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April 2006

This document was developed by: ECOFYS

The Gold Standard for VERs has received financial support from:
reeep renewable energy & energy efficiency partnership

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Explanatory information on how to complete the PDD and how to obtain Gold Standard registration can be found in the project developer's manual available on the Gold Standard website.

This template of the PDD is applicable for micro-, small- and large-scale projects. Note that the shaded boxes present information on the Gold Standard VER project development procedures. Project developers should delete these shaded boxes when preparing their PDD.

a. VOLUNTARY OFFSET PROJECTS

PROJECT DESIGN DOCUMENT FORM (GS-VER-PDD)

Version 01 - in effect as of: January 2006)

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity

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Title: Integrated Biomass Energy Conservation Project - Malawi.
Version: 3
Date: 19th November, 2010

A.2. Description of the project activity

Malawi is over dependent on woodfuel,[1] which accounts for 93% of the country's aggregate energy use.[2] Deforestation is not only resulting in increased scarcity of woodfuel for energy but it is also causing many other environmental problems, which directly increase socio-economic vulnerability, such as increased soil erosion, river siltation, increased vulnerability to flooding, the sinking of the water table and reduced natural habitat for biodiversity. It is estimated that in Malawi, 90 percent of household and industrial energy requirements are met from forests.[3]

Tobacco is Malawi's main export[4] and an important cash crop for smallholder farmers. Smallholder tobacco producers that farm areas of around 1 hectare of land[5] use fuelwood as a fuel to 'flue-cure'[6] tobacco leaves in inefficient conventional barns. Although improved barn technologies are available, their use is mainly restricted to large-scale estates. Smallholder tobacco growers do not operate their own fuelwood plantations due to scarcity of land. One study stated that tobacco induced deforestation in Africa is probably most serious in Malawi.[7]

The project reduces greenhouse gas emissions from non-renewable biomass fuel by dissemination of improved household and institutional cook-stoves and fuel-efficient rocket barns to replace existing inefficient curing barns. The project is based on research and development in the stoves and barns by the Programme for Biomass Energy Conservation (ProBEC) in Malawi. A company that promotes fuel-efficient technologies called Hestian Rural Innovation Development was founded on the basis of this pilot work in 2008.

This project disseminates on a large-scale four types of improved cook-stoves and improved tobacco-curing barns or 'rocket barns'. (see Table A.2 1, A.2 2 and A.2 3):

a. Improved fuel-efficient portable ceramic stoves *(Chitetezo mbaula* – the "protective stove"*),*

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1 Woodfuel is used to mean all fuels originating from woody biomass, including charcoal, in distinction from firewood or fuelwood, which are understood to mean the wood in its original composition.

2 National Energy Policy, 2003.

3 Chipompha, N.W.S., Belo, W.S. & Mjojo, D.P.K. *Deforestation in Malawi, its nature, causes and corrective methods*. Forestry Department, Lilongwe, Malawi (1993).

4 Tobacco is the main export crop accounting for over 70.0 per cent of total export earnings. (Source: Malawi Growth and Development Strategy "From Poverty to Prosperity 2006-2011', GoM, 2007).

5 Ninety-five per cent of rural households in Malawi have 1 hectare or less and the average in the Southern Region is just 0.4 ha (National Forestry Programme, 2001).

6 *Flue-cured* tobacco is strung onto tobacco sticks, which are hung from tier-poles in curing barns. These barns have flues which run from externally fed furnaces, heat-curing the tobacco without exposing it to smoke, slowly raising the temperature over the course of the curing. Hence, flue-cured tobacco is not naturally cured by air or sun, but artificially by external energy sources. Tobacco is cured to obtain the characteristic taste, aroma and colour, and to preserve it for storage, transport and processing.

7 Geist, H. "How tobacco farming contributes to tropical deforestation". Paper presented at the Tobacco Deliberation Group Meeting, National Committee for International Cooperation and Sustainable Development, Utrecht, 29 October 1997.

b. Improved fuel-efficient fixed *esperanza* stoves,
c. Improved fuel-efficient rocket barns for curing agricultural produce
d. Institutional Stoves
e. Urban Cook Stoves

				
Portable ceramic stove	Fixed *esperanza* stove	Rocket Barn	Institutional Cook Stove	Urban Cook Stove

The improved stoves reduce fuel consumption by improved combustion and improve heat transfer. The stoves raise the cooking pot to the hottest point above the flame. The fixed stove, institutional cook stove and the urban cook stove have elbow-jointed combustion chambers that increase combustion efficiency.

The 'rocket barn' reduces fuel consumption by introduction of a double chimney that uses 'waste heat' to increase convective flow through the tobacco and barn structure for improved heat transfer systems, which ensure equal heat distribution with improved air-flow minimising the risk of barn fires. The rocket barn has a twofold increase in heat exchanger surface area compared to the conventional barn and has an improved, extended, and durable "*venturi*" furnace. The term 'rocket barn' was chosen for the improved barns as the combustion chambers of the barns are based on the well-proven rocket technology for improved cook-stoves.

Tests were conducted in 2008 and 2009 to measure the fuel savings introduced by the improved devices, with the following results:

- The improved portable ceramic stove reduced wood consumption in sampled households by 39% on average, in some cases saving more than 50% of fuel used previously,
- The fixed esperanza stove reduced wood consumption by 48% on average in the sampled households,
- The improved rocket barns reduced fuel-use by 63% on average in sampled farms,

During the second round stakeholder consultation, feedback was received suggesting that the project incorporate:

(a) efficient cook stoves sized for cooking at institutions such as schools, colleges, prisons and hospitals (Institutional Cook Stoves); and

(b) efficient cook stoves that are appropriate for urban and peri-urban areas and that allow for more efficient cooking with charcoal and/or a mix of charcoal and wood (Urban Cook Stoves).

As a result of this feedback the project intends to incorporate Institutional Cook Stoves (ICS) and Urban Cook Stoves (UCS). Tests will be conducted in 2009/2010 to measure the fuel savings introduced by the ICS and UCS.

The ICS and UCS are expected to apply proven 'rocket' technology by introduction of an insulated combustion chamber, increasing combustion efficiency and retaining heat while also raising the cooking pot to the hottest point above the flame. Both stoves will further increase heat transfer by having the cooking pot rest within a skirt.

The improved stoves and barns significantly reduce fuel consumption and greenhouse gas emissions. They simultaneously provide ancillary benefits to users and families in the form of reduced exposure to indoor air pollution (in the case of stoves), relief from high fuel costs; less time hand-gathering domestic fuel-wood and reduced burden for farmers to transport wood over distances that are increasing. Public benefits of the devices promoted come in the form of reduced pressure on Malawi's natural resources.

Fixed esperanza stove are targeted at rural households in Malawi and initially households that already have access to micro-finance; Portable ceramic stove are targeted at rural food-insecure households and, Rocket Barns are targeted at smallholder tobacco farmers that have access to micro-finance and are farming approximately 1 hectare of tobacco. The institutional stoves are targeted at institutions that regularly cook for large groups of people, such as schools, health centres, prisons, barracks etc. Urban cook stoves are targeted at the urban and peri-urban households.

The Project is being implemented in all three Regions of Malawi: Southern, Central and Northern. The project disseminates both fixed stoves and barns in the Central, Southern and Northern regions and concentrates portable ceramic stove dissemination in one district of the Southern Region. Institutional and urban cookstoves will be disseminated throughout Malawi. Improved portable ceramic stoves are marketed at a village level in collaboration with local and traditional authorities, while the fixed stoves, urban cook-stoves and rocket barns are disseminated in collaboration with micro-finance institutions and agro-industries. Institutional cook stoves may be disseminated through school feeding programmes and *via* national institutions.

Since 2007, plans were made to access the carbon market to finance the project to overcome various constraints so that sales could be increased dramatically through training specialised building teams and production groups, marketing and promotion, technical development and improved after sales services. From July 2008, using carbon finance advances and monies expected to be recouped from carbon finance, the expansion was implemented, operational capacity was improved, the company HRID was incorporated, quality assurance systems were devised, user manuals were developed and technical design of the devices were improved to achieve the high levels of efficiency listed above.

Table A.2 1, A.2 2 and A.2 3 project the expected volume of improved stoves and barns throughout the project period. Table A.2 3 calculates operational barn years on the assumption that barns are built before the start of each curing season, which runs from January to April each year. Operational stove years are calculated based on the amount of time that the stoves are in use. An improved stove, for example, working for six months qualifies as ½ operational barn year.

Table A.2 1 assumes that the fixed esperanza stoves have a 5-year working life, the portable ceramic stoves have a working life of at least 2 years while the rocket barns have a working life of ten years or more. These assumptions are not made by the monitoring protocol, which requires that actual usage drop off rates are measured during project operation.

In order to assure conservativeness, emission reduction calculations are made only for one stove per household (many households will have more than one improved stove) and the average values of one stove are multiplied by the projected number of operational stove years. For barns, initially only the smallest size barns (250 stick capacity) are being disseminated. Rocket barns with greater capacity (e.g. 260 and 300 stick), that use the same technology and fuel, will be included in the small barn cluster as this gives a conservative result when quantitative test results for fuel savings of small barns are applied to larger barns.

Carbon finance creates a strong incentive for quality assurance and customer service to ensure user awareness, proper use and continuity of emissions reductions. Quality expectations are being established amongst end-users and efficient cooking and curing is becoming more sought after. The quality assurance system extends the working life times of the stoves and barns and maintains performance levels by providing subsidised or free damage repairs and maintenance for the devices. The figures presented on Table A.2 1, A.2 2 and A.2 3 are targets that can be reached by making the technologies affordable and by building customer loyalty through quality customer service.

Table A.2 1 Projected Annual Sales and Operational Improved Fixed Stove Years

Project Year	Calendar Year	Sales Fixed Stoves	Expiries	Number of users by year end	Projected Operational Stove Years (Cumulative)
0	2007-08	0			
1	Q4-2008 to Q4-2009	250	0	250	50
2	Q4-09 to Q4-10	6,000	0	6,250	3,250
3	Q4-10 to Q4-11	8,000	0	14,250	10,250
4	Q4-11 to Q4-12	10,000	0	24,250	19,250
5	Q4-12 to Q4-13	12,000	0	36,000	30,250
6	Q4-13 to Q4-14	14,000	250	44,000	43,000
7	Q4-14 to Q4-15	16,000	6,000	60,000	52,000
	Totals	**66,250**			**158,050**

Table A.2 2 Projected Annual Sales and Operational Improved Portable Ceramic Stove Years

Project Year	Calendar Year	Sales Portable Stoves	Expiries	Number of users by year end	Projected Operational Stove Years (Cumulative)
0	Q4-2007 to Q4-08	0	0	0	0
1	Q4-08 to Q4-09	2,268	0	2,268	189
2	Q4-09 to Q4-10	8,165	0	10,433	6,351
3	Q4-10 to Q4-11	9,979	2,268	18,144	15,423
4	Q4-11 to Q4-12	10,080	8,165	20,059	23,184
5	Q4-12 to Q4-13	12,096	9,979	22,176	26,107
6	Q4-13 to Q4-14	14,515	10,080	26,611	29,434
7	Q4-14 to Q4-15	17,418	12,096	31,933	35,320
	Totals	**74,521**			**136,007**

Table A.2 3 Projected Annual Builds and Operational Rocket Barn Years

Project Year	Calendar Year	RBs (built before curing season)	Expiries	Barns built in time for curing season	Projected Operational Barn Years (Cumulative)
0	Q4-2007 to Q4-2008	170			
1	Q4-08 to Q4-09	159	0	159	159
2	Q4-09 to Q4-10	600	0	759	759
3	Q4-10 to Q4-11	1,850	0	2,609	2,609
4	Q4-11 to Q4-12	2,200	0	4,809	4,809
5	Q4-12 to Q4-13	1,850	0	6,659	6,659
6	Q4-13 to Q4-14	1,500	0	8,159	8,159
7	Q4-14 to Q4-15	750	0	8,909	8,909
	Totals	**8,909**			**32,063**

Table A.2 4 Projected Annual Sales and Operational Institutional Cook Stove Years

Project Year	Calendar Year	Sales Institutional Cook Stoves	Expiries	Number of users by year end	Projected Operational Stove Years (Cumulative)
0	2007-08	0			
1	Q4-2008 to Q4-2009	0	0	0	0
2	Q4-09 to Q4-10	200	0	200	100
3	Q4-10 to Q4-11	400	0	600	400
4	Q4-11 to Q4-12	700	0	1,300	950
5	Q4-12 to Q4-13	1,000	0	2,300	1,800
6	Q4-13 to Q4-14	1,000	0	3,300	2,800
7	Q4-14 to Q4-15	1,000	0	4,300	3,800
	Totals	**4,300**			**9,850**

Table A.2 4 Projected Annual Sales and Operational Urban Cook Stove Years

Project Year	Calendar Year	Sales Urban Cook Stoves	Expiries	Number of users by year end	Projected Operational Stove Years (Cumulative)
0	2007-08	0			
1	Q4-2008 to Q4-2009	0	0	0	0
2	Q4-09 to Q4-10	1,500	0	1,500	750
3	Q4-10 to Q4-11	4,000	0	5,500	3,500
4	Q4-11 to Q4-12	6,000	0	11,500	8,500
5	Q4-12 to Q4-13	8,000	1,500	15,500	15,500
6	Q4-13 to Q4-14	8,000	4,000	17,500	19,500
7	Q4-14 to Q4-15	8,000	6,000	25,500	21,500
	Totals	**35,500**			**69,250**

The sustainability analysis assesses the project in terms of environmental and sustainable development impact. The project complements and is consistent with the priority actions of Malawi's National Adaptation Programme of Action (NAPA) and can strengthen livelihoods in rural communities that are highly vulnerable to climate change. The relevant indicators are:

1. Air pollution: Reduced exposure to indoor air pollution, which is linked to many different diseases, including, tuberculosis, asthma, cardiovascular and ocular diseases, peri-natal health outcomes and acute and chronic respiratory diseases which is a major killer of children under age of 5 in the world.[8] Indoor air pollution disproportionately affects women and children who spend most time near the

[8] It is estimated that in 2002 in Malawi,12,240 deaths of children less than 5 years old from acute lower respiratory infections were attributable to solid fuel use (Indoor Air Pollution, National Burden of Disease Estimates, WHO, 2007). Initial tests in Dowa and Ntchisi Districts showed that a follow-up kitchen test resulted in a 55% decrease in average one-hour concentrations of particulate matter during cooking time in the kitchen, attributable to improved cook stoves, better ventilated kitchens and improved firewood management. Follow-up PM levels, however, were still higher than critical concentration values stipulated by the WHO, 1999.

domestic hearth. What about indoor air pollution in tobacco barns?[9]

2. Water quality and quantity: River siltation from soil erosion is mitigated due to reduction in tree felling.

3. Soil condition: soil quality at a community level is enhanced due to reduced soil erosion from the reduction in tree felling.[10]

4. Biodiversity is conserved through the project by reducing pressure on remaining forest reserves and by mitigation of alteration and destruction of natural habitat *via* reduced tree felling.

5. Quality of employment: Project staff is covered by MASM (Medical Aid Society of Malawi) health insurance. All staff and sub-contracted personnel are trained on new skills. To date, staff has been trained in business, accountancy, finance, management, participatory video making and Geographic Information Systems. Salaries and labour conditions are competitive and above average.

6. Livelihood of the poor: The resilience of livelihoods will be improved through reduced household and farm expense (reduced woodfuel purchases, which in turn reduces increasingly expensive transport of fuel-wood from further distances). The project also has the potential to improve food security through improving kitchen fuel security. The improved stoves are safer as they protect women and children from scalds and burns, as the stoves' body shields the fire to contain the heat. Woman and girls walk shorter distances and spend less time gathering firewood for cooking and heating. Benefits of the Rocket Barn include fuel and transport savings, yield increase *via* weight gain, quality gain of whole crop, reduced curing time and reduced maintenance costs.

7. Access to affordable and clean energy services: The project's geographically broad dissemination plan improves access to locally produced / assembled affordable technologies that significantly reduce the use of woodfuel (purchased &/or gathered) for cooking & curing.

8. Skills and human capacity: positive change in the number of jobs and positions for women, a change in female earned income, and empowerment to women as a result of women-specific training for stove production and kitchen and fuelwood management.

9. Quantitative employment and income generation: Demand for improved stoves and barns generate sustainable livelihoods and income generating opportunities at a village level around Malawi, particularly for women. To date 20 staff and over 80 specialised builders, metalworkers and carpenters have been contracted to build rocket barns and fixed stoves. There are also 11 production groups for portable ceramic stoves, which generate "off-farm" income for approximately 200 people, many of whom are women. There are also 60 village based stove promoters that receive a stipend for monitoring tasks and earn a steady income from sales of stoves. As the rate of dissemination increases, the project is likely to generate more employment and income.

