PROGRAMME DESIGN DOCUMENT FORM FOR
SMALL-SCALE CDM PROGRAMMES OF ACTIVITIES (F-CDM-SSC-PoA-DD)
Version 02.0

PROGRAMME OF ACTIVITIES DESIGN DOCUMENT (PoA-DD)

PART I. Programme of activities (PoA)

SECTION A. General description of PoA

A.1. Title of the PoA

CDM Africa Sustainable Energy Programme
Version 4
30/08/2013

A.2. Purpose and general description of the PoA

(a) Policy/measure or stated goal that the PoA seeks to promote;

The purpose and goal of this Small Scale Programme of Activities (SSC-PoA) is to reduce greenhouse gas emissions from cook-stoves using wood-fuel (charcoal and firewood) derived from non-renewable sources, in domestic kitchens, in community kitchens and in small and medium enterprises (SMEs). Throughout Africa, the widespread use of non-renewing wood-fuel for cooking is a cause of greenhouse gas emissions due to high deforestation rates and failure therefore of CO_2 emissions to be re-absorbed into fresh growth of woody biomass.

The SSC-PoA aims to achieve its goal by making cleaner, more efficient improved cooking systems (ICS) using renewable biomass affordable and available to users in the host countries. The strategy will be to supply renewable biomass and ICS to all areas, initially focusing on users in urban areas where charcoal is the primary fuel, as well as rural areas where firewood is the primary fuel[1,2,3]. This will reduce global greenhouse gas emissions by switching cooks to sustainably harvested biomass consumed in highly efficient cooking stoves.

(b) Framework for the implementation of the proposed PoA;

This PoA will provide kitchens throughout Africa with highly efficient and durable improved cooking systems (ICS) that are fuelled by wood-chips, wood-sticks or wood-pellets derived from managed resources where growth and harvesting rates are balanced. In other words, the PoA will displace current

[1] 2010, Malawi Demographic and Health Survey, National Statistical Office, Zomba, Malawi, TABLE 2.8 PAGE 21
[2] Zambia Demographic and Health Survey 2007, Central Statistical Office of Zambia, TABLE 2.9, PAGE 27
[3] Urban areas in Malawi are defined as per the United Nations Demographic Yearbook as “All townships and town planning areas and all district centres”. In order to increase clarity, the CME defined rural communities as areas outside of urban boundaries of towns, townships, district centres and cities of population greater than 4765 – the lowest population number found in the classification” cities, towns, villages” as per the website (http://www.citypopulation.de/Malawi.html (last visited on 14/12/2012). Urban areas in Zambia are defined as per the United Nations Demographic Yearbook as “Localities of 5,000 or more inhabitants, the majority of whom all depend on non-agricultural activities.” (http://unstats.un.org/unsd/demographic/products/dyb/dyb2008.htm). There is no specific definition for rural areas in Zambia, this is considered to be all areas which are not urban. Hence rural households are those which are physically located in a non-urban area of Zambia. Note in the baseline study for urban Zambia only areas with populations greater than 10,000 were considered, therefore excluding urban areas from 5,000 – 10,000.

use of non-renewable biomass (NRB), by virtue of distributing renewable biomass fuels together with modern cook stoves designed to burn the Renewable Biomass (RB) efficiently.

Conventional cook-stoves used throughout Africa are inefficient, using large quantities of wood-fuel. The stoves distributed under this PoA will in contrast burn renewable biomass efficiently, consuming very much less woody biomass to accomplish the same cooking duties.

The new stoves (hereafter referred to as the improved cooking system or ICS) and the renewable biomass fuels (henceforth RB fuels) will be sold both on a commercial and a non-commercial basis. Carbon finance will be used to facilitate the purchase, distribution and marketing of stoves and RB fuels, so making these products more affordable to users; without carbon finance, these activities would not take place.

The new ICS will be distributed to users along with supply of renewable biomass. The mechanisms for supply of the ICS and renewable biomass will vary according to the CPA and details will be elaborated on CPA level. The renewable biomass will originate from:

- residues from existing plantations and forests which are sustainably managed for timber production
- new short or long rotation plantations that will be developed to specifically supply RB fuel
- municipal wood waste in urban centres.

C-Quest Capital Malaysia Global Stoves Limited (“CQC”) will be the coordinating/managing entity (CME) of this PoA and shall communicate with the Executive Board. The PoA is a voluntary action by the CME.

The end user will be informed that carbon finance is being generated by deployment of the ICS associated with use of renewable biomass, and this finance is in turn used to lower the sales price of the ICS and the renewable biomass. The buyer or recipient of the ICS will confirm via a sales agreement or registration card (or equivalent such as an SMS text message) to the CME a waiver of possible claims and transfer of any possible rights to the CERs generated by the PoA. The sales agreement or registration card (or equivalent) will contain information on ICS model, unique stove identification number, and location/address and contact details of the end user. This information will be stored by the CME in hard copy and in an electronic data management system, or monitoring database, to ensure no double counting of ICS sales.

(c) Sustainable development;

In addition to emission reductions, the programme will deliver a long-term, secure and simple contribution to sustainable development that, without carbon finance, would not exist. This is discussed in more detail as follows:

ICS will reduce indoor air pollution levels and the health risks associated with breathing products of combustion during cooking. Emissions of carbon monoxide (CO) are a significant percentage of the emissions of traditional wood-fuel stoves. Inefficient cooking stoves have been found to cause considerable disease and death, particularly among women and children. The World Health Organisation[4] has found that 40% of all childhood pneumonia can be attributed to exposure to smoke from fires in homes, and exposure to smoke has been found to cause chronic lung disease in women. Approximately 1.5 million people die from smoke inhalation each year; most are women and children in low-income countries. Ill health can result in loss of productivity and costs associated with health care. The ICS effectively reduces indoor air pollution and its harmful social consequences.

[4] World Health Organisation World Health Report, 2002.

In low-income countries wood collection is a time-consuming burden that falls mainly on women[5]. Where wood and charcoal are purchased, cooking fuel imposes a significant financial burden on families. The inefficient use of wood also places considerable and unnecessary pressure on local ecosystems and biomass resources, including forests. Reducing consumption of charcoal and firewood can reduce this pressure.

The programme has economic as well as social benefits. Many of the ICS will be imported from outside the country, including Annex I countries. Thus, there will be some technology transfer from abroad. Moreover, the programme will generate local jobs.

There are no major negative environmental and social impacts caused by this programme, and it contributes to sustainable development through positive social, economic, environmental and technological impacts.

In summary, the proposed PoA contributes to the sustainable development in a number of ways:

i. Environmental

- The PoA will help significantly reduce greenhouse gas emissions over its lifetime
- The PoA will help reduce the use of non-renewable biomass from African forests assisting the maintenance of existing forest stock, protecting natural forest eco-systems and wildlife habitats
- The protection of standing forests will ensure the maintenance of watersheds that regulate water table levels and prevent flash flooding

ii. Social

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

iii. Economic

- Saved user labour can be diverted to more productive economic activities.
- Strengthening the employee base of partner organizations and creation of direct local employment opportunities in operational and management roles, as well as future assembly and/or manufacturing initiatives.

The proposed PoA will deliver a long-term, secure and simple contribution to sustainable development that, without carbon finance, would not exist.

A.3. CMEs and participants of PoA

[5] Biran, A., J. Abbot, and R. Mace. 2004. Families and firewood: A comparative analysis of the costs and benefits of children in firewood collection and use in two rural communities in Sub-Saharan Africa. Human Ecology 32, no. 1: 1-25.

C-Quest Capital Malaysia Global Stoves Limited, Total Land Care (TLC), a registered non-governmental organisation (NGO) in both Malawi and Zambia are currently the only project participants to the PoA. Project participants may or may not be involved in one of the component project activities (CPAs) related to the PoA. The CME is C-Quest Capital Malaysia Global Stoves Limited and is also the entity that communicates with the Board.

A.4. Party(ies)

Name of 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)
Sweden	C-Quest Capital Malaysia Global Stoves Limited (CQC)	No
Republic of Malawi (host)	Total Land Care (TLC), Malawi	No
Republic of Zambia (host)	Total Land Care (TLC), Zambia	No

A.5. Physical/ Geographical boundary of the PoA

The PoA will be implemented in different countries in the African continent. The boundaries will be the geographic borders of the following countries: Republic of Malawi and Republic of Zambia.

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

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

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

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

Zambia, Northern Point
Latitude: -8.210000° N
Longitude: 30.760000° E

Zambia, Western Point
Latitude: -13.000000° N
Longitude: 22.000000° E

Zambia, Eastern Point
Latitude: -10.560000° N
Longitude: 33.700000° E

Zambia, Southern Point
Latitude: -18.080000° N
Longitude: 26.690000° E

The fuel specific geographic boundaries for urban (charcoal) users in Malawi are all settlements with a population over 4,765 as defined as urban in section A.2 of the PoA-DD separated into the following homogenous areas as identified in the baseline study (see Appendix 4 for full reports). Northern[6] (Northern: Latitude:-9.366667°N, Longitude: 33.000000°E, Western: Latitude:-9.419258°N, Longitude: 32.940903°E, Southern: Latitude:-12.736801°N, Longitude: 33.657761°E, Eastern: Latitude:-11.662996°N, Longitude: 34.323578°E), Central Capital (Northern: Latitude: -13.862747°N, Longitude: 33.747139°E, Western: Latitude:-13.930735°N, Longitude: 33.715954°E, Southern: Latitude:-14.063653°N, Longitude: 33.801441°E, Eastern: Latitude:-13.95406°N, Longitude: 33.848076°E), Central Smaller Settlements (Excluding Central Capital Northern: Latitude: -12.157486°N, Longitude: 33.858948°E, Western: Latitude:-13.600000°N, Longitude: 32.666667°E, Southern: Latitude:-15.310678°N, Longitude: 34.814758°E, Eastern: Latitude:-14.785505°N, Longitude: 34.979553°E), Southern Capital (Northern: Latitude:-15.682213°N, Longitude: 35.02676°E, Western: Latitude:-15.781682°N, Longitude: 34.952602°E, Southern: Latitude: -15.870204°N, Longitude: 35.04221°E, Eastern: Latitude: -15.787959°N, Longitude: 35.109501°E), Southern Smaller Settlements (Excluding Southern Capital Northern: Latitude:-13.517838°N, Longitude: 34.86969°E, Western: Latitude:-15.834536°N, 34.248962°E, Southern: Latitude:-17.133333°N , Longitude: 35.283333°E, Eastern: Latitude:-14.883333°N , Longitude: 35.916667°E).

The fuel specific geographic boundary for rural (firewood) users in Malawi are all settlements with a population under 4,765 as defined as urban in section A.2 of the PoA-DD.

The fuel specific geographic boundary for urban (charcoal) users in Zambia includes all cities with populations greater than 10,000 except for the following exclusions: Petauke in Eastern province (Northern: Latitude:-14.225949°N , Longitude: 31.331414°E, Eastern: Latitude: -14.251073°N, 31.362133°E, Southern: Latitude: -14.27137°N, Longitude: 31.321964°E, Western: Latitude:-14.240757°N, Longitude: 31.298618°E) and neighbourhoods in Livingstone (Zambezi (AKA Dambwa Central) (Northern: Latitude:-17.854434°N, Longitude: 25.841939°E, Western: Latitude:-17.860071°N, Longitude: 25.836396°E, Southern: Latitude:-17.861950°N, Longitude: 25.847887°E, Eastern: Latitude:-17.857436°N, Longitude: 25.848938°E), Kariba (Northern: Latitude:-17.857416°N, Longitude: 25.850780°E, Western: Latitude: -17.859662°N, Longitude: 25.845587°E, Southern: Latitude: -17.861991°N, Longitude: 25.850952°E, Eastern: Latitude: -17.859867°N, Longitude: 25.855139°E), Lizuma (AKA Dambwa North) (Northern: Latitude: -17.836092°N, Longitude: 25.82516°E, Western:

[6] In the northern areas (Northern capital and Northern smaller settlements) there are no statistical differences according to the baseline study report and thus can be considered as a single homogeneous cluster. See Annex for full baseline reports.

Latitude:-17.838584°N, Longitude: 25.824022°E, Southern: Latitude: -17.854434°N, Longitude: 25.839643°E, Eastern: Latitude: -17.848061°N , Longitude: 25.843077°E) and Akapelwa (Northern: Latitude: -17.840177°N, 25.85353 °E, Western: Latitude: -17.841689°N , Longitude: 25.847801°E, Southern: Latitude: -17.850043°N, Longitude: 25.860654°E, Eastern: Latitude: -17.846999°N, Longitude: 25.861473°E)). In addition there is a wet zone divided into two areas which are defined as a separate fuel specific geographic areas (Area 1: , Northern: Latitude: -10.898042°N, Longitude: 24.038086°E, Western: Latitude: -12.533115°N, Longitude: 23.90625°E, Southern: Latitude: -13.496473°N, Longitude: 26.828613°E, Eastern: Latitude: -12.961736°N , Longitude: 28.630371°E, Area 2: Northern: Latitude: -9.21056°N, Longitude: 29.311523°E, Western: Latitude: -9.882275°N , Longitude: 28.630371°E, Southern: Latitude: -12.189704°N, Longitude: 29.597168°E, Eastern: Latitude: -9.968851°N, Longitude: 32.274169°E). All urban areas greater than 5,000 and less than 10,000 are excluded from the project boundary in Zambia.

The fuel specific geographic boundary for rural (firewood) users in Zambia are all areas outside of urban areas with a population of more than 5,000 as defined as urban in section A.2 of the PoA-DD.

A.6. Technologies/measures

The activities under the proposed SSC-PoA will promote ICS which burn renewable biomass resulting in substantially reduced GHG emissions. The ICS used in this SSC-PoA have characteristics that improve the efficiency of combustion and thermal transfer to the pot and will replace a traditional wood-fuel stove. ICS is a single or multi pot portable or in-situ cook stove using wood-fuel. Each CPA shall clearly describe in detail each type of ICS it is implementing.

For the purpose of this PoA, ICS can be classified according to the following two characteristics:

1. **Construction material -** ICS are commonly composed of a selection of the following materials: metal, clay/mud, fired-clay/mud or ceramics and bricks. Classification based on the material helps in selecting an appropriate design on the basis of locally available raw materials, skills for fabrication and necessary production facilities (e.g. centralised/decentralised) in the target area.

2. **Portability -** On this basis, an ICS can be classified as fixed (in-situ) or portable. Metal and ceramic ICS are normally portable in nature while clay/brick, clay/stone ICS are generally high mass and thus are fixed. Stoves in this category can be further sub-divided into different categories depending on the number of pot rests, e.g., single, double and triple.

Types of ICS: the list of ICS below is indicative of the types of technologies to be implemented under this PoA. It is important to note that several other models of ICS combining the above characteristics of construction material and portability may be later implemented under this PoA-DD. Specific stoves types will be described for each SSC-CPA.

Picture (example)	Category	Material	Portability
	Improved Mud/brick Stoves	Clay, straw, dung, cement, stone, bricks	Fixed (in-situ)
	Improved metal and ceramic stove	Metal with ceramic combustion chamber	Portable
	Pyrolysis stove	Metal with air flow forced by an integral fan	Portable

For example, one ICS which is expected to be disseminated under this programme is the African Clean Energy Company, Philips Smokeless Stove (ACE). The ACE is an efficient pyrolysis stove with integrated forced air flow (using an electrically operated fan) which substantially reduces fuel consumption and gaseous emissions arising from cooking and water heating. Figure 1 shows the ACE Phillips stove.

Figure 1 The ACE stove

The ACE Stove has a primary combustion zone at the bottom of the combustion chamber, into which the burning fuel is injected with sufficient air to drive partial combustion and create a high temperature – around 1000°C. The resultant gas and particulate matter, unable to burn in the absence of oxygen, rises to the secondary combustion zone, where air is forced into the hot gaseous mix. An electrically operated fan

integrated into the stove body creates the air flow. The mix can then continue to burn, which it does with almost complete efficacy, so that no smoke remains to escape, and the energy contained in the fuel is released completely.

The stove consumes small pieces of woody biomass or processed biomass, such as wood chips produced from waste woods and material during appropriately managed harvest operations. It burns less fuel than traditional stoves, and produces a higher heat which reduces food preparation time. It burns cleanly so indoor air quality is improved, and emissions are significantly reduced. Most homes have some access to electricity, so recharging the battery in the forced ventilation stove is easily accomplished[7], the ACE stove can also come with a solar charge option. The fully charged battery is capable of powering the blower unit for three weeks or more for normal family cooking demand.

A.7. Public funding of PoA

No public funding from Annex I parties to the United Nations Framework Convention on Climate Change (UNFCCC) is to be made available for the proposed PoA, or any CPA under the proposed PoA. If public funding from Annex I parties to the UNFCCC is provided, the CME shall confirm that the funding is not a diversion of Official Development Assistance (ODA)[8].

SECTION B. Demonstration of additionality and development of eligibility criteria

B.1. Demonstration of additionality for PoA

There are no mandated government policies for the distribution of ICS in the host countries, and the PoA is implementing a voluntary coordinated action.[9]

As per the 'Guidelines on the Demonstration of Additionality of Small-Scale Project Activities', Version 9, EB 68 Annex 27, Clause 2 (c), this PoA and CPAs are 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% ($2.25MW_{th}$)[10] of the small-scale CDM thresholds. Each ICS distributed under this PoA will have a power rating significantly less than the $2.25MW_{th}$ limit as will be demonstrated at CPA level. Therefore documentation of barriers is not required as this technology is defined as automatically additional.

Significant capital is required to invest in a programme which could match the achievements of this proposed SSC-PoA, including for import of technologies, creating the renewable fuel supply, developing the brand, widespread marketing, and establishing a distribution and retail network. CQC has been unable to find investors willing to provide the level of capital necessary to implement such a program without the hard-currency revenues from selling CERs. CQC's team of investors, which have key roles in providing both debt and equity in this initiative, have all provided letters stating that they would not consider this

[7] There are often charging access points throughout villages and in urban areas currently used for mobile phones that could be used if a household does not have direct access.

[8] Official development assistance (ODA) is defined in the *OECD Glossary of Statistical Terms* as follows: Flows of official financing administered with the promotion of the economic development and welfare of developing countries as the main objective, and which are concessional in character with a grant element of at least 25 percent (using a fixed 10 percent rate of discount). By convention, ODA flows comprise contributions of donor government agencies, at all levels, to developing countries ("bilateral ODA") and to multilateral institutions. ODA receipts comprise disbursements by bilateral donors and multilateral institutions (*OECD Glossary of Statistical Terms*)

[9] Demonstrated in Malawi by the National Energy Policy, 2003 and the Biomass Energy Strategy, 2009 and in Zambia by the 2011 National Programme of Sustainable Consumption and Production, the 2011 Sixth National Development Plan and the 2008 Zambia National Energy Policy.

[10] The small scale limit is 15MW, however this is equivalent to $45MW_{th}$. 5% of 45 is $2.25MW_{th}$.

kind of investment unless this PoA is CDM registered and eligible to sell CERs. CQC has been unable to find any other investors in this project, given the risks of doing this kind of project.

B.2. Eligibility criteria for inclusion of a CPA in the PoA

SSC-CPAs to be included under this SSC-PoA must fulfil the following eligibility criteria:

No.	Requirement[11]	Eligibility Criteria	Means of Validation
1	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA	Be implemented entirely within a single fuel-specific geographical boundary (as specified in section A.4.5 of the PoA-DD) according to the targeted fuel type, fuel-consumption cluster (if applicable), and host country region of the CPA-DD	One of the following documents will be provided as evidence: • Business plan • Declaration by CME or CPA implementer
2	Conditions that avoid double counting of emission reductions such as unique identification of product and end-user locations.	The CPA will: 1. Have a database that will uniquely identify and define users in which ICS have been installed or distributed. In addition, each stove itself will have to be uniquely identified with a serial number clearly starting with "CQC-FS" 2. Not involve users already involved in any other CPA or CDM project involving the distribution and/or installation of ICS. 3. Not be registered as individual CDM project activities nor included in another registered SSC-PoA, as well as in any other voluntary scheme (such as Gold Standard, VCS, VER+)	Any of the following documents may be provided: • Evidence of database • Declaration from CME or CPA implementer • Registration card template • CME manual • CME declaration checking CDM and other voluntary scheme websites.
3	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;	All CPAs will be required to conform to national standards where available. Detailed descriptions of the ICS to be implemented will be described at CPA level. Each ICS must deliver the same or higher level of service in comparison with the baseline system being replaced. Each ICS will be required to meet the following technical specifications of having a kW_{th} capacity of less than $450kW_{th}$ and being either fixed or portable. In	Documents to be provided: • Evidence of compliance with national standards (if any) • Technical description of ICS from manufacturer provided in section A.5. of the CPA-DD and compliance with

[11] Requirements are as per EB 74, version 3.0, Annex 5, Clause 16, Standard: Demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities, Version 02.0. The requirement for a Local Stakeholder Consultation has been removed as this will be undertaken at PoA level.

		addition the ICS must meet at least one of the following technical specifications: • Thermal efficiency of greater than 20% as determined by a Water Boiling Test. • Have an improved combustion chamber utilizing either the rocket stove design, insulated chamber or pyrolysis.	testing/certifications as per manufacturers specifications (if any). Justify that the same or higher level of service will be provided, that the kW_{th} capacity of the ICS is less than $450kW_{th}$, that the ICS is either fixed or portable and at least one of the other technical specifications are met.
4	Conditions to check the start date of the CPA through documentary evidence;	The start date of the CPA must not be before the start date of the PoA. Documentary evidence will be provided to justify the start date of the CPA.	The start of the CPA will be the date of first distribution as demonstrated by Registration Cards or other appropriate forms indicating the first dissemination of ICS.
5	Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs;	Comply with applicability conditions and other requirements set out in AMS I.E version 5: *1. This category comprises activities to displace the use of non-renewable biomass by introducing renewable energy technologies.* *2. Project participants are able to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.* *3.The use of this methodology in a project activity under a programme of activities is legitimate if the following leakages are estimated and accounted for, if required on a sample basis using a 90/30 precision for the selection of samples, and accounted for:* *(a) Use of non-renewable woody biomass saved under the project activity to justify the baseline of other CDM project activities can also be a potential source of leakage. If this leakage assessment quantifies a portion of non-renewable woody biomass saved under the project*	1. Each CPA will provide evidence of the supply of renewable biomass and details of the ICS that burn the fuel. 2. Details of the use of NRB since 31 December 1989 in the host countries will be demonstrated on CPA level. 3. Option C will be used in each CPA

		activity that is then used as the baseline of other CDM project activities then Bold is adjusted to account for the quantified leakage; *(b) Increase in the use of non-renewable woody biomass outside the project boundary to create non-renewable woody biomass baselines can also be a potential source of leakage. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass outside the project boundary then Bold is adjusted to account for the quantified leakage;* *(c) As an alternative to subparagraphs (a) and (b), Bold can be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.*	
6	The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality	Demonstrate, as per EB 68 Annex 27 Clause 2(c) that the project is additional by targeting households, communities and/or SMEs and that the ICS have a rated capacity below 2.25MW_{th} as per section A.5. of the CPA-DD.	Evidence of ICS capacity and target group will be provided
7	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis.	As described in section E.1. of the PoA-DD environmental clearance is required for CPAs in Zambia.[12]	If applicable evidence of environmental clearance
8	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis.	The CPAs will include a mechanism that waives possible claims and transfers possible ownership rights of CERs from the ICS user to the CME (or any affiliate it so designates). The precise mechanism to be established on a CPA basis. For example, a Registration Card, SMS, ICT or other means, which is signed or received by the end-user upon distribution or installation of the ICS, which shall state that the end-user transfers ownership of the carbon assets to the CME for the life of the stove.	Evidence of mechanism, template registration card etc.

[12] List A and B of the Malawi Environmental Management Act, 1996, indicates the type of projects that may require EIA and this does not include ICS / renewable fuel projects.

9	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis	Be approved by the CME prior to its incorporation into the SSC-PoA	Evidence of CME decision to include CPA
10	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance;	Affirm that no funding is coming from Annex I parties, or if it does, that this is not a diversion of ODA	A statement by the CME or CPA implementer will be provided to demonstrate no funding has been received from Annex I parties. If money is received from Annex I parties confirmation of non-diversion will be provided by the funder.
11	Where applicable, target group and distribution mechanisms	• CPAs will involve the promotion and distribution of ICS through direct installation, delivery, community sales events, direct sales or sales through commercial/retail outlets • CPAs will involve the supply of demonstrably renewable biomass • CPAs will target households, communities and/or SMEs	One of the following documents will be provided: • Business plan • Statement by CME or CPA implementer
12	Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys	CPAs will adhere to all requirements related to sampling for a PoA in accordance with the approved standard (EB 74 Annex 6 and EB75, Annex 8), as outlined in section B.7.2 of the PoA-DD.	Evidenced by CME or CPA implementer statement or agreement.
13	Where applicable, the conditions that ensure that every CPA in aggregate meets the small-scale or micro-scale threshold criteria and remains within those thresholds throughout the crediting period of the CPA	Each CPA will have a maximum capacity of 45 MW_{th} throughout the CPA's crediting period.	Evidence of rated capacity of ICS to be disseminated and limit of stoves to be installed
14	Where applicable, the requirements for the debundling check, in case CPAs belong to small-scale (SSC) or micro-scale project categories.	Each CPA will ensure that it is not de-bundled as each ICS will not exceed 1% of the 45 MW_{th} (0.45 MW_{th}) for a small-scale project as defined by the Project Standard.	Evidence of ICS rated capacity

B.3. Application of methodologies

Type I – Renewable Energy Projects; category: E

AMS I.E. “Switch from Non-Renewable Biomass for Thermal Applications by the User” Version 5.

The project activity is a Type I project activity (“Renewable Energy Projects”) because it involves renewable energy technology that supplies thermal energy to the user (participating user) directly. The methodology used is AMS-I.E. version 05 (‘Switch from Non-Renewable Biomass for Thermal Applications by the User”). The PoA displaces the use of non-renewable biomass with renewably harvested biomass.

The project falls into this category as it provides thermal energy through the introduction of new renewable energy end-user technologies. Through the combination of renewable biomass fuel using improved cook stoves, current non-renewable biomass consumption is reduced or completely avoided. Therefore, the project category AMS-I.E. is applicable.

