INSTALLATION OF HIGH EFFICIENCY WOOD BURNING COOKSTOVES IN MALAWI

Document Prepared by

C-Quest Capital SG Stoves Private Limited

Project Title	Installation of high efficiency wood burning cookstoves in Malawi
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CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

A summary description of the implementation status of the technologies/ measures (e.g., plant, equipment, process, or management or conservation measure) included in the project.

The project involves the distribution and installation of TLC Stoves for use by households in Malawi. Before the adoption of the TLC Stove, households in Malawi used inefficient, conventional open fire. The ICS will burn wood more efficiently thereby improving thermal transfer to pots, hence saving fuel. Not only will this halt the rapidly progressing deforestation in Malawi but will also reduce health hazards from indoor smoke pollution and women and children will have to spend less time collecting firewood.

The ICS deployed under this project is TLC-CQC Rocket Stove which substantially reduces fuel consumption and emissions for conducting cooking and water heating tasks in homes. The ICS improve the efficiency of combustion and thermal transfer to the pot compared with a traditional pot support or three-stone fire by incorporating a number of cutting-edge components, including one or more of; a 'rocket elbow'; a highly insulated combustion chamber which provides a conducive environment for clean and efficient combustion of wood. It substantially reduces fuel wood consumption compared with a three-stone fire or traditional pot support.

The first TLC Stove was installed on 01-December-2020. Till the end of 3rd monitoring period, a total of 268,664 TLC Stoves were installed under the project. The details of instances added for each monitoring period is depicted in the table below.

All the data recorded during stove registration process was captured via hand held digital devices (smart phones and/or tablets). The information collected is then transferred to a centralized online project database. PP has distributed one or two improved cookstoves in the households as per the requirement of the stove users.

The relevant implementation dates (e.g., dates of construction, commissioning, and continued operation periods).

Monitoring Period

1st Monitoring Period	01-December-2020 – 15-April-2021
2nd Monitoring period	16-April-2021 – 15-October-2021
3rd Monitoring period	16-October-2021 to 28-February-2022

Installation of ICS

Date of first ICS installed	01-December-2020
Date of last ICS installed in 3rd MP	28-February-2022
No. of instances added/ICS installed during 1st MP	54,638
No. of instances added/ICS installed during 2nd MP	137,502
No. of instances added/ICS installed during 3rd MP	76,524
Total no. of ICS distributed till end of 3rd MP (28-February-2022)	268,664

First Monitoring Survey

Survey dates for parameters $N_{y,i,j}$ and $B_{y=1,new,i,j,survey}$	09-July-2021 to 20-July-2021

Second Monitoring Survey

Survey dates for parameters $N_{y,i,j}$	03-February-2022 to 10-February-2022

Third Monitoring Survey

Survey dates for parameters $N_{y,i,j}$	12-April-2022 to 17-April-2022

The total GHG emission reductions or removals generated in this monitoring period.

The project results in a total emission reduction of 250,133 tCO_2e over the monitoring period of 16-October-2021 to 28-February-2022.

1.2 Sectoral Scope and Project Type

The project is categorised under type/category as below:

a) Sectoral scope: 03 - Energy demand

b) Type: II – Energy efficiency improvement projects

The project is a grouped project activity.

1.3 Project Proponent

Organization name	C-Quest Capital Stoves Asia Limited
Contact person	Ken Newcombe
Title	Director
Address	Brumby Centre, Lot 42, Jalan Muhibbah, 87000 Labuan, Malaysia.
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Organization name	C-Quest Capital SG Stoves Private Ltd
Contact person	Ken Newcombe
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Address	38 Beach Road #29-11, South beach Tower, Singapore 189767
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1.4 Other Entities Involved in the Project

C-Quest Capital SG Stoves Private Ltd and C-Quest Capital Stoves Asia Limited are the only Project Proponents involved in the project. Apart from the Project Proponent(s), there are no other entities involved in the Project.

1.5 Project Start Date

The start date of this grouped project activity is 01-December-2020, which is the delivery/installation date of first TLC stove (first project activity instance).

1.6 Project Crediting Period

01-December-2020 to 30-November-2030 (both days included), ten years fixed crediting period.

1.7 Project Location

The project location is the geographical boundary of Republic of Malawi. The project boundary is the geographic borders of the Republic of Malawi.

