energy services	*Extrapolated based on total sales and average household size*	*Improved energy access*	*People/year*
Other pollutants	*Periodic assessment of conditions*	*Proper disposal*	*Qualitative assessment*

B.2.3. Data concerning GHG emissions by sources of the project activity:

Source 1: Production (of charcoal)
No change from baseline. See B 2.4

Source 2: Cooking

Data	**Value**	**Source**	**Frequency of collection**
Stove sales	55,331 units (from 31/8/2007 to 8/9//2009)	Toyola Sales Records	Monthly
Average daily household consumption of charcoal	1.0 kg/HH-day	2008 Baseline KPT Study	Bi-annually
Average daily household consumption of wood	0.87 kg/HH-day	2008 Baseline KPT Study	Bi-annually
Prevalence of HH Wood Consumption	30%	2008 Baseline Study and KS	Bi-annually
Cumulative Usage	20% decrease per year	Conservative Projection	Bi-annually

B.2.4. Data concerning GHG emissions by sources of the baseline:

Source 1 = Production (of charcoal)

Data	**Value**	**Source**	**Frequency of Collection**
Non-Renewable Biomass Baseline (charcoal)	73%	2008 Baseline study	Bi-annually
Non-Renewable Biomass Baseline (wood)	73%	2008 Baseline Study	Bi-annually

Source 2= Cooking

Data	**Value**	**Source**	**Frequency of Collection**
Average Daily Household Consumption (charcoal)	1.5 kg/HH-day	2008 Baseline KPT Study	Bi-annually
Average Daily Household Consumption (wood)	1.08 kg/HH-day	2008 Baseline KPT Study	Bi-annually

Prevalence of HH wood consumption	30%	2008 Baseline and Monitoring Kitchen Survey	Bi-annually

B.2.5. Data concerning leakage:

No significant sources of leakage were identified at this point in the project, but future offset calculations will be adjusted accordingly if significant sources are later identified. The following possible sources of leakage will continue to be monitored in future Kitchen Surveys (KS) and Kitchen Performance Tests (KPT).

a) Increased use of non-renewing biomass as a result of savings in charcoal use

b) Users of efficient stoves replace lower emissions technology than the improved stove. For example, switching from inefficient fuelwood to efficient charcoal can yield an increase in overall emissions in some cases.

c) Improved stove users compensate for loss of the space heating effect of inefficient cook-stoves by adopting some other form of heating, such as open fires, or by retaining some use of inefficient stoves.

d) The traditional charcoal stoves replaced by the improved stoves are re-used by the same families or other families in a manner suggesting increased consumption of charcoal beyond the baseline demand level. In cases where replaced stoves are used by other families, they do not replace efficient stoves and therefore do not yield a net increase in emissions. Furthermore, an inefficient stove buyback system is in place, which provides incentives to surrender inefficient stoves in exchange for a discount on efficient stoves

e) Manufacture, distribution, or use of the improved stoves gives rise to new emissions associated with transport or manufacturing. Evidence exists that this effect is more than compensated for by reduction in transport emissions due to decreases in charcoal use.

With respect to point d) above, the project has instituted a baseline stove buyback program whereby users are offered the option to surrender their old stove in exchange for a 20% discount on their new stove, as outlined in section B.1.1 of the PDD. Stoves are taken by Toyola and destroyed and used as scrap metal. Toyola is deeply involved in the scrap metal business since much of their stoves are manufactured from scrap metal. After they are destroyed, the metal from old stoves is sold into the same scrap metal market where many of the metal claddings for efficient stoves are manufactured. The program has been quite successful to date and there is a constant flow of users taking advantage of the incentive.

B.2.6. Data concerning environmental impacts:

-Air quality

Indoor air pollution is assessed qualitatively in the Kitchen Survey (KS).