In addition, surveys, published literature, official reports and statistics confirm that non-renewable biomass has been used since 31 December 1989

<table>
<tr>
<td>Malawi</td>
<td>
Paragraph 2 of AMS I.E methodology requires project participants to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.
Non-renewable biomass has been in use since December 31, 1989 as evidenced by various FAO statistical data. The Global Forest Resources Assessment 2010[13] (FAO) indicates that forest areas decline yearly, and that the total forest area declined by 27% from 1973 to 2010, as summarized in the table below.
Trends in extent of forest 1973-2010 - Malawi[14]
<table>
<tr><th colspan="6">Area (1000 hectares)</th></tr>
<tr><th></th><th>1973</th><th>1990</th><th>2000</th><th>2005</th><th>2010</th></tr>
<tr><td>Forest</td><td>4456</td><td>3863</td><td>3567</td><td>3402</td><td>3237</td></tr>
</table>
Paragraph 7 of AMS I.E methodology requires the demonstration of NRB through at least two supporting indicators. The fact that biomass is harvested from a net non-renewable source 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;
Total living forest biomass carbon stocks have depleted from 173 million tons in 1990 to approximately 144 million tons in 2010, or by approximately 17 percent. The annual loss in carbon stock in living forest biomass is estimated between 1 and 2 million tonnes of carbon per year[15].
</td>
</tr>
</table>

[13] FAO, Global Forest Resources Assessment 2010, Country Reports, Malawi PAGE 11
[14] FAO, Global Forest Resources Assessment 2010, Country Reports, Malawi PAGE 11
[15] Global Forest Resources Assessment 2010 (FAO) http://www.fao.org/forestry/fra/fra2010/en/ GLOBAL TABLES, Table 11

Trends in carbon stock in living forest biomass 1990-2010 - Malawi[16]

Country / area	Carbon stock in living forest biomass (million tonnes)					Annual change (million tonnes/yr)			Annual change per hectare (t/ha/yr)		
	1990	2000	2005	2010	Per hectare 2010 (tonnes)	1990-2000	2000-2005	2005-2010	1990-2000	2000-2005	2005-2010
Malawi	173	159	151	144	44	-1	-2	-1	n.s.	n.s.	n.s.

n.s. = not significant, indicating a very small value

2) Trend showing an increase in time spent or distance travelled for gathering fuelwood, 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 Malawi Integrated Household Survey gives an opportunity for analyzing a trend that expands from 2004-2005 to 2010-2011 for the time it takes for collecting firewood. The average length of time it takes for a person aged 15 years plus to collect firewood has more than doubled in just five years, from 12 minutes a day in 2005 to 30 minutes a day in 2010.

Trends in Firewood Collection in Malawi, 2004-2005 and 2010-2011 (people over 15 years of age)

Year	Source	Geographic Boundary	Avg. length of time collecting firewood per person **(minutes/day)**	Avg. length of time collecting firewood per person **(hours/week)**
2004 / 2005	National Statistical Office, Republic of Malawi[17]	National	12*	1.4
2010 / 2011	National Statistical Office, Republic of Malawi[18]	National	30***	3.5**

* The following value is calculated by taking the average weekly hours (1.4) as published in the report multiplied by 60 minutes in an hour then divided by 7 days in a week.
** The following value is calculated by taking the average daily hours (0.5) as published in the report multiplied by 7 days in a week.
*** The following value is calculated by taking the average hours/week (3.5) multiplied by 60 minutes in an hour then divided by 7 days in a week.

Paragraph 9 of AMS I.E methodology requires project participants to provide evidence that the trends identified are not occurring due to the enforcement of local/national regulations:

Although a forest policy and legal framework was established starting in the mid to late 1990's for the conservation, management, protection and utilization of forest resources in Malawi[19], forest area continues to decline steadily according to FAO data presented above. The declining trends in the extent of forest area and carbon stocks occurred in the face of

[16] *Ibid*
[17] Integrated Household Survey 2004-2005, Republic of Malawi PAGE 59 http://www.nsomalawi.mw/images/stories/data_on_line/economics/ihs/IHS2/IHS2_Report.pdf
[18] Integrated Household Survey 2010-2011, Republic of Malawi PAGE 95 http://www.nsomalawi.mw/images/stories/data_on_line/economics/ihs/IHS3/IHS3_Report.pdf
[19] Luhanga, J. (2009) Malawi: The timber trade. South African Resource Watch. http://www.africafiles.org/article.asp?ID=20978 Section "Forest Policy"

<table>
<tr><td></td><td>government efforts to protect such forest resources, evidencing the lack of enforcement of any existing regulation.

There are several documented reasons why regulations are not being enforced by the Malawian government bodies. Ultimately, these reasons stem from lack of resources[20], lack of human resource capacity[21], and a policy of tolerance that has been adopted in the face of high levels of poverty and food insecurity in local communities where regardless of legality, the forest activities are the only source of livelihood [22,23].

In view of the combined evidence of declining forested areas since 1973, trend in loss in carbon stock since 1990, trend in the increased length of time spent for collecting firewood, and presently such a high fraction of non-renewable biomass, it may be deducted that the majority of wood-fuel used across Malawi since December 31, 1989 was from non-renewable sources.</td></tr>
<tr><td>Zambia</td><td>Paragraph 2 of AMS I.E methodology requires project participants to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.

Non-renewable biomass has been in use since December 31, 1989 as evidenced by various FAO statistical data summarized below. Supporting evidence is the trend in loss of forest from 1990 to 2010. The Global Forest Resources Assessment 2010[24] (FAO) indicates that total forest area declined by 7% from 1990 to 2010, as summarized in the following table.

Trends in extent of forest 1990-2010
<table><tr><th rowspan="3">Country / area</th><th colspan="4">Forest area (1 000 ha)</th><th colspan="6">Annual change rate</th></tr><tr><th rowspan="2">1990</th><th rowspan="2">2000</th><th rowspan="2">2005</th><th rowspan="2">2010</th><th colspan="2">1990-2000</th><th colspan="2">2000-2005</th><th colspan="2">2005-2010</th></tr><tr><th>1 000 ha/yr</th><th>%[a]</th><th>1 000 ha/yr</th><th>%[a]</th><th>1 000 ha/yr</th><th>%[a]</th></tr><tr><td>Zambia</td><td>52800</td><td>51134</td><td>50301</td><td>49468</td><td>-167</td><td>-0.32</td><td>-167</td><td>-0.33</td><td>-167</td><td>-0.33</td></tr></table>
The harvesting of non-renewable biomass is commonplace in Zambia and can be reasonably concluded that has been the case since 31 December 1989. Between 1990 and 2000, Zambia lost, on average, 444,800 hectares of forest per year. This amounts to an average annual deforestation rate of 0.91%.

Between 2000 and 2005, the rate of forest change increased by 10.0% to 1.00% per annum. In total, between 1990 and 2005, Zambia lost 13.6% of its forest cover, or around 6,672,000 hectares. Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2005 interval, Zambia lost 14.3% of its forest and woodland habitat[25].

Paragraph 7 of AMS I.E methodology requires the demonstration of NRB through at least two supporting indicators. The fact that biomass is harvested from a net non-renewable source is supported by the following indicators:</td></tr>
</table>

[20] Ibid Section "Major Challenges to Forestry in Malawi"
[21] Ibid
[22] Nangoma, D. and Nangoma, E. Climate change and adaptation strategies: a case study of the Mulanje Mountain Forest Reserve and its surroundings. Mulanje Mountain Conservation Trust. Page 14
[23] Sibale, B. and Banda G. 2004. A study on livelihoods, governance and illegality: Law enforcement, illegality and the forest dependent poor in Malawi Forest Governance Learning Group, Malawi. PAGES 23 & 24
[24] http://www.fao.org/forestry/fra/fra2010/en/ GLOBAL TABLES, Table 3
[25] http://rainforests.mongabay.com/deforestation/2000/Zambia.htm

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;
Total living forest biomass carbon stocks have depleted from 2,579 million hectares in 1990 to 2,416 hectares in 2010, or by approximately 7%. The annual loss in carbon stock in living forest biomass is estimated at 8 million tonnes of carbon per year[26].

Trends in carbon stock in living forest biomass 1990-2010

Country / area	Carbon stock in living forest biomass (million tonnes)					Annual change (million tonnes/yr)			Annual change per hectare (t/ha/yr)		
	1990	2000	2005	2010	Per hectare 2010 (tonnes)	1990-2000	2000-2005	2005-2010	1990-2000	2000-2005	2005-2010
Zambia	2579	2497	2457	2416	49	-8	-8	-8	n.s.	n.s.	n.s.

2) Trends in the type of cooking fuel collected by users, suggesting scarcity of woody biomass
"The high demand for wood-fuel has resulted in non-species selective cutting regimes being applied by many wood-fuel producers, culminating in severe depletion of many forest ecosystems and the resultant land degradation. Since rural communities can now neither find productive land nor meet the costs for agricultural inputs, the implied situation is one that perpetuates forest destruction irrespective of tree size, species and/or quality."[27]

In view of the combined evidence of declining forested areas since 1990, trend in loss in carbon stock since 1990, trend in the type of cooking fuel collected by users, and presently such a high fraction of non-renewable biomass, it may be deducted that the majority of wood-fuel used across Zambia since December 31, 1989 was from non-renewable sources.

The thermal capacity of each small scale CPA will be below the SSC threshold of 45 MW (thermal). The project proposes the replacement of non-renewable biomass through renewable energy for the supply of individual users with thermal energy.
Finally, the use of this methodology in a project activity under a programme of activities is legitimate if the following leakages are estimated and accounted for, if required on a sample basis using a 90/30 precision for the selection of samples:

(a) Use of non-renewable woody biomass saved under the project activity to justify the baseline of other CDM project activities can be a potential source of leakage. If this leakage assessment quantifies a portion of non-renewable woody biomass saved under the project activity that is then used as the baseline of other CDM project activities then B_y is adjusted to account for the quantified leakage.
(b) Increase in the use of non-renewable woody biomass outside the project boundary to create a non-renewable woody biomass baselines can also be a potential source of leakage. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass outside the project boundary, then By is adjusted to account for the quantifies leakage;
(c) As an alternative to sub-paragraphs (a) and (b) By can be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.

This PoA will use Option (c) to account for leakages.

[26] http://www.fao.org/forestry/fra/fra2010/en/ GLOBAL TABLES, Table 11
[27] Mulombwa, J. 1998. Woodfuel review and assessment in Zambia. Technical report. Series: Forestry Statistics and Data Collection AFDCA/WE/22. Food and Agriculture Organisation of the United Nations: Addis Ababa, Ethiopia. 55 pp.

Sampling Plan
A detailed sampling plan can be found in section B.7.2. of the Generic CPA below.

SECTION C. Management system

Each SSC-CPA will involve promotion, distribution and/or installation of affordable ICS to users, on a commercial or non-commercial basis.

Implementation and management
CQC and its local partners such as Total Land Care in Malawi and Zambia will manage and coordinate the promotion, distribution and sale of the ICS and the supply of renewable biomass through a variety of different potential channels to be described on CPA-level.

CQC in collaboration with the local partners (e.g. local women associations) will arrange cooking demonstrations and awareness generating activities. This will ensure that potential end users are informed about the benefits associated with the ICS especially in terms of savings in firewood consumption, health benefits and cost savings to the user.

CQC, Total Land Care Malawi and Zambia will manage and coordinate activities of the partners, and also provide all necessary marketing and promotion assistants to the businesses. CQC will also coordinate the monitoring of the programme activities.

CPA Implementers
These are entities which will manage and coordinate the promotion, distribution and/or installation of the ICS in the countries. CPA implementers are also responsible for monitoring activities of the SSC-CPAs. Examples of CPA implementers are: NGOs, religious, environmental, social organisations, farmers associations and private, public or governmental entities. CPA implementers will have an agreement with the CME establishing roles and responsibilities for the successful implementation of the SSC-CPA.

Each CPA implementer will define and establish its distribution channel(s) for ICS and supply channel(s) for renewable biomass. One or more of the following distribution channels are envisaged to achieve the SSC-POA objective:

- The first channel will leverage community organizations including NGOs, religious organizations and farmers associations.
- The second channel will market directly to consumers through direct distribution/installation in communities, at local market days and other large community events.
- The third channel will utilize existing local, experienced commercial distributors. Each of the distributors will have their own established network of retailers.

Coordinating/Managing Entity
CQC as CME will manage and coordinate activities of the CPA implementers and also provide necessary marketing and promotion assistance to the businesses. The CME will also coordinate the monitoring of the SSC-PoA and all the communications with the UNFCCC Executive Board.

Data Collection and Transfer

Registration Card
CPA implementers must gather the necessary information to identify users of its ICS during the course of the project. To facilitate this process, the CPA implementers will assign a serial number to each ICS or to

the user[28]. This number will be recorded in the Registration Card together with the following information (as appropriate and as available):

- Name of ICS user
- Address of ICS user
- Phone number of ICS user
- Stove model
- Date of adoption for use
- ICS serial number
- Retailer/distributer name, contact details and location

Means of collecting end-users' information

CPA implementers shall ensure that the information contained in the Registration Card[29] is collected and transferred to the CME. Collection of end-users' information can be achieved through different means. The following methods are expected:

- Direct contact: the CPA implementer instructs their field team, or contracts retailers, to fill the Registration Card with users' information when selling/installing the ICS. This is initially envisaged as a manual action using ink on a printed Registration Card, but new Information and Communication Technologies (ICT) to increase the efficiency of data collection and data transfer may be applied. One example of these technologies is the personal digital assistant (PDA) - a handhold device that transfers data over the internet.
- Indirect: the users' data (same information as per Registration Card) may be directly transferred to the CPA implementer via Short Message Service (SMS) also known as text messaging service. In this instance, the CPA implementer will provide the user or retailer with instruction on how to submit the SMS to the CPA implementer.

Users' participation on the SSC-POA and transfer of Carbon Rights to the CME

During the sale/installation of the ICS, the user shall confirm the ICS is replacing a wood-fuel stove and shall be informed by the CPA implementer of their participation on the SSC-PoA and that CDM finance is being used to fund the ICS. Users shall agree, as per the Registration Card, to waive possible claims or transfer possible rights to any emission reduction generated by the ICS to the CME.

In case of direct contact, the collection of users' information can be achieved by instructing the CPA implementer's sales/field team members to read out the required information to users and writing down (either on the Registration Card or on the ICT) the answers. In this instance, CPA implementers shall also read out the clauses acknowledging users participation on the SSC-PoA and waiving of any claims or transfer of possible carbon rights to the users. CPA implementers shall tick a check-box next to clause once end-user acknowledges it.

When SMS is used, this clause can be written on the instruction for the user and retailer on how to submit the information to the CPA implementer. By sending the SMS, users are acknowledging that they are voluntarily participating in the SSC-PoA, that the ICS is replacing a charcoal or firewood stove and that it agrees to waive possible claims and transfer possible carbon rights to the CME.

Project Database

The information collected by the CPA implementer is transferred to an electronic database which is updated regularly and will be shared with the CME at the end of implementation.

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[28] In cases where the stove is fixed and a serial number plate is difficult to be assembled to the ICS (eg. mud stoves which are constantly being repaired by users with a new layer of mud), a serial number will be associated with the user, instead of to the stove. For instances where the serial number plate can be attached to the ICS itself, it will be.

[29] Registration Card may be a SMS database entry, another Information Communication Technologies (ICT) method, or a physical document.

CPA implementer will have the hard-copy data input into an electronic database which is managed by the CPA implementer. For information transferred via ICT, there will be no hard-copy. The electronic data is transferred from the ICT device to the database managed by the CPA implementer. Similarly, SMS data is transferred directly to the electronic database managed by the CPA implementer. The CPA implementer will give full access to the database to the CME. The database will be backed up to a server managed by the CME. The hardcopy of the Registration Card (if applicable) shall be archived with the CPA implementer.

The CME will maintain copies of the database from all of the CPAs and will also act as a backup to CPA implementers' database/s. The CPA implementer personnel entering the data from each ICS will be trained in the basic functions of Excel (or other appropriate software used to build the database) by CPA implementer. CPA implementer staff will sample and cross-check the data at minimum once every three months by randomly selecting at least 20 database (across all its CPAs) entries and comparing the information in the cells with the information from the SMS texts ICT uploads or Registration Cards. The database will be sortable by the information collected as per Registration Card and will be made available to the DOE at verification.

The CPA implementer will verify accuracy and completeness and confirm that there is no double entry of serial numbers in the database. The CPA implementer will identify any discrepancy and the correct information will be entered into the database.

In case a replacement stove is being issued / sold to a customer already registered on the project database, a new registration will not be required. The replacement stove will be recorded in the project database in such a way that it is clear that the replaced stove ceases to be included in the CPA; and the replacement stove is associated with the customer's details as a new stove, with a new serial number, and is included in the CPA as a new stove.

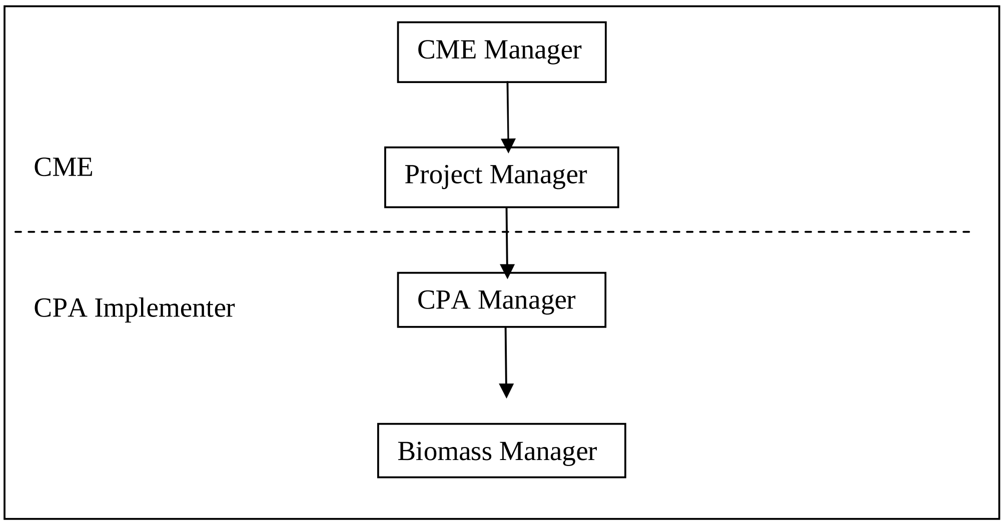
Responsibilities of Operational and Management Entities

CQC is the CME for this SSC-POA. CQC, TLC or other third parties may act as CPA Implementers. The responsibilities of each party are summarised below.

Entity	**Responsibilities**
CME	- Review all CPAs to confirm that all eligibility requirements are met before a CPA is proposed for inclusion - CME Manager - Coordinate and manage the market promotion necessary for successful distribution- Project Manager - Overall coordination and management of ICS distribution and renewable biomass supply- Project Manager - Coordinate and manage the implementation of the monitoring plan- Project Manager - Maintain all the project database and back-up records necessary to verify stoves sold within each CPA and the PoA overall- Project Manager - Implement and oversee day-to-day operation of the PoA- Project Manager - Coordinate with a DOE to verify emissions reductions from CPAs - CME Manager
CPA Implementer	- Direct coordination and management of ICS distribution process and renewable biomass supply – CPA Manager & Biomass Manager - Plan and implement market promotion – CPA Manager - Implement the monitoring plan – CPA Manager - Coordinate the efforts of all local partner organisations for ICS sales/distribution and renewable biomass supply – CPA Manager

	- Provide training to local partner organisation staff on distribution and monitoring – CPA Manager - Maintain all records necessary to verify stoves sold within each CPA it is implementing – CPA Manager - Implement and oversee day-to-day operation of the CPA, including ensuring users of the stoves are aware of how they should be used – CPA Manager - Identify and enlist distribution chain actors to ensure adequate stove sales – CPA Manager - Be responsible for tracking stoves to end users and verifying use – CPA Manager - Spot check end user tracking system – CPA Manager

Local partners will be required to conform to the systems designed by the CME under services agreements signed with the CME. An example organogram for one CPA is included below:



Operational and management plan:

a) Definition of roles and responsibilities of personnel involved in the process of inclusion of CPAs, including a review of their competencies;

A clear definition of roles and responsibilities of the parties involved in this PoA has been given in the section above. The CME shall have the competencies to check the features of potential CPAs and ensure that each CPA meets all requirements and eligibility criteria before inclusion in the PoA.

CME Competencies: CQC has been a leader in the development of Programme of Activities under the CDM, having developed the CFL lighting scheme-"Bachat Lamp Yojana" POA (CDM Ref. 3223) and implemented more than 4 CPAs under it (at the time of the validation of this SSC—PoA). CQC is currently the CME for six SSC-PoAs:

PoA 1: Distribution of fuel-efficient improved cook stoves in Nigeria
PoA 2: Distribution of ONIL-stoves Mexico
PoA 3: Distribution of ONIL-stoves Guatemala
PoA 4: Distribution of improved cook stoves in Zambia
PoA 5: Distribution of Improved Cook Stoves in Sub-Saharan Africa
PoA 6: Improved Cookstove Program for Malawi and cross-border region of Mozambique

CQC staff has over 20 years of experience with ICS, having been involved and lead key operations to provide funding in different countries through multiple instruments for cook stoves. These operations have proven successful and introduced consumers to the opportunity of ICS. CQC staff has established working relationship with major international stove producers and have been involved in the development of registered methodologies and PDDs and PoAs for ICS.

b) Records of arrangements for training and capacity development for personnel

Baseline survey: The quality of the interviewing will be key element in achieving an accurate baseline assessment. For this reason, the CME has established general guidance for interviewers to follow when conducting baseline fuel surveys in homes. This guidance is provided to the CPA implementer and outlines the questions and manner in which the interview should be conducted.

Monitoring: Training, including that of field personnel, is needed to ensure monitoring activities are conducted effectively. This will include spot checking a random sample of homes with ICS to ensure the stoves are continuing to be used.

ICS distribution/installation: CPA implementers shall provide evidence of their ability to train technicians/instructors/field staff on ICS assembly, manufacture, installation, sales and distribution in accordance with the type of stove implemented under its CPA.

c) Procedures for technical review of inclusion of CPAs

The CME will undertake the following activities to ensure proper eligibility of the CPAs before they are uploaded for official inclusion into the PoA:

- CME will review each CPA document and methodically go through each and every eligibility/applicability criterion of the PoA to make sure there is no question that the CPA meets each requirement. In cases where there is doubt, the CME will not upload the CPA document until the requirements are met to the CME's satisfaction.
- CME will review the ICS models that are proposed for distribution/installation under each CPA.
- CME will review the supply of renewable biomass under each CPA.
- CME will review of database/registration procedures to ensure proper recording of the stove in line with the methodology and PoA eligibility criteria.
- CME will review all proposed monitoring procedures to ensure they are in line with PoA, including stove efficiency testing and confirming the new stoves are continuing to be used.
- During the implementation of a CPA, CQC personnel will visit each CPA region to ensure all procedures outlined in the PoA are being followed, particularly on stove registration and database updating.

d) A procedure to avoid double counting (e.g. to avoid the case of including a new CPA that has already been registered either as a CDM project activity or as a CPA of another PoA)

Each ICS in each SSC-CPA included in this PoA will be identified by a unique combination of customer name and geographical location, as well as a unique serial number. Double registrations of ICS will be flagged and removed from the database, so eliminating the risk of double counting within a single CPA, as well as across the PoA. The serial number will start with an identifier CQC-FS which will allow for a clear distinction between the stoves from this PoA with those of other potential PoAs. Each stove's serial number will be entered into a database that will keep track of which stoves are in which CPAs. Each CPA will have a set of serial numbers so a project participant or verifier can easily determine that any stove identified with any user is affiliated with one – and only one – CPA. No individual serial number can be in more than one CPA, so it will not be possible for one stove to be counted in two different CPAs. In addition, each CPA will be cross-checked with other CPAs in this PoA and with CPAs in any other

PoA or in a CDM project activity operating in the country using the UNFCCC, the Gold Standard, and other relevant voluntary carbon schemes to ensure that the CPA is not included in any other PoA, CDM project activity or voluntary carbon project activity.

When a new ICS Registration Card is filled out, or sent via SMS or ICT, the customer will acknowledge that they previously used a wood-fuel stove and are not part of any other ICS program to earn carbon credits. Registration data collected will be verified by spot-checks. This will ensure that no customers/recipients will be included in a new CPA if they already own an ICS that is included in a CPA of another PoA (or any carbon financed project) that is registered or is seeking registration.

e) Records and documentation control process for each CPA under the PoA

(i) There will be a record keeping system for each CPA under the PoA,

As explained in section “Means of collecting end-users' information" in Section C, detailed information will be collected from each customer/recipient at the time of installation/distribution of the ICS using either electronic or paper-based means, directly by the CPA implementer’s field personnel or through partner organizations or independent distributers/retailers This information is detailed on the “Registration Card”, and will allow CPA implementers to track each individual ICS and/or user. The information collected by the CPA implementer is transferred to an electronic database which is updated regularly and shared with the CME – additional details can be found on section “Project Data-Base” in Section C. Each CPA will have its own database with a cumulative maximum number of ICS below the limit established in the methodology.

The SMS or completed Registration Card (or equivalent) (in hard or soft copy, if via ICT) will also constitute an agreement that the user formerly used a charcoal or firewood stove, and is willing to waive possible claims and transfer possible rights to carbon assets created by the ICS to the CME (or any affiliate it so designates). The SMS system may replace the hard-copy system altogether.

In case a replacement stove is being issued to a customer already registered on the project database, a new registration will not be required. The replacement stove will be recorded in the project database in such a way that it is clear that the replaced stove ceases to be included in the CPA; and the replacement stove is associated with the customer’s details as a new stove and serial number, and is included in the CPA as a new stove.

SMS data will be collated automatically, and backup records will be generated from this data and stored securely by the CPA implementer and the CME after CPA implementation. Written registration cards will be entered manually onto the same database and the originals stored securely. In this way there will be both hardcopy and electronic records kept for each ICS installed or distributed in the SSC-PoA. The SMS system may replace the hard-copy system altogether.

(ii) The SSC-CPA included in the PoA is not a de-bundled component of another CDM programme activity (CPA) or CDM project activity.

Paragraph 10 of EB54, Annex 13 ‘Guidelines on assessment of de bundling for SSC project activities’ states that:

‘If each of the independent subsystems/measures (e.g., biogas digester, solar home system) included in the CPA of a PoA is no larger than 1% of the small-scale thresholds defined by the methodology applied then that CPA of PoA is exempted from performing de-bundling check i.e., considering as not being a de-bundled component of a large scale activity.’

The small-scale threshold defined in the Project Standard[30] is 45 MW thermal output/rated capacity per year. Therefore, 1% of 45 MW corresponds to 450kW thermal output/rated capacity. The de-bundling procedure does not apply to this SSC-PoA because the rated capacity of each ICS is substantially smaller than the threshold limit imposed by AMS-I.E. version 5.

Each CPA will be exempt from performing the de-bundling check and this will be confirmed on CPA level.

