**PROJECT DESIGN DOCUMENT FORM
FOR SMALL-SCALE CDM PROJECT ACTIVITIES (F-CDM-SSC-PDD)
Version 04.1**

# PROJECT DESIGN DOCUMENT (PDD)

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|---|---|
| **Title of the project activity** | Improved Cook Stove Project 1, Nkhata Bay District, Malawi |
| **Version number of the PDD** | 1.6 |
| **Completion date of the PDD** | 15/09/14 |
| **Project participant(s)** | The Sigma Global Company Pty Ltd<br>Vimiti Limited |
| **Host Party(ies)** | Malawi |
| **Sectoral scope(s) and selected methodology(ies)** | Sectoral Scope: 3, Energy Demand<br>Project Type: II, Energy Efficiency Improvement Projects<br>Methodology: AMS-II.G, Energy efficiency measures in thermal applications of non-renewable biomass, version 5.0 |
| **Estimated amount of annual average GHG emission reductions** | 32672 $tCO_2e/yr$ |

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

>>

**Purpose**

The project involves dissemination of the Changu Changu Moto high efficiency biomass cook stoves to approximately 19,000 households in Nkhata Bay District, Malawi. The project is being developed under the small scale CDM methodology AMS- II.G. Energy efficiency measures in thermal applications of non-renewable biomass, version 5.

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

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

**Current Scenario**

Malawi's population is over 13 million people, with about 86% living in rural areas and largely dependent on subsistence agriculture and natural resources[1]. The National Statistical Office of Malawi has estimated that the population will be about 18 million by the year 2020. This population growth will significantly increase the demand for natural resources, including fuelwood, water, and the clearing of land for cultivation and settlement.

The forest cover in Malawi is characterised by miombo woodland. The forest in turn falls under three categories of land tenure in Malawi: customary, private and public land tenure1. The distribution and control of Customary land falls under the jurisdiction of Traditional Authorities and leaders, and is administered under customary law. In 2002, out of the total land area of 94,270 $km^2$ of Malawi, 38 % was classified as forest. Of this area, 17 % was classified as natural woodlands on customary lands, 11 % as national parks and game reserves, and the remaining 10 % as forest reserves and protected hill slopes[2]. Wood fuel collection occurs in all categories of land type, but customary forests are currently under the most severe pressure of overexploitation and degradation[3].

The majority of the population in Malawi depend on firewood for cooking, with 97% of households reported to use firewood as a main source of fuel for cooking within the project area[4]. Of households that depend on wood for cooking, 91% are reported to use the three stone fire[5]. Electricity use in Malawi is only 2%, and high electricity tariffs, intermittent supply and the cost of devices are causing reverse fuel-

[1] **Ministry of Natural Resources, Energy and Environment, Malawi Government. 2010.** *Malawi State of Environment and Outlook Report.* s.l. : Environmental Affairs Department, 2010.

[2] *Country Profile - Republic of Malawi.* **Environmental Affairs Department, Ministry of Natural Resources and Environmental Affairs. 2002.** The World Summit on Sustainable Development.

[3] *Modeling choice of fuelwood source among rural households in Malawi: A multinomial probit analysis.* **Jumbe, C. B.L. and Angelsen, A. 2011.** Energy Economics, Vol. 33.

[4] **National Statistical Office, Republic of Malawi. 2010.** *Statistical Yearbook 2010.*

[5] **Department of Energy Affairs, Government of Malawi. 2003.** *National Energy Policy.* Lilongwe : s.n., 2003.

switching away from electricity[6]. This makes the population even more dependent on forest resources, and therefore even more vulnerable to the loss of these resources[7].

Forested areas in Malawi are decreasing at an alarming rate. Reported values likely under represent the amount of deforestation and degradation that has occurred in recent years. The last comprehensive study of forest resources in Malawi was conducted in 1992 and recent estimates of forest areas are based on projections from this study. The 2010 State of Environment Report[8] states:
*"In estimating forest cover, forest reserves and national parks are estimated to be intact but in actual fact they are degraded due to illegal cutting of trees for charcoal and firewood. Although there has not been a recent biomass assessment, it is estimated that forest cover is almost two thirds of what it used to be in 1990s."*

Malawi's Second National Communication to COP of the UNFCCC on Mitigation Analysis For The Forestry And Land Use Sector states that the main causes of forest degradation and deforestation in Malawi are agricultural expansion, high population growth, increased woodfuel demand, and forest fires[9]. Recent estimates of the deforestation rate are around 2.8 % per annum, but is highest in the northern region where the rate is estimated at around 3.4 % per annum. The communication also states that the demand for woodfuel exceeds available sustainable supply and the deficit is increasing every year.

Malawi's National Adaptation Programmes Of Action (NAPA)[10] identified a list of fifteen urgent and immediate priority needs for adaptation. Improving energy access and security in rural areas, including dissemination of improved cook stoves, was identified as one of the fifteen urgent and immediate priority needs. However, this priority need was not included in the first five selected for immediate development, and little progress has been made in this area at a national level since the publication of the NAPA.

Malawi's 2003 Climate Technology Transfer and Needs Assessment[11] also identified the high potential for development of biomass technologies such as improved stoves, but noted that barriers to rapid development of the technologies include inadequate financial resources, high end price for the products and lack of technical capacity.

Comprehensive analysis undertaken in Malawi's Second National Communication to COP of the UNFCCC on Mitigation Analysis For The Forestry And Land Use Sector determined forest protection measures, including measures such as improving the efficiency of cook stoves can reduce carbon emissions in Malawi at a lower cost per tonne (or cost per hectare) than reforestation9. However, they also concluded that inadequate financial resources were currently preventing the implementation of protection measures. The implementation of this project as a CDM project activity will contribute to reversing this trend.
In summary, the current situation in Malawi is one of rapidly depleting forest resources, in part due to the high use of non-renewable biomass by householders for meeting energy needs. The opportunity to improve energy efficiency through replacing the low efficiency 3-stone fire stove, which is the dominant

[6] **Food and Agriculture Organization of the United Nations. 2003.** *Forestry Outlook Study for Africa - Subregional Report Southern Africa.* 2003.
[7] *Country Profile - Republic of Malawi.* **Environmental Affairs Department, Ministry of Natural Resources and Environmental Affairs. 2002.** The World Summit on Sustainable Development.
[8] **Ministry of Natural Resources, Energy and Environment, Malawi Government. 2010.** *Malawi State of Environment and Outlook Report.* s.l. : Environmental Affairs Department, 2010.
[9] **Nkwanda, P., Chanyenga, T., Kasulo, V. and Kalenga Saka, J.D. 2008.** *Malawi's Second National Communication to COP of the UNFCCC - Mitigation Analysis For The Forestry And Land Use Sector.* 2008.
[10] **Environmental Affairs Department, Ministry of Mines, Natural Resources and Environment, Republic of Malawi. 2006.** *Malawi's National Adaptation Programmes of Action under the UNFCCC, First edition.* 2006.
[11] **Environmental Affairs Department, Ministry of Natural Resources and Environmental Affairs, Government of Malawi. 2003.** *Report on Malawi's Climate Technology Transfer and Needs Assessment under UNFCCC - Expedited Phase II.* Lilongwe : s.n., 2003.

firewood end-use system for cooking within Malawi, has been identified, but little progress has been made. This situation is expected to continue without interventions such as the proposed project activity.

**Baseline scenario**
As stated in paragraph 10 of AMS-II.G v5.0, "*it is assumed that in the absence of the project activity, the baseline scenario is the use of fossil fuels for meeting similar thermal energy needs*". Therefore, emission reductions are calculated by multiplying the thermal energy equivalent of annual non-renewable biomass savings by an emission factor for fossil fuels.

**Estimated emission reductions**
As detailed in section B.6, the ex-ante estimate of emission reductions under project is 320,589 $tCO_2e$ over the 10 year crediting period, or an average of 32,059 $tCO_2e$/yr over the same period.

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

- Environmental
  - The project will help significantly reduce Malawi's greenhouse gas emissions;
  - The project will help reduce the use of non-renewable biomass from forests, thus assisting in conserving existing forest stocks, and the protection of natural forest eco-systems and wildlife habitats; and
  - The protection of standing forests will also help protect watersheds, reduce soil erosion and maintain rainfall in the project area.
- Social
  - The Changu Changu Moto stove provides a significantly safer method for cooking with biomass, helping to reduce burn injuries, especially for children;
  - The improved efficiency of the Changu Changu Moto stove significantly reduces wood fuel consumption, meaning that considerably less time is required to collect wood fuel. This reduces the work burden on rural families and allows for alternative opportunities for economic development.
- Health
  - Worldwide, it is estimated that around 1.5 million premature deaths occur annually due to indoor air pollution, with around 15,000 per year in Malawi[12]. Women and children are the main victims. Adoption of more efficient stoves can significantly reduce indoor air pollution respiratory and health problems associated with smoke emission from biomass stoves[13] [14]. The decrease in total biomass burned and an increase in the temperature of combustion in the Changu Changu Moto improved cook stove will result in lower carbon dioxide, carbon monoxide and particulate emissions.
- Economic
  - The project will create employment and contribute to the economic development of Nkhata Bay District through the stove construction, maintenance and monitoring activities.
  - In areas where wood fuel is purchased, use of the Changu Changu Moto stove will significantly reduce household expenditure on cooking fuel.

[12] **Country profile of Environmental Burden of Disease - Malawi.** [Online] 2004. [Cited: 13 June 2012.] http://www.who.int/quantifying_ehimpacts/national/countryprofile/malawi.pdf
[13] *Quantifying the effects of exposure to indoor air pollution from biomass combustion on acute respiratory infections in developing countries.* **Ezzati, M and Kammen, D M. 2001.** 2001, Environ Health Perspect, Vol. 109, pp. 481-488.
[14] **Khennas S., Anderson T., Doig A. and Rees D**., 1999. Rural Energy Services: A Handbook for Sustainable Energy Development. London, United Kingdom: Intermediate Technology Publications

## A.2. Location of project activity

### A.2.1. Host Party(ies)

>>
Malawi

### A.2.2. Region/State/Province etc.

>>
Nkhata Bay District

### A.2.3. City/Town/Community etc.

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This project will install improved cook stoves in eligible households within the boundaries of seven Traditional Authorities within Nkhata Bay District as shown in Table 1. Dwambazi town center is part of Nkhotacota District, but will be included as part of this project due to its proximity to TA Zilakoma.

**Table 1 Traditional Authorities in project boundary**

| Traditional Authority |
|---|
| Mkumbira |
| Mankhambira |
| Fukamalaza |
| Malanda |
| Malengamzoma |
| Fukamapiri |
| Zilakoma |

The total number of eligible households in the project area is estimated at 19,000.
These Traditional Authorities also contain areas that were included in a pilot project. Approximately 2,000 households received Changu Changu Moto improved cook stoves under the pilot project. These households will not be eligible to participate in this project and are not included in the count of eligible households. Procedures to ensure pilot project households are not included in emission reduction calculations are contained in section B.7.3.

### A.2.4. Physical/ Geographical location

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The location of the seven Traditional Authorities that make up the project area is shown in Figure 1.

