



Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT

Title of the project activity	Improved Cook Stove Project 2, Nkhata Bay District, Malawi	
UNFCCC reference number of the project activity	9935	
Version number of the monitoring report	1	
Completion date of the monitoring report	05/11/2015	
Monitoring period number and duration of this monitoring period	Monitoring period 1. 27/10/2014 to 05/08/2015.	
Project participant(s)	The Sigma Global Company Pty Ltd Vimiti Limited	
Host Party	Malawi	
Sectoral scope(s)	Sectoral Scope: 3, Energy Demand Project Type: II, Energy Efficiency Improvement Projects	
Selected methodology(ies)	AMS-II.G, Energy efficiency measures in thermal applications of non-renewable biomass, version 5.0	
Selected standardized baseline(s)	n/a	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	35,317 tCO ₂ e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
		35,317 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project involves dissemination of the Changu Changu Moto high efficiency biomass cook stoves to approximately 22,000 households in Nkhata Bay District, Malawi. The project is being developed under the small scale CDM methodology AMS- II.G. Energy efficiency measures in thermal applications of non-renewable biomass, version 5.

The Changu Changu Moto is a low cost, high efficiency biomass fired cook stove developed through extensive trials with the local communities and is specifically designed for local Malawian conditions. The stove is constructed from locally available materials and does not require specialist construction skills or equipment. The stove design is a brick rocket stove, constructed using 26 mud bricks and a mud mortar mix. The Chichewan name Changu Changu Moto translates to “Fast Fast Fire”, and reflects one of the main benefits of the improved cook stove in reducing cooking time and saving wood fuel.

The Changu Changu Moto improved cook stove replaces the low efficiency 3-stone fire stove, which is the dominant firewood end-use system for cooking within Malawi. Emission reductions are achieved through improving household energy efficiency and thus reducing the consumption of non-renewable woody biomass.

Sustainable development

The project contributes to the sustainable development of the Nkhata Bay District and Malawi in a number of ways:

- Environmental
 - The project helps significantly reduce Malawi's greenhouse gas emissions;
 - The project helps reduce the use of non-renewable biomass from forests, thus assisting in conserving existing forest stocks, and the protection of natural forest eco-systems and wildlife habitats; and
 - The protection of standing forests also helps protect watersheds, reduce soil erosion and maintain rainfall in the project area.
- Social
 - The Changu Changu Moto stove provides a significantly safer method for cooking with biomass, helping to reduce burn injuries, especially for children;
 - The improved efficiency of the Changu Changu Moto stove significantly reduces wood fuel consumption, meaning that considerably less time is required to collect wood fuel. This reduces the work burden on rural families and allows for alternative opportunities for economic development.
- Health
 - Worldwide, it is estimated that around 4 million premature deaths occur annually due to indoor air pollution, with around 15,000 per year in Malawi¹. Women and children are the main victims. Adoption of more efficient stoves significantly reduces indoor air pollution respiratory and health problems associated with smoke emission from biomass stoves^{2 3}. The decrease in total biomass burned and an increase in the temperature of combustion in the Changu Changu Moto improved cook stove will result in lower carbon dioxide, carbon monoxide and particulate emissions.
- Economic

¹ Country profile of Environmental Burden of Disease - Malawi. [Online] 2004. [Cited: 13 June 2012.]

http://www.who.int/quantifying_ehimpacts/national/countryprofile/malawi.pdf

² Quantifying the effects of exposure to indoor air pollution from biomass combustion on acute respiratory infections in developing countries. Ezzati, M and Kammen, D M. 2001, Environ Health Perspect, Vol. 109, pp. 481-488.

³ Khennas S., Anderson T., Doig A. and Rees D., 1999. Rural Energy Services: A Handbook for Sustainable Energy Development. London, United Kingdom: Intermediate Technology Publications

- The project creates employment and contributes to the economic development of Nkhata Bay District through the stove construction, maintenance and monitoring activities.
- In areas where wood fuel is purchased, use of the Changu Changu Moto stove will significantly reduce household expenditure on cooking fuel.

A.2. Location of project activity

Nkhata Bay District, Malawi

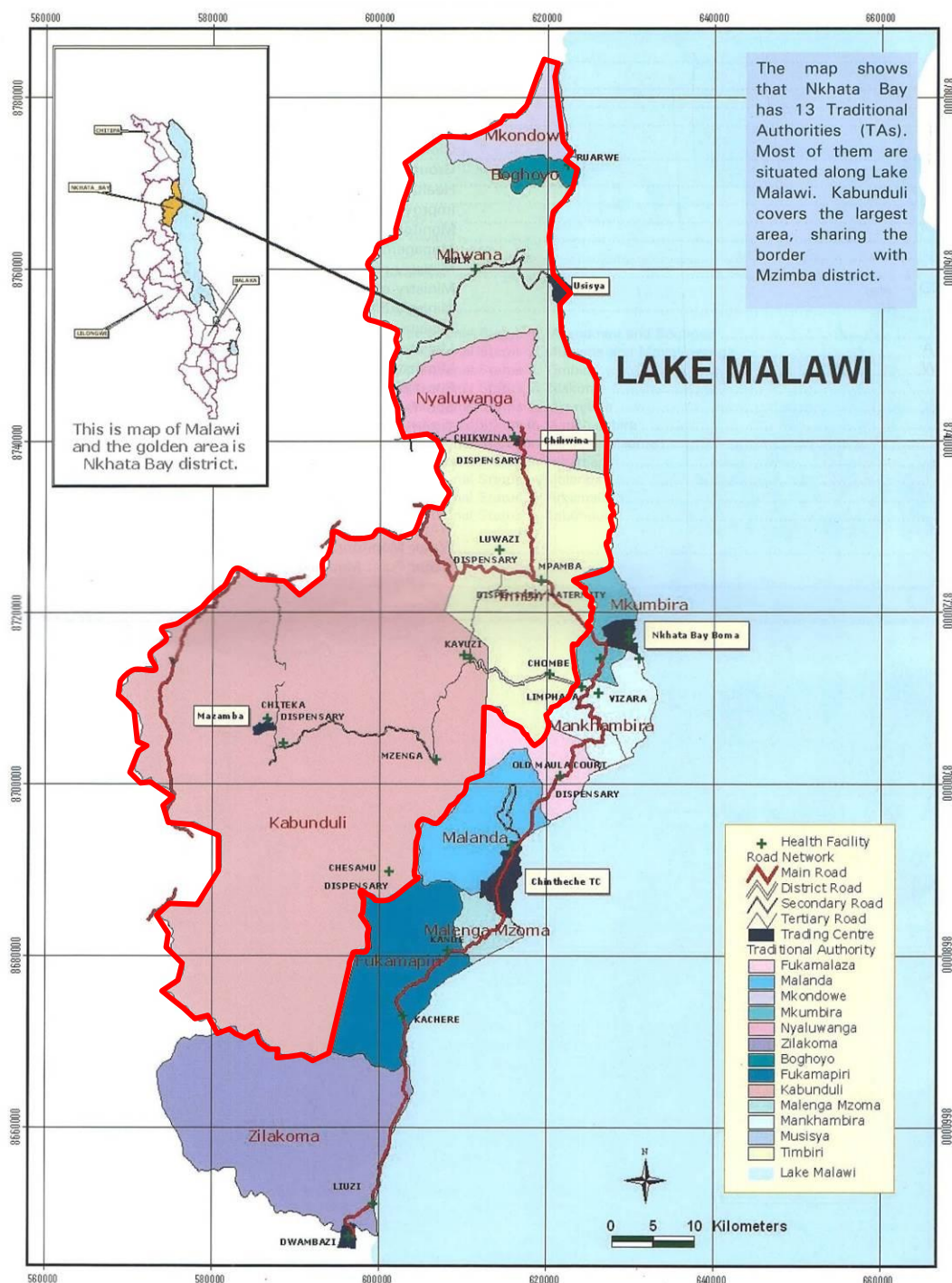
This project will install improved cook stoves in eligible households within the boundaries of six Traditional Authorities within Nkhata Bay District as shown in Table 1.

