INSTALLATION OF HIGH EFFICIENCY WOOD BURNING COOKSTOVES IN MALAWI

Document Prepared by

C-Quest Capital Stoves Asia 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 Project

A summary description of the technologies/ measures to be implemented by the project.

The project status is under development. The project involves distribution of fuel-efficient improved cookstoves (ICS) in Malawi. The ICS disseminated through this project will replace the baseline cookstoves.

Through this project, the distribution and installation of approximately 500,000 ICS will be undertaken for households in Malawi. It is intended that under this project single pot, TLC-CQC Rocket Stove will be distributed. 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 end user will be informed in advance that the use of ICS generates carbon finance which in turn is used for subsidising the price of ICS and for recovering project implementation costs.

The location of the project.

The project will take place in Malawi. The details of the project location are provided in Section 1.12.

An explanation of how the project is expected to generate GHG emission reductions or removals.

The ICS will substitute the currently common cooking on open fire. The ICS burns wood more efficiently thereby improving thermal transfer to pots, hence saving fuel and lowering greenhouse gas emissions.

A brief description of the scenario existing prior to the implementation of the project.

The baseline scenario is the continued use of non-renewable wood fuel by the target population to meet similar thermal energy needs as provided by project cookstoves in absence of project activity.

An estimate of annual average and total GHG emission reductions and removals.

The average annual GHG emission reduction from the project is expected to be 1,483,782 t CO_2e.

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.

1.3 Project Eligibility

The project involves energy efficient cookstove distribution which falls under the category of efficiency improvements in thermal applications, therefore it is eligible under the scope of VCS Program.

1.4 Project Design

The project is a grouped project.

Eligibility Criteria

For the inclusion of new project activity instances, the project proponent shall 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) will meet the applicability conditions set out in Section 3.2 where the target of the end-user is household and the ICS deployed is at least 25% of thermal efficiency.
2	Use the technologies or measures specified in the project description.	Only TLC-CQC Rocket stoves to be 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 to be adopted in the project and it will 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 will be installed within Malawi only and subject to the same baseline scenario determined in Section 3.4.
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 will 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 will comply 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 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.	No project activity instance shall exceed the applicable limit, which is 180 GWh_{th}/y. The expected annual energy saving for each project activity instance is approximately 0.02 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.

1.5 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.
Telephone	+6 087 423828
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1.6 Other Entities Involved in the Project

At the present, C-Quest Capital Stoves Asia Limited is the sole entity involved in the project.

1.7 Ownership

The project ownership is with C-Quest Capital Stoves Asia Limited. The Host Country Approval of the project is the proof of title for the project.

1.8 Project Start Date

01 January 2021 (The estimated date of commissioning of ICS batch 1)

1.9 Project Crediting Period

01 January 2021 to 31 December 2030, ten years.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	X

Year	Estimated GHG emission reductions or removals (tCO_2e)
Year 1	985,327
Year 2	1,811,717
Year 3	2,483,515
Year 4	3,005,002
Year 5	2,395,068
Year 6	1,802,132

Year 7	1,225,941
Year 8	704,454
Year 9	329,061
Year 10	95,607
Total estimated ERs	**14,837,824**
Total number of crediting years	**10**
Average annual ERs	**1,483,782**

1.11 Description of the Project Activity

The project involves distribution of fuel-efficient improved cookstoves (ICS) to replace the baseline cookstoves in households.

The ICS to be 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 woodfuel consumption compared with a three-stone fire or traditional pot support.

Technology/Measure

TLC-CQC Rocket Stove uses a total of 16 bricks that will be made by the households using locally available clay. The average size of the brick would be 22.5cm x 11cm x 6.5cm. The bricks will be joined together using a mixture of 5 liters clay, 5 liters sand, 5 liters manure/cow dung and 5 liters of water. This ensures reduction in heat loss and better insulation. Metal components have been added to the design to optimize combustion and heat transfer.

TLC-CQC Rocket Stove

Stove components

Stove has a metal top that allows the pot to sit higher improving the flow of air into the combustion chamber and out through the top of the stove

An adjustable metal pot skirt ensures more effective transfer of heat from the fire into the pot, increasing efficiency and also helping to block wind

TLC-CQC stoves come with a metal stick support which is placed in front of and slightly into the opening of the stove and acts as a firewood feeding platform. This ensures adequate airflow while feeding the fuel into the combustion chamber resulting in complete combustion of wood.

According to independent stove efficiency tests performed by Aprovecho Research Centre on the TLC Rocket Stove, the WBT results yielded an average thermal efficiency of 34.5%. for boiling 5 litres of water.