(iii) The provisions to ensure that those operating the CPA are aware of and have agreed that their activity is being subscribed to the PoA;

CPA implementers have the operational responsibility for implementing and monitoring the CPAs under this SSC-PoA. The CME will have legal contracts put in place with implementing partners and with entities assisting with the implementation which clearly state that the implementation of CPA activities are subscribed to this SSC-PoA.

f) Measures for continuous improvements of the PoA management system

The CME will undertake an annual review of the overall PoA management system, including identifying any problems with stove distribution/installation, stove use once in the homes, monitoring continued stove use and overall database maintenance. This review will take place during the verification stage, which will assist the CME in obtaining an outside perspective of the overall management process.

SECTION D. Duration of PoA

D.1. Start date of PoA

26/04/2013 or the date at which the PoA was uploaded at the UNFCCC website for global stakeholder consultation (GSP), whichever is later.

D.2. Length of the PoA

28 years

SECTION E. Environmental impacts

E.1. Level at which environmental analysis is undertaken

The environmental analysis will take place at the PoA level for all CPAs. For CPAs in Zambia to comply with national legislation environmental clearance will have to be obtained at CPA level as reflected in eligibility criterion 7. The environmental impacts of the PoA will be broadly consistent across all CPAs and are not anticipated to vary significantly, therefore a PoA-level analysis of environmental impacts is most appropriate.

E.2. Analysis of the environmental impacts

No negative environmental impacts have been identified from the proposed PoA.

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[30] Project standard, version 04 (EB74, Annex 03)

The ICS disseminated in this programme are expected to present a substantially lower risk to the local and global environment compared to the baseline, and also result in real socio-economic and health benefits to users.

In particular, the activities will result in the following positive environmental impacts:

- Avoiding the non-sustainable logging of trees and the negative consequences of deforestation (land degradation, erosion, micro climate change, reduced precipitation, dwindling water retention, increasing water turbidity, loss of biodiversity);
- Enabling a sustainable forest management and improving forest maintenance and prevention of forest fires and other issues (for example issues with insects) by converting renewably harvested residues and small wood products (sticks) to a highly appreciated commodity;
- Avoiding almost completely emission of the toxic carbon monoxide gas. The combustion in the selected ICS is highly effective and produces only small amounts of carbon monoxide;
- Avoiding greenhouse gas emission from transport, production and use of charcoal and firewood.

One of the positive environmental impacts of the programme will be raising awareness and knowledge about environmental challenges, enabled by an accompanying educational programme. The educational programme will address also health impacts and how to avoid smoke in the kitchen.

With the new ICS, the annual wood fuel requirement of a typical user will be dramatically reduced, which will conserve a key environmental resource, woody biomass. The woody biomass used in the programme will be supplied renewably from existing forest plantations, municipal waste and from new short-term or long-term rotation plantations.

The programme will contribute to efforts to reduce deforestation caused through reduced wood-fuel consumption and through sustainable harvesting practice.

In accordance with Malawian[31] regulations, an environmental impact assessment is not required for typical CPAs included in the proposed PoA. For CPAs in Zambia it will be necessary to obtaining environmental clearance by submitting a project brief to the Zambia Environmental Management Authority (ZEMA) or any other appropriate agency to decide whether or not an EIA will be necessary.

SECTION F. Local stakeholder comments

F.1. Solicitation of comments from local stakeholders

1. Local stakeholder consultation is done at PoA level X
2. Local stakeholder consultation is done at SSC-CPA level ☐

The CPA boundaries are defined by individual ICS/user locations which extend across the SSC-PoA project area, although not crossing country borders; CPAs are therefore geographically confined to one country. Therefore a PoA-level Stakeholder Consultation in each individual country is deemed most appropriate, covering the whole project area. The environmental, social and economic impacts of the PoA will be broadly consistent across CPAs, so the CME do not expect significantly different comments from stakeholders across CPAs.

Malawi

[31] List A and B of the Malawi Environmental Management Act, 1996, indicates the type of projects that may require EIA and this does not include ICS projects.

A stakeholder consultation was held on 30th of April 2013 at the Pacific Hotel, City Center Lilongwe. The objective of the consultation was to explain the PoA to all the relevant stakeholders in Malawi and to receive their comments on the programme.

Stakeholders were invited by email or by the reception of hand-delivered letters, especially in the instance of governmental or institutional stakeholders. Newspaper adverts were placed to reach other stakeholders in the two national papers, The Daily Times and The Nation on both 18/04/2013 and 25/04/2013. A selection of national and international stakeholders was invited in order to cover the many sections of the Malawian society as much as possible together with international players, such as international NGOs.

The stakeholder consultation was structured as follows:

- **Arrival and Registration of Participants and Guest of Honour**
- **Welcome with Prayer, Opening Remarks and Introductions**
- **Agenda and Expectations:** Presentation of agenda and expectations/purpose
- **Keynote Address:** Dr Aloysius Kamperewera, Director of Environmental Affairs
- **Official Opening by Guest of Honour: Deputy Minister Hon. Godfrey Kamanya Jefa** from the Minister of the Environment & Climate Change
- **Project Goal:**
    - Renewable Biomass Supply and Improved Cook-Stoves and Access to Carbon Markets
    - Project Implementers
    - Initial Feedback from the Participants
- **Project Description:**
    - Geographic Scope
    - Program and Technology to be implemented
    - Environmental, Socio-economic and Health Benefits
    - Brief on the Clean Development Mechanism (CDM)
    - Project Phases & Timeline
    - Next Steps in Project Development, Reviews and Approvals
- **Questions and Clarifications on Proposed Project**
- **Evaluation Form:** To be circulated and filled in by participants
- **Official Closing**
    - Plan for distribution of minutes with contact details for CQC and TLC
    - Official Closing
    - Closing Prayer

Zambia

A Local Stakeholder Consultation meeting for this PoA was held in Lusaka on the 26th of April 2013 at Top Floor, Elunda II, Rhodespark, Zambia. Stakeholders were invited to the meeting using a number of means which included a newspaper advertisement in a national daily, The Post, a radio announcement on Radio 4 of the Zambia National Broadcasting Corporation, email invitations as well as hand delivered invitations. The key stakeholders invited to the consultation included representatives from the Designated National Authority, Department of Natural Resources and Environmental Protection, Energy Department, Zambia Development Agency, Community Based Organizations, cook stoves users and CDM project implementers.

Participants were welcomed to the meeting and informed that the purpose of the meeting was to explain a new project to supply renewable biomass and disseminate improved cook-stoves in Sub-Saharan Africa including Zambia, to seek feedback from participants on project design and implementation and to also address questions from participants. A sign in sheet was circulated to participants to confirm attendance. A power point presentation explaining the purpose of the programme of activities was made.

The stakeholder consultation was structured as follows:

- **Arrival and Registration of Participants and Guest of Honour**
- **Welcome with Prayer, Opening Remarks and Introductions**
- **Agenda and Expectations:** Presentation of agenda and expectations/purpose
- **Official Opening of Meeting**
- **Project Goal:**
    - Renewable Biomass Supply and Improved Cook-Stoves and Access to Carbon Markets
    - Project Implementers
    - Initial Feedback from the Participants
- **Project Description:**
    - Geographic Scope
    - Program and Technology to be implemented
    - Environmental, Socio-economic and Health Benefits
    - Brief on the Clean Development Mechanism (CDM)
    - Project Phases & Timeline
    - Next Steps in Project Development, Reviews and Approvals
- **Questions and Clarifications on Proposed Project**
- **Evaluation Form:** To be circulated and filled in by participants
- **Official Closing**
    - Plan for distribution of minutes with contact details for CQC and TLC
    - Official Closing
    - Closing Prayer

F.2. Summary of comments received

Malawi

In general, the comments expressed by the stakeholders were extremely positive. All stakeholders welcomed the programme as they engaged proactively in the discussion. Many aspects of the programme were probed and, at the same time, possible collaborations to underpin its success were suggested. The programme was deemed by most stakeholders as powerful way of addressing environmental degradation in Malawi in particular deforestation and, simultaneously, some participants lauded the initiative by recognizing the economic value attached to the new renewable fuel the programme is incentivising.

Deputy Minister Hon. Godfrey Kamanya Jefa from the Minister of the Environment & Climate Change, confirmed that the project participant TLC is the best forest operator in Malawi. He confirmed he had visited the block that TLC manages in the Viphya and that he was very positively impressed. The Deputy Minister also requested TLC to apply for more areas and that he would support this.

The comments and questions from the stakeholder consultation include the following points:

Q1. Stakeholders asked if the stoves were imported or locally made.

A1. The CME responded that initially these are going to be imported from China and from Lesotho, but the CME does incentivise the local production of stoves. The Designated Focal Point for CDM , Mrs. Shamiso Najira, also mentioned that the DNA would support any technology transfer in this field.

Q2. Stakeholder requested that local companies are used not only to manufacture the stoves but also to distribute these.

A2. The CME clarified that it is currently formulating the commercial plans for distributing the stoves and that it is considering several scenarios, including the use of local retailers.

Q3. Stakeholders asked what the cost of the stoves was. They were surprised with the cost of the improved stoves currently thought to be distributed under the POA varying from USD20 to over USD100.

A3. Again, the CME expressed interest in analysing locally made stoves or stoves manufactured in African continent, which would ultimately reduce these costs, due to the reduce import taxes which imported stoves currently face.

Q4. It was also advised by stakeholder to ensure that the POA is in line with Malawi's national energy and forestry strategies. It was raised for example the new presidential initiative to disseminate 2 million stoves by 2020 in Malawi.

A4. The CME confirmed that it has scheduled meeting with both ministries and with the DNA in order to confirm that the POA objectives are aligned with the government's objectives. There are no laws/regulations governing the dissemination of ICS or renewable biomass fuel in Malawi.

Q5. A technical question about how CERs are calculated, the methodology used, how to assess leakage was asked and the CME responded in general terms.

A5. The CME advised the interested party to look for the methodology AMS.I.E at the UNFCCC website and said that soon the POA-DD would also be available online.

Q6. Stakeholders questioned the CME on how the revenues from CERs are shared and how TLC and local households benefit from it.

A6. The CME explained that it is still negotiating the terms for financing this POA and that the vast majority of the CERs are used to repay investors. Residual CERs will be shared between CME to pay for its services and TLC. The CME also clarified to stakeholders that the objective of the POA is to make cooking cleaner and cheaper, so by definition, the first stakeholder benefiting from the CERs are households, which are saving money and time.

Zambia

The participants of the LSC meeting gave positive remarks about the consultation, stating that it was a very useful event for sharing updates about the programme and for the promotion of the programme to stakeholders.

The stakeholders also perceived the programme as a very positive because it helps in supporting the use of renewable biomass, had social, economic and environmental benefits. Participants also commented that the programme should be given media coverage so that the general public would appreciate the use of improved cook stoves. Participants commented to the fact that there was need for the government to actively participate in such important developmental issues. Participants also expressed that it was good that there could be many projects (CPA'S) across the country under one umbrella Programme. The flexibility of the PoA was found to be a very positive aspect because it allowed different project developers and different cook stove technologies to take part in the programme.

Based on the evaluation, most of the attendants had positive feedback about the programme. The comments and questions from the stakeholder consultation include the following points:

Q1. What is the lifespan of the programme?

A1. The programme of activities can run up to a maximum of 28 years.

Q2. Are the stoves going to be produced locally?

A2. There is a number of choices regarding where the stove is produced, it could be produced locally depending on type of stove and availability of raw materials to produce it. The stove components could be prefabricated elsewhere, imported and then assembled locally or the stove could be imported as a finished product.

Q3. How does the local community benefit from the programme?

A3. The local community benefits from a number of ways, environmental, socio-economic as well as health. The direct benefits to the community also include creation of employment by the programme for the distribution and monitoring of the ICS and RB

Q4. How many projects can be implemented under the programme of activities? What is the maximum number of stoves in each CPA?

A4. There can be as many projects as possible but the boundary of the CPA must be clearly defined. The threshold of cook stoves can be as many as 20,000[32] systems per CPA.

Q5. Will the local population be able to afford the improved cookstoves?

A5. The programme could involve the sale of various technologies at different price points and close attention will be paid to the local populations willingness to pay compared to the retail price of each stove. The intent is to sell stoves on a commercial basis, so they must be affordable to the target markets.

Q6. Is there a government policy to promote the disseminations of ICS?

A6. In the Sixth National Development Plan and the Renewable Energy strategy of 2010, there are no mandatory targets but pronouncements have been made of what the sector may achieve over a given period in the promotion of ICS.

F.3. Report on consideration of comments received

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All clarifications requested during the stakeholder consultations were addressed to the satisfaction of attendees. No unresolved issues were raised, nor were any misgivings cited. All other comments received were positive in relation to the planned activities. No follow up action was required in respect of the comments received.

SECTION G. Approval and authorization

Letters of Approval from Malawi and Zambia are pending.

PART II. Generic component project activity (CPA)

SECTION A. General description of a generic CPA

A.1. Purpose and general description of generic CPAs

[32] This value will differ from CPA to CPA

A typical CPA will involve the distribution of ICS on a commercial or non-commercial basis to users, communities and/or SMEs along with sources of renewable biomass enabling a fuel switch from non-renewable biomass. The purpose is to reduce greenhouse gas emissions, by reducing the use of non-renewable biomass and provide high quality improved cook stoves to users along with a reliable supply of renewable biomass.

SECTION B. Application of a baseline and monitoring methodology

B.1. Reference of the approved baseline and monitoring methodology(ies) selected

Type I – Renewable Energy Projects; AMS I.E. "Switch from Non-Renewable Biomass for Thermal Applications by the User" Version 5. EB 68 Annex 22.

B.2. Application of methodology(ies)

The project activity is a Type I project activity ("Renewable Energy Projects") because it involves renewable energy technology that supply thermal energy to the participating user directly. The project activity uses methodology AMS-I.E. ('Switch from Non-Renewable Biomass for Thermal Applications by the User") because the project displaces the use of non-renewable biomass with renewably harvested wood.

Applicability Criteria from AMS-I.E. v05	CPA compliance
This category comprises activities to displace the use of non-renewable biomass by introducing renewable energy technologies. Examples of these technologies include, but are not limited to biogas stoves, solar cookers, passive solar homes, renewable energy based drinking water treatment technologies (e.g. sand filters followed by solar water disinfection; water boiling using renewable biomass).	The CPAs will involve the introduction of ICS that use renewable biomass replacing the use of non-renewable biomass
Project participants are able to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.	As demonstrated below NRB has been used in Zambia and Malawi since 31 December 1989
The use of this methodology in a project activity under a programme of activities is legitimate if the following leakages are estimated and accounted for, if required on a sample basis using a 90/30 precision for the selection of samples, and accounted for: (a) Use of non-renewable woody biomass saved under the project activity to justify the baseline of other CDM project activities can also be a potential source of leakage. If this leakage assessment quantifies a portion of non-renewable woody biomass saved under the project activity that is then used as the baseline of other CDM project activities then Bold is adjusted to account for the quantified leakage; (b) Increase in the use of non-renewable woody	All CPAs will use option (c) and take 0.95 to account for leakages.

biomass outside the project boundary to create non-renewable woody biomass baselines can also be a potential source of leakage. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass outside the project boundary then Bold is adjusted to account for the quantified leakage; (c) As an alternative to subparagraphs (a) and (b), Bold can be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.	

The project falls into this category as it provides thermal energy through the introduction of new renewable energy end-user technologies: Through the combination of renewable biomass fuel using ICS, the non-renewable biomass consumption can be reduced or completely avoided. Therefore, the project category AMS-I.E. is applicable.

In addition, surveys, published literature, official reports and statistics confirm that non-renewable biomass has been used since 31 December 1989

<table>
<tr><td>Malawi</td><td>
Paragraph 2 of AMS I.E methodology requires project participants to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.
Non-renewable biomass has been in use since December 31, 1989 as evidenced by various FAO statistical data. The Global Forest Resources Assessment 2010[33] (FAO) indicates that forest areas decline yearly, and that the total forest area declined by 27% from 1973 to 2010, as summarized in the table below.
Trends in extent of forest 1973-2010 - Malawi[34]
<table>
<tr><th colspan="6">Area (1000 hectares)</th></tr>
<tr><th></th><th>1973</th><th>1990</th><th>2000</th><th>2005</th><th>2010</th></tr>
<tr><td>Forest</td><td>4456</td><td>3863</td><td>3567</td><td>3402</td><td>3237</td></tr>
</table>
Paragraph 7 of AMS I.E methodology requires the demonstration of NRB through at least two supporting indicators. The fact that biomass is harvested from a net non-renewable source 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;
Total living forest biomass carbon stocks have depleted from 173 million tons in 1990 to approximately 144 million tons in 2010, or by approximately 17 percent. The annual loss in carbon stock in living forest biomass is estimated between 1 and 2 million tonnes of carbon per year[35].
</td></tr>
</table>

[33] FAO, Global Forest Resources Assessment 2010, Country Reports, Malawi PAGE 11
[34] FAO, Global Forest Resources Assessment 2010, Country Reports, Malawi PAGE 11
[35] Global Forest Resources Assessment 2010 (FAO) http://www.fao.org/forestry/fra/fra2010/en/ GLOBAL TABLES, Table 11

Trends in carbon stock in living forest biomass 1990-2010 - Malawi[36]

Country / area	Carbon stock in living forest biomass (million tonnes)					Annual change (million tonnes/yr)			Annual change per hectare (t/ha/yr)		
	1990	2000	2005	2010	Per hectare 2010 (tonnes)	1990-2000	2000-2005	2005-2010	1990-2000	2000-2005	2005-2010
Malawi	173	159	151	144	44	-1	-2	-1	n.s.	n.s.	n.s.

n.s. = not significant, indicating a very small value

2) Trend showing an increase in time spent or distance travelled for gathering fuelwood, 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 Malawi Integrated Household Survey gives an opportunity for analyzing a trend that expands from 2004-2005 to 2010-2011 for the time it takes for collecting firewood. The average length of time it takes for a person aged 15 years plus to collect firewood has more than doubled in just five years, from 12 minutes a day in 2005 to 30 minutes a day in 2010.

Trends in Firewood Collection in Malawi, 2004-2005 and 2010-2011 (people over 15 years of age)

Year	Source	Geographic Boundary	Avg. length of time collecting firewood per person **(minutes/day)**	Avg. length of time collecting firewood per person **(hours/week)**
2004 / 2005	National Statistical Office, Republic of Malawi[37]	National	12*	1.4
2010 / 2011	National Statistical Office, Republic of Malawi[38]	National	30***	3.5**

* The following value is calculated by taking the average weekly hours (1.4) as published in the report multiplied by 60 minutes in an hour then divided by 7 days in a week.
** The following value is calculated by taking the average daily hours (0.5) as published in the report multiplied by 7 days in a week.
*** The following value is calculated by taking the average hours/week (3.5) multiplied by 60 minutes in an hour then divided by 7 days in a week.

Paragraph 9 of AMS I.E methodology requires project participants to provide evidence that the trends identified are not occurring due to the enforcement of local/national regulations:

Although a forest policy and legal framework was established starting in the mid to late 1990's for the conservation, management, protection and utilization of forest resources in Malawi[39], forest area continues to decline steadily according to FAO data presented above. The declining trends in the extent of forest area and carbon stocks occurred in the face of government efforts to protect such forest resources, evidencing the lack of enforcement of

[36] *Ibid*
[37] Integrated Household Survey 2004-2005, Republic of Malawi PAGE 59 http://www.nsomalawi.mw/images/stories/data_on_line/economics/ihs/IHS2/IHS2_Report.pdf
[38] Integrated Household Survey 2010-2011, Republic of Malawi PAGE 95 http://www.nsomalawi.mw/images/stories/data_on_line/economics/ihs/IHS3/IHS3_Report.pdf
[39] Luhanga, J. (2009) Malawi: The timber trade. South African Resource Watch. http://www.africafiles.org/article.asp?ID=20978 Section "Forest Policy"

any existing regulation.

There are several documented reasons why regulations are not being enforced by the Malawian government bodies. Ultimately, these reasons stem from lack of resources[40], lack of human resource capacity[41], and a policy of tolerance that has been adopted in the face of high levels of poverty and food insecurity in local communities where regardless of legality, the forest activities are the only source of livelihood [42,43].

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

Zambia

Paragraph 2 of AMS I.E methodology requires project participants to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.

Non-renewable biomass has been in use since December 31, 1989 as evidenced by various FAO statistical data summarized below. Supporting evidence is the trend in loss of forest from 1990 to 2010. The Global Forest Resources Assessment 2010[44] (FAO) indicates that total forest area declined by 7% from 1990 to 2010, as summarized in the following table.

Trends in extent of forest 1990-2010

Country / area	Forest area (1 000 ha)				Annual change rate					
					1990-2000		2000-2005		2005-2010	
	1990	2000	2005	2010	1 000 ha/yr	%[a]	1 000 ha/yr	%[a]	1 000 ha/yr	%[a]
Zambia	52800	51134	50301	49468	-167	-0.32	-167	-0.33	-167	-0.33

The harvesting of non-renewable biomass is commonplace in Zambia and can be reasonably concluded that has been the case since 31 December 1989. Between 1990 and 2000, Zambia lost, on average, 444,800 hectares of forest per year. This amounts to an average annual deforestation rate of 0.91%.

Between 2000 and 2005, the rate of forest change increased by 10.0% to 1.00% per annum. In total, between 1990 and 2005, Zambia lost 13.6% of its forest cover, or around 6,672,000 hectares. Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2005 interval, Zambia lost 14.3% of its forest and woodland habitat[45].

Paragraph 7 of AMS I.E methodology requires the demonstration of NRB through at least two supporting indicators. The fact that biomass is harvested from a net non-renewable source is supported by the following indicators:

[40] Ibid Section "Major Challenges to Forestry in Malawi"
[41] Ibid
[42] Nangoma, D. and Nangoma, E. Climate change and adaptation strategies: a case study of the Mulanje Mountain Forest Reserve and its surroundings. Mulanje Mountain Conservation Trust. Page 14
[43] Sibale, B. and Banda G. 2004. A study on livelihoods, governance and illegality: Law enforcement, illegality and the forest dependent poor in Malawi Forest Governance Learning Group, Malawi. PAGES 23 & 24
[44] http://www.fao.org/forestry/fra/fra2010/en/ GLOBAL TABLES, Table 3
[45] http://rainforests.mongabay.com/deforestation/2000/Zambia.htm

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;

Total living forest biomass carbon stocks have depleted from 2,579 million hectares in 1990 to 2,416 hectares in 2010, or by approximately 7%. The annual loss in carbon stock in living forest biomass is estimated at 8 million tonnes of carbon per year[46].

Trends in carbon stock in living forest biomass 1990-2010

Country / area	Carbon stock in living forest biomass (million tonnes)					Annual change (million tonnes/yr)			Annual change per hectare (t/ha/yr)		
	1990	2000	2005	2010	Per hectare 2010 (tonnes)	1990-2000	2000-2005	2005-2010	1990-2000	2000-2005	2005-2010
Zambia	2579	2497	2457	2416	49	-8	-8	-8	n.s.	n.s.	n.s.

2) Trends in the type of cooking fuel collected by users, suggesting scarcity of woody biomass

"The high demand for wood-fuel has resulted in non-species selective cutting regimes being applied by many wood-fuel producers, culminating in severe depletion of many forest ecosystems and the resultant land degradation. Since rural communities can now neither find productive land nor meet the costs for agricultural inputs, the implied situation is one that perpetuates forest destruction irrespective of tree size, species and/or quality."[47]

In view of the combined evidence of declining forested areas since 1990, trend in loss in carbon stock since 1990, trend in the type of cooking fuel collected by users, and presently such a high fraction of non-renewable biomass, it may be deducted that the majority of wood-fuel used across Zambia since December 31, 1989 was from non-renewable sources.

The thermal capacity of each small scale CPA will be below the SSC threshold of 45 MW (thermal)[48]. The project proposes the replacement of non-renewable biomass through renewable energy for the supply of individual users with thermal energy.

B.3. Sources and GHGs

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The project boundary is the physical, geographical site of the efficient systems (i.e. ICS) using renewable biomass. The geographical area within which all SSC-CPAs included in the SSC-PoA will be implemented are the host countries and boundaries described in Section A.4 and A.5 above.

	Source	Gas	Included?	Justification/Explanation

[46] http://www.fao.org/forestry/fra/fra2010/en/ GLOBAL TABLES, Table 11

[47] Mulombwa, J. 1998. Woodfuel review and assessment in Zambia. Technical report. Series: Forestry Statistics and Data Collection AFDCA/WE/22. Food and Agriculture Organisation of the United Nations: Addis Ababa, Ethiopia. 55 pp.

[48] CDM Project Standard (Version 5), EB 65, Annex 5, define in § 82c: "For biomass, biofuel and biogas project activities, the maximal limit of 15 MW(e) is equivalent to a 45 MW thermal output of the equipment or the plant (e.g. boilers). For thermal applications of biomass, biofuels or biogas (e.g. cook stoves), the limit of 45 MWth is the installed/rated capacity of the thermal application equipment or device(s) (e.g. biogas stoves)."

Baseline Scenario	Combustion of non-renewable biomass (charcoal and firewood) in traditional charcoal or firewood stoves	CO_2	Yes	Major source of emissions
		CH_4	No	Minor source of emissions and limited data available.
		N_2O	No	Minor source of emissions and limited data available.
Project Scenario	Combustion of renewable biomass for cooking (ICS)	CO_2	Yes	Major source of emissions
		CH_4	No	Minor source of emissions and limited data available.
		N_2O	No	Minor source of emissions and limited data available.

B.4. Description of baseline scenario

According to the methodology, it is assumed that in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs. In this particular project, the baseline is the avoidance of non-renewable biomass, which actually has a higher emissions factor than coal, kerosene and liquefied petroleum gas. As a result, using the default EF of 81.6 tCO_2/TJ is conservative.