Malawi map

Malawi (National)

Malawi, Northern Point
Latitude: - 9.366667° S
Longitude: 33.000000° E

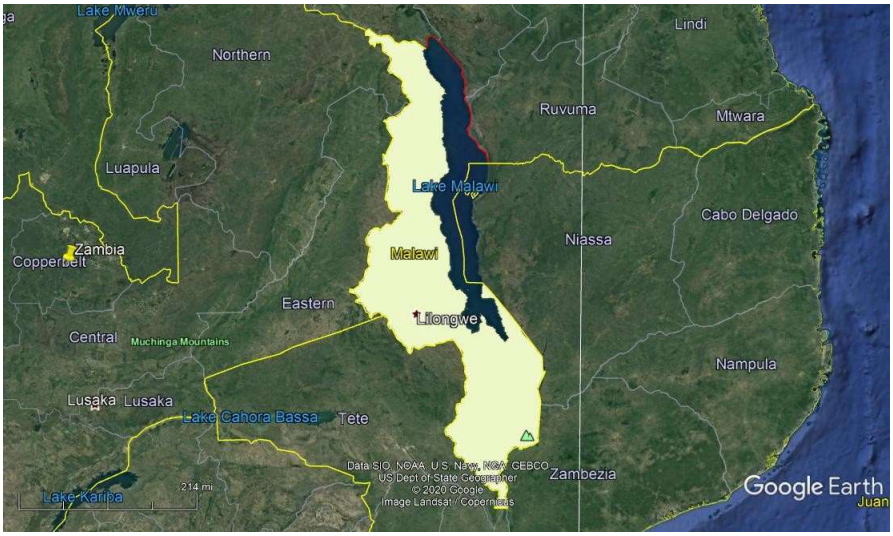
Malawi, Western Point
Latitude: - 13.600000° S
Longitude: 32.666667° E

Malawi, Eastern Point
Latitude: - 14.883333° S
Longitude: 35.916667° E

Malawi, Southern Point
Latitude: - 17.133333° S
Longitude: 35.283333° E

Map:
http://www.ephotopix.com/malawi_region_map.html

Geographical coordinates obtained from Google Earth®



Map of project area

Republic of Malawi is divided into 3 regions – Northern, Central and Southern regions. To facilitate the management, implementation, and monitoring of the project, the project proponent divides the project boundary into 3 project regions according to the region.

No.	Project Region	Regions
1	Northern Area	Northern
2	Central Area	Central
3	Southern Area	Southern

1.8 Title and Reference of Methodology

- VMR0006: Methodology for Installation of High Efficiency Firewood Cookstoves, Version 1.1[1].
- Tool 30: Calculation of the fraction of non-renewable biomass, Version 3.0[2]
- Standard: Sampling and Surveys for CDM project activities and programmes of activities, Version 09.0[3]

[1] https://verra.org/methodology/vmr0006-methodology-for-installation-of-high-efficiency-firewood-cookstoves/
[2] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-30-v3.0.pdf
[3] https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20210531160756223/Meth_Stan05.pdf

1.9 Participation under other GHG Programs

Project is not registered under any other GHG programs.

1.10 Other Forms of Credit

Project has not applied for any other programme to create another form of GHG-related environment credit.

1.11 Sustainable Development Contributions

The project contributes to sustainable development in a number of ways:

a) Environmental Sustainability

- The project helped significantly reduce greenhouse gas emissions over the monitoring period.
- The project helped reduce the use of non-renewable biomass from forests, thus assist in conserving existing forest stock and the protection of natural forest eco-systems and wildlife habitats.

b) Social Sustainability

- Considerably less time need to be spent collecting wood fuel for the family home thereby reducing the work burden on rural families and presenting alternative opportunities for economic development.
- The amount of indoor pollutants from the burning of biomass in the family home reduced. Less carbon dioxide, carbon monoxide and particulates emitted due to the decrease in total biomass burned and an increase in the temperature of combustion.
- The stove provides a safer method for combusting biomass for cooking, helping to reduce burn injuries, especially for children, in the family home.

c) Economic Sustainability

- The project helped develop a section of the local economy, in the distribution, local assembly, maintenance and monitoring activities.
- Household expenditures on cooking fuel reduced through the use of the ICS.
- Saved household labour can be diverted to more productive economic activities.

The project created local employment opportunities in operational and management roles, as well as future assembly and/or manufacturing initiatives.

In accordance with Paragraph 3.17.1 of VCS Standard, version 4.3[4], *"Where project complete a validation or verification to the Sustainable Development Verified Impact Standard (SD VISta) Program at the same time as a VCS Program validation or verification, they are not required to conduct a separate demonstration of compliance with the requirements set out in this Section 3.17"*

[4] https://verra.org/wp-content/uploads/2022/06/VCS-Standard_v4.3.pdf

The project is being pursued for validation and verification under SD Vista for the present monitoring period. Therefore, details of SDGs claimed is not required to be mentioned in VCS-MR.