Technical Specifications

Stove Size	Depth: 35 cm Width: 35 cm Height: 28 cm
Combustion Chamber Size	Depth: 12 cm Width: 12 cm Height: 28 cm
Efficiency	34.5%

Data collection of ICS end-user

Project proponent must gather the necessary information to identify households using its ICS during the course of the project. To facilitate this process, each ICS will be assigned a unique serial number. This number will be recorded during the registration process together with the following information (as appropriate and as available):

- Name of ICS user or head of the household
- Address / GPS of ICS household
- Phone number of ICS user or household, where available.
- Stove model
- Date of distribution/installation
- ICS serial number
- Retailer/distributer information

The information collected will be stored in the electronic database which will serve as project database for project monitoring and sampling purposes.

1.12 Project Location

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

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®

Malawi map

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

No.	Project Area	Regions
1	Northern Area	Northern

2	Central Area	Central
3	Southern Area	Southern

1.13 Conditions Prior to Project Initiation

The conditions prior to project initiation is the continued use of non-renewable wood fuel (firewood) by the target population to meet similar thermal energy needs as provided by project cookstoves in absence of project activity.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

There are no laws and regulations governing the use of improved cookstoves in Malawi households.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project has not been registered, nor is it seeking registration under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG program.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project is not included in an emissions trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

The project has not sought or received another form of GHG-related environmental credit.

1.17 Additional Information Relevant to the Project

Leakage Management

Not applicable as the project adopts a net gross adjustment factor of 95% to account for leakage.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Sustainable Development

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

a) Environmental Sustainability

- The project will help significantly reduce greenhouse gas emissions over its lifetime.
- The project will help 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 will be reduced. Less carbon dioxide, carbon monoxide and particulates will be 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 will help develop a section of the local economy, in the distribution, local assembly, maintenance and monitoring activities.
- Household expenditures on cooking fuel will be reduced through the use of the ICS.
- Saved household labour can be diverted to more productive economic activities.
- The project will create local employment opportunities in operational and management roles, as well as future assembly and/or manufacturing initiatives.

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

No potential negative environmental or socio-economic impacts have been identified for the project.

2.2 Local Stakeholder Consultation

This section is not applicable as the project is listed under development.

2.3 Environmental Impact

No negative environmental impacts have been identified from the project and environmental impact assessment (EIA) is not required for the project.

2.4 Public Comments

This section is not applicable as the project is listed under development.

2.5 AFOLU-Specific Safeguards

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

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Methodology for Installation of High Efficiency Firewood Cookstoves, Version 1[1]

3.2 Applicability of Methodology

Applicability criterion	How the project complies
Project activities shall be implemented in domestic premises or in community-based kitchen	The proposed project involves deployment of ICS only in households.
The project stove shall have specified high-power thermal efficiency of at least 25% per the manufacturer's specifications and shall exclusively use woody biomass and can be single pot or multi-pot;	TLC-CQC Rocket stoves planned to be installed under this project are single pot wood cookstoves that have an efficiency of 34.5% as per the manufacturer's specifications.
Non-renewable biomass has been used in the project region since 31 December 1989, using survey methods or referring to published literature, official reports or statistics;	Non-renewable biomass has been used since 31 December 1989 in Malawi as demonstrated at below.

[1] https://verra.org/methodology/methodology-for-installation-of-high-efficiency-firewood-cookstoves/

For the specific case of biomass residues processed as a fuel (e.g. briquettes, wood chips	Not applicable. The ICS is introduced as energy efficiency measure to replace baseline stoves and reduce the use of non-renewable biomass for combustion.

Evidence that the non-renewable biomass has been in use since 1989

Non-renewable biomass has been in use since December 31, 1989 as evidenced by various FAO statistical data. The Global Forest Resources Assessment 2010[2] (FAO) indicates that forest areas decline yearly, and that the total forest area declined by 27% from 1973 to 2010, as summarized in the table below. It is now estimated that the fraction of non-renewable biomass in total biomass is 94 percent.

Trends in extent of forest 1973-2010 - Malawi

Area (1000 hectares)					
	1973	1990	2000	2005	2010
Forest	4456	3863	3567	3402	3237

In view of the combined evidence of declining forested areas since 1973, trend in loss in carbon stock since 1990, trend in the increased length of time spent for collecting firewood, and presently such a high fraction of non-renewable biomass, it may be deducted that the majority of fuelwood used across Malawi since December 31, 1989 was from non-renewable sources.

3.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Emission from use of non-renewable biomass/Fossil fuel	CO_2	Yes	Major source
		CH_4	Yes	Major source
		N_2O	Yes	Major source
		Other	No	No other source identified
Project	Emission from use of non-	CO_2	Yes	Major source
		CH_4	Yes	Major source

[2] FAO, Global Forest Resources Assessment 2010, Country Reports, Malawi PAGE 11

	renewable biomass	N_2O	Yes	Major source
		Other	No	No other source identified

3.4 Baseline Scenario

The baseline scenario is the continued use of non-renewable wood fuel (firewood) by the target population to meet similar thermal energy needs as provided by project cookstoves in absence of project activity

3.5 Additionality

The methodology uses activity method for the demonstration of additionality.