B.5. Demonstration of eligibility for a generic CPA

No.	Eligibility Criteria	Means of Validation
1	Be implemented entirely within a single fuel-specific geographical boundary (as specified in section A.4.5 of the PoA-DD) according to the targeted fuel type, fuel-consumption cluster (if applicable), and host country region of the CPA-DD.	One of the following documents will be provided as evidence: • Business plan • Declaration by CME or CPA implementer
2	The CPA will: 1. Have a database that will uniquely identify and define users in which ICS have been installed or distributed. In addition, each stove itself will have to be uniquely identified with a serial number clearly starting with "CQC-FS" 2. Not involve users already involved in any other CPA or CDM project involving the distribution and/or installation of ICS. 3. Not be registered as individual CDM project activities nor included in another registered SSC-PoA, as well as in any other voluntary scheme (such as Gold Standard, VCS, VER+)	Any of the following documents may be provided: • Evidence of database • Declaration from CME or CPA implementer • Registration card template • CME manual • CME declaration checking CDM and other voluntary scheme websites.
3	All CPAs will be required to conform to national standards where available. Detailed descriptions of the ICS to be implemented will be described at CPA level. Each ICS must deliver the same or higher level of service in comparison with the baseline system being replaced. Each ICS will be required to meet the following technical specifications of having a kW_{th} capacity of less than $450kW_{th}$ and being either fixed or portable. In addition the ICS must meet at least one of the following technical specifications: • Thermal efficiency of greater than 20% as determined by a Water Boiling Test.	Documents to be provided: • Evidence of compliance with national standards (if any) • Technical description of ICS from manufacturer provided in section A.5. of the CPA-DD and compliance with testing/certifications as per manufacturers specifications (if any). Justify that the same or higher level of service will be provided, that the kW_{th} capacity of the ICS is less than $450kW_{th}$, that the ICS is either fixed

	• Have an improved combustion chamber utilizing either the rocket stove design, insulated chamber or pyrolysis.	or portable and at least one of the other technical specifications are met.
4	The start date of the CPA must not be before the start date of the PoA. Documentary evidence will be provided to justify the start date of the CPA.	The start of the CPAs will be the date of first sales as demonstrated by Registration Cards or other appropriate forms indicating the first dissemination of ICS.
5	Comply with applicability conditions and other requirements set out in AMS I.E version 5: *1. This category comprises activities to displace the use of non-renewable biomass by introducing renewable energy technologies.* *2. Project participants are able to show that non-renewable biomass has been used since 31 December 1989, using survey methods or referring to published literature, official reports or statistics.* *3.The use of this methodology in a project activity under a programme of activities is legitimate if the following leakages are estimated and accounted for, if required on a sample basis using a 90/30 precision for the selection of samples, and accounted for:* *(a) Use of non-renewable woody biomass saved under the project activity to justify the baseline of other CDM project activities can also be a potential source of leakage. If this leakage assessment quantifies a portion of non-renewable woody biomass saved under the project activity that is then used as the baseline of other CDM project activities then Bold is adjusted to account for the quantified leakage;* *(b) Increase in the use of non-renewable woody biomass outside the project boundary to create non-renewable woody biomass baselines can also be a potential source of leakage. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass outside the project boundary then Bold is adjusted to account for the quantified leakage;* *(c) As an alternative to subparagraphs (a) and (b), Bold can be multiplied by a net to gross adjustment factor of 0.95 to account for leakages, in which case surveys are not required.*	1. Each CPA will provide evidence of the supply of renewable biomass and details of the ICS that burn the fuel. 2. Details of the use of NRB since 31 December 1989 in the host countries will be demonstrated on CPA level. 3. Option C will be used in each CPA
6	Demonstrate, as per EB 68 Annex 27 Clause 2(c) that the project is additional by targeting users, communities and/or SMEs and that the ICS have a rated capacity below 2.25MW_{th} as per section A,5, of the CPA-DD.	Evidence of ICS capacity and target group will be provided
7	As described in section E.1. of the PoA-DD	If applicable evidence of environmental

	environmental clearance is required for CPAs in Zambia.[49]	clearance
8	The CPAs will include a mechanism that transfers the ownership rights of CERs from the ICS user to the CME (or any affiliate it so designates), the precise mechanism to be established on a CPA basis. For example, a Registration Card, SMS, ICT or other means, which is signed or received by the end-user upon distribution or installation of the ICS, which shall state that the end-user transfers ownership of the carbon assets to the CME for the life of the stove.	Evidence of mechanism, template registration card etc.
9	Be approved by the CME prior to its incorporation into the SSC-PoA	Evidence of CME decision to include CPA
10	Affirm that no funding is coming from Annex I parties, or if it does, that this is not a diversion of ODA	A statement by the CME or CPA implementer will be provided to demonstrate no funding has been received from Annex I parties. If money is received from Annex I parties confirmation of non-diversion will be provided by the funder.
11	• CPAs will involve the promotion and distribution of ICS through direct installation, delivery, community sales events, direct sales or sales through commercial/retail outlets • CPAs will involve the supply of demonstratably renewable biomass • CPAs will target households, communities and/or SMEs	One of the following documents will be provided: • Business plan • Statement by CPA implementer
12	CPAs will adhere to all requirements related to sampling for a PoA in accordance with the approved standard (EB74 Annex 6 and EB69, Annex5), as outlined in section B.7.2 of the PoA-DD.	Evidenced by CPA implementer statement or agreement with CME
13	Each CPA will have a maximum capacity of 45 MW_{th} throughout the CPA's crediting period.	Evidence of rated capacity of ICS to be disseminated and limit of stoves to be installed
14	Each CPA will ensure that it is not de-bundled as each ICS will not exceed 1% of the 45 MW_{th} (0.45 MW_{th}) for a small-scale project as defined by the Project Standard.	Evidence of ICS rated capacity

B.6. Estimation of emission reductions of a generic CPA

B.6.1. Explanation of methodological choices

A typical CPA includes the switching of fuel from NRB to renewable biomass. Each CPA implementer will be involved with the dissemination of ICS. It is assumed that in the absence of the project activity, the baseline scenario would be the use of fossil fuels for meeting similar thermal energy needs. Each CPA

[49] List A and B of the Malawi Environmental Management Act, 1996, indicates the type of projects that may require EIA and this does not include ICS / renewable fuel projects.

will apply the small-scale baseline and monitoring methodology AMS I.E, Version 05, entitled "Switch from non-renewable biomass for thermal applications by the user".[50]

Under AMS I.E., emission reductions are calculated using the following equation:

$$ER_y = B_y * f_{NRB,y} * NCV_{biomass} * EF_{projected\_fossilfuel} \quad (1)$$

Where:

ER_y	Emission reductions during the year *y* in tCO_2e
B_y	Quantity of woody biomass that is substituted or displaced in tonnes
$f_{NRB,y}$	Fraction of woody biomass used in the absence of the project activity in year *y* that can be established as non renewable biomass using survey methods
$NCV_{biomass}$	Net calorific value of the non-renewable woody biomass that is substituted (IPCC default for wood fuel, 0.015 TJ/tonne)
$EF_{projected\_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers. Use a value of 81.6 tCO_2/TJ[51]

B_y can be determined using one of three options:

(a) Calculated as the product of the number of appliances multiplied by the estimate of average annual consumption of woody biomass per appliance (tonnes/year); This can be derived from historical data or estimated using survey methods; or

(b) Calculated from the thermal energy generated in the project activity; or

(c) In the specific case of renewable energy based water treatment technologies, B_y is calculated as the product of target population of the project multiplied by the volume of drinking water per person per day and the mass of woody biomass that would have been required to boil one litre of water.

Each CPA will chose between either option (a) or (b).

Leakage Emissions

B_y is multiplied by a net to gross adjustment factor of 0.95 to account for leakages as described in section B.2.

The other source of leakage occurs if equipment currently being utilised is transferred from outside the boundary to the project activity. All ICS in the SSC-PoA will be newly manufactured/assembled or newly installed. Where second-hand/used ICS are distributed to an end-user the ICS will be from within the project (ie previously newly manufactured/assembled and either a demonstration model or transferred from one end-user within the project to another new or existing end-user). In both of these cases there will be no equipment (ICS) being utilized outside the project area (any project non-participant) that is transferred to the project area (included as an ICS in the database) so leakage defined in paragraph 11 of the AMS I.E (version 5) methodology is not considered. Where second-hand/used ICS are transferred

[50] http://cdm.unfccc.int/methodologies/DB/WHTQUFLWCVNB9CIUZC198A712WGQR4, EB68 Annex 22

[51] This value represents the emission factor of the substitution fuels likely to be used by similar users, on a weighted average basis. It is assumed that the mix of present and future fuels used would consist of a solid fossil fuel (lowest in the ladder of fuel choices), a liquid fossil fuel (represents a progression over solid fuel in the ladder of fuel use choices) and a gaseous fuel (represents a progression over liquid fuel in the ladder of fuel use choices). Thus a 50% weight is assigned to coal as the alternative solid fossil fuel (96 tCO_2/TJ) and a 25% weight is assigned to both liquid and gaseous fuels (71.5 tCO_2/TJ for kerosene and 63.0 tCO_2/TJ for Liquefied Petroleum Gas (LPG).

within the project area (between end-user project participants) the database will be updated to reflect this change to ensure there is no double counting of ICS.

B.6.2. Data and parameters that are to be reported ex-ante

Data / Parameter	$EF_{projected\_fossilfuel}$
Unit	tCO_2/TJ
Description	Emission factor for the substitution of non-renewable woody biomass
Source of data	AMS I.E.
Value(s) applied	81.6
Choice of data or Measurement methods and procedures	IPCC default specified in the methodology.
Purpose of data	Calculation of baseline emissions
Additional comment	

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 value
Value(s) applied	0.015 = 15 MJ/kg
Choice of data or Measurement methods and procedures	IPCC default value, cited in methodology AMS-I.E. Version 05
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	CAP_{stove}
Unit	kW_{th}
Description	Installed/rated capacity of stove in kilowatt equivalent for thermal energy
Source of data	CPA implementer
Value(s) applied	Will vary depending on stove model(s) used.
Choice of data or Measurement methods and procedures	Either data from stove manufacturer or calculated in a transparent manner. The calculation will vary depending on the most appropriate data source and therefore will be detailed on CPA level and described by stove type.
Purpose of data	To ensure that the total rated capacity of all the stoves in the CPA do not exceed the relevant limit, $45MW_{th}$ per CPA.
Additional comment	

Data / Parameter	$f_{NRB,y}$
Unit	Fraction, dimensionless
Description	Fraction of biomass used in the absence of the project activity in year y that can be established as non-renewable biomass using survey methods
Source of data	Independent 3rd Party report / EB67 Annex 22
Value(s) applied	Country specific. To be determined at the country level (Malawi national 81%, Zambia national 84%)
Choice of data	An independent consultant assessed the overall biomass usage in Zambia and,

or Measurement methods and procedures	according to independently published sources, ascertained the proportion biomass which is non-renewable. The fNRB for Malawi was taken from the default values provided by EB67 Annex 22, which were approved by the EB and the DNAs' of the respective countries as found at: http://cdm.unfccc.int/DNA/fNRB/index.html
Purpose of data	Calculation of baseline emissions.
Additional comment	

If option 6 (a) is used

Data / Parameter	***C***
Unit	tonnes/stove/year
Description	Baseline wood-fuel consumption per baseline appliance per year
Source of data	Survey or historical data
Value(s) applied	For CPAs in urban areas of Northern Malawi (charcoal): 5.67[52] For CPAs in urban areas of Central Capital Malawi (charcoal): 4.64[53] For CPAs in urban areas of Central Smaller Settlements Malawi (charcoal): 5.34[54] For CPAs in urban areas of Southern Capital Malawi (charcoal): 6.21[55] For CPAs in urban areas of Southern Smaller Settlements Malawi (charcoal): 5.32[56] For CPAs in dry urban areas of Zambia (charcoal):5.45[57] For CPAs in wet urban areas of Zambia (charcoal): 4.62[58] For CPAs in rural areas of Malawi (fuelwood): 3.15[59]

[52] Consumption for charcoal is 2.59 kg/stove/day as per baseline study: National Urban Malawi AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp /public/gl/guidelin/ch1ref3.pdf).

[53] Consumption for charcoal is 2.12 kg/stove/day as per baseline study: National Urban Malawi AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp /public/gl/guidelin/ch1ref3.pdf).

[54] Consumption for charcoal is 2.44 kg/stove/day as per baseline study: National Urban Malawi AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp /public/gl/guidelin/ch1ref3.pdf).

[55] Consumption for charcoal is 2.84 kg/stove/day as per baseline study: National Urban Malawi AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp /public/gl/guidelin/ch1ref3.pdf).

[56] Consumption for charcoal is 2.43 kg/stove/day as per baseline study: National Urban Malawi AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp /public/gl/guidelin/ch1ref3.pdf).

[57] Consumption for charcoal in dry cities is 2.49 kg/stove/day as per baseline study: Cities in Zambia AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref3.pdf)..

[58] Consumption for charcoal in wet cities is 2.11 kg/stove/day as per baseline study: Cities in Zambia AMS IE Baseline Charcoal Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year and 6 to convert to fuelwood as per IPCC guidelines (http://www.ipcc-nggip.iges.or.jp
/public/gl/guidelin/ch1ref3.pdf)..

	For CPAs in rural areas of Zambia (fuelwood): 5.07[60]
Choice of data or Measurement methods and procedures	Surveys were undertaken to the confidence precision required in AMS-I.E version 05 and following the standard and guidelines for sampling surveys as found in EB74 Annex 6 and EB69, Annex5. See Appendix 4 for full reports. Reductions were made in from total household fuel usage to convert to take into account multiple stove usage. In Malawi 20.87% of rural household used multiple stove compared to 28.3% in Northern urban areas, 25.3% in Central Capital, 10.9% in Central Smaller Settlements, 34.7% in Southern Capital and 23.7% in Southern Smaller Settlements. In Zambia 23.0% of rural household used multiple stove compared to 35.6% in urban dry areas and 42.4% in urban wet areas. To convert from charcoal to firewood the default value of 6 is applied following the recommendation in the IPCC Guidelines.
Purpose of data	Calculation of baseline emissions.
Additional comment	

If option 6 (b) is used

Data / Parameter	$\mathbf{NCV_{RB}}$
Unit	TJ/tonne
Description	Net calorific value of renewable biomass
Source of data	Default value or test in laboratory
Value(s) applied	CPA specific
Choice of data or Measurement methods and procedures	This value will be determined as per appropriate standards, depending on the type of renewable biomass. The default value as per the methodology may be applied (0.015 TJ/tonne)
Purpose of data	Calculation of baseline emissions.
Additional comments	

Data / Parameter	$\boldsymbol{\eta_{new}}$
Unit	Fraction
Description	Efficiency of new appliance
Source of data	Manufacturers specification or Water Boiling Test
Value(s) applied	CPA specific depending on stove model
Choice of data or Measurement methods and procedures	All Water Boiling Tests (WBT) shall be existing or newly commissioned studies conducted to appropriate international standards
Purpose of data	Calculation of baseline emissions.
Additional comments	

Data / Parameter	$\boldsymbol{\eta_{old}}$

[59] Consumption for fuelwood is 8.64 kg/stove/day as per baseline study: Rural Malawi AMS IE Baseline Firewood Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year.

[60] Consumption for fuelwood is 13.90 kg/stove/day as per baseline study: Zambia AMS IE Baseline Wood Fuel Consumption Study for C Quest Capital LLC, HED Consulting Ltd. This value is multiplied by 365/1000 to convert to t/stove/year.

Unit	Fraction
Description	Efficiency of old appliance
Source of data	Default methodology value
Value(s) applied	0.1 in Zambia and Malawi rural, 0.2 in urban Malawi
Choice of data or Measurement methods and procedures	The default value will be used from AMS-I.E v5. The vast majority of cooking methods taking place throughout sub-Saharan Africa, including Malawi and Zambia are the use of three-stone fires or unimproved charcoal stoves. These devices have no improved combustion air supply or flue gas ventilation system, i.e. without a grate or a chimney. In urban Malawi often stoves with improved combustion chambers are used so a conservative value of 0.2 is used.
Purpose of data	Calculation of baseline emissions.
Additional comments	

B.6.3. Ex-ante calculations of emission reductions

As per AMS-I.E. emission reductions are calculated as follows:

$$ER_y = B_y * f_{NRB,y} * NCV_{biomass} * EF_{projected\_fossilfuel} \quad (1)$$

Where

ER_y Emission reductions during the year y in tCO_2e

B_y Quantity of woody biomass that is substituted or displaced in tonnes.

$f_{NRB,y}$ Fraction of woody biomass used in the absence of the project activity in year y that can be established as non-renewable biomass using survey methods or government data or approved default country specific fraction of non-renewable woody biomass (fNRB) values available on the CDM website

$NCV_{biomass}$ Net calorific value of the non-renewable woody biomass that is substituted (IPCC default for wood fuel, 0.015 TJ/tonne)

$EF_{projected\_fossilfuel}$ Emission factor for the substitution of non-renewable woody biomass by similar consumers. Use a value of 81.6 tCO_2/TJ

<u>Determination of B_y under option 6(a) of AMS-I.E</u>

$$B_y = (C - C_{ps,y}) * N_{operational,y} * L$$

Where

C Baseline wood-fuel consumption per user in year y determined from a survey or historical data (tonnes/year)

$C_{ps,y}$ Non project wood-fuel consumed in the project stove in year y (tonnes/year)

$N_{operational,y}$ Number of operational stoves in year y

L Leakage, a value of 0.95 will be used as per AMS-I.E clause 18 (c)

Determination of $N_{operational,y}$

$$N_{operational,y} = n_y \cdot \sum_{1}^{N_y} T_y$$

Where

N_y Total number of stoves disseminated in year y

n_y Proportion of stoves operational in year y

T_y Fraction of time in year y each ICS was installed (see section B.7.1 for further details of how this is determined).

Determining B_y under option 6(b) of AMS-I.E

$B_y = HG_{p,y} / (NCV_{biomass} * \eta_{old}) * L$

Where

$HG_{p,y}$	Quantity of thermal energy generated by the new renewable energy technology in the project year y (TJ)
η_{old}	Efficiency of the system being replaced, for all CPAs in rural Malawi and Zambia the default value of 0.1 will be chosen or 0.2 in urban Malawi as further described in section B.6.2.

Determining $HG_{p,y}$

$HG_{p,y} = RB_y * NCV_{RB} * \eta_{new} * N_{operational,y}$

Where

RB_y	Quantity of renewable biomass consumed (tonnes)
NCV_{RB}	Net calorific value of renewable biomass (TJ/tonne)
η_{new}	Efficiency of new ICS
$N_{operational,y}$	Number of operational stoves in year y

Determination of $N_{operational,y}$

$$N_{operational,y} = n_y \cdot \sum_{1}^{N_y} T_y$$

Where

N_y	Total number of stoves disseminated in year y
n_y	Proportion of stoves operational in year y
T_y	Fraction of time in year y each ICS was installed. (see section B.7.1 for further details of how this is determined).

Determining fNRB,y

The fraction of non-renewable biomass is estimated separately for each country included in this PoA. As indicated in AMS I.E, Version 5, the estimation is determined by:

fNRB = NRB/(NRB+DRB)

Where

NRB	non-renewable woody biomass
DRB	demonstrably renewable woody biomass

Assurance that threshold limit is not exceeded

The installed or rated capacity of each ICS model included in the CPA must be determined and multiplied by the number of stoves to ensure that the threshold limit of that CPA is not exceeded, $45MW_{th}$. This can be determined by the following

$$N_y * CAP_{stove} \quad (16)$$

Where

CAP_{stove} = the rated/installed capacity in kW_{th} of each stove model included in the CPA.

Determining CAP_{stove}

CAP_{stove} will be determined based on the most appropriate information available. It is either specified by the manufacturer or a calculation such as the one below may be used:

$$CAP_{stove} = \frac{B_y * NCV_{baselinefuel} * \frac{\eta_{old}}{\eta_{new}} * 0.2777778}{h}$$

Where

B_y	Baseline woody biomass consumption per stove (kg/day)
$NCV_{baselinefuel}$	Net calorific value of the baseline fuel
0.277778	Conversion factor from MJ to kWh
h	Hours spent cooking in an average day (hours)
η_{old}	Efficiency of the system being replaced, for all CPAs in rural Malawi and Zambia the default value of 0.1 will be chosen or 0.2 in urban Malawi as further described in section B.6.2.
η_{new}	Efficiency of new ICS

B.7. Application of the monitoring methodology and description of the monitoring plan

B.7.1. Data and parameters to be monitored by each generic CPA

Data / Parameter	N_y
Unit	Dimensionless
Description	Total number of stoves disseminated in year y
Source of data	CPA database or contracts
Value(s) applied	Variable per CPA
Measurement methods and procedures	This will be determined by all registered users in the project database
Monitoring Frequency	Continuous
QA/QC procedures	Entry of information into the database will be checked to ensure accuracy and to ensure no double entry
Purpose of data	Calculation of baseline emissions
Additional comments	

Data / Parameter	n_y
Unit	Dimensionless
Description	Proportion of ICS still operational in year y
Source of data	Survey
Value(s) applied	Variable per CPA
Measurement methods and procedures	Randomly selected users will be surveyed to see if their ICS is still in use. The survey will be required to comply with AMS-I.E and the standard for sampling as found in EB 74 Annex 6.
Monitoring Frequency	Annually or biennially
QA/QC procedures	The survey will be required to comply with AMS-I.E and the standard for sampling as found in EB 74 Annex 6.
Purpose of data	Calculation of baseline emissions

Additional comments	

Data / Parameter	T_y
Unit	Dimensionless
Description	Fraction of time in year y each ICS was installed
Source of data	CPA database
Value(s) applied	Variable per CPA
Measurement methods and procedures	This is the fraction of time a ICS has been installed in year y. T_y will be determined for each individual stove in a CPA as follows: Number of days stove installed in year y = End date of year y – Stove installation date in year y T_y = Number of days stove installed in year y / Number of days in year y. If the stove installation date is before year y then T_y will be 1. For example, if an ICS was installed on 1 July 2013 would have been installed for 184 days over the whole of 2013 or 184/365 = 0.504
Monitoring Frequency	Continuous
QA/QC procedures	Database records will be checked for accuracy
Purpose of data	Calculation of baseline emissions
Additional comments	

Data / Parameter	$C_{ps,y}$
Unit	Tonnes / year
Description	Non project wood-fuel consumed in the project stove in year y
Source of data	Survey
Value(s) applied	Variable per CPA
Measurement methods and procedures	Randomly selected users will be surveyed to determine the amount of non-project wood-fuel consumed in the project stove. The survey will be required to comply with AMS-I.E and the standard for sampling as found in EB 74 Annex 6.
Monitoring Frequency	Annually or biennially
QA/QC procedures	The survey will be required to comply with AMS-I.E and the standard for sampling as found in EB 74 Annex 6.
Purpose of data	Calculation of baseline emissions
Additional comments	

Data / Parameter	RB_y
Unit	tonne/year
Description	Mass of renewable biomass consumed by the end users in year y
Source of data	Variable per CPA. Could be user questionnaire as part of a survey or sales records.
Value(s) applied	Variable per CPA
Measurement methods and procedures	Variable per CPA. Could be user sampled survey questionnaire or sales records.
Monitoring Frequency	Variable per CPA. Monitoring will be continuous or annually / biennially

QA/QC procedures	Variable per CPA
Purpose of data	Calculation of baseline emissions as per clause 14 AMS-I.E version 05
Additional comments	

B.7.2. Description of the monitoring plan for a generic CPA

The monitoring plan applied in this PoA involves a number of key elements that ensure that the CME and CPA-Implementer have high-quality, unbiased and reliable information regarding the performance of the project in terms of implementation and outcomes, and for the purposes of calculating Certified Emission Reductions (CERs) following AMS I.E version 5.0 on the basis of the mass of non-renewable biomass saved by the ICS in the project activity.

- Monitoring Concept
- Data collection procedures
- Monitoring Reporting
- Sampling Plan

<u>**Monitoring Concept**</u>
According to methodology AMS-I.E. Version 5 monitoring;

1. Shall consist of checking of all appliances or a representative sample thereof, at least once every two years (biennial) to ensure that they are still operating or are replaced by an equivalent service appliance.

A sampling survey of all users as contained in the database will be carried out to determine the fraction of operational project stoves (the parameter n_y as described in the sampling plan below).

2(a). Should confirm the displacement or substitution of the non-renewable woody biomass at each location.

Monitoring shall confirm the displacement or substitution of NRB. The fNRB as per equation 4 in AMS-I.E v05 has been determined at PoA level and fixed ex ante for the crediting period. The continued replacement of NRB will be monitored by combination of the results of three investigations: (a) determination of n_y as above (b) use of renewable biomass by the project stove users (c) investigation of the four indicators of NRB on CPA level, confirming NRB by detecting presence of at least two of the indicators as described in paragraph 7 of AMS-I.E v05. The indicators are to be monitored as part of the monitoring survey or through appropriate studies or reports.

2(b). Should in the case of appliances switching to renewable biomass monitor the quantity of renewable biomass used.
The precise procedure for monitoring of the quantity of renewable biomass (RB) used will be determined on CPA-level, as different methods of supply of RB will be adopted in different CPAs depending on other features of each CPA such as stove type. Examples of monitoring approaches dependent on supply methods are (i) Supply contracts, (ii) receipts and delivery notes confirming supply of specified volumes to users, (iii) retailer records of discounted sales of RB to registered stove users (iv) survey of users as further described in the sampling plan.

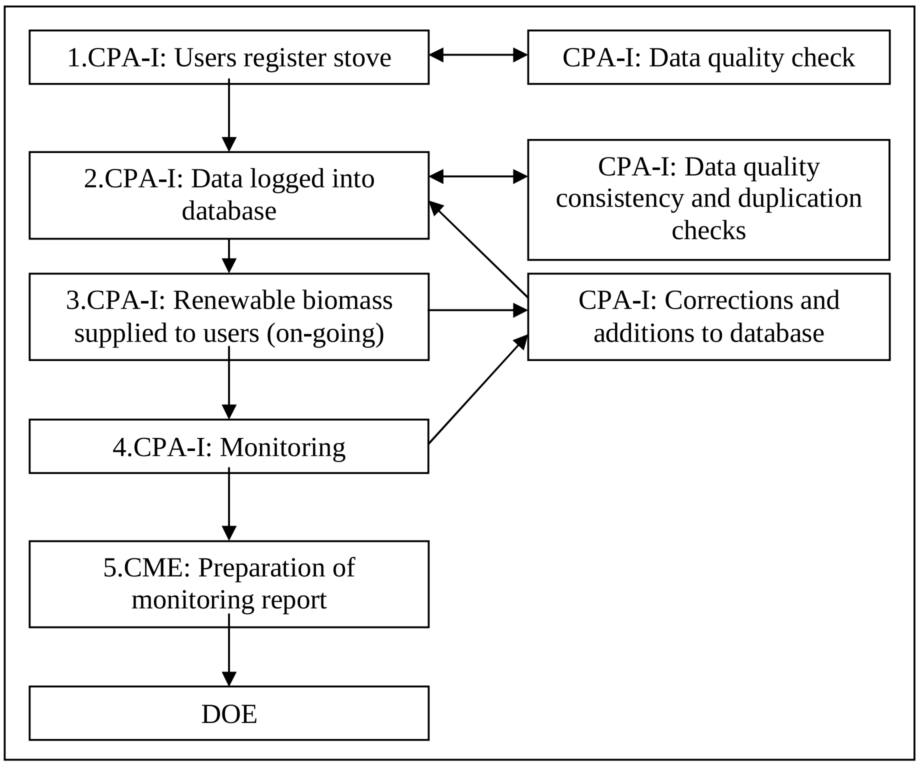
For quality assurance, records derived from the harvesting and supply areas (including municipal waste as well as plantation supply areas), such as reports from the Biomass Managers supervising harvesting, packing and delivery, or records of Municipal Waste collectors, will be used as cross-checks to confirm quantities and quality of the renewable biomass.