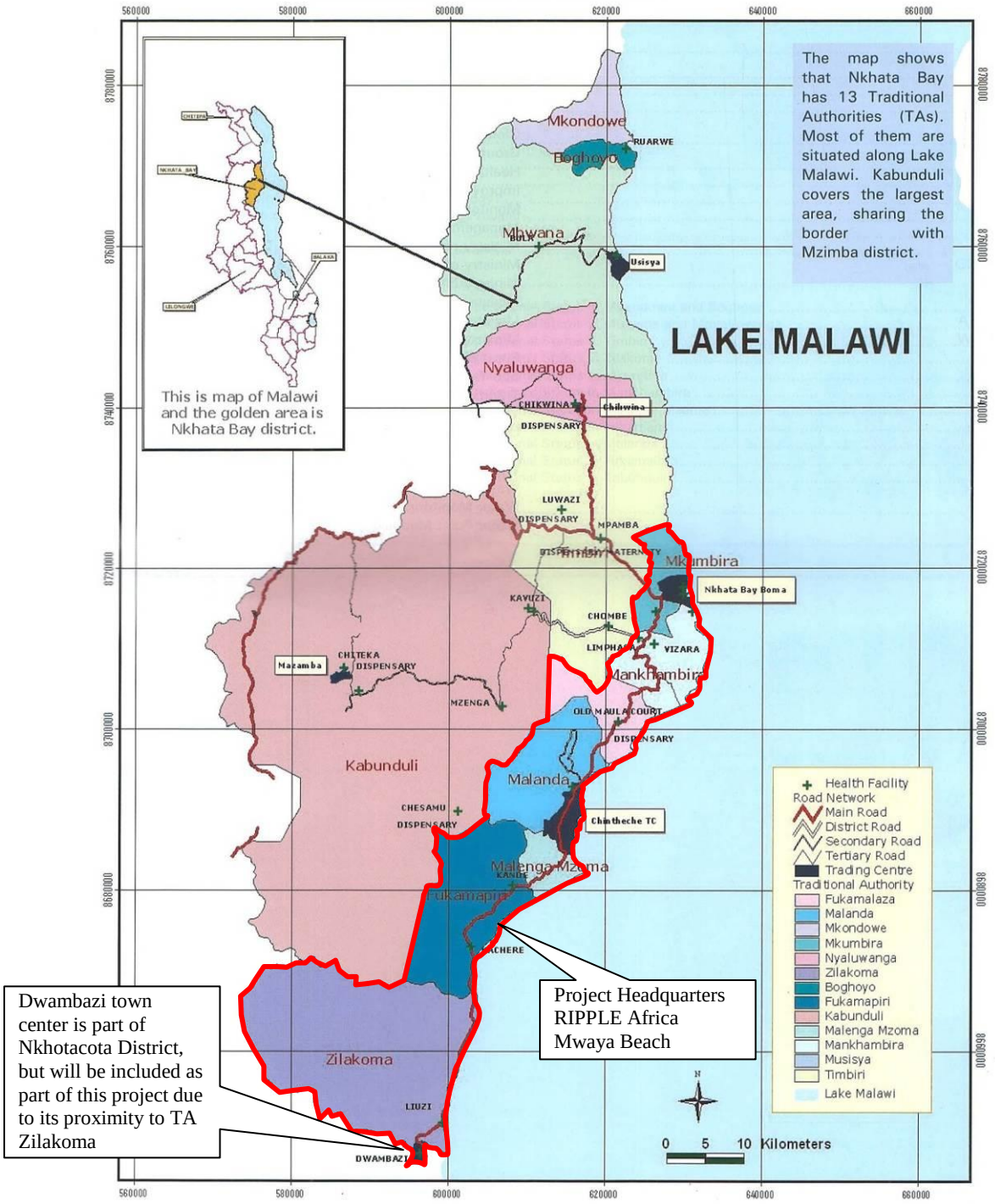


**Figure 1: Map of Nkhata Bay District showing the Traditional Authorities (TAs) where the project will be implemented (within red border)**[15]

The project headquarters will be at RIPPLE Africa, Mwaya Beach, Nkhata Bay District, Malawi. The coordinates of this location are:
11°58'55.06"S 34°4'46.44"E

The geographical extents of the project area are approximately:
North: 11°31'49"S 34°16'2"E

[15] Nkhata Bay District Council, 2012

East: 11°39'55"S 34°19'38"E
South: 12°14'57"S 33°59'41"E
West: 12°4 4'2"S 33°46'35"E

**A.3. Technologies and/or measures**

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**Existing Scenario**

The majority of the population in Malawi and Nkhata Bay District depend on firewood for cooking. Data from the 2010 Statistical Yearbook from the National Statistical Office reproduced in Table 2 shows that, within the project area, 97% of households use firewood as a main source of fuel for cooking[16]. Electricity use within Nkhata Bay District is reported as nil, and only 2% for Malawi as a whole. This compares to 1.7% electricity use reported for Nkhata Bay District in 2004-2005[17], and higher levels in Malawi in previous years, indicating that reverse fuel-switching is occurring[18]. For households that did have electricity, possible reasons for the switch away from electricity include high electricity tariffs, intermittent supply and the cost of devices.

**Table 2: Percentage distribution of households by main source of fuel for cooking[16]**

| | Firewood | Charcoal | Electricity | Solar | Gas | Paraffin | Other |
|---|---|---|---|---|---|---|---|
| **Malawi** | 87.0 | 8.0 | 2.0 | 0.0 | 0.0 | 0.0 | 3.0 |
| **Nkhata Bay District** | 97.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |

Malawi's 2003 Climate Technology Transfer and Needs Assessment[19] describes the dire state of the current technology situation:

> *"Both the urban poor households and rural households predominantly use low efficiency end-use devices...The low efficiency 3-stone fire stove is the dominant firewood end-use systems for cooking. The high household preference for low efficiency firewood and charcoal end-use technologies threatens the sustainability of the environment due to deforestation and greenhouse gas emissions."*

The use of 3 stone fires is also reported as being around 91% in Malawi in the 2003 National Energy Policy[20]. The continued use of 3 stone fires since this date is confirmed by the report Forestry and carbon stocks in Nkhata Bay District [21] that states:

*"In rural areas of Nkhata Bay District, almost every household cooks using wood on a traditional three-stone fire"*

Furthermore, the project implementers have conducted a baseline survey of characteristics and wood fuel use in the project area, as detailed in Appendix 4:Part A. The survey confirmed that the low efficiency 3-stone fire is the dominant end-use systems for cooking within the project area, with 100% of survey respondents reporting that they use this method of cooking. This traditional method of cooking has been in use in Malawi since the first human settlement and new technologies are unlikely to be widely adopted without significant input from programs such as this project (see section B.5 for a further discussion on barriers).

[16] **National Statistical Office, Republic of Malawi. 2010.** *Statistical Yearbook 2010.*
[17] **National Statistical Office, Republic of Malawi. 2005.** *Integrated Household Survey 2004-2005.*
[18] **Food and Agriculture Organization of the United Nations. 2003.** *Forestry Outlook Study for Africa - Subregional Report Southern Africa.* 2003.
[19] **Environmental Affairs Department, Ministry of Natural Resources and Environmental Affairs, Government of Malawi. 2003.** *Report on Malawi's Climate Technology Transfer and Needs Assessment under UNFCCC - Expedited Phase II.* Lilongwe : s.n., 2003.
[20] **Department of Energy Affairs, Government of Malawi. 2003.** *National Energy Policy.* Lilongwe : s.n., 2003.
[21] **Gondwe, Suzgo. 2012.** *Forestry and carbon stocks in Nkhata Bay District.* 2012.

**Figure 2 Typical 3 stone fire being used in Nkhata Bay District**

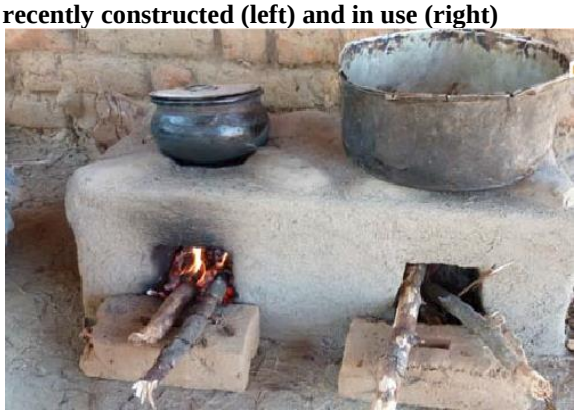
**Baseline Scenario**

As stated in paragraph 10 of AMS-II.G v5.0, "*it is assumed that in the absence of the project activity, the baseline scenario is the use of fossil fuels for meeting similar thermal energy needs*".
Therefore, emission reductions are calculated by multiplying the thermal energy equivalent of annual non-renewable biomass savings by an emission factor for fossil fuels.

**Technology of Project Activity**

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

**Figure 3 The Changu Changu Moto improved cook stove, recently constructed (left) and in use (right)**



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

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

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

The project proponents and RIPPLE Africa have undertaken extensive design trials and community stakeholder consultations to provide a truly sustainable high efficiency biomass fired cook stove. This has resulted in the Changu Changu Moto stove design that brings numerous benefits to Malawi, including:

- **Sustainability**: The Changu Changu Moto fuel-efficient cook stove is made from 100% local materials (including various types of mud, sand and manure, depending on availability), making it a completely sustainable solution for Malawi.
- **Simplicity**: It takes trained persons just one hour to make a Changu Changu Moto fuel-efficient cook stove, and the stove can be used as soon as it dries.
- **Durability**: The Changu Changu Moto fuel-efficient cook stove is strong and sturdy, and any damage can easily be repaired by the householder simply with available materials.
- **Efficiency**: The Changu Changu Moto fuel-efficient cook stove design has been tested by the Malawi Bureau of Standards, who have assessed the thermal efficiency as above 20%[22].
- **Safety**: The Changu Changu Moto fuel-efficient cook stove contains the fire within the stove at the side of the kitchen, so women and children are less likely to incur serious burns compared to a traditional three-stone fire.
- **Health Benefits**: The Changu Changu Moto fuel-efficient cook stove produces substantially less smoke than the traditional three-stone fire, so women and children inhale less smoke and are less likely to have smoke related illnesses.
- **Quality of Life**: Fuel savings mean that the time taken to gather wood is significantly reduced.
- **Culturally Appropriate**: The Changu Changu Moto fuel-efficient cook stove is a two burner design, making it perfectly suited to Malawian cooking methods of simultaneously preparing rice or nsima in one pot, and cooking vegetables or meat, or heating water, in another pot.

**Transfer of technologies and measures and know-how**

The project facilitates transfer and adoption of locally designed and tested technologies appropriate for the local conditions of the project area. The Changu Changu Moto improved cook stoves do not involve exotic parts or tools and promote self-reliance.
Transfer of know-how is facilitated by the training conducted by the project implementation team on construction, use and maintenance of the Changu Changu Moto improved cook stove. Human capacity related to improved household energy technology is further improved by the monitoring that will be conducted under the project.

### A.4. Parties and project participants

| Party involved (host) indicates a host Party | Private and/or public entity(ies) project participants (as applicable) | Indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Malawi (host) | The Sigma Global Company Pty Ltd (private entity)<br>Vimiti Limited (private entity) | No |

### A.5. Public funding of project activity

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The project activity will not receive public funding from any Parties.

[22] See Appendix 3: for details of the test results

### A.6. Debundling for project activity

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Paragraph 7 of the Guidelines on Assessment of Debundling for SSC Project Activities version 3 (Annex 13 from Executive Board meeting 54) states:

*If each of the independent subsystems/measures (e.g., biogas digesters, residential solar energy systems, kerosene or incandescent lighting replacements) included in one or more CDM project activities is no greater than 1% of the small scale thresholds defined by the applied methodology and the subsystems/measures are indicated in the PDDs to be each implemented at or in multiple locations (e.g., installed at or in multiple homes) then these CDM project activities are exempted from performing a de-bundling check, i.e., considered as being not a de-bundled component of a large scale activity.*

As detailed in section B.2, the maximum number of households with an operating improved cook stove is estimated to be 15,200 under this project activity, and the maximum annual energy savings for the project are calculated *ex ante* to be 153.3 $GWh_{th}$. Each household therefore achieves annual energy savings of approximately 10 $MWh_{th}$, and contributes approximately 0.007% to the small-scale threshold. Additionally, the Changu Changu Moto improved cook stoves are to be implemented at multiple households within the project area. Therefore, according to Paragraph 10 of Annex 13 from Executive Board meeting 54, the project activity is exempted from performing a de-bundling check.

## SECTION B. Application of selected approved baseline and monitoring methodology

### B.1. Reference of methodology

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

The project activity meets the applicability criteria of Annex 11 of EB 76 para 14 as follows:

**a) Determination of equipment performance.**

The efficiency of the Changu Changu Moto improved cook stove has been assessed as being above 20% by the Malawi Bureau of Standards[23].