[9] The Rocket Barn is designed so that no smoke enters the inside of the barn – the heat generated in the furnace from burning wood passes through a sealed flue fire-box until it exits through the double-chimney – smoke would contaminate the tobacco leaves and should not be emitted inside. Once the curing process begins the person attending the cure very rarely enters the barn. Smoke is emitted from the furnace door once lit, but once the furnace fire is burning the smoke travels through the flue and out the chimney.

[10] Extensive land use, including the wanton cutting down of trees has resulted in severe land degradation and soil erosion, leading to siltation of rivers seriously affecting hydro-electric power generation, human health and fisheries (Adapted from Malawi's NAPA, 2006). By reducing tree-felling soil erosion can be reversed.

10. Balance of payments: The project facilitates direct foreign investment of private funds in multiple regions of Malawi in improved technologies.

11. Technological transfer and technological self-reliance: Appropriate technological transfer e.g. south-south, rural–rural transfer. The project facilitates transfer and adoption of appropriate locally designed and tested "made in Malawi" technologies. Technologies do not involve exotic parts or tools and promote self-reliance. The project's approach can be replicated in other countries, where there is an estimated wood deficit or prospective wood deficit situations (see Figure A.2).

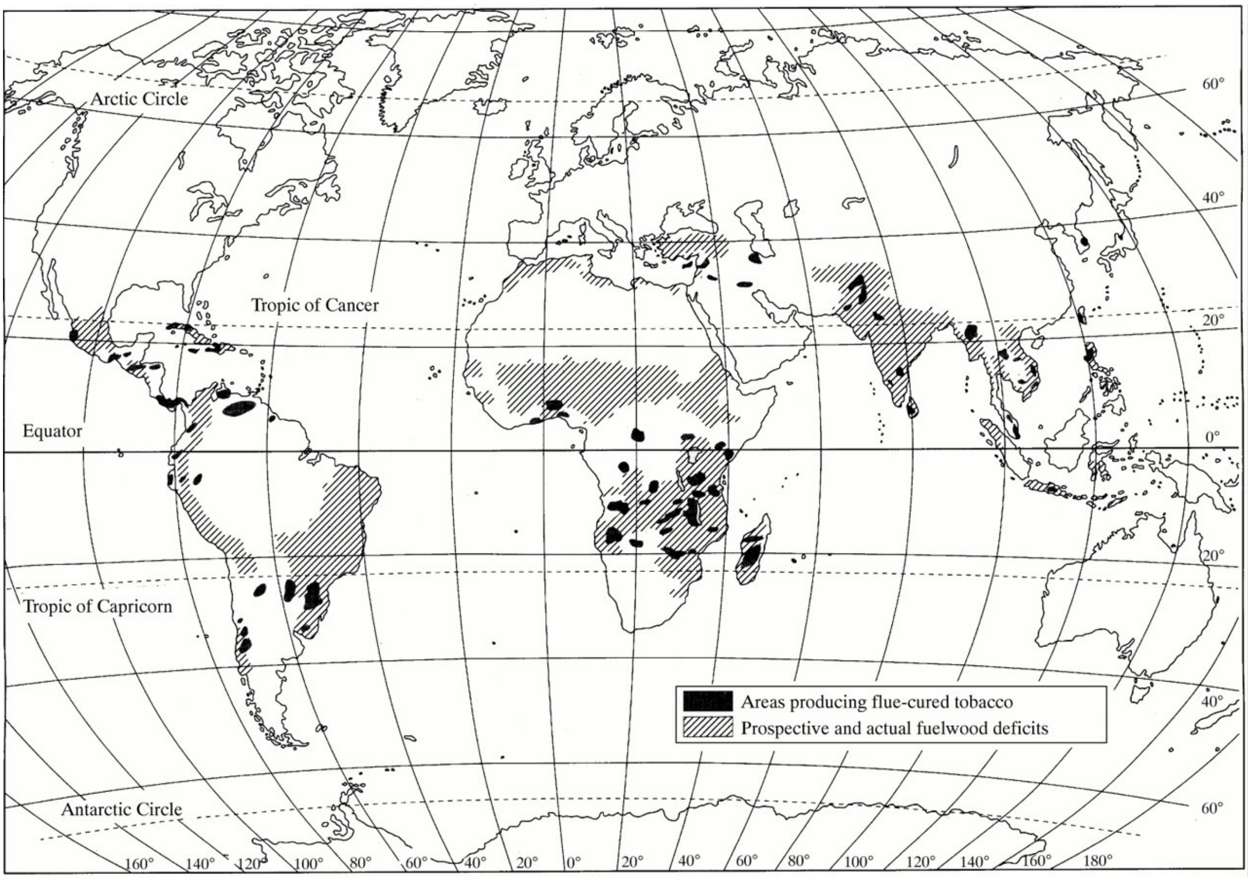

Figure A.2 In many countries where flue-cured tobacco is grown, fuelwood demand is not sustainable. Fraser (1986)[11]

No negative indicators arise from the project activities and an overall score is achieved as follows:

Component Indicators	**Matrix Score (-2 to 2)**
Local/Regional/global environment	
Air quality (emissions other than GHGs)	1

[11] Fraser, A. I. (1986): The use of wood by the tobacco industry and the ecological implications. - International Forestry Science Consultancy: Edinburgh.

Water quality and quantity	1
Other pollutants (including, where relevant, toxicity, radioactivity, POPs, stratospheric ozone layer depleting gases)	0
Soil condition (quality and quantity)	0
Biodiversity (species and habitat conservation)	1
Sub-total	**3**
Social sustainability and development	
Employment (including job quality, fulfilment of labour standards)	1
Livelihood of the poor (including poverty alleviation, distributional equity, and access to essential services)	1
Access to energy services	1
Human and institutional capacity (including empowerment, education, involvement, gender)	1
Sub-total	**4**
Economic and technological development	
Employment (numbers)	1
Balance of Payments (sustainability)	1
Technological self-reliance (including project replicability, hard currency liability, skills development, institutional capacity, technology transfer)	1
Sub-total	**3**
TOTAL	**10**

Box A.2 1 Sustainable Development Assessment Matrix

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (yes/no)
The project is voluntary: no Kyoto party participates	Hestian Innovation Ltd.	The Project is voluntary: no Kyoto party participates.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The project operates in all three regions of Malawi, namely Northern, Central and Southern Regions (initially in the Districts of Balaka, Dowa, Kasungu, Mzimba, and Ntchisi).

Malawi does not have a quantitative reduction target under the Kyoto Protocol.

A.4.1.1. Host Party (ies):

The project is voluntary and therefore is not hosted or invested in by a Party to the Kyoto Protocol.

A.4.1.2. Region/State/Province etc.:

All regions of Malawi, Southern Africa.

A.4.1.3. City/Town/Community etc:

Malawi. Improved stoves and rocket barns are disseminated in all three Regions of Malawi.
>>

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

Hestian Rural Innovation Development is the implementing the dissemination of the stoves and barns and conducts the project from its offices in Lilongwe:

Contact Person(s): Mr. Conor Fox
hestianrural@gmail.com

Address: Area 9 Plot Number 428,
P.O. Box 1306, Lilongwe, Malawi.
Phone: +265(0) 1 971 397, +265(0) 995 469 484

A.4.2. Size of the project:

Large-scale (> 60,000 tonnes of CO_2e reduced per year on average).

A.4.3. Category(ies) of project activity:

According to the eligibility criteria of the Gold Standard Requirements 2.1, August 2009, this project belongs to the category "End-use Energy Efficiency Improvement" and is classified as a large-scale project.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The project reduces the amount of greenhouse gases (GHGs) emitted from firewood as cooking and curing fuels, by introducing widespread use of improved cook-stoves and rocket barns which replace existing less efficient devices.

It was agreed in 2008, that only through the incentive of carbon finance can (i) the dissemination targets be reached and (ii) the appropriate use and maintenance of the devices be ensured.

The project has not previously been announced for implementation without seeking carbon finance within the last 3 years.

The UNFCCC "tool for the demonstration and assessment of additionality" (Version 05.2), to show that the implementation of the project activity would not be possible without carbon finance, requires that 4 steps be taken to investigate whether or not the reduction would be obtained in the absence of project activity. Taking these 4 steps in turn:

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations:

Sub-step 1a. Define alternatives to the project activity:

- Project activity implemented without carbon finance
- Continuation of current situation: Firewood from non-renewable sources would continue to supply thermal energy for the users (baseline scenario).
- Designing a project achieving the same result using different methods. For example, energy is delivered to households and farms through liquid fossil fuels such as LPG or through electricity.

Dissemination of improved stoves and barns is expensive. Carbon finance, which allows for predictable revenue streams and is not subject to 'alternating preferences' of grant-givers, is the only realistic source of finance to ensure that (i) significant targets are met and (ii) quality assurance over time is guaranteed.

Other realistic and credible scenarios that deliver out puts and services with similar quality:

a) There is no evidence in Malawi that householders or institutions are making a shift towards LPG for cooking and curing. LPG is too expensive for households and family farms that currently use woodfuel.

b) It is unlikely that many Malawians will move towards cooking and curing with electricity in the short to medium term future. First and foremost the national grid only reaches 4% of the population in Malawi[12](and only 0.5%[13] of rural households have access to electricity)[14]. Secondly the cost of electrical appliances and of safe electrical connection is too high and thirdly the supplies are unreliable due to load shedding.

Of the three alternatives the continuation of the current situation is the most feasible in practical terms, and it is in compliance with national regulations and standards. This project is therefore not non-additional on single compliance grounds. The project goes 'beyond compliance' as legislation that requires the use of efficient cook-stoves and barns does not exist in Malawi and is not expected to be introduced during the project period.

Sub-step 1b: Consistency with mandatory laws and regulations

Woody biomass as a fuel is legal. Existing conventional technologies are the norm and are not illegal. There are not any existing standards on efficiency or emission factors of wood burning technologies.

Step 2: Investment analysis. Instead of an investment analysis, a barrier analysis is conducted.

Step 3: Barrier analysis.

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[12] National Energy Policy, 2003.

[13] National Energy Policy, 2003.

[14] The Government of Malawi has set out the objective of increasing the number of households with access to electricity to 10% by 2010, to 30% by 2020 and 40% by 2050 (National Energy Plan, 2003). Due to low returns and few incentives for private investors for rural electrification, it is likely that the bulk of increased electricity capacity will serve urban populations. The Welfare Monitoring Survey undertaken by the National Statistics Office covering about 19,000 households from all districts of the country revealed that only 2% of Malawians use electricity for cooking and that the electrification rate of households in rural areas, where about 80% of the population live, still remains at less than 1% (The Nation, 03/09/09).

No project activity of this type and scope is currently operational in Malawi. Without the incentive of carbon finance the project would neither be economically viable nor attainable. Although short-term finance has been made available in the past and was sufficient to develop the technologies and to motivate a pilot programme to design and develop prototypes in Malawi, this external finance was not available as needed for 2008 and beyond, and were it available would be inadequate in quantity to achieve the projected level of improved stove and 'rocket barn' dissemination.

Fixed esperanza stoves are paid through micro-finance, which is guaranteed by other actors such as agro-industries. Portable ceramic stoves are paid for in cash at a village level. Rocket Barns are paid for through guaranteed micro-finance (duration 2 years). Urban cook stoves and institutional cook stoves can be paid for through cash and micro-finance. Carbon finance facilitates training for production, marketing and user-training and creates incentives for dissemination targets, after-sales service and monitoring.

It is clear that to transform the cooking and curing reality in Malawi, finance and incentives are necessary to train staff and to develop skill sets, and to invest in capacity building, user-training, an after-sales and customer support strategy, a quality control system, and other such requirements. Revenue from building improved efficiency stoves and rocket barns at affordable market prices would be inadequate to address the barriers faced.

- *Investment barriers* Private capital is not readily available from domestic or international capital markets due to real or perceived risks associated with investment in the country where the project activity is being implemented.

  This is demonstrated by the following:

  - Foreign direct investment net inflows to Malawi for [2010] were reported at only $ 60,447,137[15];

  - Malawi is estimated to be the 8th poorest country in the world[16].

  - The World Bank has ranked Malawi 132nd of 183 in its 'Ease of Doing Business' rankings[17]

  - Malawi was ranked 162nd of 179 in the 2008 UNDP Human Development Index.

  - Financing possibilities inside Malawi are limited with commercial interest rates of 20-30%[18].

  - It is understood that Malawi has not been rated by any of the major credit rating agencies (Standard & Poor's, Moody's, Fitch).

- *Cost barrier.* In the absence of the project activity, the potential customers would choose the cheaper alternative of continued use of conventional cooking and curing methods, with much higher emissions, as they have limited access to finance and cannot afford the higher price of either:

[15] http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD?order=wbapi_data_value_2009+wbapi_data_value+wbapi_data_value-last&sort=asc&cid=GPD_53.

[16] On a GDP per capita basis. https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html.

[17] http://www.doingbusiness.org/Rankings.

[18] Reserve Bank of Malawi: http://www.rbm.mw/data/findata/index.asp?content=cbir.

- Modern fossil-fuel stoves and barns and the associated fossil-fuels,
- Stoves and barns with increased efficiency, sold at a price reflecting the full cost of disseminating these (e.g. training, monitoring, quality control, logistics, marketing etc.) without carbon finance assistance,
- Alternatives (solar-powered electric stoves and barns, electric stoves and barns etc.).

Malawi is estimated to be the 8th poorest country in the world in terms of GDP per capita[19] and very little cash is available for non-essential expenses.

The fact that in Malawi, 91% of rural households use 3-stone stoves for domestic cooking and heating[20] is evidence of the effect of the cost barrier. The Kitchen surveys revealed that 100% of the households interviewed used wood as a fuel.

Please see Annex 4 for a discussion of and specific examples of "alternatives undertaken and operated by private entities". To our knowledge these similar activities have "only been implemented with grants" (please see Annex 4 for further details).

- *Technology barrier.* A key obstacle preventing the proposed activity from taking place without the project, is an inability to access improved technologies. This is largely due to a lack of awareness amongst potential purchasers and users, as to benefits of the improved technologies. Another major obstacle to dissemination, in the absence of the project, is that many potential users are located in remote areas, very distant from main roads and principal trading centres. The fact that 91% of rural households in Malawi use 3-stone stoves for domestic cooking and heating21 is evidence of the effect of the technology barrier. "Lack of infrastructure for implementation and logistics for maintenance" of various technologies is discussed in specific detail in Annex 4.

  Skilled and/or properly trained labour to operate and maintain the technology is scarce in Malawi. Education expenditure countrywide is estimated at only 4.2% of GDP (ranking 101st in the world)[22]. This leads to an unacceptably high risk of device disrepair and malfunctioning and underperformance.

- *Prevailing practice.* Habitual use of three-stone fires and conventional barns imposes a very strong influence on the baseline scenario, resulting in the continued use of conventional, inefficient technologies. 91% of rural households in Malawi use 3-stone stoves for domestic cooking and heating.[23] Kitchen surveys revealed that 90% (Dowa and Ntchisi) and 91% (Balaka) of households in the baseline still cooked on three-stone fires.

- *Barriers such as institutional, limited information, managerial resources, organisational capacity, financial resources, capacity to absorb new technologies.* The widespread introduction of improved technologies into the market requires considerable input in the form of business development capacity, financial investment, management skills, technical training and new technology absorption capacity. All these resources are scarce in the project region, a situation that poses a severe obstacle to introduction of

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19 https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html.

20 National Energy Policy, 2003.

21 National Energy Policy, 2003.

22 https://www.cia.gov/library/publications/the-world-factbook/geos/mi.html

23 National Energy Policy, 2003.

improved stoves and barns.

Step 4: Common practice analysis.

In Malawi, 91% of rural households use 3-stone stoves for domestic cooking and heating[24] that are not fuel efficient, produce much smoke and are the source of many injuries and accidents. Kitchen surveys revealed that 90% (Dowa and Ntchisi) and 91% (Balaka) of households in the baseline still cooked on three-stone fires. The Kitchen surveys also revealed that 100% of the households interviewed used wood as a fuel. The barn surveys revealed that 100% of smallholders used wood as fuel in conventional barns. Similarly, curing barns used by smallholders are fuelled 100% with firewood.

Sub-step 4a: Analyze other activities similar to the proposed project activity:

There is not any other improved barn project in Malawi. ProBEC is promoting the Rocket Barn in other Southern African Countries. In Tanzania, 18 Rocket Barns were constructed in 2007, 56 in 2008 and 15 by November 2009. A smaller number of barns have been constructed in Zambia.[25] This volume is only a small fraction of the 800+ Rocket Barns that have been constructed to date as part of the Integrated Biomass Energy Conservation Project and a quality assurance and post-sales service has not been established in other countries.