B.2.7 Monitoring Results for Gold Standard Sustainability Indicators (Gold Standard Requirement)

B.2.7 Monitoring Results for Gold Standard Sustainability Indicators (Gold Standard Requirement)

Indicator	Data type	Data variable	Data unit	Value	Source
Air Quality	Self-reported IAP reduction, and/or ambient CO & PM concentrations	Reduced indoor air pollution (IAP)	Ambient IAP concentration	Some of the survey respondents stated that “reduced smoke” and “reduced cough and eye irritation” were some of the reasons they purchased a Toyola’s Coalpot	Berkeley Air’s *2008 Annual Carbon Monitoring Report: Toyola Coalpot improved charcoal stoves of Toyola Energy, Ltd. Ghana (raw data)*
Livelihood of the Poor	Survey results	Household fuel cost savings	$ saved/year	142.35 GHc/year	Berkeley Air’s *2008 Annual Carbon Monitoring Report: Toyola Coalpot improved charcoal stoves of Toyola Energy, Ltd. Ghana*
Employment	New employment	Job creation	Jobs/Year	28 new jobs between December 2007 and December 2008	*E+Co Monitoring and Evaluation Reports from Jan-June, 2008 and July-Dec, 2008*
Employment quality	Periodic assessment of conditions	Employment quality	Qualitative assessment	Toyola’s employees are paid wages that exceed Ghana’s minimum wage[3] and work in conditions that meet or exceed Ghanaian labor law requirements	*E+Co Monitoring and Evaluation Reports 2008*
Access to energy services	Extrapolated based on total sales and average household size	Improved energy access	People/year	287,721 people total, or 142,108 people/year on average over the monitoring period[4]	Berkeley Air’s *2008 Annual Carbon Monitoring Report: Toyola Coalpot improved charcoal stoves of Toyola Energy, Ltd. Ghana* *Sales records from 31/8/07 to 9/8/09*
Other Pollutants	Periodic assessment of conditions	Proper disposal	Qualitative assessment	Scrap metal is periodically collected and sent to smelting company. Empty paint containers are also collected and sent to paint manufacturers who dispose of them	*Site visit by Project Proponent and Monitoring and Evaluation Reports*

[3] http://ghanabusinessnews.com/2009/04/03/ghana-minimum-wage-raised-by-18-per-cent/

[4] Based on sales from 31/8/07-9/9/08. 55,331 stoves were sold and the average household size is 5.2 people based on Berkeley Air surveys. Average yearly access is calculated by calculating average new access per day by dividing the total number with new access during the monitoring period by the number of days in the period, and finally multiplying by 365.

B.2.8 Data concerning double counting

The project continues to monitor any risks of double counting in this project, specifically determining whether any of the stoves sold as part of this project are counted in any other emission reduction projects. At this time, to the best of our knowledge there are no other greenhouse gas emission reduction projects in Ghana around stoves that have issued credits, and thus today no risk of double counting exists. However, the project developers continue to monitor whether any other projects exist. In such cases, the project developer will cross reference our total sales database and end user database with any other projects to ensure that there is no overlap. In addition, the project continues to use all legal documentation outlined in the PDD to ensure legal ownership over offsets, a step that further avoids double counting.

B.3. Data processing and archiving (incl. software used):

Sales records and results of kitchen surveys are first captured in paper form then compiled in a Microsoft Excel spreadsheet. Records will be kept for two years after the project activity is completed.
Monitoring data is analyzed using Microsoft Excel, Stata (Data Analysis and Statistical Software) and SAS (Statistical Analysis Software).

B.4. Special event log:

- Any special events which occurred should be listed here with date and details.

In July 2008, Toyola changed the name of its stoves from Gyapa to Toyola Coalpot to differentiate its product from other Gyapa stoves.

SECTION C. Quality assurance and quality control measures

C.1. Documented procedures and management plan:

C.1.1. Roles and responsibilities:

E+Carbon assists the project implementing body Toyola to maintain and make available accurate records. E+Carbon collates a composite electronic Total Sales record and Toyola keeps backup paper records. Toyola’s existing accounting and records system accurately tracks sales, inventories and supply and purchases. Toyola maintains a full sales database in Excel of all sales that take place, listed according to the sales mechanism, date and stove type. Sales databases are cross checked with production records and other data to ensure consistency and accuracy.