Activity Method

Step 1: Regulatory Surplus

There is no mandated government programme or policy in host country of this project ensuring the distribution of domestic fuel-efficient cookstoves. The project is not mandated by any law, statute or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute or other regulatory framework.

Households may only participate voluntarily in this project. It is hereby confirmed that the proposed project is a voluntary coordinated action by CQC.

Step 2: Positive List

As per Section 3.2, the project meets the applicability conditions of the methodology which represent the positive list.

The project installs the ICS at zero cost to the household and has no other source of revenue other than the sale of GHG credits.

The project is not implemented as part of government schemes or supported by multilateral funds.

Conclusion: As the project fulfills the conditions above, it is deemed additional.

3.6 Methodology Deviations

The project did not apply any methodology deviations.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The methodology does not account for baseline emissions separately, but instead quantifies net emission reductions achieved by the project. Please refer to Section 4.4.

4.2 Project Emissions

The methodology does not account for project emissions separately, but instead quantifies net emission reductions achieved by the project. Please refer to Section 4.4.

4.3 Leakage

Leakage shall be considered as default 0.95 in accordance with methodology.

4.4 Net GHG Emission Reductions and Removals

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

$$ER_y = \sum_i \sum_j ER_{y,i,j}$$ 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

$$ER_{y,i,j} = B_{y,savings,i,j} \times NCV_{wood\ fuel} \times f_{NRB,y} \times \left(EF_{wf,CO2} + EF_{wf,non\ CO2}\right) \times N_{y,i,j} \times 0.95$$ 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 (fNRB)[3]
$NCV_{wood\ fuel}$	=	Net calorific value of the non-renewable woody biomass that is substituted or reduced (IPCC default for wood fuel, 0.0156 TJ/tonne)[4]
$EF_{wf,CO2}$	=	CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 112 tCO_2/TJ)[5]
$EF_{wf,non\ CO2}$	=	Non-CO_2 emission factor for the use of wood fuel in baseline scenario (IPCC default for wood fuel, 26.23 tCO_2/TJ)[6]
$N_{y,i,j}$	=	Number of improved cookstoves of type *i* and batch *j* operating during year *y*
0.95	=	Discount factor to account for leakage

The quantify of woody biomass saved due to implementation of improved cookstoves to be estimated using equation below:

$$B_{y,savings,i,j} = B_{y=1,new,i,survey} \times \left(\frac{\eta_{new,y,i,j}}{\eta_{old}} - 1\right)$$ Equation (3)

where

η_{old}	=	Efficiency of baseline cookstove
$\eta_{new,y,i,j}$	=	Efficiency of the improved cookstove type *i* and batch *j* determined through water boiling test (WBT) during year *y* Alternatively, efficiency may be determined using Equation 4.
$B_{y=1,new,i,j,survey}$	=	Annual quantity of woody biomass used by improved cookstoves in tonnes per device of type *i* and batch *j*, determined in the first year of the implementation of the project through a sample survey.

$$\eta_{new,y,i,j} = \eta_p \times (DF_n)^{y-1} \times 0.94$$ Equation (4)

[3] Default values endorsed by designated national authorities and approved by the Board are available at https://cdm.unfccc.int/DNA/fNRB/index.html

[4] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 1 Introduction

[5] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 2 Stationary Combustion

[6] 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Volume 2 Energy, Chapter 2 Stationary Combustion

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). This value may be based on actual monitoring or based on manufacturer's declaration on expected loss in efficiency or through publicly available literature on relevant industry standards. Alternatively default value of 0.99 efficiency loss per year can be considered.
0.94	=	Adjustment factor to account for uncertainty related to project cookstove efficiency test.

For ex-ante calculation purpose, the assumption below is applied.

1) The project will install up to 500,000 ICS.
2) ICS installation to be implemented in 4 batches with each batch comprises of 125,000 ICS.
3) The life span of ICS is 7 years; thus the operational lifetime of each batch is taken as 7 years.
4) The expected operational lifetime of all ICS batches during 10 crediting period is described as below

Batch	Operational lifetime of batch
Batch 1	Years 1 to 7
Batch 2	Years 2 to 8
Batch 3	Years 3 to 9
Batch 4	Years 4 to 10

5) The ex-ante calculation will be performed for Batch 1.
6) Annual stove loss rate is estimated at 14.9%
7) $B_{y=1,new,i,j,survey}$ is assumed as 1.83 tonnes / device / year