2 SAFEGUARDS

2.1 No Net Harm

There are no potential negative environmental or socio-economic impacts for this project activity based on the following facts:

- The project does not coerce the population into any practice or habit which they are not willing to take up as the cooking practice or habit on the project stove is similar to what was practiced before implementing this project activity, i.e., on the baseline stove.
- The project activity promotes gender equality as it intends to reduce the burden on women in the most vulnerable communities by reducing the fuel wood consumption. The amount of time spent collecting fuel wood and cooking will be reduced. Women will have more time for other pursuits. The risk of being exposed to gender-based violence will also reduce.
- The project is neither involved in any activity that would bring environmental deterioration nor will lead to any emission of toxic substances. The project stoves will rather reduce emissions due to the increased thermal efficiency compared to the baseline stoves.
- There are no threats anticipated in terms of negative effects on the local economy. Moreover, the locals will also be employed as a result of this project activity. Thereby improving the economic growth in the region where the project activity has been implemented.

2.2 Local Stakeholder Consultation

Feedback was requested from local stakeholders for the “Installation of high efficiency wood burning cookstoves in Malawi” program between 26-October-2020 and 25-November-2020. Necessary precautions were taken place in light of the COVID-19 pandemic, with feedback having been conducted electronically when possible, minimizing large groups and socially distancing during in person meetings.

The outcomes from the local stakeholder consultation are available in Section 2.2 of the PD.

As a part of the ongoing communication, the Stove users can contact the local implementation partner in case any support or replacement of any stove part is required. The contact details of the local implementation partner have been shared with the end users during the stove installation. The local support staff address the end users’ query by providing the necessary support. In case of replacement of stove part is needed, local staff coordinates with the

management team to arrange the replacement of the part. At the time of monitoring survey also, field staff takes feedback from the local stakeholders. All stakeholders' concerns (positive or negative) during implementation of the project activity, have been compiled in the survey results spreadsheet.

PP has a robust feedback and grievance redress policy and procedure in order to ensure that grievances of project-affected communities and individual stakeholders are properly handled and addressed. These procedures are implemented to enhance PP's accountability and transparency, as well as to promote project activities that can help communities in identifying adverse effects to them or their environment that PP had not previously identified and mitigated.

During the current monitoring period no grievance have been received from the end users that required action by the implementation partners.

2.3 AFOLU-Specific Safeguards

This section is not applicable as the project is a non-AFOLU project.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

Till the end of the monitoring period, the project installed 268,664 stoves. Only one stove model (TLC-CQC Rocket Stove) was distributed in the project.

VCS methodology VMR0006, version 1.1 allows the use of a correction factor of 0.95 applied to the overall emissions reductions to account for any possible leakage. This factor has been applied to the emissions reductions presented in this report

During the current monitoring period, no incident or event occurred, that could affect GHG emissions reduction and approved monitoring plan.

3.2 Deviations

3.2.1 Methodology Deviations

This project did not apply any methodology deviations

3.2.2 Project Description Deviations

This project did not apply any deviations related to Project Description.

3.3 Grouped Projects

New project activity instances included under this grouped project ensure that it meets the eligibility criteria below.

No.	Criterion	How the new project activity instances to comply
1	Meet the applicability conditions set out in the methodology applied to the project	New project activity instances (TLC-CQC Rocket Stoves) meet the applicability conditions set out in Section 3.2 of the PD, where the end-user is household and the ICS deployed is 34.5% of thermal efficiency (Please refer the efficiency report attached).
2	Use the technologies or measures specified in the project description.	Only TLC-CQC Rocket stoves have been adopted in the project,
3	Apply the technologies or measures in the same manner as specified in the project description.	Only TLC-CQC Rocket stoves have been adopted in the project and it replace traditional cookstoves in household
4	Are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	The new project activity instances were installed within Malawi only and subject to the same baseline scenario determined in Section 3.4 of PD.
5	Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area.	All new project activity instances use the activity method for demonstration of additionality. Step 1: Regulatory Surplus There is no mandated government programme or policy in host country of this project ensuring the distribution of new project activity instances. Step 2: Positive List The inclusion of new project activity instances complies with positive list as it satisfies criterion 1 where it meets all the applicability conditions of the methodology.
6	Where a capacity limit applies to a project activity included in the project, no project activity instance shall exceed	No project activity instance exceeds the applicable limit, which is 180 GWh_{th}/y.

	such limit. Further, no single cluster of project activity instances shall exceed the capacity limit, determined as follows: 1) Each project activity instance that exceeds one percent of the capacity limit shall be identified. 2) Such instances shall be divided into clusters, whereby each cluster is comprised of any system of instances such that each instance is within one kilometer of at least one other instance in the cluster. Instances that are not within one kilometer of any other instance shall not be assigned to clusters. 3) None of the clusters shall exceed the capacity limit and no further project activity instances shall be added to the project that would cause any of the clusters to exceed the capacity limit.	The expected annual energy saving for each project activity instance is approximately 0.00787 GWh_{th}/y or 0.01% of the limit. As the annual energy saving is below 1% of the limit, therefore no project activity instance is identified and divided into clusters.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	$f_{NRB,y}$
Data unit	Fraction
Description	Fraction of woody biomass saved by the project activity during year *y* that can be established as non-renewable biomass
Source of data	IPCC 2019 refinement[5], UNData[6] & FAO reports[7]
Value applied	0.91