**b) Cases where leakage is to be considered.**

As specified in paragraph 20 of AMS-II.G. the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources must be considered as a potential source of leakage.

Under paragraph 20, the use of a net to gross adjustment factor of 0.95 applied to $B_{old}$ to account for this source of leakage has been chosen by the project participants. The default adjustment factor is chosen to avoid conducting surveys of non-project households/users, which could potentially be located outside the defined project area.

**c) Lifetime of existing equipment.**

With the correct use and maintenance procedures, the lifetime of each Changu Changu Moto high efficiency improved cook stove is in excess of 10 years. The use of virtually unlimited, locally available, natural materials to construct the stove allows repairs and re-builds of stoves to be conducted as required at little cost ad infinitum.

**d) Lifetime of household devices/appliances.**

The eligible households in the project activity do not have any household devices or appliances apart from pots and pans for cooking.

**e) Use of norms, specifications, standards and test procedures cited in the SSC methodology.**

The PDD references all norms, specifications, standards and test procedures as were applied according to the PDD.

[23] See Appendix 3: for details of the test results

**B.2. Project activity eligibility**

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The project activity meets the applicability criteria of AMS - II.G version 5.0 as follows:

1. **This category comprises energy efficiency improvements in thermal applications of non-renewable biomass. Examples of applicable technologies and measures include the introduction of high efficiency biomass fired cook stoves or ovens or dryers and/or energy efficiency improvements in existing biomass fired cook stoves or ovens or dryers.**
   The project activity involves distribution of the Changu Changu Moto high efficiency improved cook stove throughout the project area. The improved cook stoves will replace existing inefficient cook stoves at eligible households using traditional 3 stone fires and will be used for cooking and heating water[24]. The efficiency of the Changu Changu Moto improved cook stove has been assessed as being above 20% by the Malawi Bureau of Standards[25]. The efficiency improvement over the traditional 3 stone fire, will reduce the use of non renewable biomass.

2. **Project participants shall be able to show that non-renewable biomass has been used in the project region since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.**
   Due to Malawi's status as a Least Developed Country, there are very few published reports or literature that include sub-national statistics on forest area and wood fuel use. Of the available published reports and research, most have not been completed within the last 5 years. The most recent information available relating to the region where the project activity is located is from the Nkhata Bay District Council[26].
   The UN FAO Global Forest Resource Assessment 2010 country report for Malawi contains estimates of the total forest area in Malawi, reproduced in Table 3 and Table 4[27]. The data is summarised by the opening paragraph in the report:

   > *"The forest resources in Malawi seem to be declining steadily. The reasons for the decline are attributed to agriculture expansion, dependence on wood fuel for energy, high population growth and high levels of poverty."*

   The FAO data shows that the forest area in Malawi in 1990 was 3,896,000 hectares. The forest area is reported to have declined to 3,237,000 hectares in 2010. The continual decline in forest area from 1990 to 2010 shows that biomass use has been non-renewable since 31st December 1989.

   The use of biomass in Malawi has also been recognised as non-renewable prior to 1990. A UNDP/World Bank report[28] from 1984 noted the country's dependence on firewood as a primary energy source, and stated "The rate of fuelwood consumption exceeds the sustainable yield and this, coupled with population growth, could seriously endanger Malawi's extensive forest resources in the future." The 1998 State of Environment Report[29] it was stated that wood consumption increased from 8.5 million tonnes per year to about 12.5 million tonnes per year over the period 1983-1990, against a sustainable wood supply of 5.2 million $m^3$ per year.

[24] Details of the procedure to confirm household eligibility is contained in section B.7.3
[25] See Appendix 3: for details of the test results
[26] **Gondwe, Suzgo. 2012.** *Forestry and carbon stocks in Nkhata Bay District.* 2012.
[27] **Forestry Department, Food and Agriculture Organisation of the United Nations. 2010.** *Global Forest Resources Assessment - Country Report - Malawi.* Rome : s.n., 2010.
[28] **Ansari, H. 1984.** *Energy Assessment Status Report - Malawi.* s.l. : Joint UNDP/World Bank Energy Sector Management Program, 1984.
[29] **Environmental Affairs Department, Government of Malawi. 1998.** Chapter 4: Forestry. *State of Environment Report for Malawi.* [Online] 1998. http://www.sdnp.org.mw/enviro/soe_report/chapter_4.html.

Further evidence of the decline of forest stocks and use of NRB since 31st December 1989 in the project area is a recent report from the Nkhata Bay District Forestry Officer, "Forestry and carbon stocks in Nkhata Bay District"[26]. This report states that forest reserves in Nkhata Bay District have declined from 221,259 Ha in 1989 to 139,854 Ha in 2010.

**Table 3: Trends in forest area 1990–2010** [27]

| Malawi | 1990 | 2000 | 2005 | 2010 |
|---|---|---|---|---|
| Forest area (1,000 ha) | 3896 | 3567 | 3402 | 3237 |
| Area of primary forest (1,000 ha) | 1727 | 1330 | 1132 | 934 |
| Area of planted forest (1,000 ha) | 132 | 197 | 285 | 365 |

**Table 4: Trends in carbon stock in living forest biomass 1990–2010**[27]

| Malawi | 1990 | 2000 | 2005 | 2010 |
|---|---|---|---|---|
| Carbon stock in living forest biomass (million tonnes) | 173 | 159 | 151 | 144 |

Based on the published reports and research available, one can reasonably assume that non-renewable biomass has been used in the project region since 31 December 1989.

**Demonstration that project activity qualifies as a Type II small scale project activity**

The threshold limit of Type II small scale projects is annual energy savings of 60GWh electrical energy, or 180GWh thermal energy. The total annual thermal energy savings of the improved cook stoves is calculated by multiplying the biomass savings for a period *y* of 1 year by the calorific value of wood.

$$Energy\ savings = B_{y,savings} \times NCV_{biomass} \times N_{i,y}$$

Where:

| | |
|---|---|
| $B_{y,savings}$ | Quantity of woody biomass that is saved in period *y* in tonnes per device |
| $NCV_{biomass}$ | Net calorific value of the non-renewable woody biomass that is substituted (IPCC default for wood fuel, 0.015 TJ/tonne) |
| $N_{i,y}$ | Number of project devices of type *i* operating in period *y* |

Biomass savings are calculated using Option 1[30] under paragraph 12 of AMS.II.G:

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

Where:

| | |
|---|---|
| $B_{old}$ | Quantity of woody biomass used in the absence of the project activity in tonnes per device |
| $B_{y,new,KPT}$ | Quantity of woody biomass used during the project activity in period *y* in tonnes per device, measured as per the Kitchen Performance Test (KPT) protocol. |

As detailed in section B.4, $B_{old}$ is determined by using option (a) under paragraph 13 of AMS.II.G. The average annual quantity of woody biomass used in the absence of the project activity per device is 5.04 t/device/yr[31] [32].

[30] The choice of this option is discussed in section B.6.1

[31] All woody biomass usage figures from KPTs are converted to and quoted on a 0% moisture dry wood basis following the applied KPT procedures specified by the PCIA. The IPCC default NCV for wood fuel in AMS-II.G.

As detailed in section B.7.1, the ex-ante estimate of $B_{y, new, KPT}$ is based on the baseline average annual quantity of woody biomass used in the absence of the project activity and results from the Changu Changu Moto improved cook stove pilot project conducted in 2010-2011. The ex-ante estimate of $B_{y, new,KPT}$ is 2.62 t/device/yr.

The ex-ante estimate of $B_{y, savings}$ is therefore 2.42 tonnes/device

The number operating Changu Changu Moto improved cook stoves will be determined through monitoring as detailed in section B.7.1. The total number of households that will be eligible to participate in the project is estimated to be 19,000, and each household is limited to one operating stove. The maximum proportion of stoves operating is estimated to be 80%, as per section B.7.1, giving a maximum of 15,200 stoves operating. Therefore $N_{max,CCM}$ = 15,200.

The maximum energy savings in any year of the project crediting period are therefore limited to 153.3 GWh of thermal energy.

**B.3. Project boundary**

>>

As stated in AMS-II.G version 5 paragraph 9, "*The project boundary is the physical, geographical site of the efficient systems that burn biomass"*.

The Changu Changu Moto improved cook stove will be distributed throughout seven Traditional Authorities in Nkhata Bay District as detailed in section A.2.3. Therefore, the project boundary is defined by the improved cook stove distribution area of these seven Traditional Authorities.

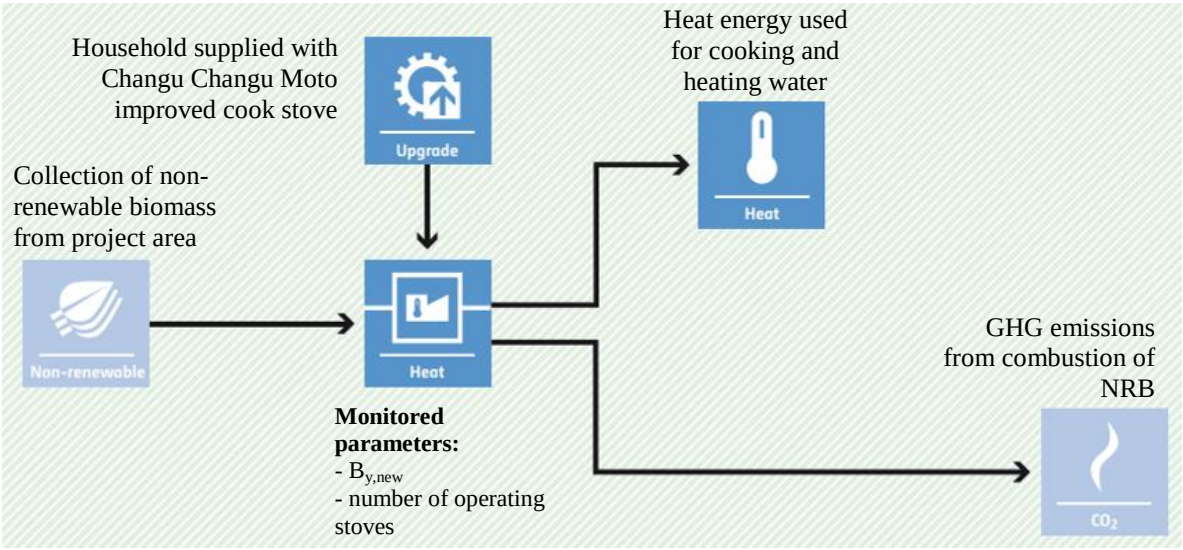
**The project boundary, flows of mass and energy and GHG emissions can also be depicted in a flow diagram of each individual system, as shown in**

Figure 4.

version 5 paragraph 11 is quoted on a "wet basis". The application of a NCV on a wet basis to woody biomass weights converted to 0% moisture dry wood weight is a chosen for conservativeness and to ensure compliance with methodology and KPT procedures simultaneously.

[32] For conservativeness the net to gross adjustment factor to account for leakage is not applied to this calculation of baseline biomass use.