Determination of number of ICS operating during year y

$N_{y,i,j}$ = 125,000 x [1 - (y-1) x 14.9%]

Example of calculation:

If y = 2,

$N_{y,i,j}$ = 125,000 x [1 - (2-1) x 14.9%]

= 125,000 x 85.1%

= 106,375

Hence, the number of ICS operating during year y is as below:

Year (y)	$N_{y,i,j}$
1	125,000
2	106,375
3	87,750
4	69,125
5	50,500
6	31,875
7	13,250

Determination of efficiency of ICS during year y

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

Where

η_p = 34.5%

DF_n = 0.99

Example of calculation:

If y= 2

$\eta_{new,y,i,j}$ = 34.5% X $(0.99)^{2-1}$ X 0.94

= 32.11%

Hence the efficiency of ICS during year y is as below:

Year (y)	$\eta_{new,y,i,j}$

1	32.43%
2	32.11%
3	31.78%
4	31.47%
5	31.15%
6	30.84%
7	30.53%

Determination of quantity of woody biomass that is saved in tonnes per ICS during year y

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

Example of calculation:

If y= 2,

$B_{y,savings,i,j}$= 1.83 X [(0.3211/0.1) -1]

= 4.0343 tonnes

Year (y)	$B_{y=1,new,i,survey}$	$\eta_{new,y,i,j}$	η_{old}	$B_{y,savings,i,j}$
1	1.83	32.43%	0.1	4.0935
2	1.83	32.11%	0.1	4.0343
3	1.83	31.78%	0.1	3.9757
4	1.83	31.47%	0.1	3.9177
5	1.83	31.15%	0.1	3.8603
6	1.83	30.84%	0.1	3.8034
7	1.83	30.53%	0.1	3.7471

Determination of emission reductions by ICS of batch 1 during year y

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

Where

$NCV_{wood\ fuel}$ = 0.0156 TJ/tonne

$f_{NRB,y}$ = 0.94

$EF_{wf,CO2} + EF_{wf,non\ CO2}$ = 112 + 26.23 = 138.23 tCO_2/TJ

Example of calculation:

If y=2,

$ER_{y,i,j}$ = 4.0343 X 0.0156 X 0.94 x 138.23 X 106,375 X 0.95

=826,390 tCO_2

Year	$B_{y,savings,i,j}$	$NCV_{wood\ fuel}$	$f_{NRB,y}$	$EF_{wf,CO2} + EF_{wf,non\ CO2}$	$N_{y,i,j}$	$ER_{y,i,j}$
1	4.0935	0.0156	0.94	138.23	125,000	985,327
2	4.0343	0.0156	0.94	138.23	106,375	826,390
3	3.9757	0.0156	0.94	138.23	87,750	671,798
4	3.9177	0.0156	0.94	138.23	69,125	521,487
5	3.8603	0.0156	0.94	138.23	50,500	375,393
6	3.8034	0.0156	0.94	138.23	31,875	233,454
7	3.7471	0.0156	0.94	138.23	13,250	95,607

As batches 2, 3 and 4 are using the same assumption applied on batch 1, therefore the total emission reductions to be achieved by the project over 10 years of crediting period is as below:

Year	Estimated emission reductions (tCO_2)				
	Batch 1	Batch 2	Batch 3	Batch 4	Total
Year 1	985,327	0	0	0	**985,327**

Year 2	826,390	985,327	0	0	**1,811,717**
Year 3	671,798	826,390	985,327	0	**2,483,515**
Year 4	521,487	671,798	826,390	985,327	**3,005,002**
Year 5	375,393	521,487	671,798	826,390	**2,395,068**
Year 6	233,454	375,393	521,487	671,798	**1,802,132**
Year 7	95,607	233,454	375,393	521,487	**1,225,941**
Year 8	0	95,607	233,454	375,393	**704,454**
Year 9	0	0	95,607	233,454	**329,061**
Year 10	0	0	0	95,607	**95,607**
			Total		**14,837,824**
			Number of crediting period		**10**
			Average annual ERs		**1,483,782**

5 MONITORING

5.1 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	Value determined from survey methods
Value applied	0.94
Justification of choice of data or description of measurement methods and procedures applied	This parameter shall be 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 fNRB will be 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	

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
Value applied	112
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value
Purpose of Data	Calculation of emission reductions
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	26.3
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value
Purpose of Data	Calculation of emission reductions
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 shall be used if 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	

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 shall be determined ex-ante
Purpose of Data	Calculation of $\eta_{new,y,i,j}$
Comments	