[5] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch04_Forest%20Land.pdf
[6] http://data.un.org/Data.aspx?d=EDATA&f=cmID%3aFW
[7] https://www.fao.org/forest-resources-assessment/past-assessments/fra-2010/country-reports/en/

Justification of choice of data or description of measurement methods and procedures applied	This parameter has determined ex-ante. C4 EcoSolutions (Pty) Ltd was appointed as third party to study and derive the f_{NRB} value for Malawi.
Purpose of Data	Calculation of emission reductions
Comments	The report of f_{NRB} was made available to VVB during the validation.

Data / Parameter	$NCV_{wood\ fuel}$
Data unit	TJ/tonne
Description	Net calorific value of the non-renewable woody biomass that is substituted or reduced
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 1 Introduction
Value applied	0.0156
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value
Purpose of Data	Calculation of emission reductions
Comments	No comments

Data / Parameter	$EF_{wf,CO2}$
Data unit	tCO_2/TJ
Description	CO_2 emission factor for the use of wood fuel in baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 2 Stationary Combustion[8]
Value applied	112
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value

[8] https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Purpose of Data	Calculation of emission reductions
Comments	No comments

Data / Parameter	$EF_{wf,non\ CO2}$
Data unit	tCO_2/TJ
Description	Non-CO_2 emission factor for the use of wood fuel in baseline scenario
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 2 Stationary Combustion
Value applied	26.23
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value
Purpose of Data	Calculation of emission reductions
Comments	No comments

Data / Parameter	η_{old}
Data unit	Fraction
Description	Efficiency of baseline cookstove
Source of data	Methodological default value
Value applied	0.1
Justification of choice of data or description of measurement methods and procedures applied	A default value of 0.1 is used, as baseline device is a three-stone fire using firewood (not charcoal), or a conventional device with no improved combustion air supply or flue gas ventilation, that is without a grate or a chimney
Purpose of Data	Calculation of emission reductions
Comments	No comments

Data / Parameter	η_p

Data unit	Fraction
Description	Efficiency of project stove at the start of project activity.
Source of data	Manufacturer's specification
Value applied	0.345
Justification of choice of data or description of measurement methods and procedures applied	This parameter has determined ex-ante
Purpose of Data	Calculation of $\eta_{\mathbf{new},y,\mathbf{i},\mathbf{j}}$
Comments	No comments

4.2 Data and Parameters Monitored

Data / Parameter	$N_{y,i,j}$
Data unit	Number
Description	Number of project devices of type i and batch j operating during year y
Source of data	Monitoring
Description of measurement methods and procedures to be applied	Measured based on a representative sample.
Frequency of monitoring/recording	At least once every two years
Value monitored	234,006
Monitoring equipment	No equipment was used to monitor this parameter
QA/QC procedures to be applied	Sampling standard "sampling and surveys for CDM project activities and programme of activities" version 9 was used for determining the sample size to achieve 90/10 confidence precision.
Purpose of data	Calculation of emission reductions

Calculation method	Proportion of operational stoves obtained from the survey is multiplied by the total commissioned stoves to arrive at this value. Proportion of operational stoves: 87.10% $N_{y,i,j}$ = 87.10% * 268,664 = 234,006
Comments	As per the current MP survey 100% of stoves were found to be operational. However, as per the stove champion follow up survey conducted in latest MP, stoves in operation was 97.56%, and as per the secondary data of other projects, stoves in operation percentage was 87.10%. Hence, PP has considered the lowest value of stoves in operation 87.10% on a conservate basis.

Data / Parameter	$\eta_{new,y,i,j}$
Data unit	Fraction
Description	Efficiency of the improved cookstove type *i* and batch *j* during year *y*
Source of data	Calculation
Description of measurement methods and procedures to be applied	To adopt Option V given in the methodology: "Efficiency of the improved cookstoves to be estimated using equation 5 above where loss in efficiency per year is calculated, and therefore this parameter does not need to be monitored"
Frequency of monitoring/recording Value monitored	Annually the value below is applied.