Table 1 Traditional Authorities in project boundary

Traditional Authority
Mkondwe
Boghoyo
Mbwana
M'nyaluwanga
Timbiri
Kabunduli

The total number of eligible households in the project area is estimated at 22,000.

The location of the seven Traditional Authorities that make up the project area is shown below.



A.3. Parties and project participant(s)

Party involved (host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Malawi (host)	The Sigma Global Company Pty Ltd (private entity) Vimiti Limited (private entity)	No

A.4. Reference of applied methodology and standardized baseline

AMS - II.G. Energy efficiency measures in thermal applications of non-renewable biomass (version 5.0)

A.5. Crediting period of project activity

27/10/2014 – 26/10/2024 (Fixed)

A.6. Contact information of responsible persons/entities

The Sigma Global Company:

Sally Burns

PO Box 117 Bondi NSW 2026 Australia

+61 423 584 483

SECTION B. Implementation of project activity**B.1. Description of implemented registered project activity**

The Changu Changu Moto is a low cost, high efficiency biomass fired cook stove designed by the project implementer, RIPPLE Africa, for local Malawian conditions. The stove is constructed from locally available materials and does not require specialist construction skills or equipment. The stove design is a two chamber brick rocket stove, constructed using 26 mud bricks and a mud mortar mix. The Changu Changu Moto improved cook stoves feature an insulated combustion chamber which retains heat while also raising the cooking pot to the hottest point above the flame. This improves combustion efficiency and heat transfer, thus reducing fuel consumption. The energy flows can be described as the household use of non-renewable woody biomass to produce heat energy for cooking and heating water, and also releasing carbon dioxide as a combustion product. The project technology improves the energy efficiency of the combustion process, using less non-renewable woody biomass, and therefore releasing less carbon dioxide, to produce the same amount of useable heat energy.

The Changu Changu Moto improved cook stove, recently constructed (left) and in use (right)



The stove replaces the 3 stone fire and other inefficient cooking methods that currently use non-renewable woody biomass within the project area.

The Changu Changu Moto improved cook stoves are manufactured by project implementation staff with the household owners, who take an active role to ensure they are able to undertake any repairs that may be required in the future. Training is provided to the householders on how to maintain and repair the stove. Project implementation staff are also available to assist householders repair and maintain their stoves. With the correct use and maintenance procedures, the lifetime of each stove is in excess of 10 years. The use of virtually unlimited, locally available,

natural materials to construct the stove allows repairs and re-builds of stoves to be conducted as required at little cost ad infinitum.

The sample group showed that construction of the Changu Changu Moto improved cook stoves occurred over a period starting from July 2013 to December 2014. The stove is constructed and then further instruction is provided to the household owner. It is not until a period later that the stove is recorded as being in use with the construction verification date, to ensure the householder knows completely how to use and repair the stove. The start of operation of the stoves shown by the verification date in the sample group was from 08/07/2013 to 10/12/2014. The construction of the stoves has been staggered according to availability of staff and geography constraints. Continuous training and assistance is provided to the household owner to ensure they know how to use and repair their stoves. If a household owner is having any difficulty a staff member is available to provide assistance when needed.

There have been no issues or events occurring during this monitoring period that will impact the applicability of the applied methodology.

No requests have been made to the CDM Board to make changes to the registered CDM project activity.

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

>> N/A

B.2.2. Corrections

>> N/A

B.2.3. Changes to start date of crediting period

>> N/A

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>> N/A

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>> N/A

B.2.6. Changes to project design of registered project activity

>> N/A

B.2.7. Types of changes specific to afforestation or reforestation project activity

>> N/A

SECTION C. Description of monitoring system

The monitoring system for the project activity consists of regular checks at the household level to assess the ongoing use and maintenance of the Changu Changu Moto improved cook stoves. It also consists of the annual KPTs conducted to determine the number of operating Changu Changu Moto improved cook stoves and the quantity of woody biomass used per Changu Changu Moto improved cook stove during the monitoring period.

The implementation team at RIPPLE Africa is responsible for gathering the necessary information from householders for monitoring purposes. An organisation chart and a summary of the roles and responsibilities of each position as they relate to the implementation and monitoring of this project are given below.

Eligibility for a household to participate in the project is determined through an Initial Survey conducted by the Community Volunteers (CVs). During the Initial Survey, a registration number is assigned to each eligible household.