5.2 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 directly or based on a representative sample. Sampling standard shall be used for determining the sample size to achieve 90/10 confidence precision according to the latest version of Standard for sampling and surveys for CDM project activities and programme of activities.
Frequency of monitoring/recording	At least once every two years
Value applied	For ex-ante emission reduction calculation, it is assumed that the project will distribute up to 500,000 ICS and the installation/ distribution of ICS to be implemented in 4 batches with each batch comprises of 125,000 ICS.
Monitoring equipment	Monitoring survey
QA/QC procedures to be applied	
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
Comments	

Data / Parameter	$\eta_{new,y,i,j}$
Data unit	Fraction
Description	Efficiency of the improved cookstove type *i* and batch *j* determined through water boiling test (WBT) 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	Annually
Value applied	For ex-ante calculation, the value below is applied.
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method	Calculation to be performed using equation below: $\eta_{new,y,i,j} = \eta_p \times (DF_n)^{y-1} \times 0.94$
Comments	

Year (y)	$\eta_{new,y,i,j}$
1	32.43%
2	32.11%
3	31.78%
4	31.47%
5	31.15%
6	30.84%
7	30.53%

Data / Parameter	$B_{y=1,new,i,j,survey}$
Data unit	Tonnes
Description	Annual quantity of woody biomass used by improved cookstoves in tonnes per device of type i and batch j, determined in the first year of the implementation of the project through a sample survey
Source of data	Monitoring survey
Description of measurement methods and procedures to be applied	Minimum sample size of each type i and batch j should be in line with the latest version of Standard for sampling and surveys for CDM project activities and programme of activities or guidelines provided in methodology Section 8.4 option (b). Determined in the first year of the introduction of the devices (e.g. during the first year of the crediting period, y=1) through measurement campaigns at representative households and/or sample survey. Sample surveys to estimate this parameter, that are solely based on questionnaires or interviews (i.e. that do not implement measurement campaigns) may only be used if the following conditions are satisfied. (i) Baseline cookstoves have been completely decommissioned and only improved cookstoves are exclusively used in the project households; (ii) If multiple devices are used in the project, it is possible from the results of the survey questions to clearly differentiate the quantity of firewood being used by each device. In other words, if more than one device, or another device that consumes firewood, are in use in project households, then the sample survey needs to distinguish the quantity of firewood used by the project device and the other devices that use firewood.
Frequency of monitoring/recording	Determined in the first year of project implementation
Value applied	For ex-ante calculation, the value is assumed as 5kg/device/day or equal to 1.83tonnes/device/year.
Monitoring equipment	Monitoring survey
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method	

Comments	

Data / Parameter	**Life Span**
Data unit	Number of years
Description	The operating lifetime of the project device. The life span should be reported if the methodology equation 5 is adopted to determine the project stove efficiency
Source of data	Manufacturer's specification
Description of measurement methods and procedures to be applied	
Frequency of monitoring/recording	Once at the time of project stove installation
Value applied	7
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method	
Comments	

Data / Parameter	**Date of commissioning of batch *j***
Data unit	Date
Description	To establish the date of commissioning, the Project Participant may opt to group the devices in "batches" and the latest date of commissioning of a device within the batch shall be used as the date of commissioning for the entire batch.
Source of data	Project database

Description of measurement methods and procedures to be applied	
Frequency of monitoring/recording	Fixed and recorded at the time of commissioning/distribution of the last project device in the batch
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	Calculation of emission reductions
Calculation method	
Comments	

Data / Parameter	Date of commissioning of project device i
Data unit	Date
Description	Actual date of commissioning of the project device
Source of data	Project database
Description of measurement methods and procedures to be applied	
Frequency of monitoring/recording	Fixed and recorded at the time of commissioning/distribution
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	

Purpose of data	Calculation of emission reductions
Calculation method	
Comments	

5.3 Monitoring Plan

Sampling Plan

As per the *Guideline for Sampling and Surveys for CDM Project Activities and Programme of Activities*, *version 04.0*, the sampling plan is the following:

(a) Sampling design

Due to the large number of ICS envisioned to be distributed under the project, it is not economically feasible to monitor each individual ICS unit distributed. Therefore, representative sampling shall be undertaken for each batch of ICS. The sampling plan to be designed in line with the requirements of the *Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities, version 08.0*.

Samples will be drawn from ICS recorded in the project database administered by the project proponent. A detailed explanation of this database is found in Section 1.11 of project description.