Many improved stoves projects have been conducted in Malawi with support form Government, International Organisations and Non-Governmental Organisations (NGOs). The most successful programme to date has been ProBEC (a Southern Africa Development Community programme that is being implemented in Malawi under the Department of Energy Affairs in collaboration with GTZ), which began in 1999 and is due to phase out in 2010.

Since at least the 1980s there have been efforts to disseminate an improved mud-stove that potentially shares many of the characteristics of the portable ceramic stove and the esperanza stove and is similarly made of materials available at a village-level in Malawi. However, without accurate tools and proper training, local producers are not in a position to produce a standardised stove to exact specifications, resulting in what is called design drift and highly uncertain emissions reductions potential.

The Portable Ceramic Stoves, promoted by the Project, has also been promoted by NGOs in Malawi. In general, ProBEC has provided technical assistance and the NGOs have supported community based organisations.[26] It is not evident if quality assurance and monitoring of these initiatives will be guaranteed in the future. As ongoing facilitation activities such as training and quality control are expensive it is unlikely that these activities will continue in the event that the project or programmes funding comes to an end (typically every 2-3 years).

The Esperanza Stove is the most popular fixed household stove option in Malawi. To date it has been mainly disseminated in the houses of tea estate employees in Mulanje District, in southern Malawi. Again a systematic quality assurance and post-sales service is not guaranteed.

Metal fixed household rocket stoves have also been commercially disseminated in Malawi. Due to the high cost of imported steel to Malawi, a land-locked country, its dissemination has been limited and post sales services of perishable insulative combustion chambers is not readily available and hence the emission reductions potential

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[24] National Energy Policy, 2003.

[25] Information provided by the Monitoring and Evaluation Officer, GTZ ProBEC.

[26] Organisations such as Concern Universal, GOAL Malawi, Ripple Africa, Total Landcare, Emmanuel International, CPAR Malawi and CADECOM have partnered ProBEC in disseminating portable ceramic stoves.

over-time is uncertain.

For charcoal users in urban and peri-urban Malawi, a local version of the Kenyan Jico charcoal stove is popular, presumably due to its affordability and availability in urban markets (see annex 4 for more details). The stove is often made from recycled metal and its lifespan can be a short as 6-months. Its non-standardised design and uncertain emission reductions potential due to its limited lifespan make it an unlikely candidate in Malawi for up-scale. Currently the stove is disseminated by metalworkers, usually based in urban markets.

In terms of cleaner cooing fuels, ethanol seems to have most potential for household use in Malawi (see annex 4). The Blue-wave stove has been developed in Malawi and is designed to be fuelled by ethanol (see annex 4), but is currently is not available for sale. Another stove, the Gel-fuel stove has ceased to be disseminated in Malawi (see annex 4).

Institutional cook-stoves have been widely disseminated in Malawi, mainly through school-feeding programmes and through institutions such as secondary schools, barracks, prisons etc. The stoves have impressive fuelwood reduction potential but as of yet are not systematically monitored and repairs and maintenance is often not guaranteed. In many schools there are not enough stoves to cover the demand and in some cases the stoves were abandoned as number of different sized pots are used. In some cases the improved institutional stoves are reported to be rarely used and the reasons given are due to end of funding for an intervention or reluctance on behalf of the cooks to use the stoves. A survey of 549 stoves in use in 2007 found that 46% of the stoves were damaged. [27] The stoves are either a portable metal stove or a fixed brick stove with internal metal liners and generally have a 50-200 litre capacity. To date there is limited systematic follow-up support service to guarantee performance quality and the emission reductions of the stove.

Sub-step 4b: Discuss any similar Options that are occurring:

Electricity is probably the cleanest and least costly form of cooking in Malawi, (see annex 4), but despite a rural electrification programme supported by the Department of Energy, only 2% of Malawians (both rural and urban) use electricity for cooking.[28]

Please refer to Annex 4 for descriptions of stoves, curing barns and fuels relevant to Malawi.

In an assessment of clean cooking fuels in Sub-Saharan Africa,[29] the failure of clean cooking fuels to attain wide-spread use is attributed to a number of market barriers including:

- Clean cooking fuels are prohibitively expensive,
- High price of compatible stoves,
- Many consumers are hesitant to adopt a new technology, and
- Under-developed infrastructure prevents these fuels (and stoves) from being made available in many local marketplaces.

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[27] De Gabrielle, J. and Msukwa, A. *Impact of the Institutional Rocket Stoves in School Kitchens*, ProBEC, 2007.

[28] The Welfare Monitoring Survey undertaken by the National Statistics Office covering about 19,000 households from all districts of the country revealed that only 2% of Malawians use electricity for cooking and that the electrification rate of households in rural areas, where about 80% of the population live, still remains at less than 1% (The Nation, 03/09/09).

[29] Market Barriers to Clean Cooking Fuels in Sub-Saharan Africa: A Review of Literature; *An SEI Working Paper of* Nicolai Schlag and Fiona Zuzarte Working Paper, Stockholm Environment Institute, April 2008; A Review of the Household Energy Programme for Cooking – GHA/UNDP/00051634

In Malawi, the major barrier preventing a significant amount of households to use cleaner modren fuels is the price of fuels where the cost per MJ of energy from clean fuels compared to biomass fuels is higher by a factor of 3 to 10. The affordability and accessibility of stove alternatives is also limited.

Experience to date with respect to development and dissemination of efficient stoves or rocket barns, or alternatives achieving the same or better reduction of GHG emissions, has resulted in very little change in the prevailing practice. The evidence has been that the barriers listed have prevented and currently prevent widespread or countrywide uptake of efficient stoves and barns.

The carbon funding proposed here is highly directionalised, by way of building specialised local capacity for widespread market dissemination of specific technologies that have been tried and tested in Malawi, and by way of establishing high quality end-user training and follow-up with quality control systems and provision of after-sales services, to remove the barriers described above in a sustainable way.

Conclusion:
The distinctions set out here between other activities and the Project Activity are so great that the project is additional.

A.4.4.1. Estimated amount of emission reductions over the crediting period:

Years	Annual estimation of emission reductions in tonnes of CO_2e
1	2,856
2	32,082
3	101,286
4	187,449
5	274,702
6	357,442
7	419,919
Total emission reductions (tonnes of CO_2e)	1,375,737
Total number of crediting years (first crediting period)	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	196,534

The table presents the project operational stove years and emission reductions (ERs) from November 2008 through to November 2015.

SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

This project follows the Gold Standard *Methodology for Improved Cook-stoves and Kitchen Regimes V.01* (Improved distributed heating and cooking devices), which includes measures that significantly reduce consumption of non-renewable biomass. This methodology covers both the baseline and monitoring requirements for such a project.

The methodology applied also draws upon the Tool for the Demonstration and Assessment of Additionality; Version 05

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

Gold Standard Methodology for Improved Cook-Stoves and Kitchen Regimes V.01 is applicable to the proposed project, because the following conditions apply:

- Low-emission cook-stoves and low-emission tobacco curing barns replace high-emission baseline scenarios: Improved cook stoves replace 3-stone fireplaces and rocket barns replace inefficient tobacco barns.
- The project boundary can be clearly identified, and the stoves and rocket barns counted in the project are not included in another voluntary market or CDM project: The project boundary includes the place of the kitchens where the project stoves are applied, the place of the tobacco barns and the place of fuel collection, production, and transport in Malawi.
- The project is located in a single country: The project is located in Malawi.
- The improved cook-stoves do not number more than ten per kitchen/household and each have continuous useful energy outputs of less than 50kW: The project activity is to provide one stove per kitchen for domestic use (cooking). The number of rocket barns per farmer depends on the size of production. A one hectare farmer can have 1-2 Rocket Barns and larger farmers may have more. The project activity is to provide not more than 10 rocket barns per farmer for tobacco curing. The urban cook stove promoted by the project has useful energy output of 1.8 to 7.5 kw,[30] the portable ceramic stove has a KW output of 0.64 kW.[31] The fixed esperanza stove has an estimated KW output of 10 kW; the Rocket Barn has an estimated KW output of 30 kW and the Institutional Cook Stove has an estimated kW output of 25 kW.

The methodology includes provision for a large amount of small, distributed heating and cooking low-emission devices and kitchen / barn management regimes that replace relatively high-emission baseline scenarios. Improved biomass stoves are included as applicable technologies as are measures that reduce consumption of non-renewable biomass or other greenhouse emitting fuels. Tobacco curing barns, although not applied for cooking, are biomass fired and reduce non-renewable biomass consumption. The stoves and barns will be introduced to householders and smallholding farmers within a distinct geographical area through the project. The shift to low emission regimes will occur in a progressive increase over the project years in adoption of improved stoves and barns. The baseline technologies are inefficient stoves and barns that are fuelled with woody biomass.

The country of Malawi as a whole is also defined as the Fuel Collection Area. There is clear evidence that the

[30] Megen Power Ltd. "Technical Evaluation of Stove Designs, WVA: Energy-efficient Wood Stoves Pilot Programme in Ethiopia" page 13.
[31] Ethio Resource Group, *Feasibility study for the use of ethanol as a household cooking fuel in Malawi.* Consultancy for UNDP Growing Sustainable Business for Poverty Reduction Programme, Lilongwe, 2007 (page 58).

harvest of woody biomass for cooking and curing fuel is not balanced by the mean annual increment or re-growth in the supply area.[32]

The methodology is suitable for a project with a large supply area where very likely other entities may seek to quantify the non-renewing portion of the biomass consumption they save. By assessing non-renewability status in a fractional manner, the methodology assures that all projects in the same area are capped equally and there is no risk of double counting.

The methodology requires that surveys and quantitative measurements be carried out in households and farms of end-users. Since the fuel consumption reductions arising from the project will be sensitive to locally determined factors the application of a methodology requiring measurements in samples of households, as opposed to one dependent on lab testing of fuel efficiency, is appropriate.

As recommended, the Project proponents include the CO_2, CH_4 and N_2O greenhouse gases, and assess on whether or not their measurement or estimation is feasible or their quantitative impact is significant for the project and baseline.

B.2. Description of how the methodology is applied in the context of the project activity:

In the context of this project, the basic assumptions of the methodology are that the green-house gas reductions arising from adoption of the devices disseminated by the project can be determined conservatively as follows:

- Emission factors for wood combustion are the same in the case of baseline devices and project devices, and the most recent IPCC default values for these wood as a fuel are appropriate
- The emission reductions resulting from dissemination of the devices are conservatively assessed, as prescribed by the methodology, by applying a rigorous statistical analysis to the results of fuel-consumption sampling (Kitchen Tests and Barn Tests) in households and farms using a specific model of the devices under a particular set of conditions.

Surveys and tests were complemented with an extensive review of the pertinent literature.

The methodology has been applied in the course of 2008 and 2009, through the development of:

- Improved cook-stove Kitchen Surveys and Kitchen Tests in rural villages in Central and Southern Malawi in 2008 and 2009.
- Barn surveys and barn tests with smallholder farmers in Central and Northern Malawi in 2008 and 2009.

For both stoves and barns, surveys and tests to estimate and quantify baseline conditions were conducted by comparing old and new device conditions in the same houses / farms, to minimise variability due to external factors other than the installation of the new device.

The project applies a fixed baseline approach. Improved stoves and barns are adopted progressively through the project period. The project applies a fixed baseline approach for the following reasons:

- The technologies on their own can only partially achieve potential efficiency improvements and emission reductions. Improved end-use and kitchen / barn and firewood management, for example, is gradual and

[32] State of the Environment Report (2001), Chapter 4; Forestry Outlook Studies in Africa (2001), page 17; National Forestry Programme (2001) Page 2; Gowela, Julio P. and Masamba, Chris R. (2002) *State of Forest and Tree Genetic Resources in Malawi*. Page 7.

requires considerable investment, but significantly contributes to emission reductions. Application of an evolving baseline can cancel out gradual emission reductions resulting from (costly) project activities that improve baseline kitchen and barn regimes. In other words, baseline conditions that are changing as a result of project activities (awareness raising and user-training) would reduce the emission reductions accruable to project activities, should an evolving baseline be applied.

- For Rocket Barns, 'early adopters' willing to try-out new technologies and curing process are a sub-set of all end-users. Evidence demonstrates that the performance of such people (many have received user training and have been the target of awareness raising campaigns) using conventional technologies significantly improves over time as a result of project activities.
- For stove users in the project area, poverty related under cooking is a reality. By applying a fixed baseline, any increase in usefully delivered energy (i.e. cooking energy utilised) for improved stove end-users is likely to result in conservative emission reduction estimations.
- NRB fraction is unlikely to reduce over the project period, implying more conservative ER estimations.

B.2.1 **Determine customer groups or project "clusters"**

Throughout the application of the methodology the project population (all end-users) can be divided into groups or clusters, that distinguish the characteristics, which determine the emissions reductions of each cluster.

Of the 4 types of stoves promoted by the project, the portable ceramic stove is targeted at low-income rural households and the fixed esperanza stove is initially targeted at rural households with access to micro-finance. The institutional stove is targeted at institutions and the urban cook stove is targeted at urban and peri-urban households.

The rocket barns promoted by the project target smallholder tobacco farmers. Initially, only 250 stick rocket barns are being promoted. Rocket barns with greater capacity (e.g. 270 stick and 300 stick rocket barns), that use the same technology and fuel, will be included in the smaller barn cluster as this gives a conservative result when quantitative test results for fuel savings of small barns are applied to larger barns. Larger barns (e.g. 500 stick and above) may be introduced later as a new cluster.

The surveys revealed that (i) all rural households use wood fuel for cooking[33] and (ii) all smallholder flue-cure tobacco producers use wood in conventional barns for curing. There is not any evidence of significant simultaneous use of renewable energy fuels, crop residue, or any other ancillary fuel type.[34] There is no evidence of trends toward significant mixing in the baseline.

Both types of stove-users and barn users are homogenous enough to qualify for sampling of fuel consumption savings as single clusters that all use wood as fuel and replace less efficient technologies:

a. Portable ceramic stoves,
b. Fixed esperanza stoves and
c. Rocket Barn
d. Institutional Stoves
e. Urban Cook Stoves

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[33] The rural household energy survey conducted with 300 households in Balaka, Southern Malawi revealed that for the baseline 2.7% of households used charcoal as a fuel and this decreased to 0.3% for the follow-up survey. 100% of households for both the baseline and follow-up survey used wood as a fuel.

[34] In the surveys and tests carried out in Balaka Southern Malawi in 2009, only 2% of respondents used maize cobs and only 0.3% of respondents used crop stalks as a fuel.

For the surveys, stove and barn users are each surveyed by a home visit. The purpose and sample sizes are as defined in the methodology, primarily to ensure that the clusters are homogenous and appropriate exclusions can be made, such that Kitchen Tests and Barn Tests will be representative and their results statistically significant.

For the portable ceramic stoves, 300 households have been tested and surveyed in Balaka, Southern Malawi in 2009. Subsequently to this an initial survey of fixed esperanza stove users was conducted with 108 households in the Districts of Dowa and Ntchisi,. Surveys and tests commence prior to installation of new improved device.

For the barns, 40 farmers were tested and surveyed in Dowa, Ntchisi, Kasungu and Mzimba in Central and Northern Malawi during 2008. The pilot sales were recorded at the same time to surveys and tests. The specific method used for these tests is described in the test report in Annex 2.

As mentioned in Section A.2 above, ICS and UCS are expected to be clusters d. and e. respectively.

B.2.2 Analysis of renewability status of biomass fuels.

The methodology for analysis of biomass renewability has been applied in the course of 2008. The details of this analysis and its results are given in this section, below.

B.2.2.1 Quantify non-renewable biomass

(a) Establish supply area and mean annual increment

Supply Area:

Wood-fuels marketed in Malawi are transported over long distances, implying that the collection areas are widespread and the country as a whole should be seen as the Fuel Collection Area or Reachable Collection Area for woodfuel. Since improved cook-stoves and rocket barns disseminated by the project will extend all three Regions of the Malawi, the entire country is considered the Fuel Collection Area or supply area.

Until recently "free" woodfuel was available easily and cheaply from indigenous woodlands, on lands of estates or in neighbouring customary land.[35] Kitchen Surveys conducted in Central and Southern Malawi indicated that more time is spent and greater distances travelled by householders to source woodfuel in recent years. The Barn Surveys indicate that fuel costs for smallholder farmers are increasing. It has been noted that only 15% of the large tobacco estates are self sufficient in wood while over 50% of estates cannot supply even half of their own requirements.[36] As confirmed by the Barn Surveys, smallholder farmers are not self-sufficient in renewable wood, do not operate their own fuelwood plantations due to scarcity of land and source wood fuel from Malawi's Total Forestry Area.