**Figure 4: Flow diagram of project boundary**[33]




## B.4. Establishment and description of baseline scenario

>>

As stated in paragraph 10 of AMS-II.G v5.0, "*it is assumed that in the absence of the project activity, the baseline scenario is the use of fossil fuels for meeting similar thermal energy needs"*. Therefore, emission reductions are calculated by multiplying the thermal energy equivalent of annual non-renewable biomass

[33] Based on diagram from the CDM Methodology Booklet, UNFCCC, May 2012

savings by an emission factor for fossil fuels. The baseline scenario is identified by applying the following steps:

| Step | Description | Data Source(s) | Derived Parameters | Type |
|---|---|---|---|---|
| 1 | Determination of quantity of woody biomass used in the absence of the project activity in tonnes per device | Baseline KPTs, published literature | $B_{old}$ | Fixed |
| 2 | Determination of annual quantity of woody biomass used during the project activity in tonnes per device | *Ex-ante* estimate: pilot project KPTs<br>*Ex post*: Annual KPTs | $B_{y,new,\ KPT}$ | Monitored |
| 3 | Determination of the share of non-renewable biomass | Default value approved by CDM EB | $f_{NRB}$ | Fixed |
| 4 | Determination of the fossil fuel most likely to be used by similar consumers | AMS-II.G. default value | $EF_{projected\_fossilfuel}$ | Fixed |
| 5 | Determination of leakage | AMS-II.G. default value | $L_{NTG}$ | Fixed |
| 6 | Determination of the number of operating devices | *Ex-ante* estimate: implementation schedules<br>*Ex post*: Annual surveys | $N_{i,y}$ | Monitored |

**Step 1: <u>Determination of quantity of woody biomass used in the absence of the project activity</u>**

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

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

A survey involving a questionnaire and a series of Kitchen Performance Tests has been conducted by the project implementer, RIPPLE Africa, within the project area to determine the quantity of woody biomass used in the absence of the project activity. A sample of households from the project area were selected to participate in the survey A detailed description of the survey sampling plan and results is contained in Appendix 4: Part A.
The KPT survey results show that the conservative estimate for the annual consumption of woody biomass per household is 5.04 tonnes/household/year. The number of operating stoves in the project is limited to one per household, so $B_{old}$ = 5.04 tonnes/device/year. The Nkhata Bay District Forestry Officer has reviewed the baseline study and has written that it is an unbiased and reliable estimate of the household wood use for cooking throughout Nkhata Bay District prior to the commencement of the Changu Changu Moto project[34].

Other published historical data available supports this figure:

- The 1999 report "The role of Wood Energy in Africa"[35] reports that the household wood fuel consumption in Malawi for 1996 was 12,160,000 $m^3$. This is equivalent to a household wood fuel use of 4.16t/household/year (see Appendix 4:Part B).
- A recent study into the wood fuel choice of rural households in Malawi[36] analysed the data collected from 2 studies on household wood fuel use in Chimaliro and Liwonde forest reserves

[34] **G. Taliana** "Support of RIPPLE Africa's Baseline Survey and Kitchen Performance Tests**"**, 2013
[35] **Forestry Department, Food and Agriculture Organization of the United Nations,Rome, Italy . 1999.** *The role of Wood Energy in Africa, Wood Energy Today for Tomorrow Regional Studies.* 1999.

located in the Central/Northern and Southern Regions of Malawi, respectively. This study reported the average annual household wood fuel consumption based on forest type (forest reserves, customary forests and plantation forests), and the value was around 4.5t/household/yr for all sources.

- At their 33rd meeting, the SSC Working Group launched a request for public inputs in relation to standardised approaches for facilitating the baseline emission calculations under SSC CDM methodologies for displacement of non-renewable biomass. The proposed regional default value for wood fuel consumption for Tropical Southern Africa, which includes Malawi, was 4.7t/household/year.

**Step 2: Determination of annual quantity of woody biomass used during the project activity**

As explained in section B.6.1, the annual quantity of woody biomass used per device during the project activity, $B_{y,\,new,\,KPT}$ will be determined *ex-post* each year under Option 1 of paragraph 12 of AMS-II.G. version 5.0. The KPTs will be conducted at a sample of households drawn from the project area following the sampling plan detailed in section B.7.2.1. The sampling plan also details the data collection and analysis procedures.

**Step 3: Determination of the share of non-renewable biomass**

The options for determining the fraction of woody biomass saved by the project activity in year *y* that can be established as non-renewable biomass ($f_{NRB,y}$) are defined in paragraph 11 of AMS-II.G. version 5.0 and include the use of survey methods, government data or default country specific values. A default value of 81% for Malawi was approved for use at the 67th Executive Board Meeting[37]. This value was approved by the Malawi DNA on 15th June 2012[38]

The default fraction of non-renewable biomass of 81% is applied to this project and is supported by the following indicators:

**1. Survey results, national or local statistics, studies, maps or other sources of information, such as remote-sensing data, that show that carbon stocks are depleting in the project area;**

Data in the UN FAO Global Forest Resource Assessment 2010 country report for Malawi[39], reproduced in Table 4, shows that carbon stocks in Malawi have decreased from 173 million tonnes in 1990 to 144 million tonnes in 2010.

In addition, the recent report from the Nkhata Bay District Forestry Officer, "Forestry and carbon stocks in Nkhata Bay District"[40], states that forest reserves in Nkhata Bay District have declined from 221,259 Ha in 1989 to 139,854 Ha in 2010.

This information shows that carbon stocks are depleting in the project area, and are expected to continue to do so in the absence of the project activity.

[36] *Modeling choice of fuelwood source among rural households in Malawi: A multinomial probit analysis.* **Jumbe, C. B.L. and Angelsen, A. 2011.** 2011, Energy Economics, Vol. 33.
[37] EB67, Annex 22 - Information note: Default values of fraction of non renewable biomass for least developed countries and small island developing States (version 01.0)
[38] http://cdm.unfccc.int/DNA/fNRB/docs/malawi.pdf
[39] **Forestry Department, Food and Agriculture Organisation of the United Nations. 2010.** *Global Forest Resources Assessment - Country Report - Malawi.* Rome : s.n., 2010.
[40] **Gondwe, Suzgo.** *Forestry and carbon stocks in Nkhata Bay District.* 2012.

**2. A trend showing an increase in time spent or distance travelled for gathering fuel-wood, by users (or fuel-wood suppliers) or alternatively, a trend showing an increase in the distance the fuel-wood is transported to the project area;**

The report "Forestry and carbon stocks in Nkhata Bay District"[40] includes information on the time taken to gather firewood:

*"Due to a reduction in the number of trees, the time spent and the distance travelled to collect wood has increased significantly. Currently, the average amount of time spent collecting wood is around 9 to 18 hours a week per household. This is typically 3 to 6 hours per bundle of wood, 3 days per week, to fuel a traditional three-stone fire. This can vary according to household location and proximity to a wood source. In some areas, where the deforestation is especially bad, it can take the whole day to collect one bundle of wood, and this has to be done three times a week."*

The baseline survey conducted by the project implementer, RIPPLE Africa, within the project area (described in Appendix 4: Part A) collected data on the time taken by households to collect wood. The survey found that the estimated average time to collect one bundle of wood is currently 4.5 hours, compared to 1 hour five years ago. In addition, 82% of households reported that wood is increasingly becoming difficult to find.

In addition, the Integrated Household Survey[41] conducted in 2004-2005 reported that the average weekly hours for persons aged 15 years and over collecting firewood was 2.6hrs in Nkhata Bay District, compared to 1.4hrs on average for the whole of Malawi. These results are consistent with the baseline survey results and show that:

1. the time taken to collect wood has increased significantly in recent years; and
2. the time taken to collect wood in Nkhata Bay District is higher than the national average, possibly due to less people buying wood than in regions of extreme wood scarcity, such as the south of the country.

**Step 4: <u>Determination of the fossil fuel most likely to be used by similar consumers</u>**

The emission factor for the substitution of non-renewable woody biomass by similar consumers, $EF_{projected\_fossilfuel}$ , is specified in AMS-II.G. as 81.6 $tCO_2/TJ$. As stated in the methodology, this value represents the emission factor of the substitution fuels likely to be used by similar users, on a weighted average basis. The assumed mix of fuels is based on a ladder of fuel choices, similar to that shown in Figure 5. It is assumed that the mix of present and future fuels used would consist of coal (50% weighting) as the alternative solid fossil fuel, and mix of Kerosene and Liquefied Petroleum Gas (LPG) as higher order liquid and gaseous fuel choices respectively (both assigned 25% weighting).

[41] **National Statistics Office, Government of Malawi.** *Integrated Household Survey 2004-2005.* 2005.

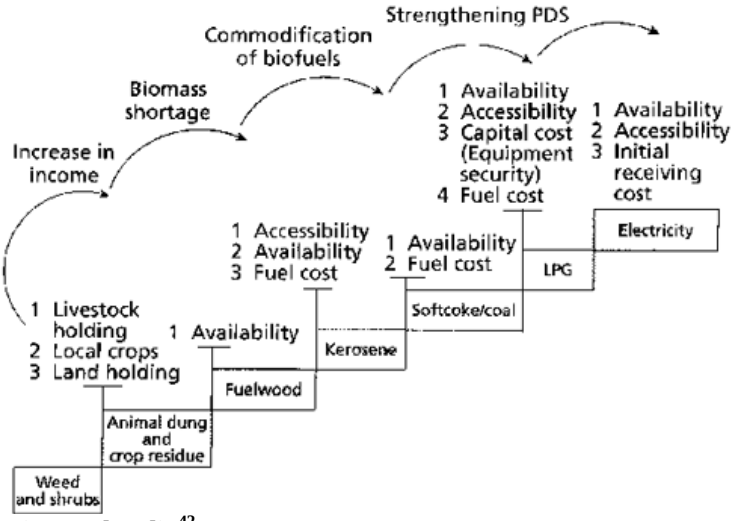



**Figure 5: Energy ladder in rural India**[42]

**Step 5: <u>Determination of leakage</u>**

As specified in paragraph 20 of AMS-II.G. the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources must be considered as a potential source of leakage.

Under paragraph 20, the use of a net to gross adjustment factor of 0.95 applied to $B_{old}$ to account for this source of leakage has been chosen by the project participants. The default adjustment factor is chosen to avoid conducting surveys of non-project households/users, which could potentially be located outside the defined project area.

**Step 6: <u>Determination of the number of operating devices</u>**

As explained in section B.6.1, the number of project devices operating will be determined *ex-post* each year following paragraph 22 of AMS-II.G. version 5.0. The number of operating devices will be determined from a sample of households drawn from the project area following the sampling plan detailed in sectionB.7.2.2. The sampling plan also details the data collection and analysis procedures.

**B.5. Demonstration of additionality**

>>

As per the Guidelines on the demonstration of additionality of small-scale project activities v9.0 (EB 68 Annex 27), certain technologies and project types are defined as automatically additional for project sizes up to and including the small-scale CDM thresholds.

Specifically, paragraph 2 (c) of EB 68 Annex 27 includes "Project activities solely composed of isolated units where the users of the technology/measure are households or communities or Small and Medium Enterprises (SMEs) and where the size of each unit is no larger than 5% of the small-scale CDM thresholds" on the positive list.

As detailed in section B.2, this project is below the threshold limit of 180GWh thermal energy savings per year for Type II small scale project activities. Additionally, as detailed in section A.6, each Changu Changu Moto improved cook stove, is an isolated unit used by a householder, and is estimated to achieve

[42] **Malhotra, Preeti.** Environmental implications of the energy ladder in rural India. *HEDON Household Energy Network.* [Online] [Cited: 26 June 2012.] http://www.hedon.info/BP42_EnvironmentalImplicationsOfTheEnergyLadderInRuralIndia.

annual energy savings of approximately 10 MWh thermal, contributes approximately 0.007% to the overall savings.

The project activity therefore meets the requirements of paragraph 2 (c) of EB 68 Annex 27, and is deemed automatically additional.

**Demonstration of prior consideration of the CDM**

The Prior Consideration of the CDM Form was sent on the 19th June 2012 to the CDM Registration Team and to the Malawi Designated National Authority. Both organisations confirmed receipt of the document.