Objectives and Reliability Requirements

The objective is to obtain an unbiased and reliable estimate of the proportion or mean value of the following key variables over the course of the crediting period. As per CDM Methodology AMS-II.G, 90/10 confidence/precision shall be applied for annual sampling requirement and 95/10 for biennial sampling inspection. As per *Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities,* 90/10 confidence/precision to be adopted for small-scale project and 95/10 for large-scale project. Given that the size of the project is under the category of large projects, hence 95/10 confidence/precision shall be adopted for all parameters unless the average annual emission reductions of the project below the threshold

Monitored Parameters:

The project involves **introduction of** improved cook stoves as energy efficiency measure:

No.	Monitoring parameters	Sampling parameters	Parameter type	Monitoring frequency
1	$N_{y,i,j}$ Number of project devices of type *i* and batch *j*	Proportion of ICS still in operation	Proportion	Biennially

	operating during year *y*			
2	$\eta_{new,y,,i,j}$ Efficiency of the device of each type *i and* batch *j* implemented as part of the project activity	Thermal Efficiency of operational ICS	Mean value	Annually (The project opts to determine the efficiency using the equation given by methodology, therefore it is not required to monitor this parameter via sampling survey.)
3	$B_{y=1,new,i,j,survey}$ Quantity of woody biomass used by project devices in tonnes per device of type *i*. and batch j	Daily consumption of woody biomass per ICS	Mean value	Determined in the first year of project implementation

Target Population

The target population will be the complete set of appliances (ICS) deployed under the project.

Sampling Method

The project involves distribution of ICS throughout the project area thereby replacing traditional cooking devices. The population is heterogeneous in nature i.e. common technology with similar operating characteristics but dispersed i.e. distribution of ICS is spread across different states/province of the country. The population consists of sub-populations which are homogeneous called as Strata. The characteristics of population (for example quantity of biomass consumed) are more similar within the stratum (ICS of same type, vintage and project area in which they are operating) than across the strata. Therefore, Stratified Sampling technique will be used to conduct sampling survey among ICS batches.

The populations of each batch will be combined together, the sample size is determined, and a single survey will be undertaken to collect data. To ensure the survey result is representative of the entire population, the dissimilarity (such as ICS type, vintage and project area in which they are operating) within the included CPAs will be taken into account in the sample size calculation. The ICS of same type, vintage and project area in which they are operating will be grouped in the same strata. Samples will be drawn by using the random number generator.

To determine the parameters, sampling will involve the following approaches (outcome in brackets):

$\boldsymbol{N_{y,i,j}}$	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)
$\boldsymbol{B_{y=1,new,i,j,survey}}$	Interview with end user and estimate the daily consumption of woody biomass of ICS (Daily consumption of woody biomass)

Sample Size

The procedure to determine the sample of households will ensure that they adequately represent the broader project population, minimizing sampling error. Using, a 90 or 95 per cent confidence level, and a 10 per cent margin of error, a random sample will be selected from each strata.

In order to calculate the required sample size estimates, values for the proportions, mean values, and standard deviations are required. As per *Guideline for Sampling and surveys for CDM project activities and programmes of activities, version 04.0*, there are different ways available to obtain the estimates of the parameter of interest:

(a) Refer to the result of previous studies and use these results;

(b) In a situation where information from previous studies is not available, a preliminary sample as a pilot could be conducted and use that sample is used to provide the estimates;

(c) Use best guesses based on the researcher's own experiences.

Proportion parameter

To estimate the sample size for proportion parameters, the following equation[7] is used:

$$n \geq \frac{1.96^2 NV}{(N-1)\times 0.1^2 + 1.96^2 \times V}$$

Where[8]:

[7] Equation 1 of Appendix 3, *Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 04.0)*

[8] Equation 2 of Appendix 3, *Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities (Version 04.0)*

$$V = \left(\frac{SD}{p}\right)^2$$

n = Sample size

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

p = Weighted overall expected proportion

SD^2 = Weighted overall expected variance

1.96 = Represents the 95% confidence required

(In the case of 90% confidence, 1.645 shall be used)

0.1 = Represents the 10% relative precision

The overall variance and proportion are calculated using equation below:

$$p = \frac{(g_a \times p_a) + (g_b \times p_b) + (g_c \times p_c) + \cdots + (g_k \times p_k)}{N}$$

$$SD^2 = \frac{\left(g_a \times p_a(1-p_a)\right) + \left(g_b \times p_b(1-p_b)\right) + \left(g_c \times p_c(1-p_c)\right) + \cdots + \left(g_k \times p_k(1-p_k)\right)}{N}$$

Where

g_i = Size of the i[th] strata where i = a,…,k

p_i = Proportion of the i[th] strata where i = a,….,k

Sample size for each strata

$$n_i = \frac{g_i}{N} \times n$$

Where:

n_i = Sample size of the i[th] strata where i = a,…,k

Mean value parameter

To estimate the sample size for mean value parameter, the following equation[9] is used:

$$n \geq \frac{1.96^2 NV}{(N-1)\times 0.1^2 + 1.96^2 \times V}$$

Where[10]:

$$V = \left(\frac{SD}{m}\right)^2$$

n	= Sample size
N	= Population size (Total number of households or ICS)
m	= Weighted overall expected mean
SD^2	= Weighted overall expected variance
1.96	= Represents the 95% confidence required (In the case of 90% confidence, 1.645 shall be used)
0.1	= Represents the 10% relative precision