3. Should in case Option (b) in paragraph 6 is chosen for baseline calculations, monitoring shall include the amount of thermal energy generated by the new renewable energy technology in the project in year y, where applicable.

The energy content of the renewable biomass will be determined before inclusion into the PoA, and also the efficiency of the ICS will be found from test reports. Then the amount of renewable biomass consumed will be monitored as above. The amount of energy $HG_{p,y}$ will be calculated as per the equations in section B.6.3.

Data Collection Procedures

The below flow-chart illustrates the roles and responsibilities of the parties during the implementation of the monitoring plan for the SSC-CPA. In the below flowchart, the CPA implementer is abbreviated to "CPA-I", and can be CQC or another party authorised by the CME. CQC is the CME.



A description of the steps shown in the flow-chart follows:

CPA-I: User registers stove: CPA implementer will collect/receive the necessary information requested on the Registration Card from the user. Means of collecting this information can be through a physical Registration Card filled by CPA-I staff, retailers, end-users or partner organization's staff, or through the use of ICTs or SMS. CPA Implementers' staff shall double check the accuracy of information provided, and request for field staff additional clarifications if needed;

CPA-I: Data logged into database: CPA implementer trained staff will input the data in the database either manually (if data collected from physical Registration Card) or this will be automatically input if data was collected using ICTs or SMS. CPA implementer staff shall double check the information included on the database and check for duplications. Any duplicate information shall be investigated and errors corrected or excluded from the database if it is a true duplicate entry.

CPA-I: Renewable biomass supplied to users (ongoing): The CPA implementer will supply renewable biomass to users. CPA implementers will record all renewable biomass distributed from their premises. Depending on the CPA implementer business model this distribution may be to suppliers, retailers or end users. In cases where renewable biomass is not distributed directly to end users and hence there is a supply chain it is desirable to employ a system that will capture records of delivery to end users.

All values will be entered into the database. Where and when information is recorded at point of delivery to an end user, this acts as additional evidence of stove operation and provides a cross-check the information on the database. Any inconsistencies found (eg. change in the address of a user) will be updated on the database.

CPA-I: Monitoring: CPA implementer will follow the requirements as per PoA-DD to collect the necessary information for a monitoring report. Spot checking of ICS will be ongoing throughout the monitoring period to check for continued use and to ensure data quality and consistency, also to check that records are not duplicated.

CME: Preparation of monitoring report: the CME will prepare the final monitoring report to be provided to the verifier DOE for verification of emission reductions. A copy of the monitoring report will remain with the CME.

The CME will coordinate and manage each CPA Implementer and assist them in implementing each element of the monitoring plan. The monitoring plan shall be elaborated per CPA an in accordance with the Sampling Plan below. To ensure the full integration of local structures, implementation of the project is accompanied by capacity building efforts. This will ensure optimal usage by the future user community.
All data will be stored electronically for more than two years after the end of the crediting period or the last issuance of CERs whichever occurs later. A redundant storage backup system ensures against data loss.

Monitoring Reporting
The CME will assess all monitoring data and produce a combined monitoring report for all CPAs in a specific monitoring period for the DOE to verify. . This report will present the data relating to the emission reductions generated by those CPAs during the monitoring period.

Sampling Plan
Due to the large number of ICS envisaged to be distributed as part of the CPAs to be included in the PoA, it is not economically feasible to monitor each individual ICS unit distributed. Therefore, representative sampling will be undertaken as part of a PoA-wide Sampling Plan that is designed in line with the requirements of AMS I.E v5 and the "Standard for sampling and surveys for CDM project activities and programme of activities" (the *Sampling standard*) from EB74, Annex 6. This sampling plan follows the recommend outline as contained in EB 75 Annex 8, Guidelines for sampling and surveys for CDM project activities and programme of activities. This approach is justified when sampling across CPAs as the differences among the sampled CPAs are taken into account in the sample size calculation by using stratified sampling.[61]

A. Sampling design

Objectives and Reliability Requirements
The objective is to obtain an unbiased and reliable estimate of the proportion or mean values of the following parameters over the course of the crediting period, and with 95/10 confidence/precision (as per

[61] EB74 Annex 06, footnote 20

paragraph 20 of EB 74 Annex 6) for annual and 95/10 for biennial sampling across CPAs. In case a single CPA is sampled, 90/10 precision for annual and 95/10 precision shall be required for biennial sampling[62].

Sampled parameter

Parameter	Description of Parameter
n_y	Proportion of ICS still in operation in year y
$C_{ps,y}$	Non project wood-fuel consumed in the project stove in year y
RB_y	Mass of renewable biomass consumed by the end users in year y[63]

Target population

The target population for n_y are the users contained in the CPA databases. The target population for all other parameters are those ICS which are found in operation.

Sampling method

The sampling method for all three monitored parameters is stratified random sampling (as per clause 5.2- lines 11 through 13 of EB 75 Annex 8). This method is justified as the population will be divided into Primary Sampling Units (PSUs) by same country and fuel consumption cluster, ICS type, ICS vintage, CPA implementer and renewable biomass supply (as described in the sampling frame). These PSUs are expected to be relatively homogenous but by dividing them into strata any variation will be captured.

Once the PSUs are defined, ICS will be randomly selected based on the relative size of the strata. To ensure a random selection of ICS, random number generators shall be applied. Each ICS in the strata is uniquely identifiable by its serial number. Each ICS can thus be allocated a Sample Selection Number in each monitoring period for the sampling frames relevant to each parameter, starting at 1 and increasing up to the total number of ICS in the Database for that pre-defined sampling frame (see below). Applying the random number generators, the ICS can then be randomly chosen from the defined strata up to the required sample size as calculated by the CME.

Sample size

For the estimation of the proportion or mean value of the parameters investigated across CPAs, the minimum sample size for each sample frame is determined to achieve the 95/10 threshold for annual[64] and 95/10 for biennial sampling[65]. In case a single CPA is sampled or sampling is not done across CPAs, a 90/10 confidence/precision is required for annual sampling and 95/10 confidence/precision shall be required for biennial sampling[66].

The procedure to determine the sample of ICS will ensure that they adequately represent the broader project population, minimizing sampling error. Using, a 95 per cent confidence level, and a 10 per cent margin of error, a stratified random sample of users will be selected using Primary Sampling Units as strata.

There are three parameters that will be estimated through sampling as described above. The parameters will be sampled in a single survey with a stratified random sample of ICS using the above described confidence/precision levels depending on annual or biennial monitoring frequency.

An overview of the estimated sample sizes for a hypothetical population of 50,000 ICS divided in four strata applying a level of 95/10 is provided below. It is likely that the sample frame will include fewer

[62] Single CPA sampling will only be applicable when a Primary Sampling Unit only consists of one CPA.
[63] If a CPA elects to monitor the parameter RB_y as per options (i), (ii) or (iii) described above in part 2 (b) of the monitoring plan, then this parameter is no longer required in the sampling plan as long as a census approach (examining all records) is taken to these options.
[64] As per EB 74 Annex 6 Section V paragraph 20, footnote 20
[65] As per Methodology AMS-I.E version 05 paragraph 17
[66] As per Methodology AMS-I.E version 05 paragraph 17

than 50,000 users and four strata in the first monitoring period, so this is a conservative approach. Of the three parameters to be monitored, one is a proportion/percentage ($n_{y,j}$) and the other two are mean values.

All strata will be sampled. The ICS within each strata shall be randomly selected.

To calculate the required sample size estimates, values for the proportions, mean values, and variances or standard deviations are required. For the first monitoring period, values from a pilot study shall be applied. For the following monitoring periods, the estimates shall be adjusted taken the results of the previous monitoring period(s) into account.

Parameter n_y
To estimate the number of users to be sampled for parameter n_y the following equation[67] is used:

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

Where:
n = Sample size
N = Total number of ICS installed
V = expected variance
1.96 = Represent the level of confidence (e.g. 1.96 for 95% confidence).
0.1 = Required precision (e.g. 10% = 0.1)

Where $V = \frac{SD^2}{\bar{p}^2} = \frac{overall\ variance}{\bar{p}^2}$ and $\bar{p}$ is the overall proportion

$$SD^2 = \frac{(g_a * p_a(1-p_a)) + (g_b * p_b(1-p_b)) + (g_c * p_c(1-p_c)) + ... + (g_k * p_k(1-p_k))}{N}$$

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

Where:
g_i Size of the ith group where i=1 or a,…,k
p_i Proportion of the ith group i=a,…,k

A hypothetical example to determine sample size for n_y with four strata is shown below[68]. In this example the total number of ICS distributed is 50,000[69].

Stratum	Number ICS deployed in PoA (g_i)	Estimated proportion (p)
A	5,000	0.87
B	6,000	0.92
C	10,000	0.87
D	29,000	0.88
Overall	50,000	0.88

[67] Equation 19, *Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities (EB75 Annex 8)*
[68] Spreadsheet of example calculation has been provided to DOE
[69] All estimated proportion and ICS distributed in each stratum are estimates.

N = 50,000 ICS
$\bar{p}$ = 0.88
SD^2 = 0.10
V = 0.13

The CPA Implementers or CME will collect pilot data to determine sample sizes for the first monitoring period. In subsequent monitoring periods, the sample size equations will be updated with the values obtained during monitoring from previous monitoring periods.

Based on the above assumptions, the resulting sampling size for a 95/10 confidence/precision is calculated as:

$$n \geq \frac{1.96^2 * 50000 * 0.13}{(50000-1) * 0.1^2 + 1.96^2 * 0.13}$$

In this hypothetical example the value of n = 52 ICS to be sampled. This is then split between the strata as follows. The sample size is then adjusted estimating an 80% response rate:

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

Stratum	Sample size (n_i)	Adjusted sample size (n_i)
A	6	8
B	7	9
C	11	14
D	31	39
Total	52	65

In case the resulting sample size to achieve the desired confidence/precision levels is smaller than 30 ICS, then the sample size shall increase to 30 to approximate normal distribution when the parameter of interest, as in this case, is a proportion. This is in accordance with EB 74 Annex 6, paragraph 12 and footnote 15.

Parameters $C_{ps,y}$ and RB_y
To estimate the number of users to be sampled for the above parameters the following equation[70] is used:

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

Where:
$V = (SD/Mean)^2$
n = Sample size
N = Total number of operational cooking systems installed ($N_y * n_y$)
Mean = Overall mean
SD = Overall standard deviation
1.96 = Represent the level of confidence (e.g. 1.96 for 95% confidence).
0.1 = Required precision (e.g. 10% = 0.1)

[70] *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities* (EB 75, Annex 8 Appendix 2, equation 19

$$SD^2 = \sqrt{\frac{(g_a * SD_a^2) + (g_b * SD_b^2) + (g_c * SD_c^2) + ... + (g_k * SD_k^2)}{N}}$$

$$mean = \frac{(g_a * m_a) + (g_b * m_b) + (g_c * m_c) + ... + (g_k * m_k)}{N}$$

Where

m_i Mean of the ith group where i=1 or a,…,k

For the purposes of determining sample sizes in the first monitoring period estimates will be made for the mean and SD values from a pilot study. For the following monitoring periods, the estimates shall be adjusted taken the results of the previous monitoring period(s) into account. In this example a hypothetical scenario with four strata has been used as shown below to achieve the required 95/10 confidence/precision.[71]

Stratum	Number ICS deployed in PoA (g_i)	$C_{ps,y}$		RB_y	
		Estimated mean (m)	Estimated SD	Estimated mean (m)	Estimated SD
A	5,000	0.18	0.06	0.95	0.5
B	6,000	0.19	0.11	0.93	0.48
C	10,000	0.22	0.13	0.92	0.47
D	29,000	0.2	0.09	0.94	0.46
Overall	50,000	0.20	0.10	0.94	0.47

Calculation for $C_{ps,y}$

N = 44,090 ICS (N_y * n_y)

Mean = 0.20

SD = 0.10

V = 0.25

In this hypothetical example the value of n = 95 ICS to be sampled. This is then split between the strata as follows. The sample size is then adjusted estimating an 80% response rate:

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

Stratum	sample size (n_i)	Adjusted sample size (n_i)
A	10	13
B	12	15
C	19	24
D	56	70
Total	97[72]	122

[71] Spreadsheet of example calculation has been provided to DOE

[72] When splitting between strata values are rounded up, this leads to a value of 97 rather than the originally calculated 95.

<u>Calculation for RB_y</u>

N = 44,090 ICS ($N_y * n_y$)
Mean = 0.94
SD = 0.47
V = 0.25

In this hypothetical example the value of n = 97 ICS to be sampled. This is then split between the strata as follows. The sample size is then adjusted estimating an 80% response rate:

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

Stratum	sample size (n_i)	Adjusted sample size (n_i)
A	10	13
B	12	15
C	20	25
D	57	72
Total	99[73]	125

In case the resulting sample size to achieve the desired confidence/precision levels is smaller than 30 ICS, then as the parameters of interest are numeric mean values the Student's t-distribution shall be used if the resulting sample size is less than 30. This is in accordance with EB 74 Annex 6, paragraph 12 and footnote 15.

<u>Sampling frame</u>

The sampling frame refers to all the information in the database. The PoA is open to different CPA Implementers, different supplies of renewable biomass and different models of ICS. As explained below, to take the different characteristics of different CPA Implementer and ICS models into consideration, CPAs shall be grouped together to create a Primary Sampling Unit (PSU). Each PSU will be homogenous and variation between the PSU will be captured by the sampling method.

The Primary Sampling Units will be identified with the following six characteristics:

1. The same country
2. The same CPA Implementer
3. The same primary baseline fuel consumption cluster[74]
4. The same ICS model
5. The same ICS vintage[75]
6. The same supply of renewable biomass[76]

[73] When splitting between strata values are rounded up, this leads to a value of 99 rather than the originally calculated 97.

[74] A fuel-consumption cluster is a population that has different fuel consumption patterns than other populations as defined by the fuel-consumption baseline studies attached to the PoA-DD. Each fuel consumption cluster is considered a homogeneous population and defined as boundaries in A.5. of the PoA-DD.

[75] Definition of ICS vintage: For the purposes of this PoA, an ICS vintage correspond to all ICSs which have been in operation for the same amount of years. For example, stoves vintage 1 are all ICSs which have been in operation for less than 365 days. ICSs vintage 2 are those which have been in operation for longer than one year but less than two years.

[76] This will be determined at the discretion of the CME. Differences may include: Biomass from plantations compared to that from municipal waste. Different methods of supply to end users e.g. direct sales compared with using retailers or different constituent wood types.

CPAs with the same six parameters as described above can therefore be grouped together and form a Primary Sampling Unit. In the event the PoA has two different CPA Implementers using the same ICS model and renewable biomass supply, these form at least two different Primary Sampling Units. The same is true if the same CPA Implementer and renewable biomass supply has two different ICS models being implemented – these will form at least two Primary Sampling Units. Additionally if the same CPA implementer using the same ICS has two different supplies of renewable biomass they will be at least two primary sampling units. If the same ICS type is being implemented by the same CPA implementer with the same supply of renewable biomass but the stoves are of different vintages then they will make up at least two Primary Sampling Units. In a CPA, users with from different baseline clusters they will form separate Primary Sampling Units. If there are two identical CPAs in different countries these again will make up two primary sampling units. This is justified by the fact that CPA Implementer might vary in terms of performance and it is important for the CME to collect and monitor accurate data for each CPA Implementer distributing each stove model.

B. Data to be collected

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

n_y:	Visual inspection of the premises to see if ICS is operational and in use. Interview with end user if required to verify that ICS is still in use. It is not expected that there will be any seasonal fluctuation in this value. (Yes/No)
$C_{,ps,y}$	Non project wood-fuel consumed in the project stove in year y, determined through interview with end user and measure of fuel. Any seasonal fluctuation will be captured as part of the interview. (mass value)
RB_y	Mass of renewable biomass consumed by the end users in year y, if sampled determined through interview with end user and measure of fuel. Any seasonal fluctuation will be captured as part of the interview. (mass value)

To monitor the required parameters the data collected will be a representative number of ICS in the database for the monitoring period. The method of collecting data will be field surveys of required sample size of ICS users in the database. The frequency of data collection is one survey per monitoring period, no less than once every two years. Data will be collected from the field surveys, entered in the database and included in the monitoring report.

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

- Oversampling - Sampling a larger number e.g. 20% more than required by the sample size equation.
- Buffer Group – Randomly selecting an extra number of users who can be sampled if it is clear that the sample will not meet the required confidence/precision.
- Draw an additional sample – If the sample does not meet the required confidence precision then additional samples may be taken until the required confidence/precision is reached.
- Use lower confidence bound – If the sample does not meet the required precision/confidence and it is not possible to undertake more samples the lower bounds may be taken depending on which is more conservative.

The CME may choose to stop monitoring a particular parameter once the required level of confidence/precision has been reached, as long as the calculated minimum number of samples has been

achieved. As an example, the following steps could logically be followed for the case of applying a 30% buffer:

1. Visit first 10% of premises required for the 30% buffer. If the number of responses is sufficient to achieve the required reliability level, then stop sampling.
2. If step 1 is not sufficient to achieve the required reliability level, then visit the next 10% of premises (increases the additional sampling to 20% of the 30% buffer). If this additional sampling is sufficient, then stop sampling.
3. If step 2 is not sufficient to achieve the required reliability level, then complete the final 10% of the additional sampling buffer (bringing the total to 30%).

The sampling plan has the following procedures in place to ensure good quality data. The CME will ensure that field personnel have reviewed, understood and have agreed to follow the monitoring plan procedures, including provisions for maximising response rates, documenting out-of-population cases, refusals and other sources of non-response. A quality control and assurance strategy will be documented. Quality control and assurance strategies include addressing non-sampling errors, such as non-response or bias from interviewer. The CME or a competent 3rd party designated by the CME with the proper skills will train the monitoring personnel on how to properly survey users to prevent bias from interviewer. In the case a user refuses to participate, another user will be chosen at random. To reduce interviewer bias, good questionnaire design and well-tested questionnaires will be used.

The calculation of the sample size will be carried out using estimates for parameter proportions, mean values and standard deviations, as the actual characteristics of the population/sampling frame are unknown. In order to ensure the quality of the sampling results, the CME can draw on the provisions for reliability calculations including estimating the bounds of the confidence interval, the standard error of the mean value, and the t-value as derived from the t-distribution[77]. In the event that the sampling results do not fulfil the required level of confidence and precision, the CME can undertake additional samples. If the reliability is still not sufficient after raw data and summary statistics are scrutinized and after additional samples have been collected[78], the sampling may be repeated with an increased sample size. Alternatively, the CME may choose to apply the lower bound of the sampling results as is allowed for by the methodology (AMS I E v4, paragraph 17).

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

Outliers
As the continued use of ICS is a binary parameter, there can be no outliers in the sampled data and no treatment for outliers is required.

The sample data for $\mathbf{C_{ps,y}}$ and $\mathbf{RB_y}$ is continuous and therefore the presence of outliers is possible. The following approach will be used to identify and address outliers for the parameters.

Outliers will be defined as those data points with values greater than three standard deviations from the mean of the sample.

[77] As provided by the *Guidelines for Sampling and Surveys in CDM Project Activities and Programme of Activities* (EB 75, Annex 8, Appendix 4
[78] As per EB 75 Annex 8, Appendix 4 para. 48-98; Appendix 5

Data points identified as outliers according to the above analysis will be examined further to correct for possible transcription and data entry errors, but will be omitted from the analysis if no such administrative errors exist.

Analysis
The CME will manage a project database that includes data that can be directly attributable to each CPA within the PoA, thereby allowing unambiguous determination of the emission reductions attributable to each CPA.

Data obtained from the samples will be used to estimate proportion and mean values for the parameters described above. The values will then be factored into the emissions reduction calculations and result in the request for issuance of CERs. The parameters are applied for emission reduction calculations as outlined in B.6.3 of the PoA-DD. The stoves that are not in use will be excluded from emissions reductions calculations and will not be counted towards the total number of ICS in operation during the monitoring period. The amount of non project wood-fuel consumed in the project stove will be used in the calculation of the per stove emission reduction, which will be subtracted from the per stove baseline value (C) and then multiplied by the number of stoves in operation in the CPA to obtain the emission reductions per CPA.

C. Implementation

Sampling for the purpose of emission reduction calculation and elaboration of the monitoring report will occur at the end of each monitoring period. This sampling will be conducted by trained personal either part of the CPA Implementer or CME team, or an experienced third party entity. The credentials and/or training materials for the sampling personal will be provided to the DOE at verification. The maximum length of one monitoring period will be two years (duration, not calendar years), as AMS I.E., version 5, provides the option for annual or biennial monitoring. The CPA Implementer will be responsible for managing user data collection and entry into the project database. Field personnel will receive training on how to properly deal with surveying techniques and reduce errors and sign a document certifying that there is no conflict of interest of those involved in data collection and analysis. If there is conflict of interest, the personnel will not be allowed to participate in data collection and analysis. The project database will record the start and end dates of each monitoring period, and record the emission reductions attributable to each monitoring period. Appropriate record keeping procedures will be implemented to ensure that each monitoring period data set can be transparently attributed to its corresponding CPA, preventing any occurrences of double counting. An internal review of the project database will be able to determine the current status of each SSC-CPA—the duration of previous monitoring periods, the users delivering monitoring data, and current verification activities.

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Appendix 1: Contact information on entity/individual responsible for the PoA

CME and Project Participant

Organization	C-Quest Capital Malaysia Global Stoves Limited (CQC)
Street/P.O. Box	Brumby Centre, Lot 42; Jalan Muhibbah; 87000 Labuan F.T., Malaysia P.O. Box 80148
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Project Participant

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Appendix 2: Affirmation regarding public funding

No public funding from Annex I parties to the United Nations Framework Convention on Climate Change (UNFCCC) is expected for this the proposed PoA, or any CPA under the proposed PoA, however if such funding takes place, it is ensured that it is not a diversion of Official Development Assistance (ODA).

Appendix 3: Application of methodology(ies)

Not applicable

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

National Urban Malawi

AMS IE

Baseline Charcoal Consumption Study

For C Quest Capital LLC

HED Consulting Ltd

Kirstie Jagoe

Liz Bates

***Project lead:* Jonathan Rouse**

With assistance from

Amulike Msukwa

Dr. Chimwemwe A.P.S. Msukwa, DeTAS, Malawi

Final

July 29 2013

HED|Consulting

Household energy & development

hedconsulting.com

Contents

Abbreviations

CI	Confidence interval
CQC	C Quest Capital LLC
DeTAS	Development Technical assistance services
HED	HED Consulting
HH	Household
SD	Standard Deviation
SE	Standard Error
PPS	Probability proportional to size

Exchange rate (approximate at time of report)

1 USD = 4.10 MWK

Interpreting the statistical tables in this report

Mean values are presented in tables alongside Standard Deviation (SD) (in [square brackets]); standard errors (SE); 90 and 95% confidence intervals (CI); and margin of errors (10 and 5% of the means).

The relationship between the CI and margin of errors is used to indicate the precision of the data as follows:

- precision '90/10' requires the 90% CI to be ≤ 10% margin of error;
- precision '95/5' requires the 95% CI to be ≤ 5% margin of error; and
- precision '95/10' requires the 95% CI to be ≤ 10% margin of error.

Document development record

Date	Content	
17 September 2012	Preliminary analysis of data completed and submitted to CQC	KJ
9 May 2013	Preparation of final draft report. Proof reading	JR & KJ
10 May 2013	Submission to CQC	JR
23 May 2013	Submission to CQC addressing comments	JR KJ
29 July 2013	Final submitted to CQC addressing further comments	JR

Executive summary

This report provides a summary of the results from the baseline study of charcoal consumption across urban areas in Malawi. Urban areas are defined as settlements with population > 4765. The study was carried out in three provincial capitals (population > 100,000) and three smaller settlements (population 4,765 – 100,000) during the dry hot season in August and September 2012. The aims of the survey were to:

- estimate the average amount of charcoal used per existing stove per day (kg/stove/day) in urban households (HH);
- account for seasonal variation and multiple stove use;
- investigate the differences in charcoal consumption between different locations (i.e. the degree of homogeneity); and
- investigate other factors to validate findings and inform successful implementation.

The results of this study are applicable to AMS IE projects. The study is further to a request from C Quest Capital LLC (CQC).

Methodology

This report describes the sampling methodology; presents the questionnaire and other methods for HH fuel consumption measurement; and outlines analysis of the dataset including QA, data cleaning, assessing variability, and determining the precision of the key outcomes. The annexes present the survey tool used, as well as further detail on some of the key calculations.

A literature review was conducted to determine the factors affecting fuel consumption in the proposed area of dissemination of stoves. The literature review along with a consultation with local partners in Malawi revealed that per capita urban consumption of charcoal increases significantly from north to south reflecting reduced wood availability and greater extent of fuel commercialization in the south, as well as between settlements of different sizes.

In view of the possible variation between the provinces and settlements of varying size, each of the provincial capitals (Blantyre, Lilongwe and Mzuzu) was included in the sample for this study. In addition, one randomly selected smaller settlement[79] was included from each province. This study design was intended to detect differences between settlements of different sizes and in different locations across the project area.

The unadjusted baseline charcoal consumption was estimated at 2.16kg/per HH/per day on average for the whole country. Two adjustments were made to the daily HH fuel consumption estimates: the first to account for reported seasonal variation in charcoal consumption (resulting in an increase of 0.48kg to the cleaned baseline); the second to account for the simultaneous use of multiple stoves (resulting in a decrease of 0.14 kg to the baseline adjusted for seasons).

Key results

Other methodological issues were investigated including the prevalence of space heating with the charcoal stove at the time of survey, but no further adjustments were considered necessary to the data set.

The mean baseline charcoal consumption for all data, adjusted for seasons and multiple stove use, is **2.50 kg/per stove/per day.** The data for this calculation meet the 90/10 and 95/10 precision requirements of the AMS IE methodology. However, as presented in the

[79] Defined as having a population of between 4,765 and 100,000 by the 2008 Population and Housing Census. Presented at City Population: Malawi. http://www.citypopulation.de/Malawi.html

section below, statistically significant differences were found amongst different clusters and it is not possible to use this metric as a homogeneous charcoal consumption baseline. The study and analysis were planned and executed to conform to the EB 65 Annex 2 and EB 69 Annex 4 and 5 guidance.

Cluster-wise analysis of data

The following table presents a summary of the mean charcoal consumption by cluster (Kg/ stove / day).

	Northern		Central		Southern	
	Capital	Smaller settlement	Capital	Smaller settlement	Capital	Smaller settlement
Mean [SD]	2.70 [1.19]	2.50 [0.93]	2.12 [0.92]	2.44 [0.86]	2.84 [1.63]	2.43 [1.27]

Analysis of the data from all locations concludes that there is a statistically significant difference between the study locations in terms of mean HH charcoal consumption [p=0.001 ANOVA]. This means that they cannot be treated as a single homogeneous cluster.