**B.6. Emission reductions**
**B.6.1. Explanation of methodological choices**
>>
Under AMS-II.G. version 5.0, emission reductions are calculated using equation (1) in paragraph 11:

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

Where:

| | |
|---|---|
| $ER_y$ | Emission reductions during the year *y* in $tCO_2e$ |
| $B_{y,savings}$ | Quantity of woody biomass that is saved in tonnes per device |
| $f_{NRB,y}$ | Fraction of woody biomass saved by the project activity in year *y* that can be established as non-renewable biomass |
| $NCV_{biomass}$ | Net calorific value of the non-renewable woody biomass that is substituted |
| $EF_{projected\_fossilfuel}$ | Emission factor for the substitution of non-renewable woody biomass by similar consumers. |
| $N_{y,i}$ | Number of project devices of type *i* operating in year *y* |

For this project activity, the calculation is refined further to allow for monitoring periods that are not equal to one year[43], fix the value for the fraction of non-renewable biomass (see section B.6.2) and limit the number of operating stoves to one stove type:

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

Where:

| | |
|---|---|
| $ER_y$ | Emission reductions during the period *y* in $tCO_2e$ |
| $B_{y,savings}$ | Quantity of woody biomass that is saved in period *y* in tonnes per device |
| $f_{NRB}$ | Fraction of woody biomass saved by the project activity established as non-renewable biomass |
| $NCV_{biomass}$ | Net calorific value of the non-renewable woody biomass that is substituted |
| $EF_{projected\_fossilfuel}$ | Emission factor for the substitution of non-renewable woody biomass by similar consumers. |
| $N_{y,CCM}$ | Number of Changu Changu Moto improved cook stoves operating in period *y* |
| *y* | Length of period *y*, in years |

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

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

[43] For example, due to the phased implementation of the improved cook stoves.

Where:

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

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

- To be consistent with the baseline quantity of woody biomass used in the absence of the project activity (also determined using the KPT);
- The KPT is a field test used to evaluate stove performance in real-world settings and is designed to assess actual impacts on household fuel consumption[44]. KPTs typically give the best indication of real world changes, and therefore the most accurate estimate of wood fuel use.
- Undertaking the KPTs is compatible with the structure of the project implementation and monitoring team.

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

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

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

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

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

Where:

| | |
|---|---|
| $B_{old}$ | Quantity of woody biomass used per device in the absence of the project activity |
| $L_{NTG}$ | Net to gross adjustment factor to account for the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources |

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

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

**B.6.2. Data and parameters fixed ex ante**

[44] Stove Testing. *Partnership for Clean Indoor Air.* [Online] [Cited: 6 June 2012.] http://pciaonline.org/testing.

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

| | |
|---|---|
| **Data / Parameter** | $EF_{projected\_fossilfuel}$ |
| **Unit** | $tCO_2/TJ$ |
| **Description** | Emission factor for the substitution of non-renewable woody biomass by similar consumers. |
| **Source of data** | Weighted average of the emission factors of substitution fuels likely to be used by similar consumers |
| **Value(s) applied** | 81.6 |
| **Choice of data or Measurement methods and procedures** | Default value provided in AMS-II.G. |
| **-Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | |

| | |
|---|---|
| **Data / Parameter** | $f_{NRB}$ |
| **Unit** | Fraction |
| **Description** | Fraction of non-renewable woody biomass saved by the project activity |
| **Source of data** | UNFCCC CDM website[45] |
| **Value(s) applied** | 0.81 |
| **Choice of data or Measurement methods and procedures** | Default Malawi specific value available on the CDM website as approved by CDM EB and the Malawi DNA. This value is fixed for the crediting period, so $f_{NRB,y} = f_{NRB} = 0.81$ |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | |

[45] http://cdm.unfccc.int/DNA/fNRB/index.html

| | |
|---|---|
| **Data / Parameter** | $B_{old}$ |
| **Unit** | tonnes/device/yr |
| **Description** | Quantity of woody biomass used per device in the absence of the project activity |
| **Source of data** | Survey/testing of local usage |
| **Value(s) applied** | 5.04 |
| **Choice of data or Measurement methods and procedures** | The value of $B_{old}$ has been determined through a survey and series of Kitchen Performance Tests conducted by the project implementer, RIPPLE Africa, within the project area. A sample of households from the project area was selected to participate and the data collected during July-August 2012. A detailed description of the sampling plan and results of the survey is contained in Appendix 4:Part A. |
| **Purpose of data** | Calculation of baseline emissions |
| **Additional comment** | |

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

**B.6.3. Ex-ante calculation of emission reductions**

>>

The calculation of $B_{old,leakage}$ is as follows:

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

Where:

| | |
|---|---|
| $B_{old}$ | Quantity of woody biomass used per device in the absence of the project activity |
| $L_{NTG}$ | Net to gross adjustment factor to account for the use/diversion of non-renewable biomass saved under the project activity by non-project households/users that previously used renewable energy sources |

Substituting values from sections B.6.2 we get:
$B_{old,leakage}$ = 5.04 x 0.95 = 4.788 tonnes woody biomass/device/year.

The *ex-ante* estimate for $B_{y,new,KPT}$ is 2.62 tonnes/device/year as shown in section B.7.1.

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

$$B_{y,savings} = B_{old,leakage} - B_{y,new,KPT} = 4.788\text{-}2.62 = 2.168 \text{ tonnes/device/year}$$

The emission reductions are calculated as:

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

Where:

| | |
|---|---|
| $ER_y$ | Emission reductions during the period *y* in $tCO_2e$ |
| $B_{y,savings}$ | Quantity of woody biomass that is saved in period *y* in tonnes per device |
| $f_{NRB}$ | Fraction of woody biomass saved by the project activity established as non-renewable biomass |
| $NCV_{biomass}$ | Net calorific value of the non-renewable woody biomass that is substituted |
| $EF_{projected\_fossilfuel}$ | Emission factor for the substitution of non-renewable woody biomass by similar consumers. |
| $N_{y,CCM}$ | Number of Changu Changu Moto improved cook stoves operating in period *y* |
| *y* | Length of period *y*, in years |

Substituting values from above and sections B.6.2 and B.7.1, the ex ante estimate of emission reductions for year 1 becomes:
$ER_y$ = 2.168 x 0.81 x 0.015 x 81.6 x 15,200 x 1 = 32,672 $tCO_2e$.

Ex ante estimates of emission reductions for subsequent years of the crediting period are calculated in a similar manner and are contained in section B.6.4.

**B.6.4. Summary of ex-ante estimates of emission reductions**

| Year | Baseline emissions ($tCO_2$ e) | Project emissions ($tCO_2$ e) | Leakage ($tCO_2$ e) | Emission reductions ($tCO_2$ e) |
|---|---|---|---|---|
| Sept 2014 to Sept 2015 | 75952 | 39483 | 3798 | 32672 |
| Sept 2015 to Sept 2016 | 75952 | 39483 | 3798 | 32672 |
| Sept 2016 to Sept 2017 | 75952 | 39483 | 3798 | 32672 |
| Sept 2017 to Sept 2018 | 75952 | 39483 | 3798 | 32672 |
| Sept 2018 to Sept 2019 | 75952 | 39483 | 3798 | 32672 |
| Sept 2019 to Sept 2020 | 75952 | 39483 | 3798 | 32672 |
| Sept 2020 to Sept 2021 | 75952 | 39483 | 3798 | 32672 |
| Sept 2021 to Sept 2022 | 75952 | 39483 | 3798 | 32672 |
| Sept 2022 to Sept 2023 | 75952 | 39483 | 3798 | 32672 |
| Sept 2023 to Sept 2024 | 75952 | 39483 | 3798 | 32672 |
| **Total** | 759522 | 394831 | 37976 | 326715 |
| **Total number of crediting years** | 10 | | | |
| **5.04Annual average over the crediting period** | 75952 | 39483 | 3798 | 32672 |

**B.7. Monitoring plan**

**B.7.1. Data and parameters to be monitored**

Data / Parameter table 1 and table 2 are completed below as per AMS-II.G version 5 section 5.1.
Data / Parameter tables 3,4, 5 and 6 are not applicable due to the methodological choices made for this project as described in section B.6.1. Data / Parameter table 7 is included as a fixed parameter in section B.6.2. Data / Parameter table 4 is included to demonstrate how the monitoring requirement of AMS-II.G version 5 paragraph 26 will be followed.

Please also refer to Appendix 5 which contains further monitoring information including the operational and management structure in place to implement the monitoring plan and quality assurance and quality control procedures.

**Data / Parameter table 1.**

| | |
|---|---|
| **Data / Parameter** | $N_{y,CCM}$ |
| **Unit** | none |
| **Description** | Number of operating Changu Changu Moto improved cook stoves in period y |
| **Source of data** | A survey conducted in the project area at a sample of households by the project implementers |
| **Value(s) applied** | The ex-ante estimated values used for the purposes of calculating estimated emission reductions are shown in the table below. These values have been estimated by the Project Participants and project implementers based on the estimated number of eligible households (19,000), expected project implementation rate and estimated stove usage rates. Following implementation, including training, it is estimated that the stove usage rates will be approximately 80%, giving a maximum of 15,200 operating stoves in any one year. The survey will also record which households are using baseline stoves. |

| 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|
| 15,200 | 15,200 | 15,200 | 15,200 | 15,200 | 15,200 | 15,200 | 15,200 | 15,200 | 15,200 |

| | |
|---|---|
| **Measurement methods and procedures** | During the project crediting period the parameter will be calculated at least biennially by following the sampling plan detailed in section B.7.2.2. |
| **Monitoring frequency** | At least annually |
| **QA/QC procedures** | As per the sampling plan detailed in section B.7.2.2. and in Appendix 5 |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | |

**Data / Parameter table 2.**

| | |
|---|---|
| **Data / Parameter** | $B_{y,new,KPT}$ |
| **Unit** | tonnes/device/yr |
| **Description** | Quantity of woody biomass used per device during the project activity in period *y* |
| **Source of data** | Kitchen Performance Tests conducted at a sample of households within the project area by the project implementers |
| **Value(s) applied** | The ex-ante estimate value used for the purposes of calculating estimated emission reductions is 2.62 tonnes/device/yr. This value has been calculated based on results from Kitchen Performance Tests conducted by the project implementers in households participating in the pilot project and the baseline average annual quantity of woody biomass used in the absence of the project activity. The calculation of this number is detailed in Appendix 4:Part A. |
| **Measurement methods and procedures** | During the project crediting period the parameter will be calculated at least annually by following the sampling plan detailed in section B.7.2.1. |
| **Monitoring frequency** | At least annually. |
| **QA/QC procedures** | As per the sampling plan detailed in section B.7.2.1. and in Appendix 5 |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | |

**Data / Parameter table 3.**

| | |
|---|---|
| **Data / Parameter** | $f_{NRB}$ |
| **Unit** | Fraction |
| **Description** | Fraction of non-renewable woody biomass saved by the project activity |
| **Source of data** | UNFCCC CDM website[46] |
| **Value(s) applied** | 0.81 |
| **Measurement methods and procedures** | Default Malawi specific value available on the CDM website as approved by CDM EB and the Malawi DNA. During the project crediting period the parameter will be monitored on the CDM website annually. |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | |

**Data / Parameter table 4.**

| | |
|---|---|
| **Data / Parameter** | $B_{old}$ |
| **Unit** | Tonnes/device/yr |
| **Description** | Fuel-wood consumption of baseline stoves |
| **Source of data** | A survey conducted in the project area at a sample of households by the project implementers |
| **Value(s) applied** | Information on households still using baseline stoves will be extracted from the survey conducted to determine the number of operating Changu Changu Moto improved cook stoves as detailed in Data / Parameter table 1. Information will also be recorded on which households continue to use the baseline stove i.e. the three stone fire. Households still using a baseline stove will be completely excluded from the project activity (reducing the total number of households) and added as baseline emissions. Therefore, $B_{old}$ is quantity of woody biomass used in the absence of the project activity in tonnes per device. |
| **Measurement methods and procedures** | During the project crediting period the parameter will be calculated at least biennially by following the sampling plan detailed in section B.7.2.2 |
| **Monitoring frequency** | At least annually |
| **QA/QC procedures** | As per the sampling plan detailed in section B.7.2.1. and in Appendix 5 |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | |

[46] http://cdm.unfccc.int/DNA/fNRB/index.html

**B.7.2. Sampling plan**

>>

**B.7.2.1. Sampling plan for the determination of the annual quantity of woody biomass used during the project activity**

The sampling plan has been designed in accordance with Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0 and Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.
It follows the recommended outline for a sampling plan in Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.
Practices for sample design and administering of the surveys and field measurements are based on *Household Sample Surveys in Developing and Transition Countries* [47] as recommended in Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.