In 1993, Malawi's Forestry Area with tree cover greater than 20% was estimated to be **2,642,800** hectares, of which 95% were indigenous forests.[37] The extent of Malawi's indigenous and plantation forest was reduced by 57% between 1972 and 1992 with subsequent annual rates of deforestation of 3.4%, 2.4% and 2.7% in the Northern,

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35 Adapted from page 47 National Forestry Programme (2001)

36 Page 47, National Forestry Programme, 2001

37 Ministry of Forestry and Natural Resources, Forestry Department (1993) Forest Resources Mapping and Biomass Assessment for Malawi. Satellitbild, Kiruna, Sweden and Department of Forestry, Lilongwe, Malawi.

Central and Southern Regions of the country, respectively, with a national average deforestation rate of 2.8% p.a. (Forestry Department, quoted in FOSA).[38]

(b) Quantify non-renewable biomass

Mean Annual Increment (MAI) or Annual wood-fuel increment:

The sum of mean annual increments of the wood species, or "re-growth" is calculated from the Mean Annual Increment (MAI) of the various forest categories. Using estimates of MAI of 0.85 m^3/ha for customary land and private forests; 1.3 m^3/ha for public forests, 14 m^3/ha for public and private plantations and between 0.1 and 0.5 m^3/ha for agricultural and public lands, the annual accessible MAI available is **3.796** million m^3 for Malawi.[39] These figures correspond to estimates of MAI of 0.8 m^3/ha for customary land; 1 m^3/ha for forest reserves and between 10 and 17 m^3/ha for plantations, with an estimated forest cover of 2.709 million hectares the annual wood-fuel increment is 4.1 million m^3 for Malawi.[40] However the later report assumes that 100% of public forests are accessible which is unrealistic. Both figures are conservative compared to estimates of The Forestry Outlook Survey of Malawi (2001) estimated wood supply to be as low as 3.7 million m^3.[41] Potentially sustainable supply is estimated to be as high as 7-8 million m^3 from current sources,[42] if among other things, sustainable yield from industrial plantations was not under-utilised and the MAI of public parks and reserves was 100% accessible. The project uses a conservative MAI of **3.796 million** m^3 for Malawi.

MAI = **3.796 million** m^3

Estimated the Harvest (H) of wood-fuels derived from supply area:

The harvest of wood is the volume of wood extracted per year. There are a number of official documents that have estimated the total harvest of wood in Malawi. The national trend of woodfuel consumption over time is increasing.[43] Over the period of 7 years (1983 - 1990), wood consumption increased from 8.5 million tons to about 12 million tons per year (16.6 million m^3), an increase of about 41 %. The Forestry Outlook Survey of Malawi (2001) estimated wood demand to be 14.5 million m^3 while the National Forestry Programme (2001) estimated aggregate annual consumption of forest products to be 15 million m^3. These figures correspond to other results using BEST ESTIMATES[44] per capita woodfuel consumption in Malawi of 1.410 m^3 and the population is estimated to be 10 million in 1998 (National Statistics Office, 2000) with population growth rates of between 2% to 3.3% p.a.

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[38] Forestry Outlook Studies in Africa, Country Report - Malawi, FAO, 2001.
http://www.fao.org/docrep/004/ab585e/AB585E00.HTM

[39] Sourced from the Ministry of Forestry and Natural Resources as presented in Bunderson W.T. and Hayes I.M., (1995); *Agricultural and environmental sustainability in Malawi,* Paper to Conference for Sustainable Agriculture for Africa, Abidjan, Cote d'Ivoire.

[40] Gowela, Julio P. and Masamba, Chris R. (2002) *State of Forest and Tree Genetic Resources in Malawi*. Prepared for the Second Regional Training Workshop on Forest Genetic Resources for Eastern and Southern African Countries 6-10 December 1999, Nairobi, Kenya; and updated for the SADC Regional Workshop on forest and tree genetic resources, 5-9 June 2000, Arusha, Tanzania. Forest Genetic Resources Working Papers, Working Paper FGR/27E. Forest Resources Development Service, Forest Resources Division. FAO, Rome (unpublished).

[41] Forestry Outlook Studies in Africa, Country Report - Malawi, FAO, 2001.

[42] National Forestry Programme, 2001

[43] Forestry Outlook Studies in Africa, Country Report - Malawi, FAO, 2001.

[44] Country Table A.BE.1, Per Capita Woodfuel Consumption according to BEST ESTIMATES Appendix 2.2.4 in *The role of wood energy in Africa*. Working Paper FOPW/99/3. FAO 1999.

H = 14.5 million m^3

To summarise, the information collected so far can be used to quantify non-renewing wood in the collection area. This quantity is the excess harvest over and above the sustainable harvest of renewing wood, or annual increment. The total harvest we have seen is, conservatively, assumed to be **14.5 million m^3/yr** and the increment is **3.796 million m^3/yr**. The quantity of non-renewing biomass NRB is the difference, **10.704** million m^3/yr.

Non-renewing biomass (NRB) or excess harvest over and above re-growth, is the amount of woody biomass removed with attendant CO2 emissions which are not absorbed by re-growth.

NRB = H – MAI = 10.704 million m^3/yr.

The fraction of extracted woody biomass that is non-renewable is denoted as Xnrb. If a quantity of woody biomass supplied from fuel collection area A is used as a fuel in cook-stoves or rocket barns, the fraction Xnrb is assumed to be non-renewable with CO2 emissions that are not reabsorbed by re-growth:

Estimated Xnrb = (NRB/H) = 73.82%

To calculate emissions reductions, the estimated non-renewable component of wood-fuel in Malawi is applied to the consumption of biomass by the project population in both the baseline and project scenarios (since the project activity does not yet make any significant impact on either the harvest or increment quantities).[45]

(c) Maintain conservativeness

Deforestation in Malawi due to clearance for agriculture and human settlement has the effect of reducing the increment (i.e. MAI), since the standing stock is shrinking (also due to the consumption of non-renewing wood). With longer drier periods and uncertain rainfall in Malawi due to climate change, the productivity of standing stock is due to decline while forests are likely to be prone to increased incidences of fire.

Demand for wood, represented by the harvest (H), has been growing rapidly in previous years and is expected to continue to grow through the project period. Malawi's economy is growing,[46] reflected in woodfuel demand increasing and rising demand for construction timber. Also, in a country with four times more people per square kilometre than Sub-Saharan Africa as a whole, of whom four fifths depend on agriculture, population growth, estimated at between 2% to 3.3% p.a., puts increasing pressure on Malawi's natural resources. Urban population growth rate is estimated to be at 6.7% per annum[47] and this has a significant impact on the rate of deforestation. Furthermore, the harvest is often under-estimated and under-reported, thus, the value of Xnrb is likely to be higher than estimated above.[48]

The equation NRB = H – MAI (non-renewable biomass = harvest – mean annual increment) must therefore be seen

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[45] In the first 7 years of the project, the planned dissemination of improved cook stoves and rocket barns will reduce wood consumption by approximately 120,000 m^3 each year. Although the project contributes in reversing the non-renewability of biomass it will not significantly impact wood availability in Malawi.

[46] Malawi's economy is predicted to grow at over 8% in 2009, GDP Growth Forecasts 2009, Economist Intelligence Unit, The Economist, 2008. http://www.economist.com/markets/indicators/displaystory.cfm?story_id=12818136

[47] Government of Malawi (2001) State of Environment Report, Department of Environmental Affairs.

[48] Global Forest Resource Assessment, FAO, 2005.

in terms of an increasing value of H and a decreasing value of MAI, giving an increasing shortfall or a worsening non-renewable biomass condition. The figures quoted from recent studies reflect conditions in the past few years, and many of them need to be updated to reflect the likelihood that the non-renewable quantity at the start of the project is greater than estimated in this document. Equally, as the project progresses, trends are likely be toward an increased non-renewable component of wood-fuels rather than decreased, although the project will have the effect of mitigating these trends.

B.2.3 Net leakage

The baseline surveys and tests for both stoves and barns investigated the following risks of leakage:(as required by the methodology):

a. Some users of the efficient devices respond to the fuel savings associated with higher- efficiency devices by increasing consumption of fuels with GHG emission characteristics, to the extent that project emissions are higher than those calculated from the assumption that cooking energy is constant. This is sometimes referred to as the 'rebound' effect.
b. The project activity stimulates increased use of a high emission fuel either for cooking or for other purposes outside the project boundary (as would be the case for example if efficient cooking stimulated an increase in NRB consumption - possibly because the NRB fuel becomes cheaper due to the project activity).
c. By virtue of promotion and marketing of a new model and type of device with high efficiency, the project might stimulate substitution of a cooking / curing fuel or device type with relatively high emissions by households who commonly using a cooking / curing fuel or device type with relatively lower emissions, in cases where such a trend is not eligible as an evolving baseline.
d. The project population might compensate for loss of the space heating effect of inefficient devices by adopting some other form of heating or by retaining some use of inefficient devices.
e. The traditional devices displaced might be re-used outside the boundary in a manner suggesting more usage than would have occurred in the absence of the project.
f. Significant emissions from transportation or construction involved in the project activity might occur, including emissions associated with production/transport of the efficient devices themselves, or production/transport of project fuels.

Observations made to date indicate no evidence of contingency (a) occurring over the extensive period of the pilot program as any shift of pressure on the resource is, at this stage, insignificant in scale. Scarcity of wood is increasing making access, for both stove and barn users, more timely and effortful. There is also evidence from the Kitchen Test (KT) and Kitchen Survey (KS) in Balaka that some of the few who were using charcoal during the baseline shifted to use of wood fuel with lower net GHG emissions. Also, end-users of barns are already purchasing wood and reduction in wood requirements is a direct cost saving.

In the case of (b) it is clear that there is 'negative leakage' from improved cook stoves as neighbours of the project's customers adopt cleaner more efficient technologies, as promoted by the project, resulting in reduced use of higher emission technologies (i.e. three-stone fire). The improved rocket barn technology on its own would not increase flue-cured production (which is a fuel intensive activity) by more than would have been the case in the absence of the project. Flue-cure farming has been increasing for some years, irrespective of improved flue-curing technologies, and its increased production is a strategic goal for Malawi, under its Growth and Development Strategy.[49] The rocket barn makes the increasing production cleaner, but is only part of a greater investment required in a switch to flue-cure farming and cannot be considered responsible for stimulating increased use of NRB.

[49] Malawi Growth and Development Strategy, from Poverty to Prosperity 2006-2011, Key Strategy, page 17.

Equally it was concluded there was no evidence of risk of (c), (d), (e), (f).

For contingency (d) there was no evidence of compensation for loss of the space heating effect of inefficient technologies. Barns are not used for space heating aside from curing. The KTs have not been conducted during the cooler months of June, July and August and have not been conducted in highland areas so that the fuel savings used for calculating emissions reductions are likely to be conservative. Retention of some use of inefficient stoves is captured in the KTs.

In the case of (f) it was confirmed that, overall, reductions in transport emission would occur (so giving rise to a surplus) as reduced fire-wood consumption by households and farmers results in reduced fire-wood transport emissions. This effect results in 'negative leakage' but is not taken into account in order to ensure conservativeness. There is no risk of leakage from the construction of stoves or barns. For example, portable ceramic stoves are fired using firewood, however the amount of fuel used for firing a single stove (2kgs of wood)[50] is negligible compared to the wood savings for a single stove with a 2-year life (at least 1,759 kgs of wood). Similarly, bricks to construct new and/or retro-fit rocket barns are fired using firewood but the emissions from firing is not significant compared to emission reductions over the 10 year life of the barn. In any case, conventional barns that would be used in the absence of the project require bricks to be burnt for annual maintenance.

During the project itself, all the above leakage risks will be monitored and re-evaluated.

There is no evidence of risks (a), (b), (c), (d), (e) and (f); hence a 0% overall leakage factor is adopted.

Table B2 – Emission Reduction by Greenhouse Gas

Year	Operational Years	CO2	Non-CO2	Total	Leakage	Net GHG reductions
Fixed Esperanza Stoves					0.00%	
1	50	83	29	112	0	112
2	3,250	5,398	1,906	7,305	0	7,305
3	10,250	17,025	6,012	23,037	0	23,037
4	19,250	31,975	11,291	43,265	0	43,265
5	30,250	50,246	17,743	67,989	0	67,989
6	43,000	71,424	25,221	96,645	0	96,645
7	52,000	86,373	30,500	116,873	0	116,873
Total	158,050	262,523	92,703	355,226	0	355,226
Yearly average	22,579	37,503	13,243	50,747	0	50,747
Portable ceramic stoves					0.00%	
1	189	214	76	290	0	290
2	6,351	7,204	2,544	9,747	0	9,747
3	15,423	17,494	6,178	23,672	0	23,672
4	23,184	26,298	9,287	35,585	0	35,585
5	26,107	29,614	10,457	40,072	0	40,072
6	29,434	33,388	11,790	45,178	0	45,178
7	35,320	40,065	14,148	54,213	0	54,213
Total Average	136,007	154,278	54,479	208,757	0	208,757
Yearly average	19,430	22,040	7,783	29,822	0	29,822

[50] In Kaphuka Village of Dedza District ,240 kgs of wood were used to fire 121 portable ceramic stoves, which equates to approximately 2kgs of wood per stove for firing.

Rocket Barns					0.00%	
1	159	1,814	640	2,454	0	2,454
2	759	8,657	3,057	11,714		11,714
3	2,609	29,758	10,508	40,267	0	40,267
4	4,809	54,852	19,369	74,221	0	74,221
5	6,659	75,953	26,821	102,774	0	102,774
6	8,159	93,062	32,862	125,925	0	125,925
7	8,909	101,617	35,883	137,500	0	137,500
Total Average	32,063	365,713	129,142	494,855	0	494,855
Yearly average	4,580	52,245	18,449	70,694	0	70,694
Institutional Cook Stove					0.00%	
1	0	0	0	0	0	0
2	100	1,290	455	1,745		1,745
3	400	5,159	1,822	6,980	0	6,980
4	950	12,252	4,326	16,578	0	16,578
5	1,800	23,213	8,197	31,411	0	31,411
6	2,800	36,110	12,751	48,861	0	48,861
7	3,800	49,006	17,305	66,311	0	66,311
Total Average	9,850	127,029	44,857	171,886	0	171,886
Yearly average	1,407	18,147	6,408	24,555	0	24,555
Urban Cook Stove					0.00%	
1	0	0	0	0	0	0
2	750	1,161	410	1,571		1,571
3	3,500	5,416	1,913	7,329	0	7,329
4	8,500	13,154	4,645	17,799	0	17,799
5	15,500	23,987	8,470	32,458	0	32,458
6	19,500	30,177	10,656	40,834	0	40,834
7	21,500	33,273	11,749	45,022	0	45,022
Total Average	69,250	107,169	37,844	145,012	0	145,012
Yearly average	9,893	15,310	5,406	20,716	0	20,716
All devices combined						
1	398	2,111	745	2,856	0	2,856
2	11,210	23,709	8,372	32,082	0	32,082
3	32,182	74,853	26,432	101,286	0	101,286
4	56,693	138,531	48,918	187,449	0	187,449
5	80,316	203,014	71,689	274,702	0	274,702
6	102,893	264,161	93,281	357,442	0	357,442
7	121,529	310,333	109,586	419,919	0	419,919
Total Average	405,220	1,016,712	359,025	1,375,737	0	1,375,737
Yearly average	57,889	145,245	51,289	196,534	0	196,534

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered VER project activity:

The Kitchen Tests for stoves deliver data specific on firewood consumption per stove-year for both the portable ceramic stove and for the fixed esperanza stove and for barns, Barn Tests deliver data specific to fuel consumption per kg of cured tobacco (which is then combined with averaged kgs cured per barn per year).

In tests and surveys conducted by the project, paired samples are taken, that is, pre- and post installation consumption is compared in the same houses and farms. As conditions indicate daily repetition of a set pattern, the three-day minimum of sampling has been applied for stoves. For barns, cures (lasting 4-9 days) are monitored at the start and finish of the cure. Pre-installation and post-installation conditions for all surveys are the same.

For the kitchen tests, the weight of fuel wood from the stockpiles was calculated by use of spring-dial hoist scales of 100 kg with a capacity and a precision of 0.5 kg on households' wood stockpiles within the 72-hour period. Samples of wood and maize cobs used for fuel by each household were obtained for determination of moisture content. To measure moisture content a VOLTCRAFT FM–100 with a capacity to measure moisture content up to 44% at an accuracy of 1% was used.