The following householder information is recorded on the Initial Survey forms:

- Householder registration number
- Name of stove user or head of the household
- Name of Chief and village (and other location information where available)
- Current cooking method
- Current time spent collecting wood
- House ownership status
- Quantity of people in household
- Condition of kitchen
- Wood purchaser
- Availability of axe

This information is then checked by the Project Coordinators and Managers to ensure the completed forms represent the situation observed. Further investigation is completed by the Coordinator or Manager to investigate any missing or inconsistent values.

The completed forms are then transferred to project headquarters. Data entry officers then enter the information into the project database. All personnel are trained in the use of the project database to reduce the chance for data entry errors.

Project eligibility is determined by the record of the current cooking method for the household. Households participating in the pilot project are identified by having a current cooking method as the Changu Changu Moto improved cook stove at the time of the initial survey. These households are recorded in the project database, but excluded from eligible households in all emission reduction calculations. Furthermore, any households using cooking methods other than the traditional three stone fire, such as charcoal or electric stoves, are also excluded from eligible households, but are recorded in the project database for tracking purposes.

Following the eligibility assessment and Initial Survey, the construction of the Changu Changu Moto improved cook stoves is recorded on separate construction monitoring forms with the following information:

- Household registration number
- Name of stove user or head of the household
- Name of Chief and village (and other location information where available)

- Stove construction date
- Stove user Signature
- CCM in use
- CCM condition
- Wood use
- Construction verification date
- Construction verification signature (by Coordinator)

Training in the use of the stove will be provided to the householder by the Community Volunteer. The Community Volunteer will then conduct checks that the householder is using the stove at different intervals following the stove construction. The outcome of these checks is recorded on the construction form. Further training is provided to the householder by the Community Volunteer as required.

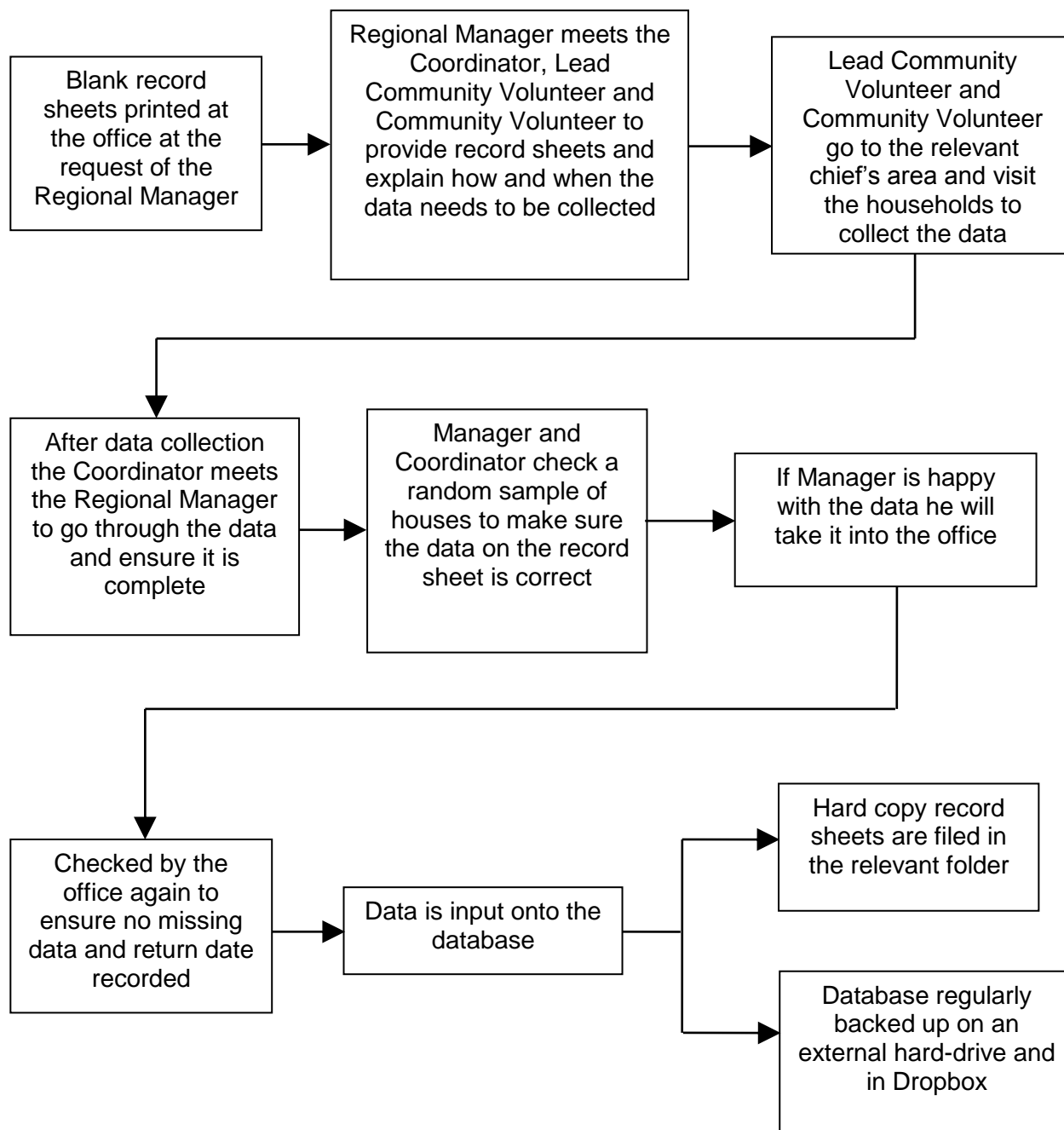
When the eight week checks have been completed for all householders in an area, the Community Volunteer forwards the completed construction monitoring forms to their Coordinator. The Coordinator then checks every household to ensure the stove is in use and in good condition, and completes the construction verification date construction verification signature.

Completed construction monitoring forms are then forwarded to the project headquarters, and all information will be entered into the project database following the QA/QC procedures detailed below.

As a conservative assumption, the emission reduction calculations for each stove are based on the date of successful construction verification by a Coordinator, rather than the actual stove build date.

Regular ongoing checks of stove usage and condition are conducted by Community Volunteers, Coordinators and Managers. Regular checks at household level are undertaken to assess the success of people using and maintaining their stoves.