Methods

Roles

A HED Consulting (HED) team led the planning of this study. Aspects of the study design, such as identification of study locations and questionnaire development, were carried out in collaboration with representatives from DeTAS, Malawi, who also trained and supervised the survey team in Malawi.

Analysis was undertaken using Microsoft Excel 14 and SPSS 16.0 by HED.

Sampling strategy

Malawi is divided into three administrative provinces: Northern, Central and Southern. This baseline study describes the whole of Malawi. The following map indicates the locations of the Southern Province of Malawi (shaded green), Central Province (orange) and Northern Province (yellow).

Figure 1: **Study area**[80]

The sample framework was designed to represent charcoal using HH in settlements within the project area with populations greater than 4,765[81] at the time of the 2008 Census. Settlements with a population of < 4,765 will not be targeted by the charcoal stove

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80 Malawi political map. http://www.mapsofworld.com/malawi/malawi-political-map.html

81 Populations of settlements in Malawi were determined from the City Population website http://www.citypopulation.de/Malawi.html

dissemination project, and so were not included in this study sample. No geographical areas were excluded from the area defined by this baseline.

Defining likely clusters in the baseline area

Section 0 describes the basis for identifying clusters within the project area in this study. The literature review and extensive dialogue with local partners concluded that per capita urban consumption of charcoal increases significantly from north to south reflecting reduced wood availability and greater extent of fuel commercialization in the south (Owen et al., 2009, p. 29). This pattern is supported by a study by Kambewa (2007, p. 10), which indicated that consumption of charcoal was greater in Lilongwe and Blantyre (in the Central and Southern Provinces respectively) than in the smaller northern capital of Mzuzu. However, Kambewa (*ibid*) suggests the reason for this trend is related to size of settlement rather than geography, as the smallest capital, Zomba, in the Southern Province had similar consumption to Mzuzu (Northern) and much less than Blantyre, also in the Southern Province.

In view of the possible variation between the provinces and settlements of varying size, each of the provincial capitals (Blantyre, Lilongwe and Mzuzu) was included in the sample for this study. In addition, one randomly selected smaller settlement was included from each province, defined as having population of between 4,765 and 100,000. This study design was intended to detect differences between settlements of different sizes and in different locations across the project area.

Provincial capitals

Two neighbourhoods were identified from each of the three provincial capitals using simple random sampling[82]. For the two larger cities, Lilongwe (population 674k (2008[83])) and Blantyre (population 661k (2008[5])), information drawn from data presented by the 2008 Population and Housing Census[84] and from local partners was used to identify neighbourhoods and sample:

- one neighbourhood near the capital centre; and
- one neighbourhood nearer to the boundary of the capital.

As data showing the precise locations of the neighborhoods could not be identified, local counterparts familiar with the settlements, were asked to categorize the list of neighborhoods by their proximity to the center of the city. The aim of this was to ensure a range of urban communities were represented in the sample. This was a qualitative approach deemed appropriate to ensure that neighbourhoods selected represented the breadth of areas within any settlement.

If the selected areas were found by the field partners to not represent a potential market for improved charcoal stoves because of non-use of charcoal (e.g. commercial or non-residential areas), they were excluded and a new location was selected.

In Mzuzu, a smaller capital of population 134k (2008), simple random sampling was used to identify two locations from all wards or neighbourhoods.

[82] This was achived using a random number generator *www.random.org*

[83] http://www.citypopulation.de/Malawi.html

[84] National Statistics Office on behalf of the Malawian Government, http://www.nsomalawi.mw/index.php/2008-population-and-housing-census/107-2008-population-and-housing-census-results.html

Smaller settlements

One smaller settlement was randomly selected from each province using probability proportional to size (PPS) (settlement population according to the 2008 Census used as the primary unit). Section 0 shows the lists of settlements and their population in the sampling framework. Where possible, two neighbourhoods were then randomly selected from each of the three selected settlements.

All selected areas were found to be residential areas with HH using predominantly charcoal as their cooking fuel, therefore no replacements were necessary.

These study locations may be considered representative of their clusters as they have been randomly selected from within these defined areas. Section 0 provides further information on the resources and references used for drawing sampling conclusions.

Sample locations

The outcome of this sampling approach is presented below.

Southern province

Provincial capital: Blantyre. Boundary neighbourhood: Nkolokoti. Central location: Ndirande North (Makata).

Smaller settlement: Zomba. Chikamveka and Chilunga wards.

Central province

Provincial capital: Lilongwe. Boundary neighbourhood: Area 25. Central location: Area 18.

Smaller settlement: Nkhotakota Boma (due to its size (population 25k (2008)) only one ward was identified in this capital. HH were randomly selected within this ward).

Northern province

Provincial capital: Mzuzu. Mchengautuwa and Katoto wards.

Smaller settlement: Chitipa (due to its size (population 15k (2008)) only one ward was identified in this capital. HH were randomly selected within this ward).

Household recruitment methodology and implications

To qualify for participation in this survey, HH were asked 'Is most of your cooking done on a **charcoal stove?'** 'Most cooking' is assumed to have been interpreted by HHs as 'more than half of cooking'. In line with the requirements of AMS IE methodology, this identified HH whose main fuel was charcoal but did not exclude users of other fuels, and ensured the sample frame included users of the full range of stoves, including any 'improved cook stoves'.

HH were chosen at random (see Section 6.1 for a full description of the process used) within the communities and, once it was established that the HH met the inclusion criteria and were willing to participate, the survey was carried out.

Attempts were made to minimize the impact of bias associated with non-response. If the HH cook was not available, an appointment was made for the following morning. If they were not available at that time, they were classed as unavailable. Any actual refusals to take part were also documented.

Sample size determination

Based on the variance seen using the same approach to measuring daily charcoal fuel consumption in other Sub-Saharan African countries to meet the 90/10 precision, the target sample size was 90 HH for each city or settlement in order to give the required resolution to

determine heterogeneity or homogeneity. In some locations additional HH were recruited in order to make optimal use of human resources on the ground.

Questionnaire development

A questionnaire was developed to explore the many factors that can impact HH charcoal use including seasonal variation; uses of the stove other than for cooking; and use of more than one stove at the same time (see Section 0 for the final version of questionnaire).

The questionnaire was then piloted in the field, along with the data transcribing and spreadsheet reporting and processing. After this, any aspects of the questionnaire that caused confusion and/or failed to collect the correct data were reviewed and edited.

Measurement of charcoal

HH were asked ‘How much charcoal do you use in an average day? Please make a pile for me to weigh’. In case the respondent did not have sufficient charcoal to demonstrate a full day’s amount, the fieldworkers offered a bag of ‘fieldwork charcoal’ for them to use. It was made clear that this charcoal would be collected and removed at the end of the survey, and was not mixed with HH charcoal.

Quality control

Local field staff received extensive training on how to administer the questionnaire and were given feedback on the pilot data to ensure that concise, complete data was collected. The team was then supervised daily by a trained field manager. The surveyors were given a field guide describing how to implement the survey and how to collect robust, accurate data.

The questionnaire was piloted as described in Section 0.

Double-entry of data was completed on a randomly selected 10% sample of transcripts. This was compared with the original dataset to identify the frequency and nature of data-entry error.

Analysis

Data checking

Examination of the double-entry data showed that there was <1% error in the key variables – i.e. charcoal-weighing data. Therefore the data-entry process was deemed accurate.

Unadjusted data from all sites

Data from 583 HH were sent to HED Consulting. Table 3.1 presents the composition of these data.

Table 3.1: Breakdown of sample by location and stove type

Region	Settlement	Name	n	Traditional stoves	Improved stoves
Northern	Capital	Mzuzu	91	13	78
Northern	Smaller settlement	Chitipa	96	48	48
Central	Capital	Lilongwe	99	1	98*
Central	Smaller settlement	Nkhotakota	101	1	100
Southern	Capital	Blantyre	98	1	97

Southern	Smaller settlement	Zomba	98	1	97
			583	65	518

*Includes three HH which were using the improved stove equally with a traditional metal stove.

Raw data nationally

The following table presents mean charcoal consumption from the full raw dataset across all areas. This data has had no outliers removed, nor has it been adjusted in any way.

Table 3.2: National raw data for mean charcoal use (kg/per HH/per day)

	National N=583
Mean [SD]	2.17 [0.86]
SE[85]	0.04
90% CI	0.07
95% CI	0.08
10% mean	0.22
5% mean	0.11

One HH was removed from the dataset as their reported daily charcoal consumption was deemed unreasonably high for daily domestic use for the number of people in the HH (7.1kg) and therefore seen as not representative of this population.

Table 3.3: National raw data for mean charcoal use: outliers removed (kg/per HH/per day)

	National N=582
Mean [SD]	2.16 [0.84]
SE[86]	0.04
90% CI	0.07
95% CI	0.08
10% mean	0.22
5% mean	0.11

[85] Standard Error (SE) is the Standard Deviation (SD) of the sample mean and describes its accuracy as an estimate of the population mean. As sample size increases, the estimator is based on more information and becomes more accurate, so its SE decreases.

Accounting for seasonal changes in amount of charcoal used

Purpose of step: to account for HH using more or less charcoal at different times of the year relative to current use.

Each participant was asked what she considered the current season to be and how long it lasted – as well as how long the 'other' seasons lasted. Using diagrams to represent increases or decreases in fuel use relative to current consumption, they were then asked to describe the changes in quantities of fuel wood used during the other seasons compared with the current. This information was then used to calculate an adjusted daily charcoal consumption that takes into account seasonal changes throughout the year (see Section 0 for description of the calculation) (see table 3.4).

Table 3.4: National daily mean HH charcoal consumption: adjusted for seasonal trends (kg/per HH/per day)

	National N=582
Mean [SD]	2.64 [1.28]
SE[87]	0.05
90% CI	0.08
95% CI	0.10
10% mean	0.26
5% mean	0.13

The seasonal fuel use adjustment has resulted in an increase in the mean charcoal fuel value of 0.48kg/day compared with unadjusted data.

Simultaneous multiple stove use

Purpose of step: to account for HH using more than one stove simultaneously and ultimately to account for occasional continued use of traditional stoves alongside improved stoves.

The questionnaire included a series of questions about the simultaneous use of more than one stove for cooking. These were designed to establish the proportion of cooking (and therefore charcoal consumption) that could be attributed to a single improved stove introduced through an improved cookstove project.

The calculation of the average number of stoves used simultaneously for cooking per family unit took into account the frequency of simultaneous stove use as well as the number of times cooking took place per day. This was compared with the stated number of times HH cooked per day (Question C1 in the survey presented in Section 0) to give a fraction adjustment (see Section 0 for a full description of this calculation).

Any HH using its stove less than once per week was excluded from this adjustment as the impact of this may be considered negligible.

Table 3.5: Simultaneous stove use from full dataset

	National N=582
% Currently using stoves simultaneously > once per week	25.1%
Stoves used per HH/family unit mean [SD]	1.06 [0.16]

At the time of interview 25.1% of the study sample were currently using two stoves at the same time at least once per week.

Overall the average (mean) number of stoves used simultaneously for cooking per HH unit was approximately 1.06, which equates to a mean adjustment to charcoal fuel weights of 1/1.06= 0.94

Note that this mean value is presented to reflect the extent of second stove use but is not applied to B_{old} *mean* to adjust for multiple stove use, but each household charcoal weight is adjusted individually according to its pattern of multiple stove use. All further steps in analysis use these adjusted daily charcoal fuel weight values. The result is presented in Table 3.6.

Table 3.6: National mean charcoal consumption adjusted for seasonal changes and patterns of multiple stove use (kg/per stove/per day)

	National N=582
Mean [SD]	2.50 [1.18]
SE	0.05
90% CI	0.08
95% CI	0.10
10% mean	0.25
5% mean	0.13

The multiple stove adjustment has resulted in a decrease in 0.14kg/day compared with data adjusted for seasonal trends. This mean value meets 90/10, 95/10 and 95/5 precision requirements.

This reduction in mean fuel consumption compared to mean firewood consumption adjusted for seasonal trends is equivalent to an adjustment of:

(Value adjusted for seasons/ value adjusted for seasons and multiple stove use)

= (2.64/2.50) = 1.056, which may be considered an adjustment factor for any calculations concerned with second stove use in the entire sample. This is close to, but slightly different from, the mean number of stoves used simultaneously per household unit (1.06), as this is applied to mean values; whereas the adjustment factor is applied to individual households.

Assessing the difference between regional means

Purpose of step: to establish whether the Malawi baseline needs to be described in a series of discrete clusters due to discernible difference, or whether it may be described as a homogenous area.

The difference in charcoal consumption (kg/stove/day) between each of the study locations was explored. An ANOVA test was used to determine any statistical significance difference between the estimated means in each of the locations.

Table 3.7: Mean charcoal consumption adjusted for seasonal changes and simultaneous stove use by region and location type (kg/per stove/per day)

	Northern		Central		Southern	
	Capital	Smaller settlement	Capital	Smaller settlement	Capital	Smaller settlement
Mean [SD]	2.70 [1.19]	2.50 [0.93]	2.12 [0.92]	2.44 [0.86]	2.84 [1.63]	2.43 [1.27]
SE	0.13	0.10	0.09	0.09	0.16	0.13
90% CI	0.21	0.17	0.15	0.15	0.26	0.21
95% CI	0.25	0.20	0.18	0.18	0.31	0.25
10% mean	0.27	0.25	0.21	0.24	0.28	0.24
5% mean	0.14	0.13	0.11	0.12	0.14	0.12

The P value for difference between regions [p=0.001 ANOVA] showed that there is compelling evidence that the means between locations are significantly different.

Further analytical tests were carried out to investigate whether any locations could be combined and described as a homogenous area.

The estimated daily charcoal consumption in the Northern capital and Northern smaller settlement were not statistically significantly different (p=0.201 independent T-test) and so the northern region could be considered as a single homogeneous cluster. The mean fuel consumption for the northern areas combined is 2.59kg/stove/day [N=187; SD 1.07]. However there was statistically significant difference between the Central capital and central smaller settlement (p=0.01), and the Southern capital and southern smaller settlement (p=0.05).

The estimated daily charcoal consumption in each of the smaller settlements was not statistically significantly different (p=0.889 ANOVA) and small settlements across the national area could be considered as a single homogeneous cluster.

However there was a statistically significant difference between the three regional cities (p=<0.001).

Key parameters, including stove usage and seasonal variation in fuel consumption will be monitored during the project. An example monitoring questionnaire is presented in Section 6.6.

Simultaneous multiple stove use by proposed cluster

Purpose of step: to account for HH using more than one stove simultaneously and ultimately to account for occasional continued use of traditional stoves alongside improved stoves within the proposed 5 clusters.

The data for frequency and extent of simultaneous stove use was explored within the 5 proposed clusters. Table 3.8 outlines the results.

Table 3.8: Simultaneous stove use for 5 clusters

	Northern	Central		Southern	
		Capital	Smaller settlement	Capital	Smaller settlement
% Currently using stoves simultaneously > once per week	28.3%	25.3%	10.9%	34.7%	23.7%
Stoves used per HH/family unit mean [SD]	1.08 [0.19]	1.06 [0.15]	1.05 [0.17]	1.07 [0.14]	1.05 [0.11]

Other factors investigated

The questionnaire survey included a number of questions on other aspects of HH energy behaviour, some of which may impact charcoal fuel consumption. This section presents the conclusions of analysis of this data.

Space heating

29.6% (n=172) of respondents reported using their charcoal cooking stove for space heating when not cooking. However this was done primarily during the cold season (n=172) with a few HH also using their stove in this way during the rainy (n=51) and post rainy seasons (n=21). No HH reported to have used their stove for space heating during the time of the study, which was the dry hot season.

Conclusion

The use of charcoal stoves for space heating may be discounted as a factor affecting the integrity of the baseline measurement.

Impact of using all of a household's charcoal for weighing

Analysis was carried out to explore whether there is a difference between the mean amount of fuel in those HH which had *all available* charcoal weighed, those which had some left in addition to that weighed and those in which the study charcoal was used to weigh the estimated daily amount used.

Analysis on national data**,** adjusted for seasonal trends and multiple stove use, showed that the mean charcoal fuel use for those where there was some charcoal remaining in the original charcoal pile was 2.54 kg/stove/day [n=432 SD=1.23] and HH where the study charcoal was used to approximate the daily consumption was 2.39 kg/stove/day [n=149 SD=1.01]. There was only one HH where all available charcoal was weighed and this weight was 2.05 kg/stove/day.

An ANOVA showed no statistically significant difference between these estimates of daily charcoal consumption [p=0.408].

Conclusion

No statistical differences were found amongst the populations that had all charcoal available against those who did not. No obvious explanation exists for this either. Therefore, there are no grounds for any adjustment or exclusion of data based on this analysis.

References

Kambewa, P., Mataya, B., Sichinga, K. and Johnson, T. *Charcoal: the reality – A study of charcoal consumption, trade and production in Malawi*. Small and Medium Forestry Enterprise Series No. 21. 2007, International Institute for Environment and Development, London, UK.

Owen, M., Openshaw, K., Van der Plas, R., Matly, M. and Hankins, M. *Malawi Biomass Energy Strategy.* 2009, Government of Malawi.

Annexes

Supporting information for sampling approach

Sampling strategy

The sample framework is designed to represent charcoal-using HH in urban areas within the national boundaries of Malawi.

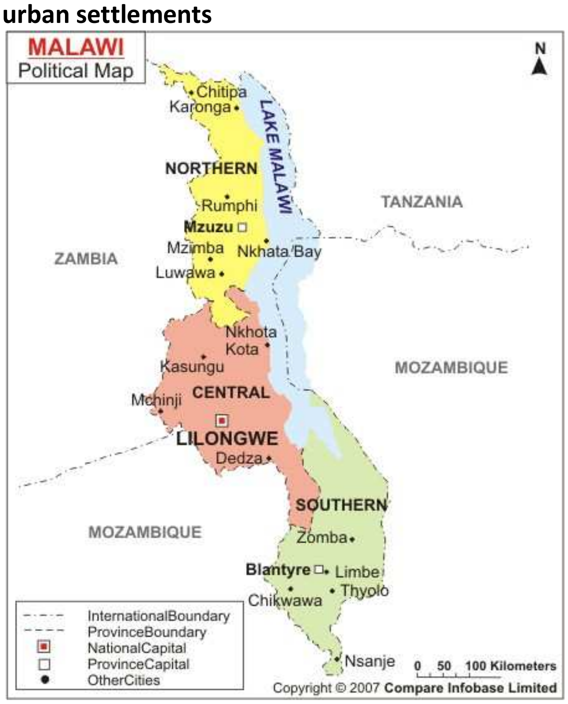
The aim of the study is to estimate baseline charcoal consumption in HH in all urban settlements with more than 4,765 inhabitants[88] in Malawi. It is possible that variation among the cities might lead to groupings, such as large versus small settlements, or north versus south and central capital cities.

Because no urban areas with a population <4,765k are included in the sampling frame, the conclusions of this study will not be applicable to settlements with a population <4,765.

Project area

Malawi is divided into three administrative provinces: Northern, Central and Southern (Figure 1). While each province is roughly the same size, the population is concentrated in the Central (42%) and Southern (46%) provinces.

Figure 1: Map of Malawi showing provinces and urban settlements



There are four major urban centres within Malawi[89] (see Figure 1 for all locations):

- Mzuzu (pop. 133,968, northern province);

[88] At the time of the 2008 National Census.
[89] City population Malawi downloaded from http://www.citypopulation.de/Malawi.html)

- Lilongwe (pop. 674,448, central province);
- Blantyre (pop. 661,256 southern province); and
- Zomba (pop. 88,314 southern province).

All other urban areas are substantially smaller and it is estimated that the above four cities represent 90% of all charcoal users in Malawi[90]

Energy consumption

Approximately 25% of HH in the four main urban centres have access to electricity and this is mostly used for lighting. Wood and charcoal are the principal cooking fuel options. On average, charcoal comprises about one third of urban HH fuel consumption in Malawi, while wood makes up 56% and electricity 9%. The share of charcoal has increased steadily in recent years, particularly in Blantyre, where charcoal is now as important as wood in energy terms (Owen et al., 2009, pp. 28–29).

National consumption trends

On a provincial basis, data suggests that per capita urban consumption of charcoal increases significantly from north to south reflecting reduced wood availability and greater extent of fuel commercialization in the south (Figure 2).

Figure 2: Per capita urban household fuel consumption by province (Owen et al., 2009, p. 29).

Region	Wood	Charcoal		Residues		*Total*	
	kg/yr	kg/yr	kg (w.e.)	kg/yr	kg (w.e.)	*kg (w.e.)/yr*	*cu.m.*
Northern	377.16	51.99	97.27	0.37	0.31	***474.74***	*0.91*
Central	328.12	76.95	143.98	0.38	0.31	***472.41***	*1.01*
Southern	243.73	118.14	221.03	0.38	0.30	***465.06***	*1.15*
Weighted average:	***292.92***	***94.02***	***175.91***	***0.38***	***0.31***	***469.14***	***1.07***

However, Kambewa suggests the reason for this trend is related to size of settlement rather than geography, as the smallest city, Zomba, in the southern district had similar consumption to Mzuzu (see Figures 3 and 4) (Kambewa et al., 2007, pp. 9–10).

[90] Kambewa, Mataya, Sichinga and Johnson. 2007. Charcoal: the reality – A study of charcoal consumption, trade and production in Malawi. Small and Medium Forestry Enterprise Series No. 21.International Institute for Environment and Development, London, UK.

Figure 3: Average annual per capita charcoal consumption by city (Kambewa et al., 2007, p. 10).

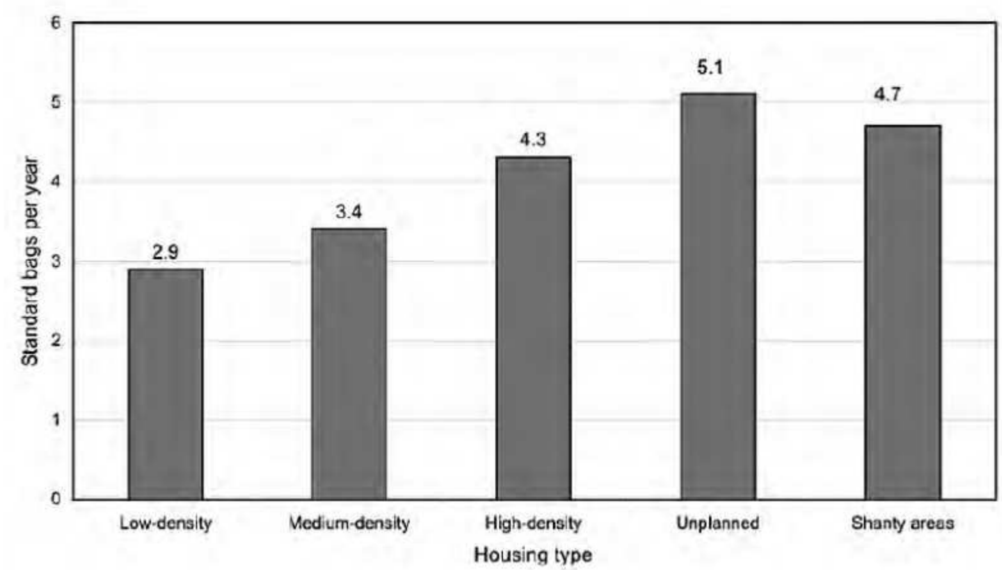
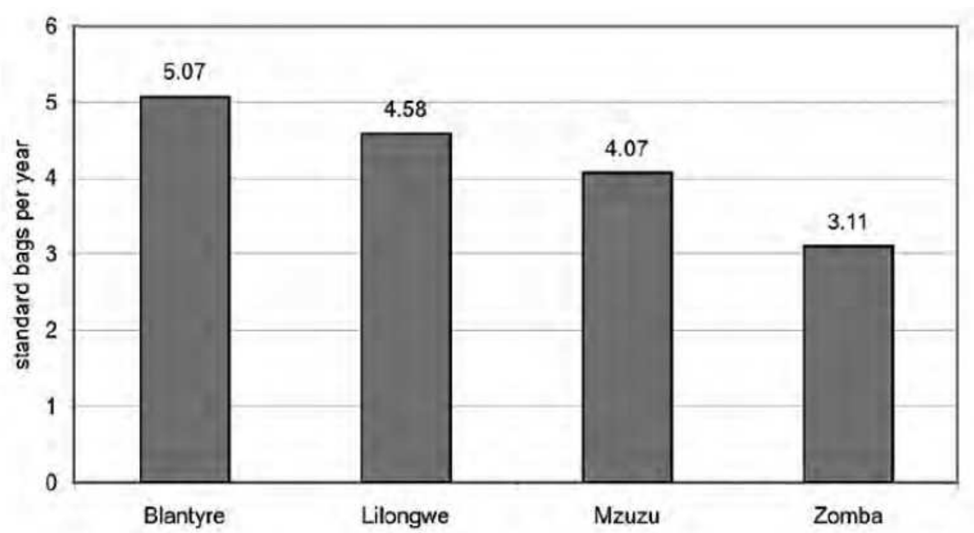


Figure 4: Annual total expenditure on charcoal and electricity by city (Kambewa et al., 2007 p. 10).



Note: although Figure 4 corroborates the apparent trend in consumption of charcoal in different cities, overall expenditure is affected by the cost of charcoal as well as volume of consumption.

In addition to the size of population, Owen (2009) suggests that the age of the settlement also has some impact on the level of charcoal consumption. This is apparently due to a switch to charcoal as firewood becomes scarcer and therefore more expensive. Charcoal is most firmly established in older towns such as Blantyre while usage in Lilongwe is somewhere in the middle as it is a big but relatively young city (Owen et al., 2009, p. 30).

Suggested clusters

The data suggests that substantial differences in charcoal consumption exist between the three provinces in Malawi. There is also some evidence that smaller settlements have a different consumption pattern compared with that in larger ones. This implies that each province should be its own cluster and that the three provincial capitals (Blantyre, Lilongwe and Mzuzu) should be considered as separate clusters from smaller settlements, since usage is significantly higher in these larger settlements compared to the smaller city of Zomba.

- Based on this evidence six locations will be selected to ensure all suggested geographic trends in fuel consumption are represented, as follows:
- all three provincial capitals; and
- three randomly selected urban settlements with a population of 4,765 to 100,000 (as defined by the 2008 Census).

From each of the provincial capitals in this study, two neighbourhoods will be randomly sampled within a framework that allows the selection of:

- one neighbourhood near the city centre; and
- one neighbourhood nearer to the boundary of the city.

If higher-income residential areas can be shown to not represent a potential market for improved charcoal stoves (e.g. because of non-use of charcoal), they will be excluded.