E+Carbon and Toyola have implemented a system of rebate cards to be completed by end users upon sale[5]. If this project is approved, the rebate will be converted into a discount at point of sale. End user information cards will still be completed upon sale once the rebate is discontinued. These cards include personal contact details of end users, which are collated into an electronic database from which project monitoring can be conducted. The excel records are backed up and sent to the project coordinator for checking prior to using them as the basis for quarterly monitoring activities. Hard copies of rebate cards are filed as additional backup and for verification purposes.

For all direct sales to end-users TEL collects this information personally. For retail and agent sales, cards are distributed with stoves and collected when the next stock of stoves is delivered. The customers in the

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[5] These cards serve three functions: they collect end user contact information to facilitate monitoring, offer a rebate, which helps to prove additionality, and they offer end users the opportunity to “sell” their ownership rights to emissions reductions in the form of a discount from a rebate.

sales record for which phone numbers or addresses are available are used for survey sampling to support the periodic monitoring activities.

Monitoring tasks, such as quarterly KSs, assessment of leakage and other such tasks are handled by a third party, the Berkeley Air Monitoring Group. It is important to note that quarterly kitchen surveys are not used directly in ER calculations, but instead serve to inform whether new clusters are required (which could in turn effect ER calculations) and monitor certain Gold Standard sustainability indicators. Berkeley Air Monitoring Group instructs a local surveyor, paid by E+Carbon, to conduct these surveys. Survey results are delivered both electronically and via DHL in hard copy directly to Berkeley Air, who analyzes the data and compiles quarterly and annual reports. The Group also performs biannual monitoring tasks according to the methodology. The integrity of data is constantly cross checked with other variables to ensure consistency and avoid mistakes.

C.1.2. Trainings:

Berkeley Air recruited local surveyors during the baseline study and trained them to conduct Kitchen Surveys (KS). These surveyors perform the quarterly KS and report directly to Berkeley Air. Toyola actively trains new managers, ceramic artisans, metal workers and technicians to be employed with Toyola. To date, they have trained over 100 new artisans in the skills needed to manufacture efficient stoves. Training new workers takes 1-3 months, depending on the individual and the skills they are aiming to achieve. Toyola prefers to use local artisans in different parts of the country because it decreases transport costs and employs local people, which is a benefit to the community and helps strengthen the company's local presence. Toyola also trains users on proper use of the stove, as outlined in section C.4. below on troubleshooting.

C.2. Involvement of Third Parties:

Berkeley Air Monitoring Group

C.3. Internal audits and control measures:

One of the most critical data in this project activity is the number of stoves sold since it is the basis to determining emission reduction. Toyola participates in E+Co monitoring and evaluation program. The Monitoring and Evaluation Officer checks Toyola's sales records, financial accounts, production records and retailers' records which are then compared to information transmitted by Toyola to E+Carbon. Additionally, Berkeley Air checks for inaccuracies in the sales database before conducting kitchen surveys.

C.4. Troubleshooting procedures:

While troubleshooting procedures do not apply directly to this project in the traditional sense, it is instructive to point out how end users tend to maintain their stoves to improve lifespan of the equipment and maintain appliance efficiency. When Toyola sells stoves, they offer some basic instructions on how to care for them. First, users should avoid leaving the stove out in the rain. While stoves can withstand some rain, they encourage users to bring stoves inside when not being used. Users often wish to extinguish the burning charcoal with water in an effort to conserve fuel when cooking is complete. Toyola urges users to take hot coals out of the stove before extinguishing them with water. Water in contact with the hot ceramic liner can eventually crack the liner. Charcoal often comes in larger pieces than is convenient to burn in the stove, requiring users to break the charcoal into smaller pieces. Toyola emphasizes that crushing charcoal should not be done inside the stove since the impact can break the ceramic liner. Interestingly, users have learned that if they put a layer of clay on the liner after each use, they greatly increase stove lifespan. Field surveys conducted during the last verification confirmed that this practice is becoming increasingly common among Toyola users.

In addition, Berkeley Air conducts home visits of a subsection of end users to complete surveys required for the methodology. During these visits, proper use of the stove is often discussed. Toyola also follows up with users through its extensive sales network. These visits serve to reinforce proper use principles outlined above.