Year (y)	$\eta_{new,y,i,j}$
1	32.43%
2	32.11%

Monitoring equipment	Calculated value
QA/QC procedures to be applied	This parameter has been calculated using equation 5 of the applied methodology
Purpose of data	Calculation of emission reductions

Calculation method	Calculation was performed using equation below: For Vintage 1 stoves - $\eta_{new,y,i,j} = \eta_p \times (DF_n)^{y-1} \times 0.94$ = 0.345 x $(0.99)^{1-1}$ x 0.94 = 0.3243
Comments	No comments

Data / Parameter	$B_{y=1,new,i,j,survey}$
Data unit	Tonnes per device per year
Description	Annual quantity of woody biomass used by improved cookstoves in tonnes per device of type i and batch j
Source of data	First Monitoring survey
Description of measurement methods and procedures to be applied	Sampling standard "sampling and surveys for CDM project activities and programme of activities" version 9 was used for determining the sample size This value was determined within the first year of the introduction of the devices through sample surveys. Under this project two TLC-CQC Rocket Stoves have been installed in each household, which are classified as Project stove 1 and project stove 2. At the time of survey, field staff asked the user to make a pile for the total firewood[11] required for cooking in a day for all the stoves available in his/her house and weighted the same. Further user was asked to extract and make the piles for the wood required for the project stove 1 and project stove 2 separately from that pile and weigh both the piles. Remaining portion, if any after the segregation of 2 piles for both project stove will be accounted as baseline stove wood fuel usage. Same has been recorded in the survey forms and in the spreadsheet. Therefore, firewood consumed for each project stove and baseline stove can be distinguished clearly. Proper training has been provided to the monitoring personnel before conducting the onsite monitoring survey
Frequency of monitoring/recording	In the first year of project implementation
Value monitored	0.8161
Monitoring equipment	Weighing scale
QA/QC procedures to be applied	Calibration of weighing scales used for measuring the fuel wood was done in house before start using on site.

Purpose of data	Calculation of emission reductions
Calculation method	This is monitored value
Comments	At the time of first monitoring survey, the surveyor enquired for firewood consumption for each stove installed in the household.

Data / Parameter	Life Span
Data unit	Number of years
Description	The operating lifetime of the project device.
Source of data	Manufacturer's specification
Description of measurement methods and procedures to be applied	TLC cookstoves manufactured under the project activity match the fixed design specification. This has achieved by using brick molds of specified dimensions to make bricks used for stove construction locally. This ensured, that each stove that is built at individual end user household measures exactly same as the

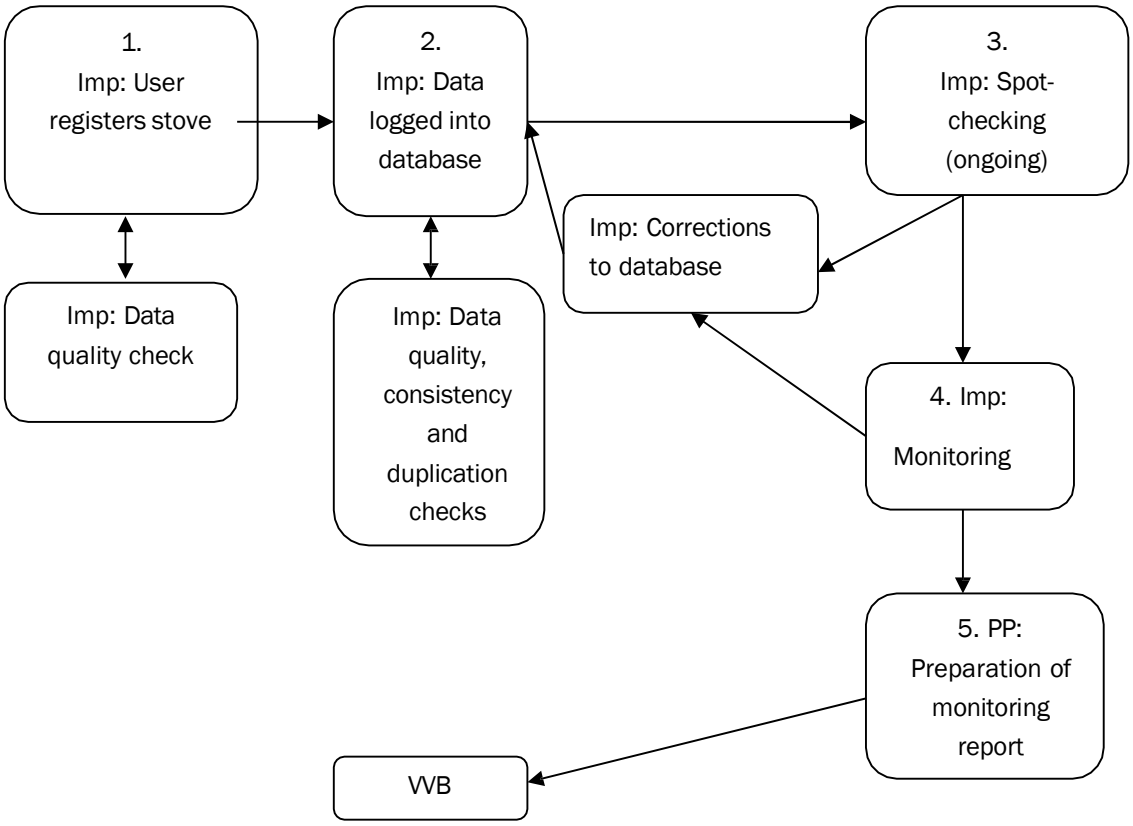
	dimensions specified by the manufacturer. Post construction, training has been provided to end users on use, care, and upkeep of these stoves. PP conducted periodic audits and surveillance of the stoves distributed under the project activity to ensure their proper functioning throughout the project lifetime. This along with spot audits and after installation maintenance services, ensure that the project stoves continue to work at efficiencies as specified by the manufacturer.
Frequency of monitoring/recording	Once at the time of project stove installation
Value monitored	10
Monitoring equipment	No equipment was used to monitor this parameter
QA/QC procedures to be applied	This parameter is referred from the Manufacturer's specification
Purpose of data	Calculation of emission reductions
Calculation method	No calculation used for this parameter
Comments	No comments