For the barn tests, measurement of fuel consumption is done through a combination of physical fuel-use measurements of "stacked cubic metres" and analysing accounting records of fuel-use before and after implementation of the rocket barns. Tobacco farmers usually specify their wood use in cubic metres.[51] Wood of one metre long by one metre wide by one metre high gives a total volume of one (stacked) cubic metre (stm^3). Due to irregular gaps and air spaces, only approximately 60–70% of the volume is made up of solid wood.[52] FAO[53] proposes a basic conversion factor for wood density of 725 kg/m^3, so that the weight of wood in one stack will range from approximately 435kg to 507.5kg. This translates into a mean stacking factor of 471.25(kg) or 0.47 (tonnes)[54]

Fuel mass is converted to GHG emissions using emission factors. Actual baseline and project conditions use the same IPCC default emission factors. Theses emission factors, the non-renewable biomass fraction (calculated in B2.2) and quantitative measurements from Kitchen Tests (KTs) and Barn Tests (BTs) for each customer group are used to calculate emission reductions. The data from the tests is statistically analysed to determine at a 90% confidence level a range of values within which the mean difference between baseline firewood consumption and project firewood consumption lies, with respect to the population of interest. The lower bound of the confidence interval represents the value of firewood consumption which should be used for all sales for the cluster in question, with 90% confidence that it will be exceeded in reality. These values are then converted into emissions reductions using default emission factors and the non-renewable biomass factor.

The unit of emission reduction for stoves is the kitchen year, that is the emission reductions from a combination of devices and practices providing the meals for an average family throughout the year. For barns the unit of emission reduction is the barn year, that is the emission reductions from curing tobacco from one barn for one year (i.e. one season).

For the portable ceramic stove cluster, 300 households were tested over 3-day (72 hour) periods for baseline and follow-up tests in Traditional Authority Msamala of Balaka District in Southern Malawi. Of these households, only 252 provided complete data sets for both the baseline and follow-up tests. The tests ,demonstrated that baseline fuel consumption was on average 2.561 tonnes of fuelwood p.a. and that woodfuel consumption can be reduced by 38.8% by portable ceramic stove. The fuel savings per year corresponds to greenhouse gas emissions reductions of 1.53 tonnes of CO_2e per year per household, given the firewood source is 73.8% non-renewable.

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51 To convert stacked wood (expressed in cubic metres) into solid wood (expressed in kilogram), a conversion factor can be used for every type of tree species. Such conversion figures are hardly available (Lowore et al. 1994) and if not available, the specification in kg is speculative.

52 Geist, H. J. "Global assessment of deforestation related to tobacco farming" *Tobacco Control*, 8, 18-28, 1999.

53 Interactive Wood Energy Statistics, i-WESTAT, FAO, 2005

54 *Adapted from* Fraser AI. The use of wood by the tobacco industry and the ecological implications. Edinburgh: International Forest Science Consultancy, 1986.

Portable ceramic stoves	t/(year*stove)	Sample size: 252
Mean before	2.561	
Mean after	1.566	
Mean change	0.955	
Standard deviation change	0.454	
Upper 90%-confidence limit for the mean change	1.111	112.6% of mean
Lower 90%-confidence limit for the mean change	0.880	88.4% of mean

For the fixed esperanza stove cluster, 108 households were tested over 3-day (72 hour) periods for baseline and follow-up tests in Districts of Dowa and Ntchisi in Central Malawi . Of these households, only 71 provided complete data sets for both the baseline and follow-up tests. The tests demonstrated ,baseline fuel consumption to be on average 3.362 tonnes of woodfuel p.a. and that woodfuel can be reduced by estimated fuelwood consumption to be reduced by 48% by fixed esperanza stove. The fuel savings per year corresponds to greenhouse gas emissions reductions of 2.25 tonnes of CO2e per year per household, given the firewood source is 73.8% non-renewable.

Fixed Esperanza stoves	t/(year*stove)	Sample size: 71
Mean before	3.362	
Mean after	1.748	
Mean change	1.614	
Standard deviation change	1.651	
Upper 90%-confidence limit for the mean change	1.941	120.3% of mean
Lower 90%-confidence limit for the mean change	1.288	79.8% of mean

For the rocket barn cluster, a Barn Test and Survey were conducted for a sample of 37 smallholder flue-curing tobacco producers using conventional barns during the curing season of 2008 (January to April) and 33 smallholder flue-curing tobacco producers using Rocket Barns during the curing season of 2009 (January to April). comparing their conventional fuel consumption with improved Barn consumption in the districts of Dowa, Kasungu, Ntchisi and Mzimba.

Rocket Barns	kg_wood / kg_tobacco	101 Cures from Conventional Barn; 128 Cures from Rocket Barn
Mean before (Conventional Barn)	11.9554	
Mean after (Rocket Barn)	4.2608	
Mean change	7.69466	
Upper 90%-confidence limit for the mean change	8.66353	107.3% of mean
Lower 90%-confidence limit for the mean change	6.7258	87.4% of mean

The barn tests show that average conventional barn consumption is 11.96 kgs of wood per kg of cured tobacco. Flue–cure tobacco producers using the rocket barns for the same purpose and thermal load (curing tobacco of the same type, volume and size) were found to reduce their consumption by and average of 7.7 tonnes per tonne of tobacco cured. From the analysis of tobacco sales in the Auction Floors the average output per Rocket Barn was calculated conservatively at 1,315 kg of cured tobacco per barn. This average fuel saving per Rocket Barn per year corresponds to a greenhouse gas emissions reduction of 15.43 tonnes of CO2e, given the biomass source for firewood is 73.8% non-renewable.

The breakdowns of CO2 emission reductions made during curing are detailed in section E.

Table B.2 presents emission reductions calculated based on Kitchen Tests and Barn Tests as detailed in Annex 2 and in accordance with the methodology.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary is defined by the kitchens and barns used by the project population (i.e. customers of devices being disseminated by the project); this is distinct to the Reachable Fuel Collection Area, which is the geographical area of Malawi where fuelwood can reasonably be expected to be collected throughout the period of the project.

As defined in the applied methodology three parameters have to be delineated: Project Boundary, Target Area, and Fuel Collection Area.

a. Project Boundary:
The project boundary in this case is defined as including

- The place of the kitchens where the project stoves are applied.
- The place of the tobacco curing barn
- The place of fuel collection, production and transport, located in the fuel collection area.

b. Target Area:
The target area is defined as the country of Malawi

c. Fuel Collection Area:
This Area is defined as the country of Malawi

The following emission sources are included or excluded from the project boundary:

	Source	Gas	Included?	Justification / Explanation
Baseline	Cooking / curing, production of fuel, and transport of fuel	CO_2	Yes	Important source of emissions
		CH_4	Yes	Important source of emissions
		N_2O	Yes	Can be significant in some fuels
Project Activity	Cooking / curing, production of fuel, and transport of fuel	CO_2	Yes	Important source of emissions
		CH_4	Yes	Important source of emissions
		N_2O	Yes	Can be significant in some fuels

/

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity(ies) determining the baseline:

For portable ceramic cook-stoves, the baseline survey and KT was conducted with 300 households in 68 villages in Msamala Traditional Authority, Balaka District, Southern Malawi between the 11th and 14th of March and was followed up between the 27th of April and 4th May 2009. The enumeration team comprised of 71 members of which 60 were Concern Universal village based promoters and 11 field facilitators under the supervision of Amulike

Msukwa of Development Technical Assistance Services (DeTAS) and Elizabeth Banda (Clioma).

For the fixed esperanza stoves, a baseline survey and KT was conducted with 108 households in the Districts of Dowa and Ntchisi, Central Malawi between 2nd to 5th of September[55] and 7th to 10th of October 2009. The enumeration team comprised of 14 enumerators under the supervision of Amulike Msukwa.

For the rocket barns, the initial baseline study was conducted with 37 farmers in the districts of Dowa, Ntchisi and Kasungu in Central Malawi between the 3rd of February and the 12th of April 2008. The enumeration team comprised of 6 enumerators contracted by Programme for Biomass Energy Conservation (ProBEC) under the supervision of biomass energy consultant, Peter Scott. In 2009, a follow-up survey was conducted with 33 farmers in the Districts of Dowa, Ntchisi, Kasungu and Mzimba in Central and Northern Malawi between 2nd of February and the 4th of April 2009. The enumeration team comprised 5 enumerators contracted by ProBEC.

The non-renewability of woodfuel was analysed by the project coordinator in August 2009.

The baseline survey was completed on the 24/08/2009.

(See Annex 2 for detailed baseline information).

[55] Pre-testing training of enumerators was carried out in Kandamanja Village, Sub-Traditional Authority Mponela, Dowa District on the 1st of September, 2009.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity: 24th of November 2008 (or was it earlier, initial stakeholder meeting, ?)

C.1.2. Expected operational lifetime of the project activity: 21 years 0 months

C.2 Choice of the crediting period and related information:

The crediting period is renewable

C.2.1. Renewable crediting period 7 years

C.2.1.1. Starting date of the first crediting period: 24/11/08

C.2.1.2. Length of the first crediting period: 7 years 0 months

C.2.2. Fixed crediting period: NA

C.2.2.1. Starting date: NA

>>

C.2.2.2. Length: NA

SECTION D. Application of a monitoring methodology and plan

Data monitored and required for verification and issuance are to be kept for two years after the end of the crediting period or the last issuance of VERs for this project activity, whatever occurs later.

D.1. Name and reference of approved monitoring methodology applied to the project activity:

The monitoring protocol is included within the methodology *Improved Cook-Stoves and Kitchen Regimes* (Improved distributed heating and cooking devices), approved by the Gold Standard Foundation, which includes measures that significantly reduce consumption of non-renewable biomass.

Please refer to the Monitoring Plan in Annex 3.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology is specifically designed to match the project conditions. As mentioned above, improved biomass stoves are included as applicable technologies as are measures that reduce consumption of non-renewable biomass or other greenhouse emitting fuels. Tobacco curing barns, although not applied for cooking, are biomass fired and reduce non-renewable biomass consumption.

Monitoring will be conducted according to the prescribed approach in the methodology and as detailed below.

The monitoring methodology is applicable as;
- A Total Sales Record, a Detailed Customer Database, and a Project Database are maintained continuously,
- Periodically Kitchen Surveys, Barn Surveys, Kitchen Tests and Barn Tests are conducted to measure or estimate parameter values and review and revise the cluster lists held in the Project Database.

Maintenance of a Total Sales Record.
The Project Coordinator collates a composite electronic **Total Sales Record** and keeps paper records also.

The **Total Sales Record** will comprise the following data:

- Date of Sale (based on delivery/installation or completion of construction of stove or rocket barn)
- Model/type: Esperanza stove / portable ceramic stove / rocket barn (New or retrofitted)
- Number of devices purchased
- ID number of the device
- Name and telephone number (if available)
  - Required for all bulk purchasers i.e. retailers and rocket barn users
  - Domestic end-users: as many as possible
- Address
  - Required for all bulk purchasers i.e. retailers and rocket barn users
  - Domestic end-users: as many as possible
- Geographic Positioning System for rocket barns

The **Sales Record** information is collected using the following methods:

Sales volumes are measured for each cluster option.

For portable ceramic stoves, village based stove promoters retail stoves directly to end-users and record sales and user training on a daily basis, which is collated into a detailed customer database that tracks the chain of transactions between the user and the producer. Monthly monitoring reports include information on random visits to end-users' homes.

For fixed esperanza stoves, village based stove promoters cause the construction of the stoves and record all sales to end-users and the training that they have received in a detailed customer database. Sales are recorded at field and office level.

For the rocket barns, potential customers are screened for credit-worthiness and once approved construction begins. On completion of construction of the barn, the end-user certifies that the barn has been completed to specifications as detailed in the user-manual (which is written in vernacular languages and contains a one-year guarantee for the barn structure). Certification results in issuance of an invoice.

The project database is the sales records re-organised, and contains distinct lists for each cluster.

Detailed Customer Database

The Detailed Customer Database is filled with the results of the Kitchen and Barn Surveys (both project and monitoring) and monitoring Kitchen Tests and Barn Tests.

Project database

The Project Database contains:

- Description of the outcome of the newest Kitchen Surveys and Kitchen Tests regarding clustering and emission reduction calculation for the newest available definitions of clusters,
- List for each cluster containing all device users from the Total Sales Record belonging to this cluster,
- List of all device users not being part of any cluster.

Continuous repetition of Kitchen and Barn Surveys

- Every 6 months, at least 25 kitchens of each stove cluster are surveyed. For tobacco curing there is only one season and thus barn surveys of at least 25 farmers (i.e. customers) will be conducted once a year (i.e. every 12 months).
- The same guidelines and questions for Kitchen Surveys and Barn Surveys are followed as described in the baseline section (B). In case new issues arise they can be included in the Kitchen Surveys or Barn Surveys,
- Results of the Kitchen Surveys and Barn Surveys will be included in the Detailed Customer Database and in the Monitoring Reports.

The data collected will be:

- Usage: Whether device (ICS or RB) is still in use or not; if not, what has replaced it,
- Telephone number and/or address,
- Type of device used by customer previously,
- Application of device (any other uses),
- Fuel mix used typically through the year: specify different types of fuel used and fractions,
- Source of fuel (purchased or hand-collected).

Additional survey questions in the KS and BS will inform leakage considerations.

Other periodic monitoring tasks:

- Net Leakage factors (discussed above) will be surveyed, and an investigation made into the possibility of new leakage and surplus effects, every second year,
- A Usage Survey will be undertaken for Total Sales made in the first year of the project, to establish the fraction of end-users who are no longer using the devices over time. The sample size will be as defined for the KS and BS. The approach will be to randomly sample from users having begun to use their devices in the first year of the project. Reported every second year,
- Stove-age KTs and rocket barn BTs will be undertaken for Total Sales made in the first year for each cluster, to measure emission reduction performance in successive years of devices of Age x years, Age y years,

and so on. A linear extrapolation is applied to all devices of intermediate age and extended age, when calculating overall project GHG reductions.

- New stove KTs and new rocket barn BTs will take place for new models and designs if they become available and when they have been in use for one year, and will be repeated annually,
- In addition, the wider social and economic impact of the project will be investigated every 2 years and an assessment made of its contribution, positive or otherwise, to sustainable development in the area.

Note, a fixed baseline is assessed to be conservative and is applied for renewability status of wood-fuel used by each cluster (NRB fraction) for the

D.2. 1. OPTION 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID #	Data variable	Source of data	Data unit	Measured (m), calculated (c) estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (Electronic/ paper)	Comment
1	*Stove Sales*	*Sales Records*	*Number of stoves by type and size*	*M*	*Daily – recorded daily in the field and later entered into sales record and database in office*	*All sales*	*Electronic and paper*	
2	*Rocket barns*	*Total Build Records*	*Number of rocket barns by type and size*	*M*	*Daily - recorded daily in the field and later entered into sales record and database in office*	*All total Builds*	*Paper and electronic*	
3	*Mass Fuel Consumption*	*KTs and BTs*	*Mass fuel per year*	*M*	*Annual*	*Measurement of sample of cluster population*	*Electronic and paper*	*Fuel consumption of improved stove and barn*
4	*Clustering definitions*	*Monitoring KS and BS*	*As specified above*	*E*	*Annual for BS and Every 6 months KS*	*Sample*	*Biannual monitoring reports*	*To ensure representative KTs and BTs*
5	*Usage factor*	*Usage KS and BS*	*% Operational*	*M, E*	*Annual*	*Sample*	*Electronic and paper*	
6	*Age factor*	*KT and BT*	*Mass fuel per year*	*M*	*Every 2 years*	*Sample*	*Electronic and paper*	
7	*New stove*	*New stove KT*	*Mass fuel*	*M*	*Baseline*	*Sample*	*Electronic and*	*Fuel*

	and barn performance	*and new barn BT*	*per year*		*and follow-up survey, subsequentl y every 2 years*		*paper*	*consumption of new improved stove and new improved barn*
8	*Non-renewability of woody biomass fuel in the project in year y*	*Study*	*Fraction*	*C / E*	*Fixed baseline for first crediting period*	*100%*	*Electronic and paper*	

D.2.1.2. Data to be collected in order to monitor project performance on the most sensitive sustainable development indicators:

No sustainable development indicators were found critical during Stakeholder Consultation and Sustainable Development Assessment but the following are monitored for reflection given the need to assess every two years the social and environmental impact of the project

Sustainable Development Indicator	Data type	Data variable	Uncertainty levels	Data unit	Measured (m), calculated (c) or estimated (e)
SD 1) Air quality	*Survey*	*Air pollutants (CO, particulates)*	*Low*	*Survey observations*	*Estimated through home interviews and observations as to inside/outside cooking*
SD 2) Livelihood of the poor	*Survey*	*Financial impact*	*Low*	*MK (Malawi Kwacha)*	*Estimated through surveys*
SD 3) Employment	*Survey*	*Numbers*	*Low*	*Employees*	*Direct employees; producers and retailers of improved cook stoves and specialised builders, metal-workers and carpenters of rocket barns*
SD 4) Human and Institutional capacity	*Survey*	*Numbers*	*Low*	*Trainees, employees*	*Attendance of women-specific training, number of jobs and positions for women;* *Awareness raising??*

D.2.1.3. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equivalent).