Figure 1 Overview of data collection and storage



Version control is implemented for all electronic records, and off-site backups to a removable hard drive and secure Cloud server are made on a monthly or more regular basis. All records will be retained for the duration of the crediting period and for at least 2 years after the end of the crediting period or the last issuance of CERs, whichever occurs later.

Figure 2 Implementation team organisation chart

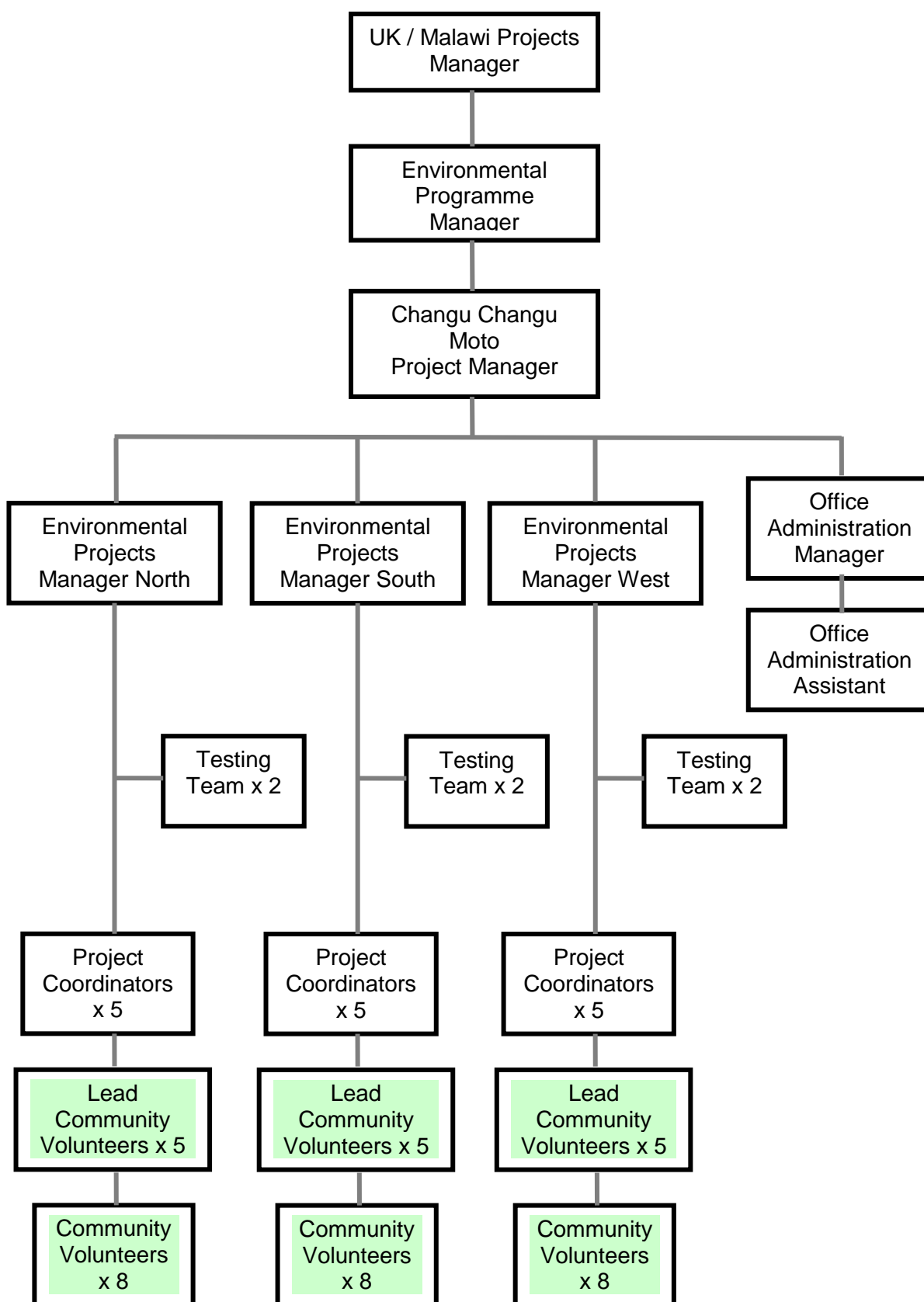
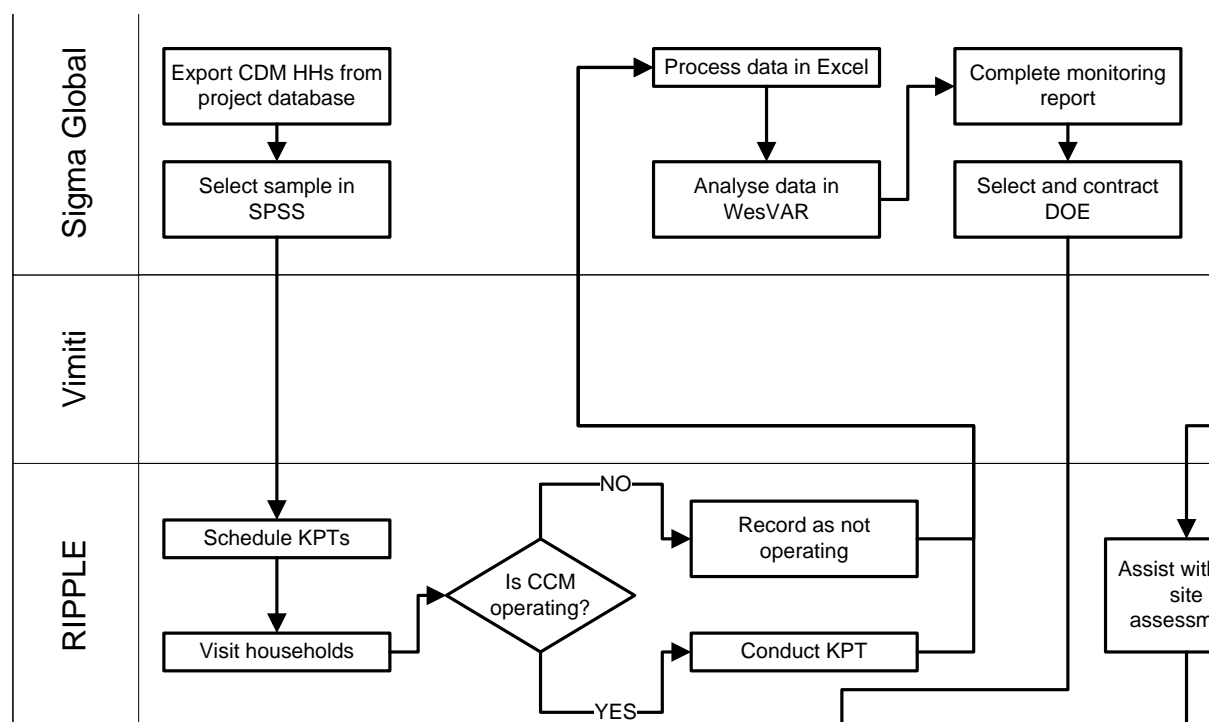


Figure 3 Overview of KPT Monitoring Procedure



Roles and Responsibilities of implementation team for monitoring of this project.