**Sampling Design**

**Objectives and Reliability Requirements**

The objective of this sampling plan is to determine an estimate of $B_{y,new,KPT}$, the quantity of woody biomass used per device during the project activity in period *y*. $B_{y,new,KPT}$ will be measured as per the Kitchen Performance Test (KPT) protocol, with a 90% confidence interval and a 10% margin of error. The KPTs will be carried out in accordance with procedures specified by the Partnership for Clean Indoor Air (PCIA)[48].

**Target Population**

The target population includes all households participating in the project, as described in section A.1 and A.2. The target population is all individual households within each chief area in the Traditional Authorities within the project area. Each household has a chief. The total number of eligible households in the project area is estimated at 19,000. Procedures to ensure pilot project households are not included in emission reduction calculations are contained in section **Error! Reference source not found.**

**Sampling Method**

The sampling method to be used is multi-stage sampling using a self weighting sampling procedure as per as per section II.E of Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0. Nkhata Bay District covers an area of 4,071 $km^2$. Transport infrastructure is limited, access to liquid fuels in Malawi is limited, and times and costs to travel within the district can be high. Multi-stage sampling was selected to significantly improve the efficiency and reduce the costs of the sampling compared to a simple random sample.

The primary sampling unit (PSU) includes all eligible households in the project area and is defined as each village under a chief (chief area) in the Traditional Authorities within the project area. The ultimate sampling units are defined as individual households within each chief area and include all households in the target population.

Each PSU will be checked to ensure it is sufficiently large enough to select the required number of households if required (i.e. as 15 households are to be selected from each PSU, as described below, each PSU must contain at least 15 households). Any PSUs below the minimum size will be combined with other adjacent PSUs.

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

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

[48] http://www.pciaonline.org/node/1049

12 PSUs will be selected with PPS sampling, and 15 households will be selected from each PSU using a simple random sample without replacement, both stages conducted using a statistical software package. The sampling plan is summarised in Table 5. In this sample design, each sample is self-weighting. Adjustments to weights may be required following data collection due to issues such as non-response. This procedure is described in the section "Quality Assurance/Quality Control".

**Table 5 Summary of sampling plan**

| **Summary** | | | **Stage 1** | **Stage 2** |
|---|---|---|---|---|
| Design Variables | Multi-stage sampling | | *Chief Ref* | *Household Ref* |
| Sample Information | Selection Method | | PPS sampling without replacement | Simple random sampling without replacement |
| | Measure of Size | | Obtained from data | |
| | Number of Units Sampled | | 12 | 15 |
| | Variables Created or Modified | Stagewise Inclusion (Selection) Probability | *InclusionProbability_1_* | *InclusionProbability_2_* |
| | | Stagewise Cumulative Sample Weight | *SampleWeightCumulative_1_* | *SampleWeightCumulative_2_* |
| Analysis Information | Estimator Assumption | | Unequal probability sampling without replacement (using joint inclusion probabilities) | Equal probability sampling without replacement |
| | Inclusion Probability | | Obtained from variable *InclusionProbability_1_* | Obtained from variable *InclusionProbability_2_* |
| Weight Variable: | | | *SampleWeight_Final_* | |

**Sample Size**

The sample size is the total number of households selected to participate in the KPTs. The parameter of interest is the average annual household use of woody biomass under the project in period *y*. The sample consists of 15 households from each of the 12 PSUs, giving a total sample size of 180 households as described below.

The number of PSUs to be sampled is calculated using equation 77 from the Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0 for multi-stage sampling as follows:

$$c = \frac{\frac{SD_B^2}{clustermean^2}\frac{M}{(M-1)} + \frac{1}{b}\frac{SD_W^2}{Overallmean^2}\frac{(\overline{N}-u)}{(\overline{N}-1)}}{\frac{d^2}{z^2} + \frac{1}{(M-1)}\frac{SD_B^2}{Clustermean^2}}$$

Where:

| | |
|---|---|
| $M$ | Total number of PSUs (chief areas) in the sampling frame |
| $c$ | Number of PSUs to be selected in stage 1 |
| $\overline{N}$ | Average number of households per PSU in the sampling frame |
| $u$ | Number of households to be selected per PSU in stage 2 |
| $Clustermean$ | Expected total mean wood use for each PSU |
| $Overallmean$ | Expected mean wood use per household |
| $SD_B^2$ | Expected unit variance between PSUs |
| $SD_W^2$ | Expected within PSU variance |
| $z$ | critical standard score for the required confidence level (1.645 for 90% confidence level) |
| $d$ | required precision (10%) |

The sample size is then calculated as
$n_c = u.c$

Where:

| | |
|---|---|
| $n_c$ | Sample size for the complex sample |

The number of households to be selected per PSU is selected as 15. The expected total mean wood use per PSU and per household and expected variances are based results from the baseline KPT study[49]. Data from this survey gave a mean wood use per household of 14.93 kg/day, and total mean wood use per village of 1539 kg/day. In addition, the unit variance between PSUs and within PSU variance were calculated as 101,453 and 4.77respectively. A total of 233 eligible PSUs were counted in the project area, with an average size of 82 households per PSU. The sample size calculation then gives a total of 12 PSUs to be selected of 15 households each, giving a total sample of 120 households to meet 90/10 confidence/precision requirements.

**Sampling Frame**

The sampling frame consists of the 7 Traditional Authorities that make up the project boundary detailed in section A.2. The sampling frame will be limited to the households that have had Changu Changu Moto improved cook stoves installed and are using the stoves at the time the sampling is conducted. Thus, the sampling frame will change as project implementation progresses.
Comprehensive record keeping in the project database will eliminate the risk that the sample frame does not cover the entire target population.

**Data**

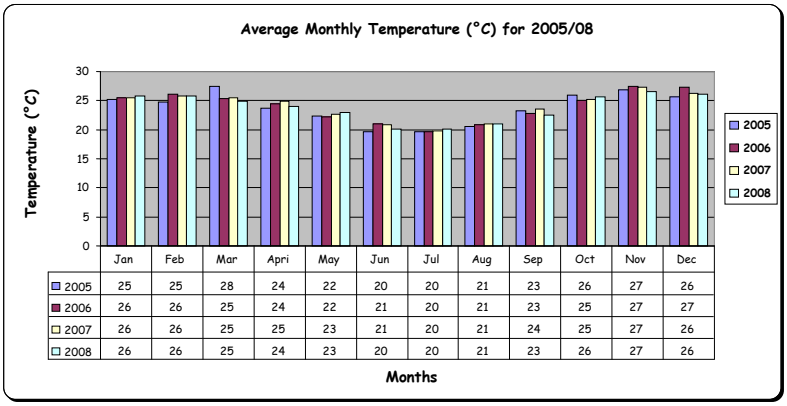
**Field Measurements**

The data will be collected as per the KPT protocol[50] from eligible households. An initial check will be conducted to determine if the household is currently using the project stove, as per the sampling plan in section B.7.2.2. If the household is not using the project stove, the KPT will not be conducted. If the household is using the project stove, the average daily household use of woody biomass will then be calculated by measuring the wood moisture content and the mass of wood used each day by the household for a period of 3 days. Households will be instructed to only use woody biomass for the duration of the test, and no biomass residues such as maize cobs or cassava stems.

The average daily household use of woody biomass during the testing period will then be scaled up to calculate the average annual household use of woody biomass. Household use of biomass during the project can also be subject to seasonal variations, primarily due to temperature, where additional wood may be used during winter months (May to September, as shown in Figure 6). A separate fire, called a

[49] See Appendix 4, Part A.
[50] http://www.pciaonline.org/node/1049

mphala, is often used for heating by men in areas outside the kitchen, but the baseline stove used for cooking is also sometimes used for heating the kitchen.
Wood used in any mphalas will not be included in the measurement. The wood use for heating with the Changu Changu Moto improved cook stove will not be separated from the wood use for cooking and heating water during the testing to ensure a conservative estimate and equivalency with the baseline test procedure. In addition, the testing will be conducted during a similar period to the baseline study to ensure equivalency.




| | Jan | Feb | Mar | Apri | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 25 | 25 | 28 | 24 | 22 | 20 | 20 | 21 | 23 | 26 | 27 | 26 |
| 2006 | 26 | 26 | 25 | 24 | 22 | 21 | 20 | 21 | 23 | 25 | 27 | 27 |
| 2007 | 26 | 26 | 25 | 25 | 23 | 21 | 20 | 21 | 24 | 25 | 27 | 26 |
| 2008 | 26 | 26 | 25 | 24 | 23 | 20 | 20 | 21 | 23 | 26 | 27 | 26 |

**Figure 6 Average Monthly Temperatures for Nkhata Bay District in the years 2005-2008**[51]

### Quality Assurance/Quality Control

The sampling and testing will be conducted by the project implementer, RIPPLE Africa, with support from the project participants. All staff involved in testing have been given comprehensive training in conducting KPTs by the Malawi Projects Manager, and the Technical Manager from Sigma Global.

Equipment used for data collection during the KPTs includes scales and electronic moisture meters. All equipment has been certified and records are available to view. Certification of equipment will be repeated at least every 3 years during the project crediting period.

Data collected during the KPTs will be recorded on printed data collection sheets. Calculations of daily household wood use will be completed in the field each day following weighing of the remaining wood piles, and recorded on the data collection sheet. This will allow for immediate investigation of any values that appeared to be outliers. Any reasons for abnormal results will also be recorded on the data collection sheet.

Electronic data entry will occur as soon as possible after the completion of the testing at each household. Any calculations will be performed in the spreadsheets by in-built formulas. Any cells with formulas in data entry spreadsheets are locked to prevent unauthorised changes.

Written and electronic copies of the test results will be backed up in multiple locations and archived for the duration of the project crediting period.

Following data entry, a box plot of the data will be used to help identify any outliers. Any potential reasons for outlier results recorded during data collection will also be analysed and a decision made regarding removal of the potential outlier. Outliers will only be removed when there is a valid reason, following the principle of conservativeness.

Provisions to maximise response rates will be implemented. As described above, the sample size has been calculated to allow for a conservative 20% non-response rate though inclusion of a reserve sample of 3

[51] **District Commissioner.** *Nkhata Bay District Assembly Socio-Economic Profile 2009/2012.* 2009.

households in each PSU to allow for a number of households being unable to or un-willing to participate in the survey for some reason.

No systematic differences between respondents and non-respondents are expected. However, steps will be taken to minimise the amount of missing data to minimise the potential for bias.
The potentially biasing effect of any unit non-response will be reduced through the creation of a reserve sample of 3 households in each PSU from which replacement households will be selected in the case of non-response, and through non-response weighting adjustment for remaining non-responsive households.

**Analysis**

Complex sampling designs can improve the data collected for a given budget, but make data analysis more difficult. Ignoring the sample design in the analysis leads to biased and misleading estimates of the standard error. Confidence intervals and statistical tests will then be incorrect if the effects of the complex sample design are ignored.

The data collected from the complex survey design will be analysed using procedures and statistical software packages appropriate to complex survey design data analysis to calculate a population estimate of the average annual quantity of woody biomass used per household during the project activity, along with a confidence interval.

The sampling procedure is designed to be self weighting, but the weights of some observations may change due to non-response or removal of outliers. Weights will be recalculated prior to data analysis to ensure non-biased estimates of the parameters.

As a conservative assumption, no adjustment will be made to the average daily household use of woody biomass during the testing period to account for wood used for heating before scaling to an annual value.

**Implementation**

The sampling plan and testing will be conducted by the project implementer, RIPPLE Africa with support from the Project Participants. The tests will be conducted at least annually for the duration of the crediting period. The work plan for conducting the KPTs at the households selected at each PSU has been developed according to the KPT Protocol and is shown in Table 6. The organisation chart and roles and responsibilities for the implementation team is shown in Appendix 5:

**Table 6 Plan for conducting KPTs at each PSU**

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

**B.7.2.2. Sampling plan for the determination of the number of operating devices**

The sampling plan has been designed in accordance with Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0 and Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.
It follows the recommended outline for a sampling plan in Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0.