When applying the not monitored variables as set out in part B, then within each cluster the emissions are calculated thus:
$PE_{i,y,z} = N_{i,y} * PE_y * Age_{,z}$

Where
$N_{i,y}$ = the number of Units in cluster I (100% working)
$N_{i,y}$ = sold stoves, x * Usage,x,z

D.2.1.4. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived:

The project has chosen a fixed baseline and hence there is no reason to monitor baseline anthropogenic emissions by sources.

D.2.1.5. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)

Please see Section E

D. 2.2. OPTION 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

Not applied

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equivalent):

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

As explained in B.2., there is no leakage expected from any source. To assess if the dissemination of efficient stoves and barns has a source of leakage, a survey is conducted via the KS and BS, which are monitored every 6 months and every year respectively.

ID #	Data variable	Source of data	Data unit	Measured (m), calculated (c) estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
11	*All leakage risks*	*KS and BS*		*e*	*Every six months for KS and once a year for BS*		*Electronic and paper*	

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equivalent).

Qualitative assessment through quarterly kitchen survey and barn survey visits throughout the project period.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equivalent).

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

See annex 2,

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

The project coordinator ensures quality control in the monitoring activities. The project coordinator and/or a third party consultant(s) are responsible for the periodic KSs, KTs, BSs, BTs, Leakage investigation, and spot-checks (including field observations of retailer and construction activities) to confirm the absence of double counting in any form. The project coordinator ensures that Detailed Customer Database and Project Database are up to date and the latter is representative of the most recent definition of clusters. Sales Records are crosschecked with the sales record of retailers/contractors and with production / construction records (materials, purchasers, staff numbers). Reports on the methods used for such crosschecks and their findings are included in the monitoring reports available to the verifier.

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Data Variable	Uncertainty level of data (High/ Medium/ Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.

Table 2.2.1 (1)	*Stove Sales*	Low	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (2)	*Rocket barns*	Low	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (3)	*Project Fuel Consumption*	*Low*	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (4)	*Clustering definitions*	*Low*	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (5)	*Usage factor*	*Low*	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (6)	*Age factor*	*Low*	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (7)	*New stove and barn performance*	*Low*	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (8)	*Non-renewability of woody biomass fuel in the project in year y*	*Low*	Third party studies are used to calculate this data
Table 2.2.1 (9)	*Non-renewable woody biomass fuel in the baseline in year y*	*Low*	Third party studies are used to calculate this data
Table 2.2.1 (10)	*Baseline fuel consumption*	*Low*	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
Table 2.2.1 (11)	*All leakage risks*	Low	The project participant is best capable of collecting this data because he knows the technology best. An internal monitoring quality standard and 3rd party expert views from local NGOs & experts are used to guarantee the quality.
SD 1	Air quality	Low	Surveys
SD 2)	Livelihood of the poor	Low	Surveys
SD 3)	Employment	Low	The project participant records used, no uncertainty applies
SD 4)	Human and Institutional capacity	Low	The project participant records used, no uncertainty applies

D.4. Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

The Project Coordinator will schedule and implement the monitoring activities described and tabulated above, and summarise results in the form of monitoring reports.

For the monitoring of the emission reductions a detailed monitoring plan exists. Quality controls are conducted both internally by the project coordinator and externally with advice from local experts (NGOs, government, university).

Specialised staff is employed by the project with specific responsibility for monitoring. The staff is trained at the beginning and works with a monitoring manual. If needed, the manual is updated and the staff is re-trained.

All data will be kept electronically for a period of 2 years after the end of the crediting period.

D.5 Name of person/entity determining the monitoring methodology:

The monitoring methodology is as prescribed in the methodology "Improved Cook-stoves and Kitchen Regimes" under the Gold Standard Foundation prepared by Hestian Innovation.

SECTION E. Estimation of GHG emissions by sources

Formulae from methodology and the rationale behind the values applied for parameters are presented in Annex 2.

E.1. Estimate of GHG emissions by sources:

EF,bio,co2	CO2 emission factor from use of biomass	tCO2/ t_biomass	1.747	1.747	1.747	1.747
EF,bio,non-co2	Non-CO2 emission factor from use of biomass	tCO2/ t_biomass	0.455	0.455	0.455	0.455
Xnrb	NRB		0.74	0.74	0.74	0.74

			Fixed Stove			
		Unit	BE	PE	LE	ER
	Total emissions per stove (lower bound confidence interval)	tCO2e	4.68	2.43	0.00	2.25
	Total Emission per stove	tCO2e	5.87	3.05	0.00	2.82
	CO2 emissions (lower bound confidence interval)	tCO2e	3.46	1.80	0.00	1.66
	CO2 emissions	tCO2e	4.34	2.25	0.00	2.08
	Non-CO2 emissions (lower bound confidence interval)	tCO2e	1.22	0.64	0.00	0.59
	Non-CO2 emissions	tCO2e	1.53	0.80	0.00	0.74
	Emission during productionof fuels	tCO2e	0.00	0.00	0.00	0.00
By	Biomass combusted (adapted to lower bound of confidence interval)	t biomass	2.68	1.39	0.00	1.29
	Biomass combusted (measured values from kitchen tests)	t biomass	3.36	1.75	0.00	1.61
LEy	Leakage		0%	0%	0%	0%
LCI	Lower bound confidence interval		79.8%	79.8%	79.8%	79.8%

			Portable Stove			
		Unit	BE	PE	LE	ER
	Total emissions per stove (lower bound confidence interval)	tCO2e	3.95	2.42	0.00	1.53
	Total Emission per stove	tCO2e	4.47	2.73	0.00	1.74
	CO2 emissions (lower bound confidence interval)	tCO2e	2.92	1.79	0.00	1.13
	CO2 emissions	tCO2e	3.30	2.02	0.00	1.28
	Non-CO2 emissions (lower bound confidence interval)	tCO2e	1.03	0.63	0.00	0.40
	Non-CO2 emissions	tCO2e	1.17	0.71	0.00	0.45
	Emission during productionof fuels	tCO2e	0.00	0.00	0.00	0.00
By	Biomass combusted (adapted to lower bound of confidence interval)	t biomass	2.26	1.38	0.00	0.88
	Biomass combusted (measured values from kitchen tests)	t biomass	2.56	1.57	0.00	1.00
LEy	Leakage		0%	0%	0%	0%
LCI	Lower bound confidence interval		88.4%	88.4%	88.4%	88.4%

		Rocket Barn (RB)			
	Unit	BE	PE	LE	ER
Total emission per barn (average of 1,315 kgs / barn with LCI)	tCO2e				15.43
Total Emission per Rocket Barn	tCO2e	27.15	9.78	0.00	17.37
CO2 emissions (lower bound confidence interval)	tCO2e				11.41
CO2 emissions	tCO2e	20.07	7.23	0.00	12.84
Non-CO2 emissions (lower bound confidence interval)	tCO2e				4.03
Non-CO2 emissions	tCO2e	7.09	2.55	0.00	4.53
Emission during productionof fuels	tCO2e	0.00	0.00	0.00	0.00

By (/RB)	Biomass combusted/ RB (average of 1,315 kgs / RB with LCI)	t biomass				8.84
	Biomass combusted / RB (average of 1,315 kgs / RB)	t biomass	15.56	5.60	0.00	9.96
By (/tonne)	Biomass combusted/t_cured (adapted to lower bound of CI)	t biomass				6.73
	Biomass combusted / t_cured (measured values from barn test)	t biomass	11.83	4.26	0.00	7.57
LEy	Leakage		0%	0%	0%	0%
LCI	Lower bound confidence interval					

(Estimation)		Institutional Stove			
	Unit	BE	PE	LE	ER
Total Emission per stove	tCO2e	43.63	26.18	0.00	17.45
CO2 emissions	tCO2e	32.24	19.34	0.00	12.90
Non-CO2 emissions	tCO2e	11.39	6.83	0.00	4.55
Emission during productionof fuels	tCO2e	0.00	0.00	0.00	0.00
Biomass combusted (measured values from kitchen tests)	t biomass	25.00	15.00	0.00	10.00

(Estimation)		Urban Stove			
	Unit	BE	PE	LE	ER
Total Emission per stove	tCO2e	4.19	2.09	0.00	2.09
CO2 emissions	tCO2e	3.10	1.55	0.00	1.55
Non-CO2 emissions	tCO2e	1.09	0.55	0.00	0.55
Emission during productionof fuels	tCO2e	0.00	0.00	0.00	0.00
Biomass combusted (measured values from kitchen tests)	t biomass	2.40	1.20	0.00	1.20

In the case of ICS and UCS, the Kitchen Tests and Kitchen Surveys have not yet been conducted. Accordingly no emission reductions will be submitted for verification until the KTs and KSs are conducted. However, indicative emissions reduction calculations are presented below.

For institutional stoves, firewood savings are based on information estimated on firewood consumption before and after the introduction of fixed institutional stove.[56] Although paired sampling was not used it was estimated that a 200 L fixed institutional stove saved an average of 25 tonnes p.a. For a 100L institutional stoves, both for fixed and portable, it is conservatively assessed that the fuel consumption reductions can be 10 tonnes of wood p.a. Kitchen tests using guidelines form the Gold Standard methodology are due to be conducted soon.

For urban cook stoves, the calculations presented above are based on urban households that principally use firewood for fuel. It is assumed that the Urban Cook Stove can achieve at least a 50% reduction in firewood consumption. A 20% adjustment is considered to allow for real-world conditions to be observed by a survey to consider factors such as the use of secondary fuels.

E.2. Estimated leakage:

This is estimated to be zero for all clusters as detailed in section B.2.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

As E.2 is estimated to be zero, the project activity emissions are those presented in E.1.

[56] DeGabriele, J. and Msukwa, A. ProBEC Study on the Impact of the Institutional Rocket Stoves in School Kitchens, August 2007.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

See E.1 and E.6

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

ERy = Σ BEi,y – Σ PEi,y – Σ LEi,y
= Σ BEi,y – Project Activity Emissions

See E.1 and E.6

E.6. Table providing values obtained when applying formulae above:

Year	Estimation of project activity emission (tonnes CO_2 e)	Estimation of baseline emissions (tonnes CO2 e)	Estimation of leakage (tonnes CO_2 e)	Estimation of emission reductions (tonnes CO_2 e)
1	747	578	0	2,856
2	47,808	27,440	0	32,082
3	141,025	80,006	0	101,286
4	258,758	145,530	0	187,449
5	388,203	216,274	0	274,702
6	521,415	289,898	0	357,442
7	638,809	356,389	0	419,919
Total	1,996,764	1,116,116	0	1,375,737

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

No adverse environmental impacts will take place as a result of the project activity. Questions in this regard (specify questions) were answered to the satisfaction of authorities attending the stakeholder consultation in November 2008.

The Department of Environmental Affairs, which is the Designated National Authority for Malawi, revised the Project's documentation and visited one of the Project's sites in November 2009. With these observations and information, the Department expressed in writing its full support of the Project as a way of supporting Malawi Government's global commitment to climate change mitigation.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

An Environmental Impact Assessment (EIA) is not needed because it is neither required by the Gold Standard procedures nor by the host country.

SECTION G. Stakeholders' comments

G.1. Brief description how comments by local stakeholders have been invited and compiled:

The stakeholder consultation was held in 2 parts. The first took place at the Crossroads Hotel in Lilongwe on Friday, November 14th, 2008 and the second (a field visit to a working farm) took place at a farm in Chamama, Kasungu on Wednesday, November 19th, 2008. The first part was attended by representatives from government, environmental and civil society organizations, academia and the private sector. There were 39 participants at the first part of the stakeholder consultation. The second part of the stakeholder consultation was attended by some of the participants of the first part and a significant number of farmers (with an attendance of 68).

Stakeholder comments were invited and compiled with the assistance of guidance from the Gold Standard Toolkit (section 2.6 and Annex J). A number of presentations on the project were made, followed by a questions /comments round and a blind sustainable development exercise (each as more fully described in the (uploaded) GS 613 Stakeholder Consultation report).

The project was, overall, very well received by the stakeholders.

G.2. Summary of the comments received:

The primary recommendations made by the stakeholders were:

1. That the implementation of the project will be spread from the pilot areas to the rest of the country.

2. With a view to minimizing negative impact on Soil Condition (from clay collection), the project could actively promote: (1) the collection of clay from above-ground piles of earth; (2) where not possible, the minimisation of pit depths; and (3) the rapid replacement of clay removed from pits with biodegradable household and agricultural wastes.

3. A small number of participants had a divergent view on the definition of biodiversity. This was discussed at length in open forum across the group. The vast majority of participants did not agree with the notion of the project having a negative impact on biodiversity. However it was stated that biodiversity could be improved by: (a) promoting the governmental policy which encourages tobacco farmers to use part of their farm land for planting trees; (b) collaborating with NGOs like the one which promotes briquettes as an alternative to wood fuels in order to further reduce the use of wood fuels; (c) ensuring that many people have access to the stoves.

4. That the project avoids taking too long to be implemented because of the lengthy process involved for carbon financing.

5. That the project has a lot of personnel on the ground to monitor performances.

6. That the community be educated and encouraged to use the new technologies devices provided by the project instead of conventional technologies.

G.3. Report on how due account was taken of any comments received:

The project has accommodated the recommendations in the following ways:

1. The project is gradually spreading in order to reach the whole country with both stoves and rocket barns but is targeting the rural areas where firewood is the main source of fuel.

2. The project will actively promote: (1) the collection of clay from aboveground piles of earth; (2) where not possible, the minimisation of pit depths; and (3) the rapid replacement of clay removed from pits with biodegradable household and agricultural wastes.

3. The project will (a) promote the governmental policy which encourages tobacco farmers to use part of their farm land for planting trees; (b) collaborate with NGOs to further reduce the use of wood fuels; (c) ensure that many people have access to the stoves.

4. The project has will endeavour to avoid implementation delays and has distributed significant numbers to date.

5. The project includes a comprehensive monitoring regime (please see Section D) involving in excess of 70 personnel.

6. The project includes a comprehensive education program whereby all end-users receive training on the usage and benefits (to end-users) of the new technologies (please see Section D).

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

BASELINE INFORMATION

The parameters table below summarises the results of the KS, RBS, KT and RBT findings as to clustering and the emission reductions per unit of each cluster.

The KS and RBS recommended that the project calculate emission reductions for devices according to the following clusters:

a. Sales of portable ceramic stoves
b. Sales of fixed esperanza stoves
c. Sales of Rocket Barns
d. Sales of institutional cook stoves
e. Sales of urban cook stoves

Cluster (a) and (b) comprises wood-burning domestic stoves. A KT in 2009 in Balaka indicated an emission saving of 1.65 tCO2e/stove-year for the portable ceramic stove and is the result of a comprehensive KT carried out with 300 rural households. A KT in 2009 in Dowa and Ntchisi indicated an emission saving of 2.25 tCO2e/stove-year for the fixed esperanza stove and is the result of a comprehensive KT carried out with 108 rural households.

Cluster (c) comprises wood-burning rocket barn. A survey was conducted together with a rocket barn test in 2008 sampling 37 farmers burning wood and using the rocket barn and conventional barns.

A further survey and test were conducted in 2009 sampling 33 farmers burning wood and using the rocket barn. A statistical analysis of the results found at 90% confidence level that rocket barn saved at least 6.72 kgs of wood per kg of cured tobacco as compared to the conventional barns in 2008 (as our baseline). For the purposes of estimating emission reductions per rocket barn, the emission reduced per kg of produce cured is multiplied by the average number of kgs cured per rocket barn per year as observed in the 2008 baseline sample. The BTs indicated an emission saving of 15.43 tCO2e / rocket barn-year.

In the case of Institutional Cook Stove and Urban Cook Stove, the Kitchen Tests and Kitchen Surveys have not yet been conducted. Accordingly no emission reductions will be submitted for verification until the KTs and KSs are conducted.

Formulae Applied:

The emission reductions per device that can be claimed under Gold Standard for reduced emissions from the use of NRB, as defined as Approach 1 in the methodology, are calculated using the following equation:

$$BE_y = X_{nrb,bl,y} . B_{bl,y} . EF_{bl.bio,co2} + \sum(AF_{bl,I,y} . EF_{af,co2,i})$$
$$+ \sum(\text{Non-}CO_2 \text{ emissions during cooking})$$
$$+ \sum(\text{GHG emissions during production of the fuels})$$

Where:

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

$X_{nrb,bl,y}$ = the non-renewable fraction of the woody biomass harvested in the project collection area in year y in the baseline scenario

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

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

$AF_{bl,i,y}$ = the mass of alternative fuel i in the baseline in year y in accordance with trends projected throughout the project period, in tonnes. This mass can be set to zero in cases where the KT is appropriately designed to subsume alternative fuels (approach 3).