Malawi Projects Manager

- Responsible overall for the project in Malawi.
- Responsible for making sure that information is collected and recorded accurately.
- Responsible for the smooth running of the implementation and monitoring of the project.
- Responsible for coordinating all stove testing and monitoring, and general problem-solving.
- Responsible for liaising with the senior management of Project Participants.

Environmental Programme Manager

- Main link with all senior Malawian stakeholders in the project, namely Traditional Authorities, District Council, and other Government staff.
- Responsible for day-to-day management of the Managers and for staff recruitment.
- Responsible for training of Managers, Coordinators, and lead Community Volunteers.
- Responsible for producing progress reports at all stages of the programme.
- Responsible for monitoring the performance of Managers, Coordinators, and Community Volunteers.

Environmental Project Managers (North and South and West)

- Responsible for introducing the project to all Chiefs and communities within their project areas.
- Responsible for all activities in their respective areas, including management of Coordinators, Lead Community Volunteers, and Community Volunteers.
- Responsible for staff training.
- Responsible for monitoring performance of all staff, data collection, programme implementation, and ongoing monitoring in their respective areas.
- Responsible for collecting field data and providing it to the Office Administration Manager on time and completed correctly.

Office Administration Manager

- Responsible for collecting and collating all handwritten data from Community Volunteers and Coordinators, and for electronic data entry into the project database.
- Responsible for QA/QC of data entry
- Responsible for additional data entry staff.
- Responsible for printing and distributing training leaflets and data entry forms for all Community Volunteers, Coordinators, and Managers.
- Responsible for providing all senior managers with data entry progress.

Testing Officers

- Responsible for organising and performing Kitchen Performance Tests and providing all data to the Malawi Projects Manager.
- Responsible for training Coordinators and Community Volunteers on site and monitoring progress under instructions from the Projects Managers

Project Coordinators

- Responsible for running the project within their defined area, which typically would include about 30 Chiefs comprising approximately 2,000 – 3,000 households in total.
- Responsible for their Lead Community Volunteer who typically would look after 6 of the above Chiefs and manage and monitor the 15 Community Volunteers who will be implementing and monitoring the project.
- Responsible for the collection of all data entry forms on a monthly basis to be provided to the Environmental Project Managers and subsequently to the Office Administration Manager.
- Responsible for checking and monitoring the accuracy of all data provided by the Lead Community Volunteers and Community Volunteers by randomly inspecting the households and scrutinising the data collected therein.
- Responsible for training all Lead Community Volunteers and Community Volunteers in their area in the construction of Changu Changu Motos, and imparting to the Community Volunteers the skills necessary for them to provide ongoing maintenance and wood use training to each household.
- Responsible for monitoring the standard of work of all Lead Community Volunteers and Community Volunteers.

Lead Community Volunteers

- Responsible to their Coordinator and responsible for approximately 6 Community Volunteers working in 15 Chiefs' areas.
- Similar responsibilities to the Coordinators above.

Community Volunteers

- Responsible to their Lead Community Volunteer.
- Responsible for the implementation and monitoring of the project in all households within a Chiefs' area (typically 100 households).
- Responsible for making all households aware of the project.
- Responsible for ensuring all households make 30 bricks each and collect mud for the construction of the Changu Changu Moto.

- Responsible for constructing the Changu Changu Moto in each householders' kitchen in conjunction with the householder (the householder must take part in the construction in order to learn the skills required).
- Responsible for full training on maintenance of the Changu Changu Moto, and how to prepare and use the wood in the new stove.
- Responsible for regular monitoring and data collection at all stages of the project.

Quality Assurance/Quality Control

- The RIPPLE Africa Malawi Projects Manager is responsible for the coordination and implementation of the sampling plan. The KPTs were conducted by 8 teams of managers and coordinators. These staff members have been given comprehensive training in conducting KPTs by the Malawi Projects Manager, and the Technical Manager from Sigma Global.
- Equipment used for data collection during the KPTs includes scales and electronic moisture meters. Certification records of all equipment used will be kept and be available to view as part of the project verification process.
- Data was collected during the KPTs, and recorded on printed data collection sheets. Calculations of daily household wood use was completed in the field each day following weighing of the remaining wood piles, and recorded on the template. This allowed immediate investigation of any values that appear to be outliers. Any reasons for abnormal results were recorded on the data collection sheet.
- Electronic data entry occurred as soon as possible after the completion of the tests. Any calculations were performed in the spreadsheets by in-built formulas. Any cells with formulas are locked to prevent unauthorised changes.
- Written and electronic copies of the test results have been backed up in multiple locations and will be archived for the duration of the project crediting period.
- Following data entry, outliers have been identified using a box plot of the data. Any potential reasons for outlier results recorded during data collection have been analysed and a decision made regarding removal of the potential outlier. Outliers will only be removed when there is a statistically valid reason, considering the sample weighting and following the principle of conservativeness. No outliers were removed in these results.
- No systematic differences between respondents and non-respondents are expected. As described the sample size has been calculated to allow for a conservative 15% non-response rate to allow for a number of households being unable to or un-willing to participate in the survey for some reason.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

(Copy this table for each piece of data and parameter)

Data/parameter:	$NCV_{biomass}$
Unit	TJ/tonne
Description	Net calorific value of the non-renewable woody biomass that is substituted
Source of data	IPCC default for wood fuel
Value(s) applied)	0.015
Choice of data or measurement methods and procedures	Default value provided in AMS-II.G.
Purpose of data	Calculation of baseline and project emissions
Additional comments	