SECTION D. Calculation of GHG emission reductions

D.1. The formulae used for ER calculations are:

$ER_q = \sum BE_{i,q} - \sum PE_{i,q} - \sum LE_{i,q}$

Where:

ER_q = Emission reduction in total project population in quarter q (tCO_2e/qr)
$BE_{i,q}$ = Baseline emissions of cluster i in quarter q (tCO_2e/qr) taking NRB fraction into account
$PE_{i,q}$ = Project emissions of cluster i in quarter q (tCO_2e/qr) taking NRB fraction into account
$LE_{i,q}$ = Net Leakage of cluster i in quarter q (tCO_2e/qr)

Within each cluster the emissions are calculated thus:

$$BE_{i,q} = \sum (F_{bio,fuel,yr} * (\%NR_{bio,fuel,yr} * EF_{bio,fuel,CO2} + EF_{bio,fuel,non\text{-}CO2}) * D_{bio,fuel,yr}) + \sum (F_{fuel,yr} * \%NR_{fuel,yr} * (EF_{fuel,CO2} + EF_{fuel,non\text{-}CO2}) * D_{fuel,yr})$$

$$PE_{i,q} = \sum (F_{bio,fuel,yr} * (\%NR_{bio,fuel,yr} * EF_{bio,fuel,CO2} + EF_{bio,fuel,non\text{-}CO2}) * D_{bio,fuel,yr} * (1 - U_{bio,fuel,yr}))$$

$$+ \sum (F_{fuel,yr} * \%NR_{fuel,yr} * (EF_{fuel,CO2} + EF_{fuel,non\text{-}CO2}) * D_{fuel,yr} * (1 - U_{bio,fuel,yr}))$$

<u>Biomass Fuels</u>

$F_{bio,fuel,yr}$: Daily fuel savings (tonnes/day) for a given biomass fuel in a given year of usage (baseline, year 1, year 2, etc.) of the project cluster's improved cooking device or regime.

$\%NR_{bio,fuel,yr}$: Fractional non-renewability of biomass baseline for a given biomass fuel in a given year.

$EF_{bio,fuel,CO2}$: CO2 Emissions Factor (tCO2/t_fuel) for a given biomass fuel[6].

$EF_{bio,fuel,non\text{-}CO2}$: Non-CO2 Emissions Factor (tCO2e/t_fuel) for a given biomass fuel[7]; includes all non-CO2 gases accounted.

$D_{bio,fuel,yr}$: Days (days) of fuel savings accounted for a given biomass fuel in a given year of usage (baseline, year 1, year 2, etc.) of the project cluster's improved cooking device or regime.

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[6] For a fuel such as charcoal this EF includes CO2 emissions from production and consumption. See Annex 2 for justification of non IPCC EFs used.

[7] For a fuel such as charcoal this EF includes CO2 emissions from production and consumption.

$U_{bio,fuel,yr}$: Annual fractional *drop-off* in the usage of the project cluster's improved cooking device or regime in a given year of usage (year 1, year 2, etc.). (Labeled 'CUM U1, 2, etc' in the excel carbon calculator).

Non-Biomass Fuels

$F_{fuel,yr}$: Daily fuel savings (tonnes/day) for a given non-biomass fuel in a given year of usage (baseline, year 1, year 2, etc.) of the project cluster's improved cooking device or regime.

$\%NR_{fuel,yr}$: Fractional non-renewability for a given non-biomass fuel in a given year. For fossil fuels the value will be 1, for renewables, 0.

$EF_{fuel,CO2}$: CO2 Emissions Factor (tCO2/t_fuel) for a given non-biomass fuel. This can include production and consumption.

$EF_{fuel,non\text{-}CO2}$: Non-CO2 Emissions Factor (tCO2e/t_fuel) for a given non-biomass fuel; includes all non-CO2 gases accounted. This can include production and consumption.

$D_{fuel,yr}$: Days (days) of fuel savings accounted for a given non-biomass fuel in a given year of usage (baseline, year 1, year 2, etc.) of the project cluster's improved cooking device or regime.