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

Non-CO2 emissions during cooking

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

GHG emissions during production of the fuels

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

Where:

$EF_{bl.bio,non\text{-}co2,i}$ = Emission factor for GHG gas i in the baseline scenario in units of tonnes gas per tonne wood-fuel

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

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

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

$EF_{bio,prod,co2,gas\ i}$ = Non-CO2 Emission factor for wood-fuel during production in tonnes gas per tonne fuel

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

Project Emissions:

$$PE_y = X_{nrb,pj,y} . B_{pj,y} . EF_{bio,co2} + \sum(AF_{pj,i,y} . EF_{af,co2,i})$$
$$+ \sum(\text{Non-}CO_2 \text{ emissions during cooking / curing})$$
$$+ \sum(\text{GHG emissions during production of the fuels})$$

Where (noting that parameters common to baseline equations are not repeated):

$X_{nrb,pj,y}$ = the non-renewable fraction of the woody biomass harvested in the project collection area in year y in the project scenario

PE_y = project emissions in year y (in tonnes of Co2e per year) specific to cluster and Unit chosen

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

$AF_{pj,i,y}$ = The mass of alternative fuel i in the project in year y in accordance with trends projected throughout the project period, in tonnes. This mass can be set to zero in cases where the KT is appropriately designed to subsume alternative fuels.

Non-CO2 emissions during cooking / curing

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

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

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

Parameters Table:

Data / Parameter:	EFbl.bio,co2
Data unit:	tCO2/t_biomass
Description:	CO2 emission factor arising from use of wood-fuel in baseline scenario
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
Value applied:	1.7472 tCO2/t wood (=112.0 tCO2/TJ * 0.0156 TJ/ t)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default IPCC values for wood / wood waste are applied
Any comment	

Data / Parameter:	EFpj.bio,co2
Data unit:	tCO2/t_biomass
Description:	CO2 emission factor arising from use of wood-fuel in project scenario

Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
Value applied:	1.7472 tCO2/t wood (=112.0 tCO2/TJ * 0.0156 TJ/ t)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default IPCC values for wood / wood waste are applied
Any comment	

Data / Parameter:	EFbl.bio,non-co2
Data unit:	tCO2/t_biomass
Description:	Non-CO2 emission factor arising from use of wood-fuel in baseline scenario
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.9 in Volume 2: Energy
Value applied:	0.4554 tCO2/t wood (=(1.224 tCO2/TJ * 0.0156 TJ/ t * 21) + (0.01125 tCO2/TJ * 0.0156 TJ/ t * 310))
Justification of the choice of data or description of measurement methods and procedures actually applied:	Default IPCC values for CH4 and N20 emissions for wood / wood waste are applied The following GWP100 are applied: 21 for CH4, 310 for N20
Any comment	Both defaults are within a range and the mean of the range is taken as the default. Technical references are from studies in developing country contexts and are more up-to-date than other default values.

Data / Parameter:	EFpj.bio,non-co2
Data unit:	tCO2/t_biomass
Description:	Non-CO2 emission factor arising from use of wood-fuel in project scenario
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.9 in Volume 2: Energy
Value applied:	0.4554 tCO2/t wood (=(1.224 tCO2/TJ * 0.0156 TJ/ t * 21) + (0.01125 tCO2/TJ * 0.0156 TJ/ t * 310))
Justification of the choice of data or description of measurement methods and procedures actually applied:	Default IPCC values for CH4 and N20 emissions for wood / wood waste are applied The following GWP100 are applied: 21 for CH4, 310 for N20
Any comment	Both defaults are within a range and the mean of the range is taken as the default. Technical references are from studies in developing country contexts and are more up-to-date than other default values.

1) Fixed 'esperanza' Stove	**Parameter**	**Value**	**Units**	**Source**
Fractional Non-Renewability (constant for baseline and project conditions)	X_{nrb}	0.738	Fraction	Baseline Study Project-Specific
Average consumption of wood	B_{bl}	3.00	t_wood/stove-yr	Pending baseline study

(baseline) per household per year *(will be updated pending more comprehensive baseline)*				
CO2 emission factor wood	$EF_{bio,co2}$	1.7472	tCO2/t_wood	Product of NCV wood (IPCC 2006 GL default 15.6MJ/kg) and CO2 emission factor (energy basis) for wood (IPCC 2006 GL default 112 tCO2/TJ) x 10^{-3}
Mass alternative fuel	AF_{bl}	NA		
CO2 emission factor alternative fuel	$EF_{af,co2}$	NA		
Average (lower bound confidence interval) consumption wood (project) per household per year	B_{pj}	1.89	t_wood/stove-yr	Pending baseline study
Non-CO2 emission factor wood	$EF_{bl.bio,non\text{-}co2,i}$	0.4554	tCO2e/t_wood	NCVwood (IPCC 2006 GL default 15.6MJ/kg) EF for CH4 average of EF ID 118531 EF for N2O average of EF ID 118539 100 year GWP from IPCC SAR IPCC (21 CH4 and 310 for N2O)
Non-CO2 emission factor alt fuel	$EF_{af,non\text{-}co2}$	N/A		
Mass alternative fuel (project)	$AF_{pi,}$	N/A		
Leakage of portable stoves in year y	$LE_{fixed\ esp\ stove,\ y}$	0.00	Fraction	

2) Portable Ceramic Stove	Parameter	Value	Units	Source
Fractional Non-Renewability (constant for baseline and project conditions)	X_{nrb}	0.738	Fraction	Baseline Study Project-Specific
Average (lower bound confidence interval) consumption of wood (baseline) per household per year	B_{bl}	2.43	t_wood/stove-yr	Baseline Study Project-Specific
CO2 emission factor wood	$EF_{bio,co2}$	1.7472	tCO2/t_wood	Product of NCVwood (IPCC 2006 GL default 15.6MJ/kg) and CO2 emission factor (energy basis) for wood (IPCC 2006 GL default 112 tCO2/TJ) x 10^{-3}
Mass alternative fuel	$AF_{pi,}$	NA		
CO2 emission factor alternative fuel	$EF_{af,co2,i}$	NA		
Average (lower bound confidence interval) consumption wood (project) per household per year	B_{pj}	1.49	t_wood/stove-yr	Baseline Study Project-Specific
Non-CO2 emission factor wood	$EF_{bl.bio,non\text{-}co2,i}$	0.4554	tCO2e/t_wood	As per Ref A above
Non-CO2 emission factor alt fuel	$EF_{af,non\text{-}co2}$	N/A		
Mass alternative fuel (project)	$AF_{pi,}$	N/A		
Leakage of portable stoves in year y	$LE_{portable\ stove,\ y}$	0.00	Fraction	

3) Rocket Barn	Parameter	Value	Units	Source
Fractional Non-Renewability (constant for baseline and project conditions)	X_{nrb}	0.738	Fraction	Baseline Study Project-Specific
Average (lower bound confidence interval) consumption of wood (baseline) per cured kg	B_{bl}	10.81	kg_wood/kg-cured	Baseline Study Project-Specific
CO2 emission factor wood	$EF_{bio,co2}$	1.7472	tCO2/t_wood	Product of NCVwood (IPCC 2006 GL default 15.6MJ/kg) and CO2 emission factor (energy basis) for wood (IPCC 2006 GL default 112 tCO2/TJ) x 10^{-3}
Mass alternative fuel	AF_{bl}	NA		
CO2 emission factor alternative fuel	$EF_{af,co2,i}$	NA		
Lower level average consumption wood (project) per cured kg	B_{pj}	3.98	kg_wood/kg-cured	Baseline Study Project-Specific
Kg wood saved per cured kg		6.83	kgs wood / kg cured produce	Baseline Study Project-Specific
Average (lower bound confidence interval) kgs cured per rocket barn (baseline)		1,164	kgs / year	Baseline Study Project-Specific
Non-CO2 emission factor wood	$EF_{bl.bio,non-co2,i}$	0.4554	tCO2e/t_wood	As per Ref A above
Non-CO2 emission factor alt fuel	$EF_{af,non-co2}$	N/A		
Mass alternative fuel (project)	$AF_{pi,}$	N/A		
Leakage of portable stoves in year y	$LE_{RB,\ y}$	0.00	Fraction	

As indicated above, in the case of Institutional Cook Stove and Urban Cook Stove, the Kitchen Tests and Kitchen Surveys have not yet been conducted. Accordingly no emission reductions will be submitted for verification until the KTs and KSs are conducted.

Annex 3 (Revised)

MONITORING PLAN

The project follows a Monitoring Plan as set out in the methodology "Improved Cook-stoves and Kitchen Regimes".

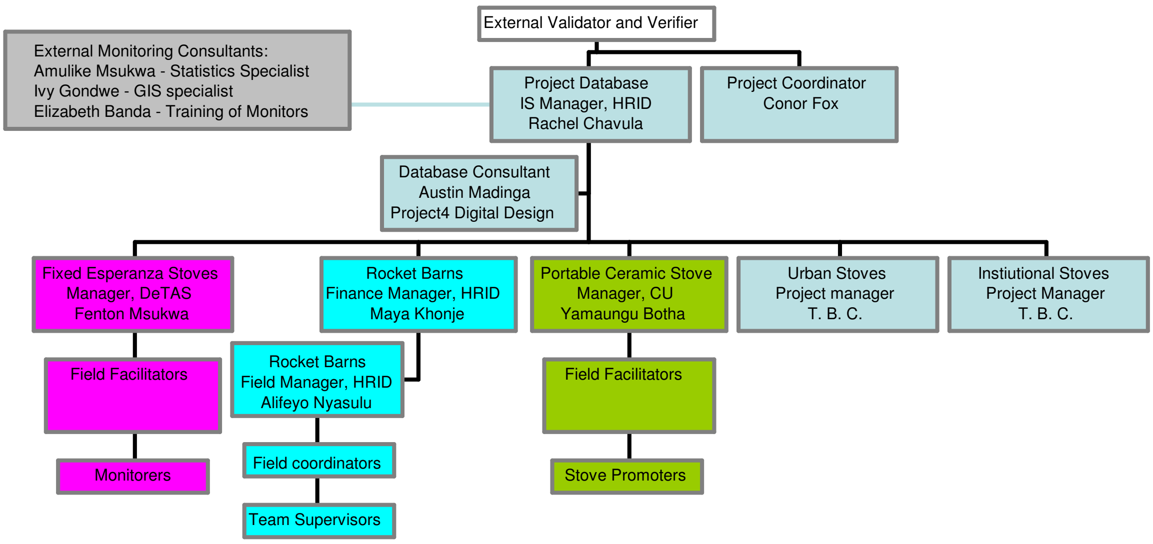
For each stove cluster a survey is undertaken of 25 customers every six months to capture seasonal variability and the data collected is held in a Detailed Customer Database. For Barns surveys, 25 customers for each barn cluster (or 10% of cluster size if it is less than 250) will be taken every curing season (i.e. annually). This data will function as a guide to sustainable development indicators, and as a guide to factors such as usage drop-off and age performance of the devices.

The Monitoring Plan also will include (i) six-monthly KS and annual BS and (ii) KTs and BTs conducted every 2 years will include investigation of the performance of ageing devices, so that adjustments can be made to the emission reduction values used in monitoring reports. Equally Usage will be investigated, and appropriate adjustments made to emissions reductions claims based on measured usage drop-off rates.

The Monitoring Plan will be adjusted for ICS and UCS in light of the results of the applicable KTs and KSs to be conducted.

Verification is expected to take place at least annually, and the Verification report will follow the methodology in the above respects. Updated assessments of sustainable development indicators will be included as a component of monitoring report submitted for Verification.

Monitoring Organigram



The Integrated Biomass Energy Conservation Project has an assigned Project Manager who is responsible for project implementation and implementation of the monitoring plan, including the training of enumerators that conduct kitchen surveys, kitchen tests, barn surveys and barn tests *(see organigram above).*

For stoves the applicable project manager is responsible for conducting monitoring tasks in close collaboration with the Information Systems manager and the Project Coordinator.

Baseline kitchen survey and test will be extended to include institutional stoves in representative sample groups (schools, hospitals, orphanages, nurseries, canteens etc.) and stoves for peri-urban households.

Monitoring information is periodically forwarded from the applicable project managers to the Information Systems Manager who is responsible for the overall project database. The Project Coordinator oversees this process and conducts periodic spot-checks in the field and of the monitoring information.

Training for monitoring exercises is coordinated by the applicable project manager in collaboration with the project coordinator and may involve technical assistance from an external statistics specialist. The training of enumerators (i.e. monitors) includes a briefing on the rationale behind surveys and tests followed by pre-testing exercises with householders. Issues arising in the pre-tests are discussed before the actual surveys and tests are conducted. Monitoring staff, coordinated by the Information Systems Manager, with possible assistance from an external consultant supervise the enumerators and check their work frequently to identify problems and any misunderstandings. After the survey and test data has been collected the raw data is entered into SPSS packages in digital format and is analysed internally with review by an external statistics specialist. Results from the surveys and tests are entered into the Project Database, which are stored with the sales data in MS Access *via* a user-friendly interface designed for the project. Monitoring manuals have been designed for the various technologies and templates of the questionnaires can be found in the Kitchen Surveys, Kitchen Tests, Barn Survey and Barn Test.

The frequency of monitoring activities is detailed in Section D.2.1. of the PDD.

Random spot-checks on at least 10 end-users are performed quarterly by the project coordinator or external consultant, in addition to planned monitoring activities as detailed in Section D.2.1, which are recorded in a spot check monitoring book.

Quality assurance for the production of the various devices begins with the training of the builder / producer on production techniques and design specifications of the devices with technical assistance from the Programme of Biomass Energy Conservation (GTZ and Department of Energy Affairs). Subsequently after the device is produced or built there is a quality control check.

Devices that are in need of repair or maintenance are reported to the applicable manager. Damages and repairs reports are filed and logged in the damages and repairs book.

The stove promoters and barn team supervisors of the project also act as retailers and trainers. They are trained on business development and on how to communicate the characteristics of the new technologies to potential end-users. Once the customer has decided to invest in a new fuel-efficient technology quality is also assured through training end-users on how (i) to operate the devices (i.e. user quality control) (ii) to improve kitchen / barn management and (iii) to improve firewood management. To complement training, user manuals are also provided to end-users. For all devices, all end-users receive user training before end-use through a demonstration, the date of which is documented in the database.

A training programme has been established which includes training of builders, stove producers, staff and end-users, all of whom are intensively trained as part of quality assurance and the provision of a professional service. *See table below.*

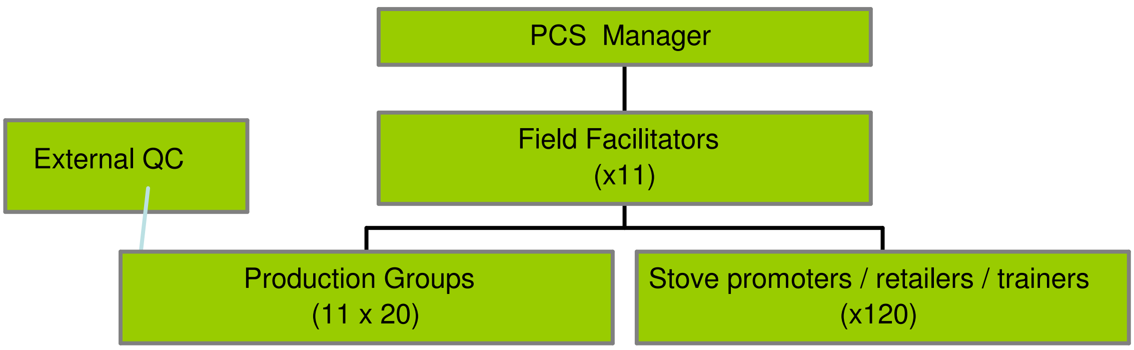
	Manufacture	Monitoring	Marketing	User Training	QC / QA
Portable	Production groups	Promoters		End-user	Promoters

Ceramic Stove	*Continuous*	*Six-monthly*	*Annual*	*Continuous*	*Continuous*
Fixed Esperanza Stoves	Liner producers & specialised builders	Promoters		End-user	Promoters
	Continuous	*Six-monthly*	*Annual*	*Continuous*	*Continuous*
Rocket Barns	Specialised building Team Leaders & Metal workers	Monitors	Team Supervisors & Field Coordinators	End-user	Monitors
	Yearly	*Annual*	*Annual*	*Annual – before & during curing season*	
Institutional Stoves	Stove producers & specialised Builders	Monitors	Installers	End-user	Monitors
	Continuous	*Six-monthly*	*Annual*	*Continuous*	*Continuous*
Urban stoves	Stove producers & metal workers	Monitors	Retailers	End-user	Monitors
	Continuous	*Six-monthly*	*Annual*	*Continuous*	*Continuous*

Table 1. Targeted training and the *frequency of training*.