Data/parameter:	$EF_{projected_fossilfuel}$
Unit	tCO ₂ /TJ
Description	Emission factor for the substitution of non-renewable woody biomass by similar consumers.
Source of data	Weighted average of the emission factors of substitution fuels likely to be used by similar consumers
Value(s) applied)	81.6
Choice of data or measurement methods and procedures	Default value provided in AMS-II.G.
Purpose of data	Calculation of baseline and project emissions
Additional comments	

Data/parameter:	f_{NRB}
Unit	Fraction
Description	Fraction of non-renewable woody biomass saved by the project activity
Source of data	UNFCCC CDM website ⁴
Value(s) applied)	0.81
Choice of data or measurement methods and procedures	Default Malawi specific value available on the CDM website as approved by CDM EB and the Malawi DNA. This value is fixed for the crediting period, so $f_{NRB,y} = f_{NRB} = 0.81$
Purpose of data	Calculation of baseline and project emissions
Additional comments	

⁴ <http://cdm.unfccc.int/DNA/fNRB/index.html>

Data/parameter:	B_{old}
Unit	tonnes/device/yr
Description	Quantity of woody biomass used per device in the absence of the project activity
Source of data	Survey/testing of local usage
Value(s) applied)	5.04
Choice of data or measurement methods and procedures	The value of B_{old} has been determined through a survey and series of Kitchen Performance Tests conducted by the project implementer, RIPPLE Africa, within the project area. A sample of households from the project area was selected to participate and the data collected during July-August 2012. A detailed description of the sampling plan and results of the survey is contained in a report.
Purpose of data	Calculation of baseline emissions
Additional comments	

Data/parameter:	L_{NTG}
Unit	factor
Description	Net to gross adjustment factor to account for the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources.
Source of data	Default value provided in AMS-II.G.
Value(s) applied)	0.95
Choice of data or measurement methods and procedures	The default adjustment factor is chosen to avoid conducting surveys of non-project households/users, a number of which could potentially be located outside the defined project area.
Purpose of data	Calculation of leakage
Additional comments	

D.2. Data and parameters monitored

(Copy this table for each piece of data and parameter)

Data/parameter:	$N_{y,CCM}$
Unit	none
Description	Number of operating Changu Changu Moto improved cook stoves in period y
Measured/calculated/default	Calculated
Source of data	Survey conducted in the project area at a sample of households
Value(s) of monitored parameter	15,380
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Recorded annually
Calculation method (if applicable):	Actual number of stoves in use taken from data base, then corrected for any stoves not in use using survey data from the sample group.
QA/QC procedures:	As per description of monitoring system above
Purpose of data:	Calculation of baseline and project emissions

Additional comments:	The number of stoves operating in the monitoring period is corrected for any stoves not in use. 93.89% of households were using the stove and so the number of operating Changu Changu Moto improved cook stoves in period y is $.9222 \times 16678 = 15,380.45$. To remain conservative we have taken the lower number.
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Data/parameter:	$B_{y,new,KPT}$
Unit	tonnes/device/yr
Description	Quantity of woody biomass used per device during the project activity in period y
Measured/calculated/default	Calculated
Source of data	Kitchen Performance Test
Value(s) of monitored parameter	1.78
Monitoring equipment	Equipment used for data collection during the KPTs includes scales and electronic moisture meters. Certification records of all equipment used will be kept and be available to view as part of the project verification process.
Measuring/reading/recording frequency:	Recorded annually
Calculation method (if applicable):	4.90kg dry wood used per device per day was the average recorded during the KPTs. To calculate the annual tonnes/device/yr: $4.90 \times 365 / 1000 = 1.78$ tonnes/device/yr.
QA/QC procedures:	As per description of monitoring system above
Purpose of data:	Calculation of project emissions
Additional comments:	

Data/parameter:	f_{NRB}
Unit	Fraction
Description	Fraction of non-renewable woody biomass saved by the project activity
Measured/calculated/default	Default
Source of data	UNFCCC CDM website ⁵
Value(s) of monitored parameter	0.81
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Reviewed during each monitoring period
Calculation method (if applicable):	N/A
QA/QC procedures:	
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	

⁵ <http://cdm.unfccc.int/DNA/fNRB/index.html>

Data/parameter:	B_{old}
Unit	Tonnes/device/yr
Description	Fuel-wood consumption of baseline stoves
Measured/calculated/default	Calculated
Source of data	Kitchen Performance Test
Value(s) of monitored parameter	5.04
Monitoring equipment	
Measuring/reading/recording frequency:	Recorded annually
Calculation method (if applicable):	
QA/QC procedures:	As per description of monitoring system above
Purpose of data:	Calculation of baseline and project emissions
Additional comments:	The number of stoves operating in the monitoring period is corrected for any stoves not in use. 7.78% of households were not using the Changu Changu Moto improved cook stoves in period y and these households were removed from the total number of households. Calculation is $.0778 \times 16,678 = 1297.5484$. To remain conservative we have taken the higher number of 1298 households removed from the total number of households.

D.3. Implementation of sampling plan

The sampling plan has been designed in accordance with Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0 and Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.

It follows the recommended outline for a sampling plan in Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.

Practices for sample design and administering of the surveys and field measurements are based on *Household Sample Surveys in Developing and Transition Countries*⁶ as recommended in Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.

The objective of the sampling plan is to determine an estimate of $B_{y,new,KPT}$, the quantity of woody biomass used per device during the project activity in period y. $B_{y,new,KPT}$ was measured as per the Kitchen Performance Test (KPT) protocol, with a 90% confidence interval and a 10% margin of error. The KPTs have been carried out in accordance with procedures specified by the Partnership for Clean Indoor Air (PCIA)⁷

The objective of the sampling plan is also to determine an estimate of $N_{y,CCM}$, the number of operating Changu Changu Moto improved cook stoves in period y. This was determined by a survey of sampled households, with a 90% confidence interval and a 10% margin of error.

The same households selected for the determination of the annual quantity of woody biomass used in the project activity was used for the determination of the number of operating Changu Changu Moto improved cook stoves.

⁶ Department of Economic and Social Affairs, Statistics Division, United Nations . *Household Sample Surveys in Developing and Transition Countries*. New York : United Nations , 2005.