$U_{fuel,yr}$: Annual fractional *drop-off* in the usage of the project cluster's improved cooking device or regime in a given year of usage (year 1, year 2, etc.). (Labeled 'CUM U1, 2, etc' in the excel carbon calculator).

The formulae governing leakage are:

LE_y = Leakage in year y – Surplus in year y

where
LE_y = net leakage in year y (in tonnes CO2e per year) specific to cluster

$$ER_y = \sum BE_{i,y} - \sum PE_{i,y} - \sum LE_{i,y}$$

Where:
- ER_y = Emission reduction in total project population in year y (tCO_2e/yr)
- $BE_{i,y}$ = Baseline emissions of cluster i in year y (tCO_2e/yr)
- $PE_{i,y}$ = Project emissions of cluster i in year y (tCO_2e/yr)
- $LE_{i,y}$ = Net Leakage of cluster i in year y (tCO_2e/yr)

The formulae applied for the Baseline Study utilize "Approach 1" as defined in the Methodology:

a) Baseline emissions:

$$BE_y = X_{nrb} \cdot B_{bl,y} \cdot EF_{bio,CO2} + \sum(AF_{bl,i,y} \cdot EF_{af,CO2,i}) + \sum(\text{Non-CO2 emissions during cooking}) + \sum(\text{GHG emissions during production of the fuels})$$

Where

BE_y = baseline emissions in year y (in tonnes CO2e per year) specific to cluster and Unit chosen

X_{nrb} = the non-renewable component of the woody biomass harvested in the project collection area

$B_{bl,y}$ = the mass of woody biomass consumed during cooking in the baseline each year (in tonnes/year).

$EF_{bio,co2}$ = the CO2 emission factor for use of the biomass fuel in tonnes CO2 per tonne fuel

$AF_{bl,i,y}$ = The mass of alternative fuel i in the baseline in year y in accordance with trends projected throughout the project period, in tonnes

$EF_{af,co2,i}$ = The CO2 emission factor for use of the alternative fuel i in the baseline in tonnes of CO2 per tonne fuel

Non-CO2 emissions during cooking = $\sum (B_{bl,y} . EF_{bio,non\text{-}co2,i}) + \sum(AF_{bl,i,y} . EF_{af,i,non\text{-}co2\ gas\ i})$

GHG emissions during production of the fuels = $X_{nrb} . B_{bl,y} . EF_{bio,prod,co2}$

$+ \sum(AF_{bl,i,y} . EF_{af,prod,co2,i})$

$+ \sum (B_{bl,y} . EF_{bio,prod,non\text{-}co2\ gas\ i})$

$+ \sum(AF_{bl,i,y} . EF_{af,i,prod,non\text{-}co2\ gas\ i})$

Where

$EF_{bio,non\text{-}co2,i}$ = Emission factor for GHG gas i in tonnes gas / tonnes wood-fuel

$EF_{af,i,non\text{-}co2\ gas\ i}$ = Non-CO2 Emission factor during cooking for alternative fuel i for GHG gas i in tonnes gas / tonnes fuel

$EF_{bio,prod,co2}$ = CO2 Emission factor for wood-fuel during production in tonnes gas / tonnes fuel

$EF_{af,prod,co2,i}$ = CO2 Emission factor for fuel i during production in tonnes gas / tonnes fuel

$EF_{bio,prod,non\text{-}co2\ gas\ I}$ = Non-CO2 Emission factor for wood-fuel during production in tonnes gas / tonnes fuel

$EF_{af,i,prod,non\text{-}co2\ gas\ I}$ = Non-CO2 Emission factor alternative fuel i for GHG gas i during production in tonnes gas / tonnes fuel

Project emissions:

Approach 1:

$PE_y = X_{nrb} . B_{pj,y} . EF_{bio,CO2} + \sum(AF_{pj,i,y}. EF_{af,CO2,i})$

$+ \sum$(Non-CO2 emissions during cooking)

$+ \sum$(GHG emissions during production of the fuels)

Where

PE_y = project emissions in year y (in tonnes CO2e per year) specific to cluster and Unit chosen

$B_{pj,y}$ = the mass of woody biomass consumed during cooking in the project each year (in tonnes/year).