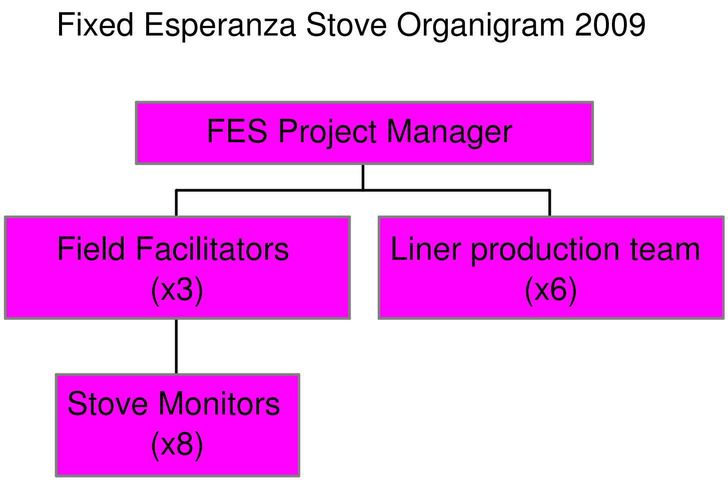
Below are detailed organigrams of the manufacturer and distribution channels, which show the additional jobs of skilled workers necessary to manufacture and distribute the efficient devices. A brief description below the graphs describes assignation of 'device-specific' tasks related to training, operation, maintenance and guarantee services.

Portable Ceramic Stove Organigram 2009

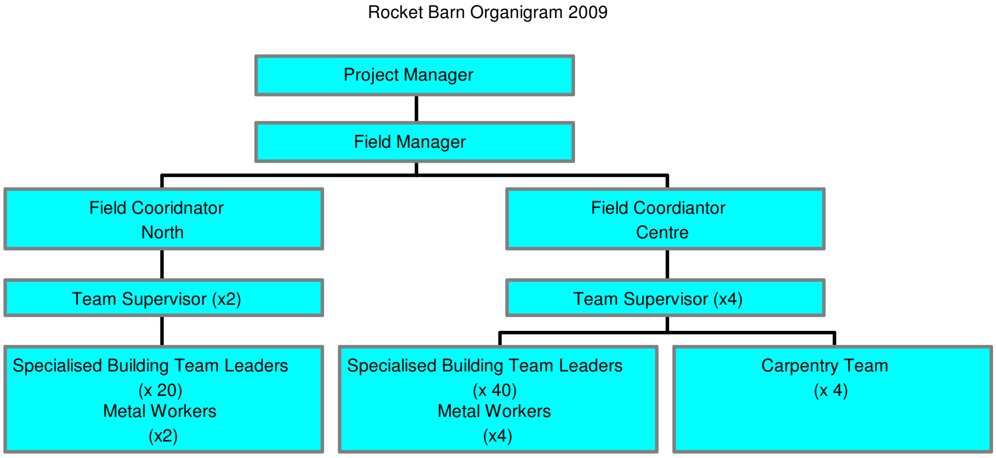


The portable ceramic stove production and distribution system has trained village production groups that produce and sell stoves in bulk to designated stove promoters that are trained by field facilitators, who in turn have been trained by ProBEC. Quality controllers trained by field facilitators certify the quality of each ceramic stove produced and ascertain the validity of records of the producer groups. The production batch is recorded in the ceramic stove's serial number so that the performance of each batch is monitored. Village-based stove promoters, that are trained by field facilitators in monitoring, user training and marketing, sell at retail prices to the stove end-users and provide *'in-situ'* user training. Portable ceramic stoves that are purchased as replacements or as complementary stoves are noted in the sales book and database, so that emission reduction calculations are made only for one stove per household.

The project manager is responsible for assisting the stove production groups and stove promoters to maintain and make available accurate records and for collating composite electronic and paper sales records. The sales records comprise sales data but also data from the stove production groups[57] including the name of the bulk-buying stove promoter, number and stove serial numbers sold.



The fixed esperanza stove production and distribution system employs ceramicists and masons trained by ProBEC to produce ceramic liners and grates that are checked for quality before being despatched. Trained specialised builders use the liners to construct stoves, under the supervision of field facilitators that have been trained by ProBEC. On commissioning of the stove the end-users (often mothers and daughters) are trained on appropriate use by a field facilitator who also checks the stove for quality. The end-user certifies by signature that the device has been built to specification to authorise payment.
Stove monitors, that are trained and supervised by field facilitators, monitor each stove in the first 6 months of its use and subsequently every 2nd year. The ceramic pot-rest and grate are guaranteed for two months, after which replacement parts are retailed by locally-based monitors. The project manager is responsible for assisting the production centres, field facilitators and stove monitors to maintain and make available accurate records and for collating composite electronic and paper sales records.



[57] The groups will keep separate production data such Stove serial number, moulder, date stove passed quality testing, Date stove fired etc

The Rocket Barn project contracts Specialised Building Team Leaders, trained by HRID field staff, to construct Rocket Barns to specification, under the direct supervision of a Team Supervisor, who in turn is supported by a Field Coordinator. The farmer certifies that the barn has been built to specification to authorise payment. Each Rocket Barn receives a one-year warranty and a health check (i.e. maintenance service conducted to repair barns affected by wear and tear), which is performed by specialised builders and metal workers, under the supervision of team supervisors and field coordinators. After the first year 'health-checks' are performed at a subsidised cost. Barn monitors are trained by HRID monitoring staff prior to the curing season and they perform monitoring tasks each year from January to April. The field manager is responsible for assisting field coordinators and team supervisors to maintain and make available accurate records for collating composite electronic and paper sales records, which is initially forwarded to the Finance Manager for payment purposes and is then passed onto the Information Systems Manager for updating the project database.

Manufacturer and distributions channels, and assignation of 'device-specific' tasks related to training, operation, maintenance and guarantee services are under development for institutional cook-stoves and domestic cook-stoves for peri-urban households.

Annex 4
STOVES, CURING BARNS AND FUELS RELEVANT TO MALAWI

Types of Stoves in Malawi

Mud-stoves are improved stoves made of a mix of local materials such as anthill clay and *dambo* or river sand. They can reduce woodfuel consumption, improve safety and stability of pots and can reduce the negative effects of strong winds. Whether they work efficiently in rural situations is uncertain, as the stove may not be made to design unless a lot of resources are dedicated to training stove builders and monitoring quality. Due to the threat of design drift where the stove is not standardised and the limited durability of the stove, this design is unlikely to be suitable for a large up-scale. As householders often build the mud-stoves themselves the monetary cost for materials is low unless a metal chimney is used.

Details of the **Portable Ceramic Stove** *(Chitetezo Mbaula)* are provided in A.2. The stove retails at MK250 to MK700 (US$1.80 to US5).

The **Kenyan Jico** Improved Charcoal Stove was developed in Kenya and has been adapted in Malawi. The stove has a metal cladding with a ceramic thermal liner that helps increase efficiency compared to the traditional all metal charcoal stove. This stove uses charcoal as a source of fuel that is lit with ignited wood in a 5-10 minute starting process. The stove tends to last for one year, due to the metal used being recycled and low grade, while the ceramic liners lasted for six months although this varied depending on quality and usage.58 The stove price depends on size but retails at MK270 to MK1,000 (US$2 to US7).

The **Bluewave (SuperBlu)** Stove is an ethanol-burning stove developed by Bluewave Ltd in Malawi. It is specially developed to burn in an economic and safe way whereby once the ethanol reaches boiling point, the fuel vaporizes and passes over a copper catalyst at 400° C. Hydrogenation takes place as the ethanol reacts to form acetaldehyde and hydrogen gas. The starting process takes under 5 minutes depending on the fuel levels in the tank. The stove is at a prototype stage and it is difficult to assess the final unit cost. Bluewave has aimed to price the stove at approximately US$10 or MK 1,4000.

The **Gel Fuel** Stove sits in a basic metal frame with a simple ‘can’ structure and regulator. Gel fuel, the source of fuel for the stove, is poured into the can through the middle of the regulator and lit with matches. The gel fuel burns with a blue flame that is turned off by placing a lid over the regulator. Modern gel fuel stoves have dial regulators like normal stoves that can regulate temperatures and put out the fire. The Gel-fuel stove was originally marketed in Lilongwe as a package including a stove and two litre bottles of gel-fuel for MK1,000 (US$7).

Plant oil stoves, such as the Bosch-Siemens PROTOS plant oil stove that is being tested by ProBEC in Tanzania, can use straight plant oils as a fuel are reported to have produced good results but purity of oil seems to play a crucial role. In Malawi there is currently limited production of oils, such as Jatropha, and their access is limited particularly in rural areas. The cost and availability of the stove is also likely to be a challenge.
A wide range of **electric stoves** is available in trading centres and towns retailing from MK3,500 (US$25). **Paraffin stoves** retail at approximately MK2,000 to MK3,000 (US$14 – 21) . **LPG** two-plate stove retails at MK12,000 to MK27,000 (US$86 – 193) and the cylinder costs MK19,321 (US$138) before tax.

Types of Curing Barns in Malawi

[58] “Bio-Ethanol as a Household Cooking Fuel: A Mini Pilot Study of the SuperBlu Stove in Peri-Urban Malawi”, J. Robinson, October 2006.

Although improved barn technologies are available, their use is mainly restricted to large-scale estates. Smallholders do not normally have the necessary capital to invest in other new technologies.

The **conventional barn** is the oldest curing technology in Malawi that is the standard barn for smallholders. Its furnace has a horizontal feed chamber: Because tending a barn is time consuming, users often prefer to over feed the furnace with wood to 'save' labour. The barn is normally built by the farmer with burnt bricks, mud, thatch and metal materials for flues. It is popular amongst smallholder farmers as it is the barn they have used and known. The barn is normally maintained every year. Curing times is approximately 7 days. The barn can cost the farmer an estimated MK85,000 (US$600).

Details of the **Rocket Barn** are provided in A.2. of the PDD. Curing times can be as low as 4 days. The market price is currently at MK140,000 (US$1,000), which includes a one-year warranty on the barn structure and subsidised maintenance and repairs.

Venturi Solar Barn has a fan-assisted furnace to improve combustion. The barn is not currently commercially disseminated and expertise on design is not widely available. The barn including solar powered fans costs approximately MK350,000 (US$2,500).

Chongololo Barn is designed for large-scale estates. A duct from one fire source, normally fuelled with coal, connects seven barns. Since the duct is long, the Chongololo uses fans, which are placed along the duct to evenly distribute the heat to the entire barn. The fans require a constant electricity supply that is often provided by diesel generators. For the Chongololo, it is difficult to monitor the heat and as such it is equipped with thermometers and thermostats. The Chongololo barn has about 7 days turn around period and has the start up capital can be in the excess of MK 5,000,000 (US$35,000).

Types of Fuel in Malawi

According to the 2005 Malawi Integrated Household Survey, the overwhelming majority of Malawians (98.1%) use biomass fuels for cooking. Fuelwood is the most important cooking fuel in Malawi (89%) followed by charcoal (6.8%). Only 1.7% and 0.3% of the population uses electricity and paraffin respectively.

In rural areas the dependence on **biomass fuels** is almost universal (99.6%). Biomass fuels are also dominant in urban areas although to a slightly lesser degree (87.3%). Almost 70% of the woody biomass is used in the household sector (58% rural and 12% urban) while the remaining 30% is absorbed by services and industries such as tobacco processing, tea estates, brick making, fish smoking, etc. In rural Malawi, almost all households collect firewood and cook on three-stone fires. In urban areas, wood is scarcer and many households buy wood and charcoal to fuel stoves. It is estimated that approximately 7 kgs of firewood is used to fire 1kg of charcoal.59 In urban areas where firewood and charcoal are for sale, firewood is less expensive per kg (Price kg of wood = MK 9.11 (US$0.07) Vrs. Price of kg of charcoal MK16.40 (bulk) or MK21.40 (small quantities)), although charcoal is has a higher energy content, is easier to transport and is viewed as more convenient by urban consumers. Over the years prices of cooking fuels have increased significantly at much higher rate than increases in income.60

Malawi is the second country in Africa after Zimbabwe to start blending **ethanol** with gasoline. Since the establishment of ETHCO in 1982, Malawi has been producing an annual production of ethanol of between 10-20

[59] Ibid

[60] Feasibility study for the use of ethanol as a household cooking fuel in Malawi, UNDP Malawi, November 2007.

million litres depending on availability of sugar molasses and requirement of ethanol for petrol blending. Gasoline blending is not compulsory in Malawi although 95% of gasoline consumed in Malawi is blended with ethanol. Initial blending ratio was 20% but has since reduced to 10% with unleaded gasoline. The surplus is used in the local industries or exported. Ethanol can also be made from various biomass feed stocks including cassava and sweet sorghum. Ethanol has been used as a fuel for domestic heating and cooking in Malawi but the fuel is relatively more expensive and is difficult to procure. Ethanol can be converted into Gel-fuel, which has a higher viscosity, making it easier to handle and a safer alternative. In Malawi, a gel fuel factory was set up near Lilongwe with the capacity to produce 1,000 ltr / day. Unfortunately production was halted in 2005 due to increase in the price of ethanol and changes to tax and duty exemption that made the fuel unaffordable to most, costing in excess of MK200 including VAT (US$1.42).

Electricity is a clean and efficient source of energy supply. Malawi generates the vast majority of is electricity from hydropower stations on the Shire River (94%)[61] and the remaining (6%) is generated from diesel-powered thermal plants. Electricity is highly subsidized such that it is the cheapest cooking fuel in the country for those who are connected. However, only 2% of households currently cook with electricity as access to the grid is limited. Another barrier to access electricity is the relatively high cost to install electricity properly so that it is safe to use.

Malawi imports all its petroleum requirements, which constitute 8.8% of Malawi total imports. **Paraffin** or kerosene is a petroleum based fuel and is the main source for lighting for 81% of households. Use of paraffin for cooking is not very common with only 1.2% of urban household's customer base. Initially, paraffin was subsidized so as to encourage use of paraffin over wood fuel but this has since ceased following abuse in the form of smuggling of paraffin to neighbouring countries. Although cleaner than biomass fuels, there are numerous hazards associated with kerosene because of its toxicity and flammability.

Jatropha oil is extracted from the seeds of the jatropha plant. It is currently being produced in Malawi and is used in some rural areas as a fuel for lighting. Current technologies for plant-oil stoves do not limit emissions enough to make jatropha an attractive alternative as a cooking fuel.[62]

Biogas is a clean cooking fuel that is produced through the anaerobic digestion of various organic wastes. Modern biogas digesters designed to produce energy for a household can function on the waste of four humans, or one to two cows. In Tanzania, which had an ambitious programme to disseminate biogas technology in the 1980s , only 200 digesters were operating as of 1991.[63] In Malawi there is potential to use biogas as a clean cooking fuel but currently there are only a small number of biogas users.

Liquefied Petroleum Gas (LPG) is a mixture of propane ad butane. It has a high energy density and can be burned very efficiently and emits few pollutants but releases GHGs into the atmosphere. Its use as a cooking fuel in Africa varies significantly across national borders and is highly dependent on government policy. In Senegal, for example LPG is the principal fuel for 37% of its population, including 71% of urban households.[64] In Malawi, the cost of

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[61] Malawi's hydropower has a potential of powering about 1670 MW.

[62] Market Barriers to Clean Cooking Fuels in Sub-Saharan Africa: A Review of Literature; *An SEI Working Paper of* Nicolai Schlag and Fiona Zuzarte Working Paper, Stockholm Environment Institute, April 2008; A Review of the Household Energy Programme for Cooking – GHA/UNDP/00051634

[63] Low-cost bio-digesters for zero grazing smallholder dairy farmers in Tanzania. Livestock research for rural development, 11(2). Rutamu, I (1999).

[64] ANSD (Agence Nationale de la Statistique et de la démographie) , 2006. Résultants du troisième recensement général de la population et de l'habitat (2002) Rapport National de présentation.

cooking with LPG is higher than all existing fuels in the market and also higher than liquid ethanol. The gap will further widen with the expected price rise for LPG.

Category	Type of Fuel	Type of Stove	Cost of Stove (MK)	Cost (MK) per MJ of energy
Traditional	Firewood	Portable ceramic stove	250 - 700 MK	3.0 MK
		Fixed esperanza stove	2,800 – 3,500 MK	
Intermediate	Charcoal	Kenyan Jico	250-1,000 MK	3.6 MK
	Paraffin	Paraffin Stove	2,000 + MK	9.0 MK
Modern	Ethanol / Gel-fuel	Ethanol Stove / Gel-fuel stove	600 + MK	12.6 MK
	LPG	LPG Stove	12,000 +	13.6 MK
	Electricity	Electric Stove	3,500 + MK	1.6 MK

Table: Comparison of fuels, stoves and their respective prices in fuel categories as grouped by the World Energy Council.[65]

65 Cost per MJ is taken from *Feasibility study for the use of ethanol as a household cooking fuel in Malawi*, UNDP Malawi, November 2007.