The overall variance and mean are calculated using equation below:

$$m = \frac{(g_a \times m_a) + (g_b \times m_b) + (g_c \times m_c) + \cdots + (g_k \times m_k)}{N}$$

$$SD^2 = \frac{\left(g_a \times SD_q^2\right) + \left(g_b \times SD_b^2\right) + \left(g_c \times SD_c^2\right) + \cdots + \left(g_k \times SD_k^2\right)}{N}$$

Where

g_i = Size of the i[th] strata where i = a,…,k

m_i = Mean of the i[th] strata where i = a,…,k

[9] Equation 19 of Appendix 3, *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities* (version 04.0)

[10] Equation 20 of Appendix 3, *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities* (version 04.0)

Sample size for each strata

$$n_i = \frac{g_i}{N} \times n$$

Where:

n_i = Sample size of the i^{th} strata where i = a,…,k

If the resulting sample size based on the above equation is smaller than 30 ICS, then as the parameter of interest is a numeric mean value (i.e. not a proportion or percentage) the Student's t-distribution shall be used.

The sample size for mean value parameter is referred to the equation below[11]:

$$n = \left(\frac{t_{n-1} \times SD}{0.1 \times mean} \right)^2$$

Where t_{n-1} is the value of the t-distribution for 95% confidence when the sample size is n. Since the sample size is not known yet, the first step is to use the value for 95% confidence when the sample is large, i.e. 1.96 and then redefine the calculation.

The calculation now need to repeat using t-value for 95% confidence. The process should be iterated until there is no change to the value of n.

The project proponent may choose to use the same sample to monitor more than one parameter. According to the Standard for sampling and surveys for CDM project activities and programme of activities, if there is more than one parameter to be estimated, then a sample size calculation should be done for each of them. Then either the largest number for the sample size is chosen as sampling effort with one common survey, or separate sampling efforts and surveys are undertaken for each parameter. For instance, the project proponent may sample separately $\boldsymbol{N_{y,i,j}}$j and $\boldsymbol{B_{y=1,new,i,j,survey}}$ –or a combination of two parameters in the same sample. Sampling more than one parameter within the same sample (household) helps reduce travel needs for monitoring and the associated costs. At the same time this approach ensures the random selection of samples for every parameter.

Oversampling is strongly encouraged, not only to compensate for any attrition, outliers or non-response associated with the sample, but also to prevent a situation at the analysis stage where the required reliability is not achieved and additional sampling efforts would be required. The

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[11] Paragraph 102, *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities* (version 04.0)

sample size shown above will be adjusted upwards to account for non-responses, Project proponent shall determine the appropriate non-responses rate based on previous experience.

Sampling Frame

Separate samples shall be taken for each batch. The sampling frames shall be defined as per below. In overall, a batch of ICS will have same group of end users which is household users, thus it is expected that the geographical locations do not have influence on the parameter of interest. Therefore, all monitoring parameters can be assumed to be highly homogeneous for each ICS model regardless of how the end user group and distribution/installation location is defined.

To formulate sample frame, all ICS operating under the batch will be combined together. The number of project devices operating may vary with ICS type and project area where they are located & efficiency of the ICS depends on the ICS type and ICS age group. Therefore, ICS can be sub- grouped into strata based on ICS batch, ICS type, ICS age group and project area where they are located.

	Batch j		
Number of ICS Operating	125,000		
Project area	Central	Northern	Southern
ICS Type	A	A	A
ICS Age Group	1	1	1
Number of ICS / strata	50,000	30,000	45,000
Strata	1	2	3
	Sampling frame		

(b) Data to be collected:

(i) Field Measurements:

The table below summarizes field measurement data requirements

Parameter	**Timing (indicative)**	**Frequency as required by methodology**	**Methods to be applied**	**Comments on seasonal fluctuation**
$N_{y,i,j}$	Monitoring will likely occur every 12 to 24 months	Biennially	Visits to the premises, visual inspection and	Not due to any seasonal fluctuation.

			interview with ICS end-user.	
$\boldsymbol{B_{y=1,new,i,j,survey}}$	Monitoring will likely occur within the first year after installation	First year of installation	Visits to the premises, visual inspection and interview with ICS end-user.	Not due to any seasonal fluctuation.

Hard copies of the surveys will be kept and the database will have back up. Original stove purchase contracts, information collected from the registration or other means of acceptance by the users will be stored in the project office. A back-up of the project database will also be stored on an electric medium. All data monitored and required for verification and issuance will be kept for two years after the end of the crediting period or the last issuance of credits for the project activity, whichever is later.