**Sampling Design**

**Objectives and Reliability Requirements**

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

**Target Population**

The target population includes all households participating in the project, as described in section A.1 and A.2.

**Sampling Method**

The sampling method to be used is multi-stage sampling using a self weighting sampling procedure as per section II.E of Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0. As detailed below, the same households selected in the sampling plan for the determination of the annual quantity of woody biomass used during the project activity will be used for this sample. The sampling method for these households is detailed in section B.7.2.1.

**Sample Size**

The sample size is the total number of households selected to participate in the survey. The parameter of interest is the proportion of stoves operating in period *y*. The sample consists of 15 households from each of the 12 PSUs, giving a total sample size of 180 households as described below.

The number of PSUs to be sampled is calculated using equation 55 from the Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities version 3.0 for multi-stage sampling as follows:

$$c = \frac{\frac{SD_B^2}{\overline{p}^2}\frac{M}{(M-1)} + \frac{1}{b}\frac{SD_W^2}{p^2}\frac{(\overline{N}-u)}{(\overline{N}-1)}}{\frac{d^2}{z^2} + \frac{1}{(M-1)}\frac{SD_B^2}{\overline{p}^2}}$$

Where:

| | |
|---|---|
| $M$ | Total number of PSUs (chief areas) in the sampling frame |
| $c$ | Number of PSUs to be selected in stage 1 |
| $\overline{N}$ | Average number of households per PSU in the sampling frame |
| $u$ | Number of households to be selected per PSU in stage 2 |
| $\overline{p}$ | Expected overall proportion of stoves operating |
| $SD_B^2$ | Expected unit variance between PSUs |
| $SD_W^2$ | Expected within PSU variance |
| $z$ | critical standard score for the required confidence level (1.645 for 90% confidence level) |
| $d$ | required precision (10%) |

The sample size is then calculated as
$n_c = u.c$

Where:

| | |
|---|---|
| $n_c$ | Sample size for the complex sample |

The number of households to be selected per PSU is selected as 15. The expected overall proportion and variances are based on a survey conducted during the pilot project. Data from this survey gave an overall proportion of stoves operating of 83% based on 336 households surveyed across 12 chief areas in 2011. In addition, the unit variance between PSUs and within PSU variance were calculated from the pilot project survey data as 0.0136 and 0.1286 respectively. A total of 233 eligible PSUs were counted in the project area, with an average size of 82 households per PSU. The sample size calculation then gives a total of 8 PSUs to be selected of 15 households each, giving a total sample of 120 households to meet 90/10 confidence/precision requirements.
As the data collection involves a simple check to see if the project stove is in use, minimal non-response is anticipated. However, to simplify the sample selection procedure, the same 180 households selected for the determination of the annual quantity of woody biomass used during the project activity detailed in section B.7.2.1 will be used for this sampling plan. The sample size for this sample is therefore increased to 180, or 1.5x the sample size to meet confidence/precision requirements. This will be made up of 15 households selected from each of 12 chief areas.

**Sampling Frame**
The sampling frame consists of the 7 Traditional Authorities that make up the project boundary detailed in section A.2. The sampling frame will be limited to the households that have had Changu Changu Moto improved cook stoves installed at the time the sampling is conducted. Thus, the sampling frame will change as project implementation progresses.
Comprehensive record keeping in the project database will eliminate the risk that the sample frame does not cover the entire target population.

**Data**
**Field Measurements**
The data will be collected as a simple survey check that the household is using the Changu Changu Moto improved cook stove. The following situations will be recorded as the stove not in use:

- The stove is not in use for any reason;
- The stove cannot be found;
- Householder cannot be contacted after repeated attempts;
- The stove is damaged beyond repair; or
- Stove other than the project stove is being used.

Any stoves not meeting any of the above criteria will be recorded as in use for the period *y*.

The period *y* for the calculation of the number of operating devices is defined as:

- the average of the period from the date of construction to the date of the survey for each device for the first survey; and
- the average of the period from the date of the last survey to the date of the current survey for each device for subsequent surveys.

As a conservative assumption, any stoves are recorded as not in use will be removed from the emission reduction calculations from the last survey date that it was recorded in use (or the date of construction for the first survey).

**Quality Assurance/Quality Control**
The survey will be conducted by the project implementer, RIPPLE Africa, with support from the Project Participants. All staff involved in testing have been given comprehensive training in conducting surveys by the Malawi Projects Manager, and the Technical Manager from Sigma Global.

No equipment that requires calibration is required for the survey.

Data collected during the survey will be recorded on printed data collection sheets. Electronic data entry will occur as soon as possible after the completion of the survey. Any calculations will be performed in the spreadsheets by in-built formulas. Any cells with formulas in data entry spreadsheets are locked to prevent unauthorised changes.

Written and electronic copies of the survey results will be backed up in multiple locations and archived for the duration of the project crediting period and for two years after the end of the crediting period or the last issuance of CERs, whichever occurs later.

Provisions to maximise response rates will be implemented. As described above, the sample size has conservatively been increased to 1.5x the minimum sample size to meet confidence/precision requirements. As the survey involves a simple check to see if the project stove is in use, few reasons for non-response are anticipated. Any stoves that can no longer be located will be recorded as not in use. If the householder is not at home at the time of the survey, the survey team will return at a suitable time to conduct the survey. If the householder cannot be contacted after repeated attempts, the stove will be recorded as not in use.

**Analysis**
Complex sampling designs can improve the data collected for a given budget, but make data analysis more difficult. Ignoring the sample design in the analysis leads to biased and misleading estimates of the standard error. Confidence intervals and statistical tests will then be incorrect if the effects of the complex sample design are ignored.

The data collected from the complex survey design will be analysed using procedures and statistical software packages appropriate to complex survey design data analysis to calculate a population estimate of the number of operating devices in period y.

The sampling procedure is designed to be self weighting, but the weights of some observations may change due to non-response or removal of outliers. Weights will be recalculated prior to data analysis to ensure non-biased estimates of the parameters.

**Implementation**
The survey will be conducted by the project implementer, RIPPLE Africa with support from the Project Participants. The tests will be conducted at least annually for the duration of the crediting period. The organisation chart and roles and responsibilities for the implementation team is shown in Appendix 5:

**B.7.3. Other elements of monitoring plan**

>>

Project implementation will be conducted by RIPPLE Africa. RIPPLE Africa is a UK registered charity working to improve local education, healthcare, and the environment in Malawi, Africa. Founded in 2003, RIPPLE Africa's activities are based around the rural village of Mwaya in the Nkhata Bay District of Malawi. RIPPLE Africa operates at a grassroots level, involving the community in all aspects of its activity. The charity's projects include running and assisting eight pre-schools, five primary schools, a secondary school and a secondary school bursary scheme, a community library, two community health clinics, Changu Changu Moto fuel-efficient cookstoves, tree-planting and fruit tree projects and woodland conservation. The charity is managed from the UK, but the Malawian managers conduct the day-to-day running of the charity, and around 150 Malawian staff are employed by the charity.

The implementation team at RIPPLE Africa will be responsible for gathering the necessary information from householders for monitoring purposes. An organisation chart and a summary of the roles and responsibilities of each position as they relate to the implementation and monitoring of this project are given in Appendix 5:.

Eligibility for a household to participate in the project is determined through an Initial Survey conducted by the Community Volunteers (CVs). During the Initial Survey, a registration number will be assigned to each eligible household. The following householder information will be recorded on the Initial Survey forms:

- Householder registration number
- Name of stove user or head of the household
- Name of Chief and village (and other location information where available)
- Latitude and longitude using GPS device
- Current cooking method
- Current time spent collecting wood
- House ownership status

This information will then be checked by the Project Coordinators and Managers to ensure the completed forms represent the situation observed. Further investigation is completed by the Coordinator or Manager to investigate any missing or inconsistent values.
The completed forms are then transferred to project headquarters. Data entry officers will then enter the information into the project database. All personnel will be trained in the use of the project database to reduce the chance for data entry errors. As a further check, supervisory staff will conduct an audit of the data at minimum once every month data entry is occurring by randomly selecting at least 50 household database entries and comparing the database record with the information from the original written monitoring form. Any inconsistencies will be rectified and will trigger an audit of all household records for that chief area.

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

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

- Household registration number

- Name of stove user or head of the household
- Name of Chief and village (and other location information where available)
- Construction of bricks
- Stove construction date
- Stove user Signature
- Construction verification date
- Construction verification signature (by Coordinator)

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

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

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

As a conservative assumption, the emission reduction calculations for each stove are based on the date of successful construction verification by a Coordinator, rather than the actual stove build date.
Regular ongoing checks of stove usage and condition are conducted by Community Volunteers, Coordinators and Managers.

Further monitoring of the annual quantity of biomass used during the project activity and the number of operating devices will be conducted according to the methods and procedures detailed in section B.7.1.

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

## SECTION C. Duration and crediting period

### C.1. Duration of project activity

#### C.1.1. Start date of project activity

>>
01/02/2012

#### C.1.2. Expected operational lifetime of project activity

>>
10 years.

With the correct use and maintenance procedures, the lifetime of each stove is in excess of 10 years. The use of virtually unlimited, locally available, natural materials to construct the stove allows repairs and re-builds of stoves to be conducted as required at little cost ad infinitum.

### C.2. Crediting period of project activity

#### C.2.1. Type of crediting period

>>

Fixed crediting period

**C.2.2. Start date of crediting period**
>>
01/09/2014, or the date of registration , whichever is later.

**C.2.3. Length of crediting period**
>>
10 years

**SECTION D. Environmental impacts**
**D.1. Analysis of environmental impacts**
>>
Section 24 (1) of the Malawi Environmental Management Act specifies that:
*The Minister may, on the recommendation of the Council, specify, by notice published in the Gazette, types and sizes of projects which shall not be implemented unless an environmental impact assessment is carried out.*
The current list of projects requiring an environmental impact assessment is available as Appendix B of the Environmental Impact Assessment Guidelines published by the Environment Affairs Department.[52] Review of this list confirms that no environmental impact assessment is required for this project type.

**SECTION E. Local stakeholder consultation**
**E.1. Solicitation of comments from local stakeholders**
>>
Public participation for the project activity has formed an integral part of the project planning. Communities and other local stakeholders were heavily involved with the design of the stove, as they are with the project implementation.

The project implementer RIPPLE Africa held a series of meetings to ensure relevant feedback was received and taken into account for the project. These meetings took place in various locations across the project area over a period of approximately 1 year. Stakeholders were notified of the meetings through letters to officials, community notices, phone calls, word of mouth and through Chiefs and members of the relevant Traditional Authorities. The Changu Changu Moto has also featured on TV and radio.

A summary of the date of the meeting held for each Traditional Authority is shown below.

| **Meeting** | **Date** |
|---|---|
| TA Fukamapiri | Thu 2/12/10 |
| TA Fukamalaza | Wed 16/02/11 |
| TA Fukamapiri | Sat 4/06/11 |
| TA Malengamzoma | Sat 23/07/11 |
| TA Fukamapiri | Thu 28/07/11 |
| Kachere FP School | Fri 20/01/12 |
| TA Zilakoma | Fri 3/08/12 |

[52] http://www.sdnp.org.mw/enviro/eia/appendixB.html

The meeting agendas included:

- Discussion on the purpose of the consultation
- Description of the project activity
- Demonstration of the Changu Changu Moto
- Questions and answers on the project activity
- Discussion on the social benefits of the project
- Discussion on forestry and agriculture issues

Meetings which included a presentation of the stove were attended by:

- Target householders and Chiefs
- Relevant Malawi government officials including:
    - Honourable Deputy Minister of Natural Resources and Environmental Affairs
    - Forestry Department officials
    - Minister of Foreign Affairs
- Relevant Nkhata Bay District government officials including:
    - District Forestry Officer
    - Assistant District Forestry Officer
- NGOs
- Malawi Designated National Authority
- Media
- RIPPLE Africa staff

Comments were sought as follows:

- During the meeting questions and comments were recorded and some immediately addressed
- Request made for comments through word of mouth and through Chiefs and members of the relevant Traditional Authorities.