$AF_{pj,i,y}$ = The mass of alternative fuel i in the project in year y in accordance with trends projected throughout the project period, in tonnes

Non-CO2 emissions during cooking = $\sum (B_{pj,y} . EF_{bio,non\text{-}co2,i}) + \sum(AF_{pj,i,y} . EF_{af,i,non\text{-}co2\ gas\ i})$

GHG emissions during production of the fuels = $X_{nrb} . B_{pj,y} . EF_{bio,prod,co2}$

$+ \sum(AF_{pj,i,y} . EF_{af,prod,co2,i})$

$$+ \sum (B_{pj,y} \,.\, EF_{bio,prod,non\text{-}co2\ gas\ i})$$
$$+ \sum (AF_{pj,i,y} \,.\, EF_{af,i,prod,non\text{-}co2\ gas\ i})$$

$EF_{af,pj,i(ebasis)}$ = The CO2 emission factor for use of the alternative fuel i in the project in tonnes of CO2 per GJ fuel

A full list of monitored parameters, as outlined in the PDD, annex 3, is included below:

Data / Parameter:	Xnrb,bl,y
Data unit:	Fraction
Description:	Non-renewability status of woody biomass fuel in year y in baseline scenario
Source of data:	Study
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	Xnrb,pj,y
Data unit:	Fraction
Description:	Non-renewability of woody biomass fuel in year y in project scenario
Source of data:	Study
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	Leakage
Data unit:	t_CO2e per year
Description:	Potential GHG emissions outside project boundary caused by project activity
Source of data:	Study
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	Bbl,y
Data unit:	t_biomass/unit-year
Description:	Mass of woody biomass combusted in the baseline in year y
Source of data:	Measurements of sample or whole of cluster population
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	Bpj,,y
Data unit:	t_biomass/unit-year
Description:	Mass of woody biomass combusted in the project in year y
Source of data:	Measurements of sample or whole of cluster population
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	Usage in year y
Data unit:	Fraction

Description:	Percentage of stoves of age x remaining in use in year y
Source of data:	Survey
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	Age
Data unit:	Fraction
Description:	Adjustment to values of $B_{pj,,y}$ and $AF_{pj,i,y}$ for stoves of age x
Source of data:	Survey
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

Data / Parameter:	New Stove
Data unit:	Fraction
Description:	Adjustment to values of $B_{pj,,y}$ and $AF_{pj,i,y}$ for new stove models
Source of data:	Measurements of sample or whole of cluster population
Monitoring frequency:	Bi-annual
QA/QC procedures:	3rd party study and report
Any comment:	

D.2. Description of how the formulas are applied in the excel carbon calculator

The Emissions Reduction (ER) Calculator calculates total emissions reductions on a daily basis for each stove in the Total Sales Database. The ER Calculator is run separately for each stove size that is included in the project. A different file for each size accompanies this report:

- Toyola calculator_HS.xlsx
- Toyola calculator_HM.xlsx
- Toyola calculator_SC.xlsx
- Toyola calculator_LC.xlsx

The calculator accounts for the day that each stove is put into use, then calculates the usage of each stove for each day. It factors in the assumed annual drop-off and other monitored parameters, which will be included as the project progresses and more monitored data is compiled. Stove usage is calculated in stoves-years, the number of stove days the stove was used divided by 365 (days).

The 'Assumptions' worksheet of each ER Calculation workbook states the 'Usage Rates' and 'Fuel Savings' (kg/stove-day). Toyola's sales are listed in the 'Project Database' worksheet, which links as an input to each carbon calculator on the "Project Database" tab.

Stove quantities and 'Usage Start-Dates' are linked from the 'Usage Record' worksheet to the 'Age 0-1', 'Age 1-2', 'Age 2-3', and 'Age 3-4' worksheets. These four 'Use' worksheets calculate usage on a daily basis for each day of the project period (x-axis) for each 'Usage Start-Date' and the corresponding stove quantity (y-axis). The four 'Use' worksheets are separate to account for stove usage at different ages. Usage for all stoves aged 0 - 1 year, which are in their 1st year of use, is accounted in the 'Age 0-1' worksheet, usage for all stoves aged 1 – 2 years, which are in their 2nd year of use, is accounted in the 'Age 0-1' worksheet, etc.