4.3 Monitoring Plan

The project's monitoring system follows the monitoring plan described in section 5.3 of the VCS-PD.

The monitoring system applied involves a number of key elements to ensure that the PP has high-quality, unbiased and reliable information regarding the performance of the project in terms of implementation and outcomes, and for the purposes of calculating Verified Carbon Units (VCUs) following VCS methodology VMR0006, version 1.1 on the basis of the amount of non-renewable biomass saved by the ICS in the project activity.

The below flow-chart illustrates the roles and responsibilities of the parties during the implementation of the monitoring plan for the project activity. In the below flowchart, the project implementer is abbreviated to "Imp", while the project proponent by "PP".



Below is the description of the above steps on the flow-chart.

1. Imp: User registers stove: Project implementer collected/received the necessary information required for the Registration process from the user. Means of collecting this information were through the use of ICTs. Project Implementers' staff double checks the accuracy of information provided, and request for field staff additional clarifications if needed;

2. Imp: Data logged into database: Registered data by the staff of the project implementer uploads in the database automatically. PP shall double check the information included on the database and check for duplications. Any duplicate information if investigated, checked for the errors, gets corrected or excluded from the database if it is a true duplicate entry.

3. PP: Spot- checking (ongoing): PP has a procedure for internal auditing called spot-checking, where field staff randomly selects households to ensure proper functioning of the project stoves throughout the project lifetime and to ensure that the project stoves continue to work as efficient as specified by the manufacturer. PP or field staff randomly select units

included in the database and visit or contact the stove users to cross-check the information on the database with the factual evidence in the field. Any inconsistencies found (e.g., change in the address of a user) gets updated on the database, and in the case, ICS are found to be no longer in use, they got clearly marked as such and excluded from emission reductions calculations.

4. Imp: Monitoring: Project implementer follows the requirements as per VCS-PD to collect the necessary information for a monitoring report.

5. PP: Preparation of monitoring report: The project implementer or the project proponent prepare the final monitoring report to be provided to the VVB for verification of emission reductions.

The Project Proponent (PP) is comprised of Project Manager, Chief Operating officer, Country Directors and field staffs/enumerators to support the team. The roles and responsibilities of the PP and the team are described below:

Roles and responsibilities

Project Manager

- Ensures compliance of the technology with project requirements.
- Follows up of registration of any project and issuance of VCUs.
- Oversees the proper implementation of project.
- Communicate with Verra and VVB.

Chief Operating Officer

- Maintain record of issued serial numbers.
- Authenticates any changes/replacements of serial numbers during the life span of the ICS.

Country Directors

- Oversees the execution of training, which includes all aspects of stove design, construction, use & maintenance of the field staffs of project proponent and project implementer.
- Periodically checks and confirms that the installed ICS conform to the standards detailed in the project description.
- Procurement and delivery of stove parts, posters, brochures, and stove ID cards (QR cards).
- Checks and keeps control of all issued serial numbers.

Field staff/Enumerator

- Execute installation and registration of stoves with the implementation partner in the selected households.
- Assist the team in conducting the monitoring survey.
- Conducts spot checking of the installed stoves.

The PP coordinates and manages the implementation of each element of the monitoring plan.

Data measuring, recording Method and Implementation of Sampling Approaches

Steps 1, 2 and 3 captured end user information and populated the database, as well as provided database quality control.

Step 4 involves creating sampling surveys to capture data on number of project devices operating during year y ($N_{y,j,j}$) .

Parameter	Description of Parameter	Sampling approach (outcome in brackets)
$N_{y,j,j}$	Number of project devices operating during year y	Visual inspection of the premises to see if ICS is operational and in use. Interview with end user if required to verify that ICS is still in use [Yes/No]

Due to the large number of ICS envisioned to be distributed in the project activity, it is not economically feasible to monitor each individual ICS unit distributed. Therefore, representative sampling was undertaken that is designed in line with the requirements of the Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities version 09.0.