All comments and information received in the meetings were recorded.

**E.2. Summary of comments received**

>>

- Overall comments received were very positive.
- All Chiefs want everyone in their community to have a Changu Changu Moto in their kitchen.
- Participants appreciated the educational aspect of the meetings provided through the explanation of the importance of preserving natural resources. This was explained through a discussion on how much wood a family uses for their three stone fire and that if it continues, there will be very little wood left.
- Participants promised to work hand in hand with RIPPLE Africa to make the project activity work.
- Participants suggested that RIPPLE Africa should train everyone on how to preserve trees.
- The Minister of Foreign Affairs (at the time of the meeting) arranged a meeting with 60 women from her constituency. Everyone was very keen to have the project activity in their area. The Minister of Foreign Affairs also suggested that RIPPLE Africa present the project activity to the key women leaders in parliament.

- The District Commissioner and the District Executive Committee members of Nkhata Bay District were introduced to the project activity. They all strongly supported the project activity and said it was much needed by the people of Nkhata Bay District. They officially approved the project activity.
- The Deputy Minister of Natural Resources and Environmental Affairs (at the time of the meeting) commented on the chronic deforestation problem largely due to the high number of households who cut down wood from the forests for their 3-stone fires. He commented on how impressed he is with the simple and effective technology. He also commented that he is very pleased the Changu Changu Moto will be made available to the people of Nkhata Bay District, but it should also be made available to other households throughout Malawi.
- An Nkhata Bay District Forestry Officer welcomed the project activity's association with the Forestry Department in Nkhata Bay District and was very keen for the project activity to be successful.
- Stakeholders would like to see the project activity extended throughout Malawi.

**E.3. Report on consideration of comments received**

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- It is the intention of the project team to expand the implementation of Changu Changu Motos to further areas in Malawi. Part of the CDM revenue will be used to finance the implementation of more Changu Changu Motos to areas outside the project activity boundary.
- RIPPLE Africa has implemented a household tree planting project. It is intended that the trees will grow large enough to provide wood for householders to use for cooking. The program also includes educational aspects.
- Regular meetings are held with participants of the project activity and community stakeholders to keep them informed of the progress of the project and get feedback from them.

**SECTION F. Approval and authorization**

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## Appendix 1: Contact information of project participants

| | |
|---|---|
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| | |
|---|---|
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## Appendix 2: Affirmation regarding public funding

The funding of the project activity will not result in a diversion of Official Development Assistance (ODA) to the project.

## Appendix 3: Applicability of selected methodology

Testing of the Changu Changu Moto improved cook stove was undertaken by the Malawi Bureau of Standards following the Shell Foundation Water Boiling Test Protocol, version 3.0. The test results are detailed in the enclosed report.

Enclosure: ***ISSU/12/AP 90 Quality check on Changu Changu Moto stove***

## Appendix 4: Further background information on ex ante calculation of emission reductions

**Part A: Baseline Survey Report**

The results of the baseline survey and kitchen performance test results are detailed in the enclosed report.

Enclosure**:** ***Nkhata Bay District Wood Use Survey, September 2012***

**Part B: Supporting information on the quantity of woody biomass used in the absence of the project activity**

The 1999 report "The role of Wood Energy in Africa"[53] reviews and collates existing information and data on wood fuels and its related energy aspects at national level with the main aim to overcome the shortcomings encountered in the main wood energy databases and to fill the main data gaps.
The report[53] includes a figure for the household wood fuel consumption in Malawi for 1996 of 12,160,000 $m^3$. In addition, the total population of Malawi in 1996 is reported as 9,846,000.
The 1998 Malawi national census[54] reported that the Average household size is 4.3 persons/household, making the total number of households approximately 2,290,000. Data from the 1998 Malawi national census also shows that 92.6% of households use wood as the main fuel for cooking.
The number of households using wood is therefore estimated as 2,120,000, and the average household wood fuel consumption can be calculated as 5.73 $m^3$/household/year.
Finally, using a reported[53] density of 0.725 t/$m^3$ for wood, average household wood fuel consumption can be stated as 4.16 t/household/year.

[53] **Forestry Department, Food and Agriculture Organization of the United Nations,Rome, Italy . 1999.** *The role of Wood Energy in Africa, Wood Energy Today for Tomorrow Regional Studies.* 1999.
[54] **National Statistical Office, Republic of Malawi. 2001.** *Statistical Yearbook 2001*

## Appendix 5: Further background information on monitoring plan

The structure of the implementation team is shown in Figure 7, and the roles and responsibilities of each position as they relate to the implementation and monitoring of this project are described below.

**Malawi Projects Manager**

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

**Environmental Programme Manager**

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

**Environmental Project Managers (North and South)**

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

**Office Administration Manager**

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

**Training and Testing Officers**

- Responsible for organising and performing Kitchen Performance Tests and providing all data to the Malawi Projects Manager.

- Responsible for training Coordinators and Community Volunteers on site and monitoring progress under instructions from the Projects Managers
- Responsible for acting as second in command to the Environmental Project Managers.

**Project Coordinators**

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

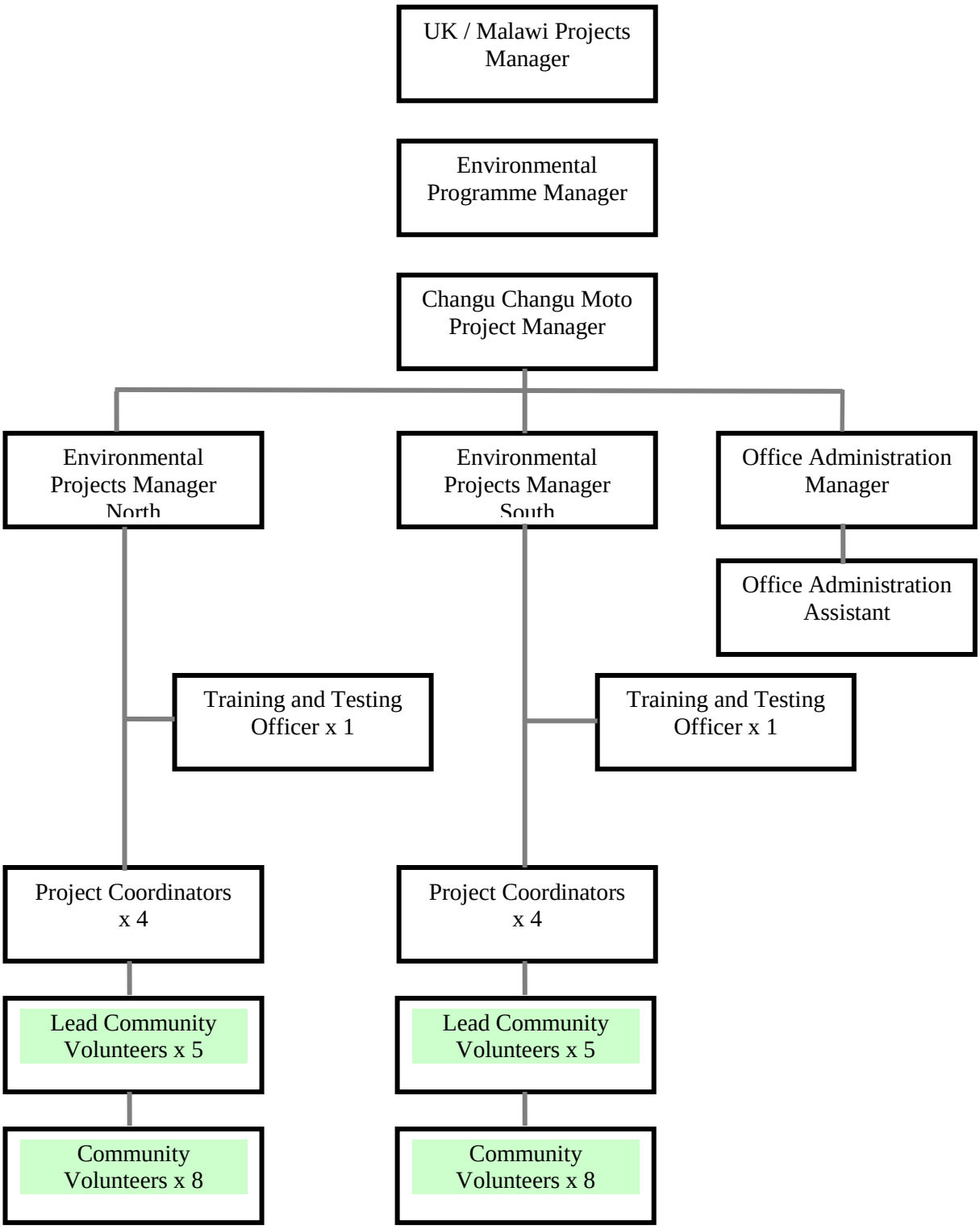
**Lead Community Volunteers**

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

**Community Volunteers**

- Responsible to their Lead Community Volunteer or Coordinator.
- Responsible for the implementation and monitoring of the project in all households within a Chiefs' area (typically 100 households).
- Responsible for making all households aware of the project.
- Responsible for ensuring all households make 30 bricks each and collect mud for the construction of the Changu Changu Moto.
- Responsible for constructing the Changu Changu Moto in each householders' kitchen in conjunction with the householder (the householder must take part in the construction in order to learn the skills required).
- Responsible for full training on maintenance of the Changu Changu Moto, and how to prepare and use the wood in the new stove.
- Responsible for regular monitoring and data collection at all stages of the project.

**Figure 7 Implementation team organisation chart**




## Quality Assurance/Quality Control

- The RIPPLE Africa Malawi Projects Manager is responsible for the coordination and implementation of the sampling plan. The KPTs will be conducted by the 2 Trainer and Tester

staff members. These staff members have been given comprehensive training in conducting KPTs by the Malawi Projects Manager, and the Technical Manager from Sigma Global.

- Equipment used for data collection during the KPTs includes scales and electronic moisture meters. Certification records of all equipment used will be kept and be available to view as part of the project validation process.

- Data will be collected during the KPTs, and recorded on printed data collection sheets as shown in Appendix 3. Calculations of daily household wood use will be completed in the field each day following weighing of the remaining wood piles, and recorded on the template. This will allow immediate investigation of any values that appear to be outliers. Any reasons for abnormal results will also be recorded on the data collection sheet.

- Electronic data entry will occur as soon as possible after the completion of the tests. Any calculations will be performed in the spreadsheets by in-built formulas. Any cells with formulas will be locked to prevent unauthorised changes.

- Written and electronic copies of the test results will be backed up in multiple locations and archived for the duration of the project crediting period.

- Following data entry, outliers will be identified using a box plot of the data. Any potential reasons for outlier results recorded during data collection will be analysed and a decision made regarding removal of the potential outlier. Outliers will only be removed when there is a statistically valid reason, considering the sample weighting and following the principle of conservativeness.

- No systematic differences between respondents and non-respondents are expected. Provisions to maximise response rates will be implemented, and may include some form of compensation to the households. Any compensation will be carefully designed to ensure it does not affect the project outcome. As described in section 1.4, the sample size has been calculated to allow for a conservative 15% non-response rate to allow for a number of households being unable to or un-willing to participate in the survey for some reason.

# Appendix 6: Summary of post registration changes

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**History of the document**

| Version | Date | Nature of revision |
|---|---|---|
| 04.1 | 11 April 2012 | Editorial revision to change history box by adding EB meeting and annex numbers in the Date column. |
| 04.0 | EB 66<br>13 March 2012 | Revision required to ensure consistency with the "Guidelines for completing the project design document form for small-scale CDM project activities" (EB 66, Annex 9). |
| 03 | EB 28, Annex 34<br>22 December 2006 | • The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM. |
| 02 | EB 20, Annex 14<br>8 July 2005 | • The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document.<br>• As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>. |
| 01 | EB 07, Annex 05<br>21 January 2003 | Initial adoption. |
| **Decision Class:** Regulatory<br>**Document Type:** Form<br>**Business Function:** Registration | | |