From each province, one settlement with a population of 4,765–100,000 inhabitants will be selected using PPS. This takes into account the size of the populations in each settlement, giving more populous areas a higher chance of being selected. The list of settlements and their population size is shown in Figure 6.

Figure 6: Malawian urban settlements with a population over 4,765 inhabitants[91]

Name	Adm.	C Cf 2008-06-08
Balaka	SOU	22,733
Chikwawa	SOU	6,987
Chitipa	NOR	14,753
Dedza	CEN	20,241
Dowa	CEN	4,765
Karonga	NOR	40,334
Kasungu	CEN	39,640
Liwonde	SOU	22,927
Luchenza	SOU	10,896
Mangochi	SOU	39,575

[91] http://www.citypopulation.de/Malawi.html

Mchinji	CEN	17,881
Monkey Bay	SOU	11,246
Mponela	CEN	No data[92]
Mulanje	SOU	14,497
Mwanza	SOU	14,226
Mzimba	NOR	20,994
Nkhata Bay	NOR	11,269
Nkhotakota	CEN	24,726
Nsanje	SOU	20,179
Ntcheu	CEN	14,642
Ntchisi	CEN	7,918
Phalombe	SOU	4,935
Rumphi	NOR	17,845
Salima	CEN	27,852
Thyolo	SOU	7,693
Zomba	SOU	88,314

HH will then be randomly chosen within the selected neighbourhoods. This will be achieved by firstly identifying a central landmark such as a mosque/church or market. Each fieldworker will spin a bottle on the ground to indicate the direction in which to walk. Each choosing a different direction, the fieldworkers will select every second HH until the required number is achieved, or the boundary of the area (i.e. neighbourhood) is reached. If the boundary is reached but further HH are required, the process will be repeated in a new direction.

[92] 2008 Census population data for this town was not listed so it was excluded from the sampling frame. However, it is still described by the baseline, as there was no basis for excluding it. In the 1998 census, it was reported as having population 9,846, so was not considered likely to be an outlier of the definition of urban.

Malawi Baseline Charcoal Consumption Questionnaire

Baseline Fuel Use Assessment: Malawi

Designed by HED Consulting August 2012

- This survey is designed to be administered to the primary cook in selected households
- The objective of this survey is find out how much charcoal is used by the MAIN stove on a daily basis in households
- Please note: Unless stated otherwise, all questions refer to general household cooking during the present season.

Italic text in [square brackets] are instructions for fieldworkers. This text should not be read out to respondents.
<u>Bold underlined text should be read out to respondents as well as the questions</u>

*[**IMPORTANT:** Before starting the survey, please ask the respondent if she/he is the main cook in the family unit. If it is not the main cook, ask to speak to the main cook, and arrange a convenient time when she/he will be available for interview**.]***

Baseline Fuel Use Assessment: Malawi

A. Introduction
READ: Good morning/afternoon, my name is____________. Thank you for making time for us. I am here today to talk to you about your family cooking practices and fuel use. If you agree to participate in this survey, we would like to ask you a few questions; it will take about 25 minutes. There are no 'right' or 'wrong' answers and the information you provide will be very useful to help use improve cooking practices throughout Malawi. All the information will be kept private and your name will not appear anywhere publically. We will however keep it in our records so that we can contact you in future. Do you have any questions?

A1	Is most of your cooking done on a **charcoal stove? [***Note: this can be a traditional stove or an improved one]*	1=Yes 2=No [*terminate interview*]	
A2	Do you use charcoal to cook commercially (use it in a small enterprise)?	1 = Yes [*terminate interview]* 2 = No	
A3	Do you agree to participate?	1 = Yes 2 = No [*terminate interview*]	
A4	Do you have a days worth of charcoal in your home?	1 = Yes 2 = No	
A5	ID number		
A6	Date of interview [DD/MM/YYYY]		
A7	Start time of interview [Use 24-hour clock]		
A8	Interviewer's name		
A9	Respondent's name		
A10	Respondent's telephone number [if available]		
A11	Name of community		
A12	Name of district		
13	Name of region		
A14	Today's weather	1 = Hot and dry 2 = Hot and wet 3 = Cold and dry 4 = Cold and wet	

	B. Household structure

B1	How many people live in your household in total?				
B2	Within your household, do different family units or groups cook separately (for example in different locations or near each other but using separate fires and pots?)			1=Yes 2=No [*go to B5*]	
B3	How many family units live within your household?				
B4	How many people are in your own family unit?				
B5	On average, how many people do you usually cook meals for each day, at this time of year? [put a 0 if none]				
	Children 14 year or younger	Female adults 15 years and older	Male adults 15 -59 years	Male adults 60 years or older	Total [NN] *[add up B5_1 to B5_4]*
	B5_1	B5_2	B5_3	B5_4	B5_5
B6	*[Check: Is the total in B5_5 the same as B4?]*			1 = Yes [Go to C] 2 = No	
B7	Why is there a difference between your family unit size and the number cooked for? [*Write down everything the respondent says]*				
	C. Cooking				
C1	On average, how many times each day do you use your stove to prepare food for your family?				
C2	What is the <u>main</u> type of charcoal stove that you use at this time of year?		1 = Kenyan Jico (Kinda) 2= Traditional Metal charcoal stove 3= others (Specify)		
	D. Simultaneous stove use for cooking using charcoal				
D1	Do you ever cook on more than one **<u>charcoal</u>** stove **<u>at the same time</u>** <u>at this time of year</u>? *[Make sure respondent is* ***not simply talking about multiple <u>pots</u>]***			1 = Yes 2 = No [*go to Section E]*	
D2	Do you do this at least once per week?			1 = Yes 2 = No [*go to Section E]*	
D3	How many days each week do you use two **<u>charcoal</u>** stoves at the same time				
D4	How many meals do you use them for **on those days**?				
D5	During which seasons do you use more than one **<u>charcoal</u>** stove at the same time for cooking ? *[select all that apply]*			1 = Rainy season 2 = Post-rainy season 3 = Cold season 4 = Dry hot season	

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	E. Stoves which can cook more than one dish at once		
E1	Do you own a charcoal stove on which you can cook two dishes at once? (double burner or two pot charcoal stove)	1 = Yes 2 = No [go to Section F]	
E2	Do you use this stove at least once per week to cook two dishes in two pots at the same time?	1 = Yes 2 = No [*Go to Section F]*	
E3	How many **days** each week do you use the **charcoal** stove to cook two dishes at the same time?		
E4	On those days, how many **meals** do you use it for to cook food in two pots at the same time?		
E5	During which seasons do you use this stove to cook two dishes in two pots at the same time? *[select all that apply]*	1 = Rainy season 2 = Post-rainy season 3 = Cold season 4 = Dry hot season	
	F. Space heating		
F1	Do you use a charcoal stove for room heating at **any time of year**?	1 = Yes 2 = No *[Go to Section G]*	
F2	Is it the same stove as you use for cooking?	1 = Yes 2 = No *[Go to Section G]*	
F3	Do you use it for heating **when not cooking**?	1 = Yes 2 = No *[Go to Section G]*	
F4	During which seasons do you use a charcoal stove for room heating?	1 = Rainy season 2 = Post-rainy season 3 = Cold season 4 = Dry hot season	
F5	What type of **charcoal** stove do you use to heat your home? *[select all that apply]*	1 = Kenyan Jico (Kinda) 2= Traditional Metal charcoal stove 3= others (Specify)	
	G. Additional uses of fires/stoves		
G1	Other than for cooking (and heating your house), for what purposes do you use a **charcoal** stove more than once per week in this current season? [*Ask the respondent to list **the three main tasks** for which they use **charcoal**, and the frequency of the task. If one or more task is not is not listed, record '20' in the box, and write in the 'other task in G1.4*]		

	No other purpose = 1	Heating water = 2	Burning incense = 3
	Brewing tea = 4	Cassava drying = 5	Ironing = 6
	Roasting = 7	Drying meat = 8	Other [describe] = 9

	Use [use coding]	**Number of days per week?**
G1.1	G1_1_1	G1_1_2
G1.2	G1_2_1	G1_2_2

G1.3	G1_3_1	G1_3_2
	[Record any other tasks that are not on the list]	
G1.4	G1_4_1	G1_4_2
G1.5	G1_5_1	G1_5_2

	J. Charcoal		
	*[This question is very important – please take time to ensure the question is understood and your measure reflects charcoal used for the respondents **family unit** in an **average day**]* **Ask: Do you have a full day's charcoal here in the house to show us how much you use?** [If yes, carry on, if no, use ONLY the charcoal in your bag- do not use any of the household charcoal]. **Ask: How much charcoal do you use on an average day at this time of year? Please make a pile for me to weigh.**		
J1	Weight of **charcoal** including bag, tin or binding *[include decimal places]*	__ __ __ . __ __**kg**	
J2	Weight of bag, tin or binding weighed with the charcoal	__ __ __ . __ __**kg**	
J3	Did you weigh all the charcoal available in the household, or was some left besides that weighed?	1= Weighed all available charcoal 2= More charcoal remained 3= Used the study charcoal	
J4	Do you make any of your charcoal?	1 = Yes 2 = No [go to J6]	
J5	About what proportion of the total charcoal fuel you use do you make at this time of year?	1 = I make most of my charcoal fuel 2 = I make about half my charcoal fuel 3 = I make a small amount of charcoal fuel	
J6	How much do you spend each time you buy **charcoal**?	**....Kwacha**	
J7	How many days would this amount of **charcoal** last? *[Express as decimal if necessary, e.g. half a day = 0.5]*	**......days**	

	K. Other fuels					
	How much of your cooking is done with the following fuels at this time of year? [*List each fuel in turn and circle the most appropriate response*]					
		None	Less than one meal per week	A few meals per week	About half of all cooking	More than half of all cooking
K1	Dung	1	2	3	4	5
K2	Fuelwood	1	2	3	4	5
K3	Kerosene	1	2	3	4	5
K4	LPG [gas]	1	2	3	4	5
K5	Crop residues	1	2	3	4	5
K6	Other [*describe*] ___________	1	2	3	4	5
	[Check with the respondent that you have discussed all of the fuels the household uses for					

	cooking]

	S. Seasonality				
	Season codes	Rainy season	Post-rainy season	Cold season	Dry hot season
		A	**B**	**C**	**D**
S1	How would you describe the <u>current season</u>? *[Read names of seasons from list above & enter code]*				
S2	**<u>Ask: When does each season fall in the year?</u>** *[Mark the calendar below using the letter codes above, <u>putting only one letter for each month</u> – e.g. if Season A lasts from April to June, put an A in each box for April to June – similarly for each season]*				

SEASON	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainy A												
Post-rainy B												
Cold C												
Dry hot D												

<u>Ask: How do each of these factors change with season compared to the current season?</u>

[If things change, put '1 'in the second column, and fill in the sentences in the third column. If it does not change put '2 'in the second column and do not fill in the third column.]

	Factor	Does it vary? 1=yes 2=no	[IF YES go through all seasons with participants and record how the factors changes]
S3	Number of **<u>people</u>** for whom meals are cooked	S3_1	In Rainy season I usually cook for [......................... S3_2] people In Post-rainy season I usually cook for [...................S3_3] people In Cold Season I usually cook for [........................... S3_4] people In Dry Hot season I usually cook for [.......................S3_5] people
S4	Number of **<u>meals</u>** cooked per day	S4_1	In Rainy Season I usually cook [.........................S4_2] meals / day In Post-rainy season I usually cook [................... S4_3] meals / day In Cold season I usually cook [.......................... S4_4] meals / day In Dry Hot season I usually cook [...................... S4_5] meals / day
S5	Main **<u>type of fuel</u>** used for cooking *[use list below]*	S5_1	In Rainy Season the fuel I generally use is [.........................S5_2] In Post-rainy season the fuel I generally use is [.....................S5_3] In Cold Season the fuel I generally use is [.............................S5_4] In Dry Hot Season the fuel I generally use is [........................ S5_5]

Charcoal =1	Woodfuel =2	Crop residues=3	Kerosene=4
LPG=5	Wood / crop residues in equal quantities=6		Other=7

6	READ using the diagram on separate sheet: **<u>Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no charcoal at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.</u>** *[First **<u>underline</u>** the current season in the column below and circle number 5;* *THEN circle the number that refers to the amount of charcoal the participant indicates **<u>for each season</u>**]*

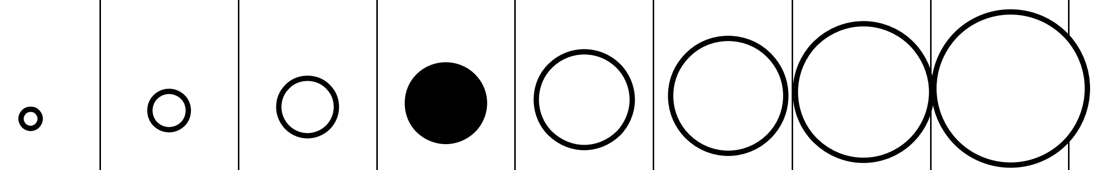
	Underline current season in column below	No charcoal	Quarter	Half	Three quarters	Current	One & a quarter	One & a half	One & three quarters	Twice as much charcoal
S6_1	**Rainy**	1	2	3	4	5	6	7	8	9
S6_2	**Post-rainy**	1	2	3	4	5	6	7	8	9
S6_3	**Cold**	1	2	3	4	5	6	7	8	9
S6_4	**Dry Hot**	1	2	3	4	5	6	7	8	9

	Z. Other observations
Z1	**Is there anything else you would like to tell us about how you use your fuel for household purposes?** [*Write down everything the participants says*]
	Thank you for your time and help in providing us with this useful information
Z2	*[Write down any observations of your own that you feel would be helpful and relevant]*

Baseline fuel Assessment: Malawi

READ: **Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in the XXX [say the other season to the current one] season.**

[Circle the number that refers to the circle the participant indicates for charcoal use]



X								
No charcoal	**Quarter**	**Half**	**Three quarters**	**Current**	**One and a quarter**	**One and a half**	**One and three quarters**	**Twice as much charcoal**
1	2	3	4	5	6	7	8	9

Calculation of adjustment for seasonal fuel use

The participants were asked 'How would you describe the current season?' and 'When does each season fall in the year?' This information was used to calculate the length of the current season and the 'other' season(s) for each participant.

The participants were asked how much charcoal they use in the 'other' season(s) compared to their current use (see question M6.1 in Section 6.2/6.3). Each response provided a fraction related to the current charcoal use as per the table below.

Relative amount of charcoal	Adjustment fraction
No charcoal	0
A quarter of the amount	0.25
Half of the amount	0.5
Three quarters of the amount	0.75
No change	1
A quarter more	1.25
A half more	1.5
Three quarters more	1.75
Double the amount	2

The current daily charcoal consumption was multiplied by this fraction to give a daily amount during the 'other' season(s).

For example: If the HH currently using 2.08kg of fuel per day reported using a quarter more during the 'other' season, the daily fuel consumption for the 'other' season was calculated by:

2.08*1.25 = 2.6kg

The overall daily charcoal consumption was adjusted to reflect the reported length of the current season and that of the 'other'. For example, if the participant said the current season was 'rainy' and it carried on for four months of the year and the 'other' season was 'dry' and lasted eight months, the following calculation was applied:

((2.08*4) + (2.6*8))/12 = 2.43 kg/day

Calculation of simultaneous stove use

This section outlines the process of gathering and analysing information on simultaneous stove use in Malawi as part of the baseline assessment.

The survey provides the following information:

- average number of meals cooked per week;
- average number of 1 stove meals cooked per week;
- average number of 2 stove meals cooked per week; and
- average number of months per year this occurs.

Using this information and assuming equal amounts of fuel were used on each stove (which is the most conservative approach), the fuel correction factor is calculated as follows:

(2*total meals per week with 2 stoves)+total meal using 1 stove = stove meals

Stove meals/7 = stove meals per day

Stove meals per day/number of meals per day = HH mean stoves used/day

Fuel correction factor = 1/(HH mean stoves used/day)

The table below shows the calculations for various combinations of simultaneous stove use.

Total meals/week	Total meals with 2 stoves /week	Total meals with 1 stove /week	Stove meals total /week	Stove meals/day	HH mean stoves used per day	Fuel correction factor
21	21	0	42	6.00	2.00	0.50
21	18	3	39	5.57	1.86	0.54
21	14	7	35	5.00	1.67	0.60
21	10	11	31	4.43	1.48	0.68
21	7	14	28	4.00	1.33	0.75
21	4	17	25	3.57	1.19	0.84
21	1	20	22	3.14	1.05	0.95
21	0	21	21	3.00	1.00	1.00
14	14	0	28	4.00	2.00	0.50
14	12	2	26	3.71	1.86	0.54
14	10	4	24	3.43	1.71	0.58
14	8	6	22	3.14	1.57	0.64
14	7	7	21	3.00	1.50	0.67
14	4	10	18	2.57	1.29	0.78
14	3	11	17	2.43	1.21	0.82
14	2	12	16	2.29	1.14	0.88
14	0	14	14	2.00	1.00	1.00

Example

Total meals per week: 21 Total 1 stove meals: 17 Total 2 stove meals: 4

Daily HH charcoal use: 2.32kg

Calculation

(2*4)+17 = 25

25/7 = 3.57 stove meals per day

3.57/3 meals per day = **1.19 stoves per day**

1/1.19 = a fuel correction factor of 0.84

Therefore a HH with a daily charcoal use of 2.32kg would be adjusted to

2.32*0.84 = 1.95kg of charcoal used per day per stove.

Any HH reporting simultaneous stove use less than once per week was given a default adjustment factor of 1.

Example monitoring questionnaire

Stove Use Patterns and Operation Monitoring Survey

Prepared by HED Consulting

	A. Identifying house and cook		
A1	Sales record number / Serial Number of Stove	A2	Village
A3	Ward	A4	District
A5	Participant telephone number		
A6	Date of interview [DD/MM/YYYY]		
A7	Start time of interview [Use 24-hour clock]		
A8	Interviewer's name		
A9	Date of stove installation		

	B. Stove use		
B1	Do you still use your '[INSERT INTERVENTION STOVE NAME]' for most cooking tasks?	1=yes 2=no [*go to D1*]	
B2	Visual confirmation of '[INSERT INTERVENTION STOVE NAME]'	1=yes 2=no	
B3	Do you still use your baseline stove	1=yes 2=no [*go to C2*]	
B4	Visual confirmation of baseline stove	1=yes 2=no [*go to C2*]	

	C. Charcoal Consumption	
C1	How much baseline charcoal do you use in your baseline stove in an average day? Please make a pile for me to weigh.	____________ kg
C1_1	READ using the diagram on separate sheet: **<u>Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.</u>**	

C1_2	**<u>Underline</u> current season <u>in column below</u>**	**No charcoal**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much charcoal**
C1_3	**Rainy**	1	2	3	4	5	6	7	8	9
C1_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C1_5	**Cold**	1	2	3	4	5	6	7	8	9
C1_6	**Dry Hot**	1	2	3	4	5	6	7	8	9

C2	Do you use non-project charcoal in the '[INSERT INTERVENTION STOVE NAME]'	1=yes 2=no [*go to C4*]
C3	How much non-project charcoal do you use in your '[INSERT INTERVENTION STOVE NAME]'in an average day <u>in the current season</u>? Please make a pile for me to weigh.	____________ kg

C3_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.** *[First **underline** the current season in the column below and circle number 5;* *THEN circle the number that refers to the amount of charcoal the participant indicates **for each season**]*

C3_2	**Underline current season in column below**	**No charcoal**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much charcoal**
C3_3	**Rainy**	1	2	3	4	5	6	7	8	9
C3_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C3_5	**Cold**	1	2	3	4	5	6	7	8	9
C3_5	**Dry Hot**	1	2	3	4	5	6	7	8	9

C4	Do you use renewable biomass supplied by '[INSERT NAME OF CPA IMPLEMENTOR]'	1=yes 2=no [*go to D1*]
C5	How much renewable biomass do you use in your '[INSERT INTERVENTION STOVE NAME]' in an average day? Please make a pile for me to weigh.	____________ kg

C5_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.** *[First **underline** the current season in the column below and circle number 5;* *THEN circle the number that refers to the amount of charcoal the participant indicates **for each season**]*

C5_2	**Underline current season in column below**	**No charcoal**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much charcoal**
C5_3	**Rainy**	1	2	3	4	5	6	7	8	9
C5_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C5_5	**Cold**	1	2	3	4	5	6	7	8	9
C5_6	**Dry Hot**	1	2	3	4	5	6	7	8	9

	D. Reasons for stopping use of '[INSERT INTERVENTION STOVE NAME]	
D1	Why do you no longer use the '[INSERT INTERVENTION STOVE NAME]? *[Write down everything the participant says]*	
D2	Which stove do you use as your primary stove now?	
	E. **Stove breakage and repair**	
E1	Since starting to use your '[INSERT INTERVENTION STOVE NAME] stove has anything broken on it?	1=yes 2=no [*go to F1*]

E2	If yes, please describe what broke [*Write down everything the respondent says*]				
E3	Did you repair the break?			1=yes 2=no	
	F. **Observations and comments**				
F1	[O*bserve the* '[INSERT INTERVENTION STOVE NAME] *and note any signs of recent use or otherwise]*				
F2	[*Please check the stove for all components- enter a 1 if present and if in correct position. Enter a 2 if not.]*	1=yes 2=no	Present	Correct	
		[ENTER COMPONENT 1]			
		[ENTER COMPONENT 2]			
F3	[*Please note any comments from the stove user*]				
F4	[*Interviewer note and observations*:]				

Rural Malawi

AMS IE

Baseline Firewood Consumption Study

For C Quest Capital LLC

HED Consulting Ltd

Project Manager: Kirstie Jagoe

Liz Bates

Jonathan Rouse

With assistance from

CAPS Msukwa and Amulike Msukwa, DeTas, Malawi

FINAL

29 July 2013

HED|Consulting

Household energy & development

hedconsulting.com

Contents

Abbreviations

CI	Confidence interval
CQC	C Quest Capital LLC
HED	HED Consulting
HH	Household
SD	Standard Deviation
SE	Standard Error
PPS	Probability proportional to size

Exchange rate (approximate at time of study)

1 USD=253.9 MWK

Interpreting the statistical tables in this report

Mean values are presented in tables alongside Standard Deviation (SD) (in [square brackets]); standard errors (SE); 90 and 95% confidence intervals (CI); and margin of errors (10 and 5% of the means).

The relationship between the CI and margin of errors is used to indicate the precision of the data as follows:

- precision '90/10' requires the 90% CI to be ≤ 10% margin of error;
- precision '95/5' requires the 95% CI to be ≤ 5% margin of error; and
- precision '95/10' requires the 95% CI to be ≤ 10% margin of error.

Document development record

Date	Content	
30 May 2012	Initial analysis of Malawi data completed and submitted to CQC	KJ
11 December 2012	Further revision made and submission of draft version	KJ JR
15 May 2013	AMS IIE Analysis of dataset completed and report submitted to CQC	KJ JR
21 May 2013	Final draft report submitted to CQC further to comments	JR
23 May 2013	Report submission to CQC further to comments	JR
29 July 2013	Final report submitted to CQC further to comments	JR

Executive summary

This report provides a summary of the results from the baseline study of rural firewood consumption in Malawi, carried out during May 2012. The aims of the survey were to:

- estimate the average amount of firewood used per existing stove per day (kg/stove/day) in rural households (HH);
- account for seasonal variation and multiple stove use;
- investigate the differences in firewood consumption between different locations (i.e. the degree of homogeneity); and
- investigate other factors to validate findings and inform successful implementation.

The results of this study are applicable to AMS IE projects. The study is further to a request from C Quest Capital LLC (CQC).

Methodology

This report describes the sampling methodology; presents the questionnaire and other methods for HH fuel consumption measurement; and outlines analysis of the dataset including QA, data cleaning, assessing variability, and determining the precision of the key outcomes. The annexes present the survey tool used, as well as further detail on some of the key calculations.

The sampling strategy was designed in such a way as to be representative of any different firewood supply, consumption and economic aspects within the proposed area of dissemination of stoves (all of rural Malawi). A literature review and consultation with local partners CAPS Msukwa and Amulike Msukwa suggests that rural per capita wood consumption decreases from north to south (GoM, 2009 p31) in line with wood scarcity[93]. While consumption is similar in the Northern and Central Regions where wood supply is adequate, consumption decreases in the Southern region where wood is relatively scarce. Based on this, the baseline area was considered in two clusters as follows:

i) Northern and Central regions of Malawi where per capita fuel consumption is similar.

ii) Southern region of Malawi, where wood is relatively scarce and per capita wood use is lower.

Rural study samples were identified from each cluster. No locations within the project area have been excluded from the sampling frame.

Results

After cleaning and removal of outliers the unadjusted baseline firewood consumption was estimated at **8.06 kg/per HH/per day**. Two adjustments were made to the daily HH fuel consumption estimates: the first to account for reported seasonal variation in firewood consumption (resulting in an increase of 1.20kg to the baseline); the second to account for the simultaneous use of multiple stoves (resulting in a decrease of 0.62 kg to the baseline data adjusted for seasonal trends).

Other methodological issues were investigated including the prevalence of space heating with the firewood stove but no further adjustments were considered necessary to the data set.

93 Information taken from http://www.ecologyandsociety.org/vol13/iss2/art24/figure3.html

Analysis of the data from all locations concludes that there is no statistically significant difference between them in terms of mean HH firewood consumption, so they may be considered as a single homogeneous cluster. The mean baseline firewood consumption for the combined clusters is **8.64 kg/per stove/per day.**

The conclusions of this AMS IE analysis are slightly different from those of the AMS IIG analysis. This is due to the inclusion of a number of HH excluded from the AMS IIG analysis due to the use of improved stoves. Sections 2.2 and 3.2 describe this in more detail.

The data for these calculations meets the precision requirements of the AMS I.E methodology (90/10) including for homogenous Programme of Activities (PoA) (95/10). The study and analysis were planned and executed to conform to the EB 65 Annex 2 and EB 69 Annex 4 and 5 guidance.