(ii) Quality Assurance/Quality Control

The project proponent will apply measures to ensure the required confidence/precision for each sampled parameter is met, allowing for non-response and the possible removal of outliers from the sample, as part of a Quality Control/Quality Assurance system. The choice of measure applied to each parameter will depend on the cost of each data collection approach and logistics required. The project proponent will determine the most effective measure for each parameter from the following list:

- Oversampling: Randomly draw a sample more than the calculated number (say 20%) and collect data from each
- Buffer Group: Randomly draw additional samples (say 20%) and collect data from only for minimum numbers of ICS as per sample size calculation. If this would not result in the required sample size data would be collected from the additional ICS that were selected in the sample.
- If precision required is not achieved by reliability check, use the lower bound or upper bound of estimates of the parameter.

The sampling plan has the following procedures in place to ensure good quality data. The project proponent will ensure that field personnel have reviewed, understand and have agreed to follow the monitoring plan procedures, including provisions for maximizing response rates, documenting out-of-population cases, refusals and other sources of non-response. A quality control and assurance strategy will be documented. Quality control and assurance strategies include addressing non-sampling errors, such as non-response or bias from interviewer. The project proponent or a competent third party designated by the project proponent with the proper skills will train the monitoring personnel on how to properly survey households to prevent bias from interviewer. In the case a household refuses to participate, another household will be chosen at random. To reduce interviewer bias, good questionnaire design and well-tested questionnaires will be used.

The sample data for mean value parameter is continuous and therefore the presence of outliers is possible. To identify and address outliers for the parameter, outliers will be defined as those data points with values greater than three standard deviations from the mean of the sample. Data points identified as outliers will be examined further to correct for possible transcription and data entry errors but will be omitted from the analysis if no such administrative errors exist.

(iii) Analysis

The project proponent will manage a project database that includes the following data that can be directly attributable to each batch within the project, thereby allowing unambiguous determination of the emission reductions attributable to each project:

- A list of households participating in each batch / project, including name, community/location, distribution/installation date and unique serial number;
- Testing to ensure that the stoves are still operating above the minimum 25% efficiency required by the methodology, by the project proponent or a third party certified by a national standards body or an appropriate certifying agency recognized by it.
- Where replacements are made, assurance that the efficiency of the new ICS is similar to the specified.

Data obtained from the samples will be used to estimate proportions and mean values for the parameters described above. The values will then be factored into the emissions reduction calculations and result in the request for issuance of VERs. The parameters are applied for emission reduction calculations. The stoves that are not in use will be excluded from emissions reductions calculations and will not be counted towards the total number of ICS in operation during the monitoring period.

(c) Implementation

Sampling for the purpose of emission reduction calculation and elaboration of the monitoring report will occur at the end of each monitoring period. This sampling will be conducted by trained personal from project proponent or an experienced third-party entity. The credentials and/or training materials for the sampling personal will be provided to the VVB at verification. The maximum length of one monitoring period will be two years (duration, not calendar years), with option for annual or bi-annual monitoring. The project proponent will be responsible for managing household data collection and entry into the project database. Field personnel will receive training on how to properly deal with surveying techniques and reduce errors and sign a document certifying that there is no conflict of interest of those involved in data collection and analysis. If there is conflict of interest, the personnel will not be allowed to participate in data collection and analysis. The project database will record the start and end dates of each monitoring period and record the emission reductions attributable to each monitoring period. Appropriate record keeping procedures will be implemented to ensure that each monitoring period data set can be transparently attributed to its corresponding batch/project, preventing any occurrences of double counting. An internal review of the project database will be able to determine the current status of each batch — the duration of previous monitoring periods, the households delivering monitoring data, and current verification activities.

(i) Assessment for Leakage

The methodology provides a net to gross adjustment factor of 0.95 to account for leakages, hence the surveys are not required to determine leakage.

The other source of leakage occurs if equipment currently being utilised is transferred from outside the boundary to the project activity. All ICS in the project will be newly manufactured/assembled or newly installed.

(ii) Disposal of Low Efficiency Appliances and Use of Baseline Stoves

When an ICS is installed, the end user receives information explaining that conventional open fire appliance must no longer be used. Follow-up meetings with end users will ensure that those who have received an ICS are using it properly and that the conventional open fire is no longer in use. If it is determined that the conventional open fire is still in use along with the operating ICS, a survey will be conducted, and discount will be applied to ER formulae for emission reduction adjustment.

(iii) Monitoring Reporting

The project proponent will assess all monitoring data and produce a monitoring report for the VVB to verify corresponding to the preceding monitoring period. This report will present the data relating to the emission reductions generated by those batches during the monitoring period.

APPENDIX

Use appendices for supporting information. Delete this appendix (title and instructions) where no appendix is required.