Daily stove use (stove-days) is calculated using Annual Usage Rates for stoves of different ages (Upj,yri). The Annual Usage Rates are calculated to reflect annual usage drop-off from the Cumulative Usage

Rates (CumUi) determined in the monitoring studies below. The Annual Usage Rate (Upj,yri) is the average annual drop-off in usage. That rate is applied to all stoves equally over the full year they are of a given age (1st year, 2nd year, etc.).

Calculating Annual Usage Rates (Upj,yri) from Cumulative Usage Rates (CumUi) is straightforward: If 100 of 100 monitored stoves are still in use after one year, the Cumulative Usage Rate (CumU1) after one year is 100%. If 50 of the original 100 stoves are still in use after two years, the Cumulative Usage Rate (CumU2) after two years is 50%. The Annual Usage Rate (Upj,yr1) in year 1 is 100%. The Annual Usage Rate (Upj,yr2) in year 2 is 75% ((100%+50%)/2).

Once daily stove usage (stove-days) is accounted in the 'Use' worksheets for stoves from each 'Usage Start-Date', it is aggregated on a daily and quarterly basis at the top of each 'Use' worksheet. Quarterly stove usage from each 'Use' worksheet, accounted in stove-days, is converted to quarterly stove usage in stove-years on the 'ER Calculations' worksheet by dividing by 365 days.

Finally, on the 'ER Calculations' worksheet, aggregate quarterly stove use (stove-years) is multiplied by ERs per stove-year (tCO2e/stove-year) to calculate total ERs on a quarterly basis. These values from the 'ER Calculations' workbook of each stove size are linked to the 'Summary Sheet' file where ERs from all stove sizes are combined and the verification period is specified for crediting. Note that since the verification period does not coincide perfectly with the start and end of quarters, the 'Summary Sheet' file is linked to the 'ER calculations' worksheet to account for specific days outside the boundaries of whole quarters or whole months (9-30 September, 2007 and 1-8 September, 2009).

D.3. Description and consideration of measurement uncertainties and error propagation:

Due to the use of multiple conservative approaches, such as use of the lower 90% confidence interval for fuel savings, an assumption that 20% of stoves break per year, etc, the ERs calculated according to the above formulas significantly underestimate total greenhouse gas savings. Nonetheless, there is a large quantity of data in the form of sales records on which the project developer performs spot checks. The project developer periodically checks excel records against paper records to confirm consistency. Moreover, financial accounts, production records, retailers' records, retailer activity and observations made during monitoring surveys and tests are also checked to confirm consistency. If any deviation is identified, the sales records are changed accordingly. Any erroneous records that look to not be consistent with actual sales are eliminated from the database. QA/QC procedures are outlined in more detail in section D.3. of the registered PDD.

D.4. GHG emission reductions (referring to B.2. of this document):

D.4.1. Leakage:

As outlined in the PDD, there is no evidence that additional leakage is present beyond that which is already incorporated in the paired KPT approach to measuring fuels savings.

D.4.2. Summary of the emissions reductions during the monitoring period:

Toyola Offset Summary - 9 September, 2007 - 8 September, 2009								
	Year	Quarter/month/date	HS	HM	SC	LC	Totals	Vintage totals
Offset generation (tons CO2e)	2007	9-30 September	4	57	8	-	69	1,246
		Q4	61	1,014	103	-	1,178	
	2008	Q1	134	2,268	172	1	2,576	20,974
		Q2	204	3,936	189	19	4,349	
		Q3	261	5,741	201	32	6,234	
		Q4	350	7,230	198	37	7,815	
	2009	Q1	487	8,870	184	53	9,595	29,009
		Q2	566	9,895	184	58	10,703	
		July	210	3,531	63	20	3,824	
		August	217	3,580	62	20	3,880	
		1-8 September	57	929	16	5	1,008	
Totals			**2,552**	**47,052**	**1,380**	**246**	**51,230**	**51,230**