⁷ <http://www.pciaonline.org/node/1049>

The target population includes all households participating in the project. The target population is all individual households within each chief area in the Traditional Authorities within the project area. Each household has a chief. The total number of eligible households in the project area for this monitoring period is 16,678.

The sampling method used was multi-stage sampling using a self weighting sampling procedure as per section II.E of Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0. Nkhata Bay District covers an area of 4,071 km². Transport infrastructure is limited, access to liquid fuels in Malawi is limited, and times and costs to travel within the district can be high. Multi-stage sampling was selected to significantly improve the efficiency and reduce the costs of the sampling compared to a simple random sample.

The primary sampling unit (PSU) includes all eligible households in the project area and is defined as each village under a chief (chief area) in the Traditional Authorities within the project area. The ultimate sampling units are defined as individual households within each chief area and include all households in the target population. The sample size is the total number of households selected to participate in the KPTs. The sample consists of 15 households from each of the 12 PSUs, giving a total sample size of 180 households.

Each PSU was checked to ensure it is sufficiently large enough to select the required number of households if required (i.e. as 15 households are to be selected from each PSU, as described below, each PSU must contain at least 15 households).

The 12 PSUs in the first stage was selected using a probability proportional to size (PPS) without replacement procedure, the size being the number of households in each unit. The number of households participating in the project in each chief area was determined from implementation data in the project database.

12 PSUs were selected with PPS sampling, and 15 households were selected from each PSU using a simple random sample without replacement, both stages were conducted using a statistical software package. In this sample design, each sample is self-weighting. Adjustments to weights may be required following data collection due to issues such as non-response. This procedure is described in the section "Quality Assurance/Quality Control".

The sample selection was done in two stages:

1. 12 chief areas were selected at random;
2. 15 households from each of the 12 chief areas were selected at random.

This gave us samples of 180 households.

A dedicated software package called the IBM SPSS Complex Samples module⁸ was used. We exported the Excel spreadsheet with all chief areas into SPSS. We then selected the sample using the Sampling Plan Wizard. We designed the sampling plan as shown in the table below. No stratification was used. The list was then sorted by *Household_ChiefArea* then *Household_GeoRef* to enable KPT planning.

Table 2 Summary of sampling plan

Summary		Stage 1	Stage 2
Design Variables	Cluster sampling	<i>Household_ChiefArea</i>	<i>Household_ID</i>
Sample Information	Selection Method	PPS sampling without replacement	Simple random sampling without replacement
	Measure of Size	Obtained from data	
	Number of Units Sampled	12	15

⁸ <http://www-03.ibm.com/software/products/en/spss-complex-samples/>

	Variables Created or Modified	Stagewise Inclusion (Selection) Probability	<i>InclusionProbability_1_</i>	<i>InclusionProbability_2_</i>
		Stagewise Cumulative Sample Weight	<i>SampleWeightCumulative_1_</i>	<i>SampleWeightCumulative_2_</i>
Analysis Information	Estimator Assumption		Unequal probability sampling without replacement (using joint inclusion probabilities)	Equal probability sampling without replacement
	Inclusion Probability		Obtained from variable <i>InclusionProbability_1_</i>	Obtained from variable <i>InclusionProbability_2_</i>
Weight Variable:			<i>SampleWeight_Final_</i>	

The sampling frame consists of the 7 Traditional Authorities that make up the project boundary. The sampling frame was limited to the households that have had Changu Changu Moto improved cook stoves installed and were using the stoves at the time the sampling was conducted. Comprehensive record keeping in the project database eliminates the risk that the sample frame does not cover the entire target population.

KPT Data

The data was collected as per the KPT protocol⁹ from eligible households. An initial check was conducted to determine if the household is currently using the project stove, as per the sampling plan. If the household was not using the project stove, the KPT was not conducted. If the household was using the project stove, the average daily household use of woody biomass was calculated by measuring the wood moisture content and the mass of wood used each day by the household for a period of 3 days. Households were instructed to only use woody biomass for the duration of the test, and no biomass residues such as maize cobs or cassava stems.

The average daily household use of woody biomass during the testing period has been scaled up to calculate the average annual household use of woody biomass.

The sampling plan and testing was conducted by the project implementer, RIPPLE Africa with support from the Project Participants. The tests were conducted between 28/06/2015 and 03/09/2015. The work plan for the KPTs conducted at the households selected at each PSU has been developed according to the KPT Protocol and is shown in the table below. The organisation chart and roles and responsibilities for the implementation team is shown in the description of the monitoring above.

Table 3 KPT conducted at each PSU

Sunday	Monday	Tuesday	Wednesday	Thursday
Train householder in test procedure	Check on test progress	Check on test progress	Check on test progress	Weigh wood
Collect household information	Moisture readings	Weigh wood	Weigh wood	Collect information on meals cooked
Weigh wood for test		Moisture readings	Moisture readings	
		Collect information on meals cooked	Collect information on meals cooked	

Data processing and analysis

The data collected from the complex survey design was combined in Excel and then analysed using statistical software appropriate to complex survey design data analysis to calculate the values for the proportion of stoves operating and the population estimate of the average annual

⁹ <http://www.pciaonline.org/node/1049>

quantity of woody biomass used per household in the project activity along with confidence intervals. Stata was used to analyse the results.

The daily wood use figures from each household have been converted to a 0% moisture dry wood basis as according to the applied KPT procedures specified by the PCIA. The IPCC default net calorific value (NCV) for wood fuel used in the CDM methodology is quoted on a “wet basis”, but it is unclear at what moisture content this is exactly. The emission reduction calculations therefore use a NCV on a wet basis and wood weights converted to 0% moisture dry wood weight to ensure conservativeness and to ensure compliance with methodology and KPT procedures simultaneously.

Each household has a sample weight, that is how many households of the full population that household represents. The sampling procedure is designed to be self-weighting, i.e. all 180 households selected represent that same number of households in the full population. The weights of all households in a chief area change if any of the 15 households in that chief did not complete the KPT. Weights were recalculated prior to data analysis to ensure non-biased estimates of the parameters.