To estimate the sample size for the parameter Ny,i,j the following equation is used:

$$n \geq \frac{1.645^2 N \times p \times (1-p)}{(N-1) \times 0.1^2 \times p^2 + 1.645^2 p \times (1-p)}$$

Where:

n = Sample size

N = Population size (Total number of households/ICS)

p = Expected proportion

1.645 = Represents the 90% confidence required

0.1 = Represents the 10% relative precision

Sample size calculation:

The calculation of the required sample size for $N_{y,i,j}$ parameter in this monitoring period is illustrated below. During 2nd MP verification, 100% of ICS were found to be in operation although expected proportion (p) was considered as 0.8. However, for this monitoring period, PP has considered value of expected proportion (p) as 0.85, so that PP covers ample samples from the population to gain required confidence and to achieve better precision level.

The resulting sampling size is calculated as:

$$n \geq \frac{1.645^2 \text{ x } 268664 \text{ x } 0.85\ (1-0.85)}{(268664-1) \text{ x } 0.1^2 \text{ x } 0.85^2 + 1.645^2 \text{ x } 0.85\ (1-0.85)} = 47.75$$

Therefore, using simple random sampling formula, 48 ICS were calculated to be surveyed. Sample stoves were selected using the random number generator technique. Under this project activity two stoves were also distributed in one household. Survey team also surveyed the second stove, if distributed in the sample household. Therefore, during this survey total 96 stoves were surveyed.

Step 5 involved monitoring analyses and accuracy and precision checks. The project proponent scrutinized the monitoring data to confirm accuracy of results, analyzed the data, and estimated the resulting emissions reductions outlined in this monitoring report.

The following parameters were obtained though sampling:

1. $N_{y,i,j}$: Number of stoves in operation

Simple random sampling was used for all monitoring parameters in accordance with the Sampling Plan of section 5.3 of the VCS-PD. The objective was to obtain reliable and unbiased estimates of the monitoring parameters. Reliability levels were set at 90% confidence and 10% precision as per VMR0006, version 1.1.

A single homogeneous population (Primary Sampling Unit, as per VCS-PD) was considered for the parameter.

The following table summarizes the sample sizes and results.

Monitored Parameter	Sample size	Survey Results	Precision achieved
Number of stoves in operation ($N_{y,i,j}$)	96	1.00	0.00%

As per the current MP survey 100% of stoves were found to be operational. However, as per the stove champion follow up survey conducted in latest MP, stoves in operation was 97.56% (precision achieved 0.09%)[1]and as per the secondary data of other projects, stoves in operation percentage was 87.10%. Hence, PP has considered the lowest value of stoves in operation 87.10% on a conservate basis.

Implementation and quality assurance and control and procedures used for handling any internal auditing performed and any non-conformities identified: project proponent trained monitoring personnel on monitoring procedures, including provisions for maximizing response rates, documenting out-of-population cases, refusals and other sources of non-response. The monitoring survey included several questions to support the information on the key monitoring parameters. These included visual inspections to confirm stove use and presence of baseline

[1]For VVB reference excel spreadsheet workbook compiling the primary data from our stove champion program with respect to stoves in operation (usage rate) for our Sub-Saharan Africa projects under review has been uploaded to the data room and available at 44.03

stoves, comments by surveyors, check of randomly selected households against actual household information, and refusal tracking. These strategies aimed at minimizing surveyor or non-response biases. The questionnaire was piloted in the field prior to implementation.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The improved cookstove is introduced as energy efficiency measure in the project, therefore equations 1 and 2 of the methodology have applied to calculate the net GHG emission reductions.

$$ER_y = \sum_i \sum_j ER_{y,i,j} \quad \text{Equation (1)}$$

Where:

i	=	Indices for the situation where more than one type/model of improved cookstove is introduced to replace three-stone fire
j	=	Indices for the situation where there is more than one batch of improved cookstove of type i
ER_y	=	Emission reductions during year y in t CO_2e
$ER_{y,i,j}$	=	Emission reductions by improved cookstove of type i and batch j during year y in t CO_2e

$$ER_{y,i,j} = B_{y,savings,i,j} \times NCV_{wood\ fuel} \times f_{NRB,y} \times (EF_{wf,CO2} + EF_{wf,non\ CO2}) \times N_{y,i,j} \times 0.95 \quad \text{Equation (2)}$$

Where:

$B_{y,savings,i,j}$	=	Quantity of woody biomass that is saved in tonnes per improved cookstove of type i and batch j during year y
$f_{NRB,y}$	=	Fraction of woody biomass that can be established as non-renewable biomass (f_{NRB})
$NCV_{wood\ fuel}$	=	Net calorific value of the non-renewable woody biomass that is substituted or reduced (IPCC default for wood fuel, 0.0156 TJ/tonne)[9]
$EF_{wf,CO2}$	=	CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 112 tCO_2/TJ)[10]
$EF_{wf,non\ CO2}$	=	Non-CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 26.23 tCO_2/TJ)[11]
$N_{y,i,j}$	=	Number of improved cookstoves of type i and batch j operating during year y
0.95	=	Discount factor to account for leakage

[9] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 1 Introduction
[10] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 2 Stationary Combustion
[11] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 2 Stationary Combustion

To calculate $B_{y,savingsi,j}$, we use equation 4 of the applied methodology[12]

$$B_{y,savings,i,j} = B_{y=1,new,i,survey} \times \left(\frac{\eta_{new,y,i,j}}{\eta_{old}} - 1\right)$$

Where:

$B_{y=1,new,i,survey}$	Annual quantity of woody biomass used by improved cook stoves in tonnes, determined in the first year of the implementation of the project through a sample survey
η_{old}	Efficiency of baseline cookstove. A default value of 0.10 has been used as the replaced system is a three stone fire, or a conventional system with no improved combustion air supply or flue gas ventilation system, i.e., without a grate or a chimney.
$\eta_{new,I,j}$	Efficiency of the improved cook stove determined using Equation 5 of the methodology.

$$\eta_{new,y,i,j} = \eta_p \times (DF_n)^{y-1} \times 0.94$$

Where:

η_p	Efficiency of project stove (fraction) at the start of project activity
$(DF_n)^{y-1}$	Discount factor to account for efficiency loss of project cookstove per year of operation (fraction). default value of 0.99 efficiency loss per year has considered for the project activity
0.94	Adjustment factor to account for uncertainty related to project cookstove efficiency test

The full set of emission reductions calculation for single stove per HH and double stove per HH is provided in separate Excel spread sheets.

5.2 Project Emissions

The methodology does not account for project emissions separately, but instead quantifies net emission reductions achieved by the project.

5.3 Leakage

Leakage is considered as default 0.95 in accordance with methodology.

[12] Equation 3 of methodology VMR0006, version 1.1

5.4 Net GHG Emission Reductions and Removals

PP has calculated the emission reduction for each ICS installed under the project activity separately. In this section example for ER calculation of one ICS (stove serial number CQCSSAMT457492) is provided:

For year 2021

Date of installation: 13-December-2020

For year 2021, vintage for the stove: Vintage 1 & Vintage 2

No. of days for vintage 1: 58 (from 16-October-2021 to 12-December-2021)

Year fraction: 58/365 = 0.1589

$B_{y=1,new,i,survey}$ = 0.8161

$\eta_{new,i,j}$ = 0.3243

$B_{y,savings,i,j}$ = 0.8161 x ((0.3243/0.1) - 1)

= 1.8305

$ER_{y,i,j}$ = 1.8305 x 0.0156 x 0.91 x (112 + 26.23) x 0.8710 x 0.95 x 0.1589

= 0.8852

Similarly,

No. of days for vintage 2: 19 (from 13-December-2021 to 31-December-2021)

Year fraction: 19/365 = 0.0521

$B_{y=1,new,i,survey}$ = 0.8161

$\eta_{new,i,j}$ = 0.3211

$B_{y,savings,i,j}$ = 0.8161 x ((0.3211/0.1) - 1)

= 1.8041

$ER_{y,i,j}$ = 1.8041 x 0.0156 x 0.91 x (112 + 26.23) x 0.8710 x 0.95 x 0.0521

= 0.1526

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)

2021 (16-October-2021 to 31-December-2021)	133,137	0	0	133,137
2022 (01-January-2022 to 28-February-2022)	116,996	0	0	116,996
Total	250,133	0	0	250,133

Comparison of Ex-Ante and Ex-Post Emission Reductions and Removals (ERR) values

Monitoring Period days: 16-Oct-2021 to 28-Feb-2022

No. of Days: 136

Actual ERs achieved during this monitoring period (tCO_2e)	Amount estimated ex-ante for this monitoring period in the VCS-PD (tCO_2e)	Remarks
250,133	385,317	Actual emission reductions achieved are lower than the value estimated in ex-ante calculation due to 87.1% ICS were found operating during the monitoring survey.

The actual amount of the ICS installed, and corresponding ex-ante ERs are as follows:

Estimated ICS Installed as per VCS-PD	Ex - ante tCO_2e/year as per VCS-PD	Actual ICS Installed as per MR	Ex – ante tCO_2e/year as per actual ICS Installed	No. of days in MP (for comparable period)	Ex-ante tCO_2e
500,000	1,924,569	268,664	1,034,124	136	385,317