Please see the confidential report attached to this document for more information: KPT Report Project 1 and 2 October 2015

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

Under AMS-II.G. version 5.0, emission reductions are calculated using equation (1) in paragraph 11:

$$ER_y = B_{y,savings} \times f_{NRB,y} \times NCV_{biomass} \times EF_{projected_fossilfuel} \times N_{y,i}$$

Where:

ER_y	Emission reductions during the year y in tCO ₂ e
$B_{y,savings}$	Quantity of woody biomass that is saved in tonnes per device
$f_{NRB,y}$	Fraction of woody biomass saved by the project activity in year y that can be established as non-renewable biomass
$NCV_{biomass}$	Net calorific value of the non-renewable woody biomass that is substituted
$EF_{projected_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.
$N_{y,i}$	Number of project devices of type i operating in year y

For this project activity, the calculation is refined further to allow for monitoring periods that are not equal to one year¹⁰, fix the value for the fraction of non-renewable biomass and limit the number of operating stoves to one stove type:

$$ER_y = B_{y,savings} \times f_{NRB} \times NCV_{biomass} \times EF_{projected_fossilfuel} \times N_{y,CCM} \times y$$

Where:

ER_y	Emission reductions during the period y in tCO ₂ e
$B_{y,savings}$	Quantity of woody biomass that is saved in period y in tonnes per device
f_{NRB}	Fraction of woody biomass saved by the project activity established as

¹⁰ For example, due to the phased implementation of the improved cook stoves.

	non-renewable biomass
$NCV_{biomass}$	Net calorific value of the non-renewable woody biomass that is substituted
$EF_{projected_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.
$N_{y,CCM}$	Number of Changu Changu Moto improved cook stoves operating in period y
y	Length of period y , in years

$B_{y,savings}$ is estimated using option 1 under paragraph 12:

$$B_{y,savings} = B_{old} - B_{y,new,KPT}$$

Where:

B_{old}	Quantity of woody biomass used in the absence of the project activity in tonnes per device
$B_{y,new}$	Quantity of woody biomass used during the project activity in period y in tonnes per device, measured as per the Kitchen Performance Test (KPT) protocol. The KPT should be carried out in accordance with national standards (if available) or international standards or guidelines (e.g. the KPT procedures specified by the Partnership for Clean Indoor Air (PCIA) < http://www.pciaonline.org/node/1049 >)

Option 1 has been chosen by the project participants to determine the annual quantity of woody biomass used during the project activity for a number of reasons:

- To be consistent with the baseline quantity of woody biomass used in the absence of the project activity (also determined using the KPT);
- The KPT is a field test used to evaluate stove performance in real-world settings and is designed to assess actual impacts on household fuel consumption¹¹. KPTs typically give the best indication of real world changes, and therefore the most accurate estimate of wood fuel use.
- Undertaking the KPTs is compatible with the structure of the project implementation and monitoring team.

The quantity of woody biomass used in the absence of the project activity in tonnes, B_{old} , has been determined by using option (a) of paragraph 13 in AMS-II.G.

Calculated as the estimated average annual consumption of woody biomass per device (tonnes/year). This may be derived from historical data or a survey of local usage.

The calculation of B_{old} will incorporate an adjustment for leakage. Under paragraph 20 (a), the use of a net to gross adjustment factor of 0.95 to account for the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources has been chosen by the project participants. The default adjustment factor is chosen to avoid conducting surveys of non-project households/users, a number of which could potentially be located outside the defined project area.

The calculation of B_{old} considering leakage therefore becomes:

$$B_{old,leakage} = B_{old} \times L_{NTG}$$

Where:

B_{old}	Quantity of woody biomass used per device in the absence of the project activity
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¹¹ Stove Testing. *Partnership for Clean Indoor Air*. [Online] [Cited: 6 June 2012.] <http://pciaonline.org/testing>.

L_{NTG} Net to gross adjustment factor to account for the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources

Taking into account the adjusted calculation of B_{old} the quantity of woody biomass that is saved in period y in tonnes per device is then calculated as:

$$B_{y,savings} = B_{old,leakage} - B_{y,new,KPT}$$

Substituting values from Data and Parameters monitored we get:

$$B_{old,leakage} = 5.04 \times 0.95 = 4.788 \text{ tonnes woody biomass/device/year.}$$

The estimate for $B_{y,new,KPT}$ is 1.78 tonnes/device/year.

The amount of woody biomass saved under the project is then calculated as:

$$B_{y,savings} = B_{old,leakage} - B_{y,new,KPT} = 4.788 - 1.78 = 3.008 \text{ tonnes/device/year}$$

The emission reductions are calculated as:

$$ER_y = B_{y,savings} \times f_{NRB} \times NCV_{biomass} \times EF_{projected_fossilfuel} \times N_{y,CCM} \times y$$

Where:

ER_y	Emission reductions during the period y in tCO ₂ e
$B_{y,savings}$	Quantity of woody biomass that is saved in period y in tonnes per device
f_{NRB}	Fraction of woody biomass saved by the project activity established as non-renewable biomass
$NCV_{biomass}$	Net calorific value of the non-renewable woody biomass that is substituted
$EF_{projected_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.
$N_{y,CCM}$	Number of Changu Moto improved cook stoves operating in period y
y	Length of period y , in years

Substituting values from above the estimate of emission reductions for year 1 becomes:

$$ER_y = 3.008 \times 0.81 \times 0.015 \times 81.6 \times 15,380 \times 0.77 = 35,317 \text{ tCO}_2\text{e.}$$

E.2. Calculation of project emissions or actual net GHG removals by sinks

Project emissions are not calculated because the methodology calculates emission reductions directly.

E.3. Calculation of leakage

Default value provided in AMS-II.G. The default adjustment factor was chosen to avoid conducting surveys of non-project households/users, a number of which could potentially be located outside the defined project area.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	GHG emission reductions or net GHG removals by sinks (t CO ₂ e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total					35,317 tCO ₂ e	35,317 tCO ₂ e

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO ₂ e)	37,830 tCO ₂ e	35,317 tCO ₂ e

E.6. Remarks on difference from estimated value in registered PDD

ERs are slightly lower due to a lower number of implemented stoves, but the results from the KPTs were better than forecast in the PDD:

- The quantity of woody biomass saved in tonnes per device $B_{y,savings}$ was higher than forecast in the PDD as the quantity of woody biomass used in the project activity was lower than forecast.
- The proportion of stoves operating was also higher than forecast in the PDD.

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

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Person/entity responsible for completing the CDM-MR-FORM
Organization name	The Sigma Global Company Pty Limited
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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
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