Methods

Roles

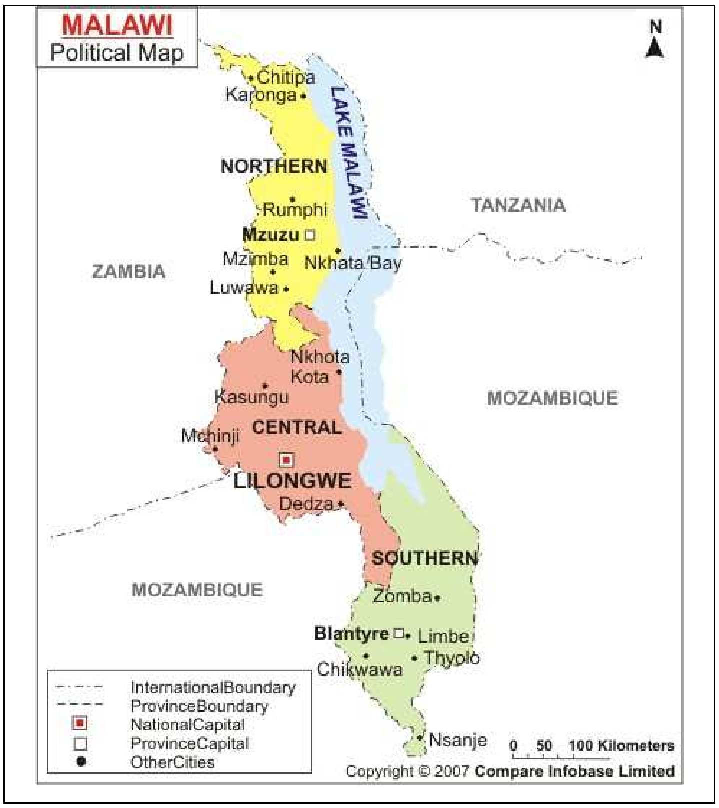
A HED Consulting (HED) team led the planning of this study. Aspects of the study design, such as questionnaire development, were carried out in collaboration with the team from De Tasin Malawi, who also trained and supervised the survey team in Malawi.

Analysis was undertaken using Excel and SPSS 16.0 by HED.

Sampling strategy

Malawi is divided into three administrative regions: Northern, Central and Southern. The following map[94] indicates the area described by this baseline study, which includes the southern region of Malawi shaded green, central (orange) and northern region (yellow).

Figure 1: Administrative regions of Malawi



The sample framework was designed to represent HHs from rural communities within these regions. Rural communities are defined as areas outside of urban boundaries, specifically stating addresses outside of towns and cities of population greater than 4765[95]. Rural areas are characterised by lack of infrastructure such as shops, hospitals, and good roads.

There were no exclusions from the area defined by this baseline.

Defining likely clusters in the baseline area

---

[94] Malawi political map. http://www.mapsofworld.com/malawi/malawi-political-map.html

[95] Citypopulation.de provides a list of cities and towns. The definition of rural excludes all towns with population defined in the data in this website.

Review of the literature suggests that rural per capita wood consumption decreases from north to south (GoM, 2009 p31) in line with wood scarcity[96]. While consumption is similar in the Northern and Central Regions where wood supply is adequate, consumption decreases in the Southern region where wood is relatively scarce. Although there is some variation in precipitation and poverty across Malawi, analysis of these factors concluded that they should not be used as a basis for clustering in Malawi. Section 0 provides further information on the resources and references used for drawing these conclusions.

Based on this evidence two clusters within Malawi were identified as follows:

i) Northern and Central regions where per capita fuel consumption is similar, and

ii) Southern region, where wood is relatively scarce and per capita wood use is lower.

Sampling approach

The study sample was selected using probability proportional to size on the primary unit, i.e. districts. This entailed listing all districts by cluster, listing rural population data, and creating a cumulative population for each cluster. A random number generator was then used to select districts. This takes into account the size of the rural populations in each area, giving more populous areas a higher chance of being selected. The rural population data was taken from http://www.nso.malawi.net/index.php?option=com_content&view=article&id=106&Itemid=6T[97]

A constituency within the selected districts was then selected using simple random sampling.

Attempts were made to minimize the impact of bias associated with non-response. If the HH cook was not available, an appointment was made for the following morning. If they were not available at that time, they were classed as unavailable. Any actual refusals to take part were also documented.

Northern/Central region

District selected: Kasungu (district 3 on the map below). Constituency: Kasungu West

Southern region

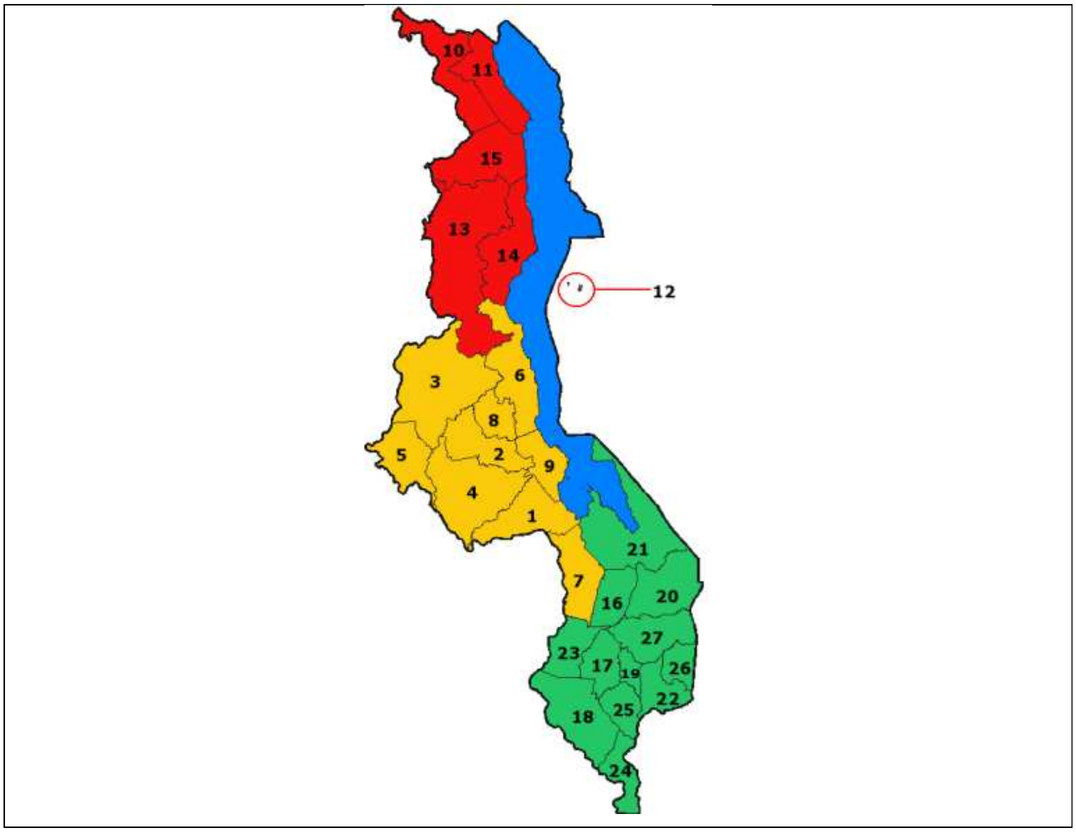
District selected: Thyolo (district 25 on the map below). Constituency: Thyolo East

These districts may be considered representative of their regions and, together, of all of rural Malawi as they have been randomly selected from two clusters each identified by literature review as relatively homogeneous in terms of firewood use and availability, and together representative of the entire country. Section 0 provides further information on the resources and references used for drawing sampling conclusions.

Map showing districts

[96] Information taken from http://www.ecologyandsociety.org/vol13/iss2/art24/figure3.html

[97] This link subsequently broke and the data can now be found at: http://www.nsomalawi.mw/index.php?option=com_content&view=article&id=107%3A2008-population-and-housing-census-results&catid=8&Itemid=6



Each constituency selected contained multiple villages. To remove the potential for bias created by selecting only larger or smaller villages, local advice was taken to identify villages of different sizes within each of these rural communities (i.e. constituencies). No data on populations of villages was found, so this qualitative approach was deemed appropriate.The fieldworkers were requested to sample a minimum of 2 villages in each constituency, using the above approach, until the required sample had been met. In the Northern / Central Cluster 9 villages were visited; in the Southern cluster 8 villages were visited.

The district of Thyolo has a large number of tea and coffee estates, which provide HH fuel for their employees. Provision of free easily accessed fuel could potentially increase the amount used per day. Following data collection, a check of locations of villages sampled was undertaken to establish whether any were located close to the estates and may therefore have been subject to free fuel. The villages included in this study were all located at least 4km from the estates and no estate employees were knowingly interviewed. Therefore the sample should reflect fuel use in homes that procure their fuel using standard methods i.e. buying or procuring fuel themselves.

Methodological implications of household recruitment

To qualify for participation in this survey, HHs were asked 'Is most of your cooking done on a **traditional firewood stove?'**. 'Most cooking' is assumed to have been interpreted by HHs as 'more than half of cooking'. This identified HHs whose main fuel was firewood used on a traditional stove, but did not exclude users of other stoves and fuels, including any 'improved cook stoves' (providing their main stove was traditional). This approach did exclude any primary users of improved wood stoves.

The field team were requested to record 'refusal rates', including those HHs who were unable to answer the qualifying question – i.e. those who did not do most of their cooking

on traditional firewood stove. Only one HH in Nangombe village in Thyolo District was rejected because it was mostly using a *Chitetezo* stove (deemed an improved, non-traditional stove) for cooking. The data collection team confirmed that no other HHs were excluded for this reason. In order to bring this analysis in line with the AMS IE methodology, this excluded HH has been added to the dataset. The dataset thus reflects all HHs encountered during a national survey which primarily cooked on wood, on any kind of stove, in line with the requirements of the IE Methodology. This additional HH accounts for some of the difference between the conclusions of this analysis compared with that of the AMS IIG analysis. Section 3.2 describes this in more detail.

HHs were chosen at random within the villages selected (as per protocol outlined in Section 2.2) and, once it was established that the HH met the inclusion criteria and were willing to participate, the survey was carried out. These protocols are available on request.

Sample size determination

Based on the variance seen using the same approach to measuring daily firewood fuel consumption in other Sub-Saharan African countries to meet the 90/10 precision, the target sample size was 80-90 HH for each cluster in order to give the required resolution to determine heterogeneity or homogeneity. Previous studies in other Sub-Saharan Africa countries, using the same approach to measure daily firewood fuel consumption, gave average variances of 40-45%.

Based on this variance the number of HHs required to meet the 90/10 precision requirements is approximately 60[98]. An additional 20 HHs were added as a contingency in case of missing or unusable data.

Questionnaire development

A questionnaire was developed to explore the many factors that can impact HH firewood use, including seasonal variation; uses of the stove other than for cooking; and use of more than one stove at the same time (see Section 0 for the Final version of questionnaire).

The questionnaire was then piloted in the field, along with the data transcribing and reporting spreadsheet and process. After this, any aspects of the questionnaire that caused confusion and/or failed to collect the correct data were reviewed and edited.

Measurement of firewood

A screening questionnaire was designed to identify HHs that had sufficient fuel available to be able to show one full day's use. HHs were asked 'How much firewood do you use in an average day? Please make a pile for me to weigh'.

Quality control

Local field staff received extensive training on how to administer the questionnaire and were given feedback on the pilot data to ensure that concise, complete data was collected. The team were then supervised daily by a trained field manager. The surveyors were given a field guide describing how to implement the survey and how to collect robust, accurate data.

The questionnaire was piloted as described in Section 0.

Double-entry of data was completed on a randomly selected 10% sample of transcripts. This was compared with the original dataset to identify the frequency and nature of data-entry error.

[98] n = [(90% Z score) * COV/.1)]^2 where z score for 90/10 prescison = 1.65

Analysis

Data checking

There was a minimal rate of refusal – <1% of the total sample – so this would not be expected to have introduced bias (for example, a significant proportion of a certain kind of HH refusing to participate).

Examination of the double-entry data showed that there was 0.6% error in the key variables – i.e. firewood-weighing data. Therefore the data-entry process was deemed accurate.

Contradictory data

Data is analysed to identify contradictory data, for example between reported use of fuels in different sections of the questionnaire. In this dataset, a small number of minor discrepancies were identified between responses to question A1 ('Do you mostly use woodfuel on a traditional fire or stove for cooking in your home?') and section K (which investigates the amount of cooking done with other fuels at this time of year).

Of all HHs that reported wood as being their primary fuel in A1, in section K 42 HHs reported using crop residues for more than half of all cooking. However, because section K is asking specifically about this time of year, while question A1 is intended to reflect the year in general, more weight is given to the response in A1, and so these HHs are retained in the study population. Moreover, including HHs that report higher levels of usage of other fuels would tend to make the baseline estimation more conservative.

Seasonality data from Section S was also analysed alongside responses to question A1 and section K. The majority of HHs that reported currently using crop residues for more than half of all cooking in section K, also reported a seasonal pattern throughout the year that showed wood to be their primary cooking fuel. Only one HH reported using mainly wood in A1, but then the seasonal fuel pattern suggested they used a wide range of fuels throughout the year, which may indicate that wood was not in fact their primary fuel. However, it is possible that the cook's response to A1 is still correct, as wood may indeed be used in *every season* but not as the primary fuel, meaning that *overall throughout the year* it is their most significant single fuel type. This HH represents only around 0.5% of the dataset; removing it would have negligible impact on the dataset, and retaining it would tend to make the baseline estimate more conservative. Therefore the decision was taken to retain this HH in the dataset.

Unadjusted data from all sites

Data from 207 HHs was sent to HED Consulting. Northern/central regions: 104 HHs and Southern region: 103 HHs.

This report presents an analysis of this data set per the AMS IE methodology, for which qualifying HHs primarily use wood on any stove (as opposed to on traditional stoves, per AMS IIG). Therefore, as outlined in section 0, the single HH that failed to qualify to participate in the AMS IIG survey, in Thyolo District has been introduced to the dataset, to make this equivalent to an AMS IE dataset. It now comprises all HHs encountered during the national survey which primarily cooked on wood. Because this single HH was excluded from the survey, no data was collected, and so its wood consumption has been set to the most conservative possible value: 0 kg per day; with an assumption of continuous 2-pot cooking (also the most conservative value for the purposes of adjustment).

13 HH for whom full data was collected (including baseline measures of firewood) were excluded from the AMS IIG dataset because they reported the use of non-traditional wood burning stoves. These HHs were retained for this AMS IE dataset.

Therefore, the total sample size for this study was 208 HHs.

Raw data nationally

The following table presents mean firewood consumption per HH per day from the full raw dataset across all areas. This data has had no outliers removed, nor has it been adjusted in anyway.

Table 3.1: National raw data for mean firewood use (kg /per HH/per day)

	National N=208
Mean [SD]	8.11 [3.27]
SE[99]	0.23
90% CI	0.38
95% CI	0.45
10% mean	0.81
5% mean	0.41

Two HHs were removed from the dataset as their reported daily firewood consumption was deemed to be an unreasonable quantity for daily domestic use (0.47kg and 27.24kg) and therefore seen as not representative of this population.

Table 3.2: National raw data for mean firewood use: outliers removed (kg/ per HH/per day)

	National N=206
Mean [SD]	8.06 [2.95]
SE[100]	0.21
90% CI	0.35
95% CI	0.41
10% mean	0.81

[99] Standard Error (SE) this is the standard deviation of the sample mean and describes its accuracy as an estimate of the population mean. As sample size increases, the estimator is based on more information and becomes more accurate, so its standard error decreases.

5% mean	0.40

Accounting for seasonal changes in amount of firewood used

Purpose of step: to account for HHs using more or less firewood at different times of the year relative to current use.

Each participant was asked what she considered the current season to be and how long it lasted - as well as how long the 'other' seasons lasted. This information was then used to calculate an adjusted daily firewood consumption that takes into account seasonal changes throughout the year (see Section 0 for description of the calculation) (see table 3.3).

Table 3.3: National daily mean HH firewood consumption: adjusted for seasonal trends (kg /per HH/per day)

	National N=206
Mean [SD]	9.26 [3.58]
SE	0.25
90% CI	0.41
95% CI	0.49
10% mean	0.93
5% mean	0.46

The seasonal fuel use adjustment has resulted in an increase in the mean firewood fuel value of 1.2kg/day compared with unadjusted data.

78.0% (n=160) of respondents[101] reported that their main fuel varied according to season. 96.3% **of these** HH used wood as their main fuel in the rainy season, 85.4% in the dry hot season but 68.8% and 67.5% used a combination of wood and crop residues during the post-rainy (current) and cold season respectively (see section 0 for further discussion).

Simultaneous multiple stove use

Purpose of step: to account for HHs currently using more than one stove simultaneously and ultimately to account for occasional continued use of traditional stoves alongside improved stoves.

The questionnaire included a series of questions about the current simultaneous use of more than one stove for cooking. These were designed to establish the proportion of cooking (and therefore firewood consumption) that could be attributed to a single improved stove introduced through an improved cook stove project.

The calculation of the average number of stoves used simultaneously for cooking per family unit took into account the frequency of simultaneous stove use as well as the number of times cooking took place per day. This was compared with the stated number of times HHs

[101] All households in the sample excluding the HH using the *Chitetezo* stove, for which no seasonal data was available. As their baseline consumption has been assumed to be 0 kg/ day, any seasonal variation would make no further reduction on their consumption, so this remains conservative.

cooked (Question C1 from the survey presented in Section 0) to give a fraction adjustment (see Section 0 for full description of this calculation).

Any HH using its stove less than once per week was excluded from this adjustment as the impact of this may be considered negligible.

The HH using the *Chitetezo* stove was included in this analysis, with the data set to the most conservative possible scenario whereby all meals were cooked on two stoves simultaneously every day.

20.87% of the HHs were using two stoves simultaneously at least once per week at the time the study was carried out (see Table 3.4).

Table 3.4: Simultaneous stove use from full dataset

	National N=206
% Using stoves simultaneously > once per week	20.87%
Stoves used per HH/family unit mean [SD]	1.10 [0.25]

Overall the average (mean) number of stoves used simultaneously for cooking per HH unit was approximately 1.10, which equates to a mean adjustment factor to firewood fuel weights of 1/1.10= 0.91.

Note that this mean value is presented to reflect the extent of second stove use but is not applied to B_{old}*mean* to adjust for multiple stove use, but each HH charcoal weight is adjusted individually according to its pattern of multiple stove use. All further steps in analysis use these adjusted daily charcoal fuel weight values. The result is presented in Table 3.5.

Table 3.5: National mean firewood consumption adjusted for seasonal changes and patterns of multiple stove use (kg/per stove/per day)

	National N=206
Mean [SD]	8.64 [3.56]
SE	0.25
90% CI	0.41
95% CI	0.49
10% mean	0.86
5% mean	0.43

This mean value meets the 90/10 and 95/10 precision requirements of the methodology.

The multiple-stove adjustment has resulted in a decrease in 0.62kg/day compared with data adjusted for seasonal trends.

This reduction in mean firewood consumption compared to mean firewood consumption adjusted for seasonal trends is equivalent to an adjustment of:

(Value adjusted for seasons/ value adjusted for seasons and multiple stove use)

= (9.26/8.64) = 1.072, which may be considered an adjustment factor for any calculations concerned with second stove use in the entire sample. This is close to, but slightly different from, the mean number of stoves used simultaneously per HH unit (1.10), as this is applied to mean values; whereas the adjustment factor is applied to individual HHs.

Assessing the difference between regional means

Purpose of step: to establish whether the Malawi baseline needs to be described in a series of discrete clusters due to discernible difference, or whether it may be described as a homogenous area.

An independent T-test was used to determine any statistical significance difference between the estimated means in each of the locations. The 'Southern' location contains the HH using the *Chitetezo* stove (for which 0 kg/day is assumed) (see Table 3.6).

Table 3.6: Mean firewood consumption adjusted for seasonal changes and patterns of multiple stove use by region (kg/per stove/per day)

Region	Mean firewood [SD]
Northern/central (n=103)	8.97 [3.80]
Southern (n=103)	8.31 [3.30]

The P value for difference between regions [p=0.185] showed that there is no evidence that the means significantly differ.

Aggregating data for national mean

Purpose of step: to establish the mean baseline charcoal fuel consumption across the country, and to determine whether this meets the precision requirements of the methodology.

No significant difference was detected between the mean fuel consumptions in each of the two locations. They represent their respective zones (i.e. Northern and Central regions, and Southern region) and therefore collectively represent the entire country, so the mean baseline fuel consumption for Malawi as a whole can be presented as per Table 3.5.

Thus, the mean baseline HH firewood consumption, adjusted for multiple stove use, across the whole of Malawi is 8.64 **kg/day/stove**. Table 3.5 presents the confidence intervals and margins of error, showing that this combined value meets both 90/10 and 95/10 precision requirements.

Key parameters, including stove usage and seasonal variation in fuel consumption will be monitored during the project. An example monitoring questionnaire is presented in Section 0.

Other factors investigated

The questionnaire survey included a number of questions on other aspects of HH energy behaviour, some of which may impact firewood consumption. This section presents the conclusions of analysis of this data (excluding the HH using the *Chitetezo* stove, for which no data on this existed).

Supplementing firewood with crop residues

95.6% of HH supplemented their firewood with crop residues during the season when the survey was carried out. Table 3.7 shows the mean kg/per stove/per day according to the proportion of wood was replaced with crop residues.

Table 3.7: Mean firewood consumption adjusted for seasonal changes and patterns of multiple stove use by crop residue use groups (kg/per stove/per day)

Current use of crop residues as cooking fuel (n=205)	Mean firewood [SD]
None n=9	9.79 [5.30]
<1 meal per week n=27	10.24 [4.30]
A few meals per week n=80	9.32 [3.71]
About half meals per week n=47	7.78 [2.61]
More than half of all cooking n=42	7.24 [2.13]

The P value for difference between groups [p=0.001] showed that there is evidence that the means significantly differ. This is expected and demonstrates that an increase in crop residue use results in a decrease in firewood used.

Although 42 respondents reported *currently* using crop residues for more than half of all cooking, it is recommended that these HHs are retained in the baseline dataset as they stated in response to Question A1 that they primarily used firewood for cooking in their home. Thus it is assumed that the relatively high usage of crop residues in these homes is during the season in which the survey was carried out only.

Moreover, in case ‘primary use of wood in traditional stove or open fire’ is used as a basis for including HHs in the project at future monitoring, it is recommended that these HHs are retained. Including them in the overall dataset also makes the baseline estimate more conservative.

Space heating

7.8% (n=16) of respondents reported using their wood cooking stove for space heating when not cooking during the season when the survey was carried out.

An independent T-test carried out showed that there was no statistically significant difference in the amount of fuel used per stove between the groups who currently space heat (i.e. heat their homes) with their firewood cooking stoves when not using it to cook (mean 9.40kg SD 3.54) and those that do not (mean 8.62kg SD 3.52) (p=0.395).

Conclusion

The use of firewood stoves for space heating may be disregarded as a factor affecting the integrity of the baseline measurement.

Impact of using all of a household’s firewood for weighing

Analysis was carried out to explore whether there is a difference between the mean amount of fuel in those HH which had *all available* firewood weighed and those which had some left in their original wood pile in addition to that weighed. For example, some HHs presented all the wood they had to hand in their home for weighing; others presented a fraction. This section investigates any impact of this on the dataset.

Analysis on national data**,** adjusted for seasonal trends and multiple stove use, showed that the mean firewood use for those HH where all available firewood was weighed was 7.96 kg/day/stove [n=57 SD=2.64] whereas in those HH where there was some firewood remaining in the original firewood pile the mean was 9.07 kg/day/stove [n=148 SD=3.74].

An independent T-test showed this difference to be statistically significant [p=0.01]. It is possible, therefore, that including data from HHs in which all firewood was weighed introduced bias to the mean and reduced it. This may be because if more firewood had been available, it would have been added to the amount indicated. However, it is possible that these are accurate measures, and represent a group of HHs who both keep less wood in their homes, and actually use less.

Conclusion

It is not deemed appropriate to exclude data from HHs in which all available firewood was weighed, even though there appears to be a slight difference in the mean values. This decision to include these HHs makes the dataset conservative.

Comparison of results with other studies

Comparison with HH firewood consumption estimates from Malawi suggests that the baseline estimate presented (**8.64kg/day/stove**,) is a reasonable estimate. The Integrated Biomass Energy Conservation Project – Malawi (Hestian Innovation Ltd 2010 p29) presented estimates of baseline woodfuel consumption to be:

Southern region: **2.56**tonnes/stove/year.

Central region: **3.36**tonnes/stove/year

This study's estimate for the Southern region is as follows:

8.31kg/stove/day

8.31*365=3033.2kg

=**3.03**tonnes/stove/year

And for the Central/ Northern region:

8.97kg/stove/day

8.97*365=3274.1kg

=**3.27**tonnes/stove/year

The HED study estimate for national consumption of **3.154** tonnes/stove/year is also in close agreement with the BEST report (GoM, 2009) which presented a weighted national average of 601.10 per capita/kg/year. Assuming an average HH size of 5 persons[102], each sharing one stove, the BEST study conclusions is equivalent to **3.005** tonnes/stove/year.

[102]Based on the finding of the survey undertaken for this baseline study

References

1. GoM, 2009. *Malawi Biomass Energy Strategy*, Lilongwe: Government of Malawi. P31

2. Integrated Biomass Energy Conservation Project – Malawi Hestian rural innovation Development. Project Design Document Form (GS-VER-PDD) Downloaded from:https://gs2.apx.com/mymodule/ProjectDoc/EditProjectDoc.asp?id1=613

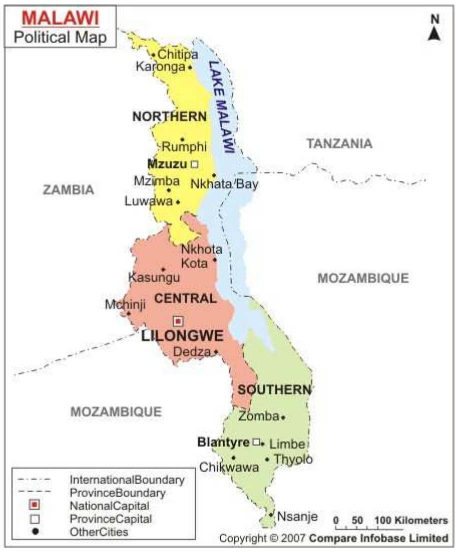
Annexes

Supporting information for sampling approach

Literature review: Patterns in Malawi Household Firewood Consumption

Malawi is divided into three administrative regions: Northern, Central and Southern (Figure 1). While each region is roughly the same size, population is concentrated in the Central (42%) and Southern (46%) regions. Population density increases from north to south as do environmental degradation and wood energy shortages[103].

Figure 1: Malawi political map
http://www.mapsofworld.com/malawi/malawi-political-map.html



Firewood supply and consumption
As a whole, Malawi has an adequate forest base to more than meet its biomass fuel needs. However, much of this supply is in the north of the country and is not accessible to population centers in the center and south of the country. Overall, the Northern region has an abundant supply of wood. Demand in the Central region is 95% of the sustainable supply while the Southern region demand exceeds supply. Urban catchments around Lilongwe and especially Blantyre and Zomba are being harvested unsustainably[104] (Figure 2).

Figure 2: Malawi forest cover, population density, and poverty rateshttp://www.ecologyandsociety.org/vol13/iss2/art24/figure3.html

[103]Government of Malawi.Malawi Biomass Energy Strategy. January 2009.
[104] Ibid.

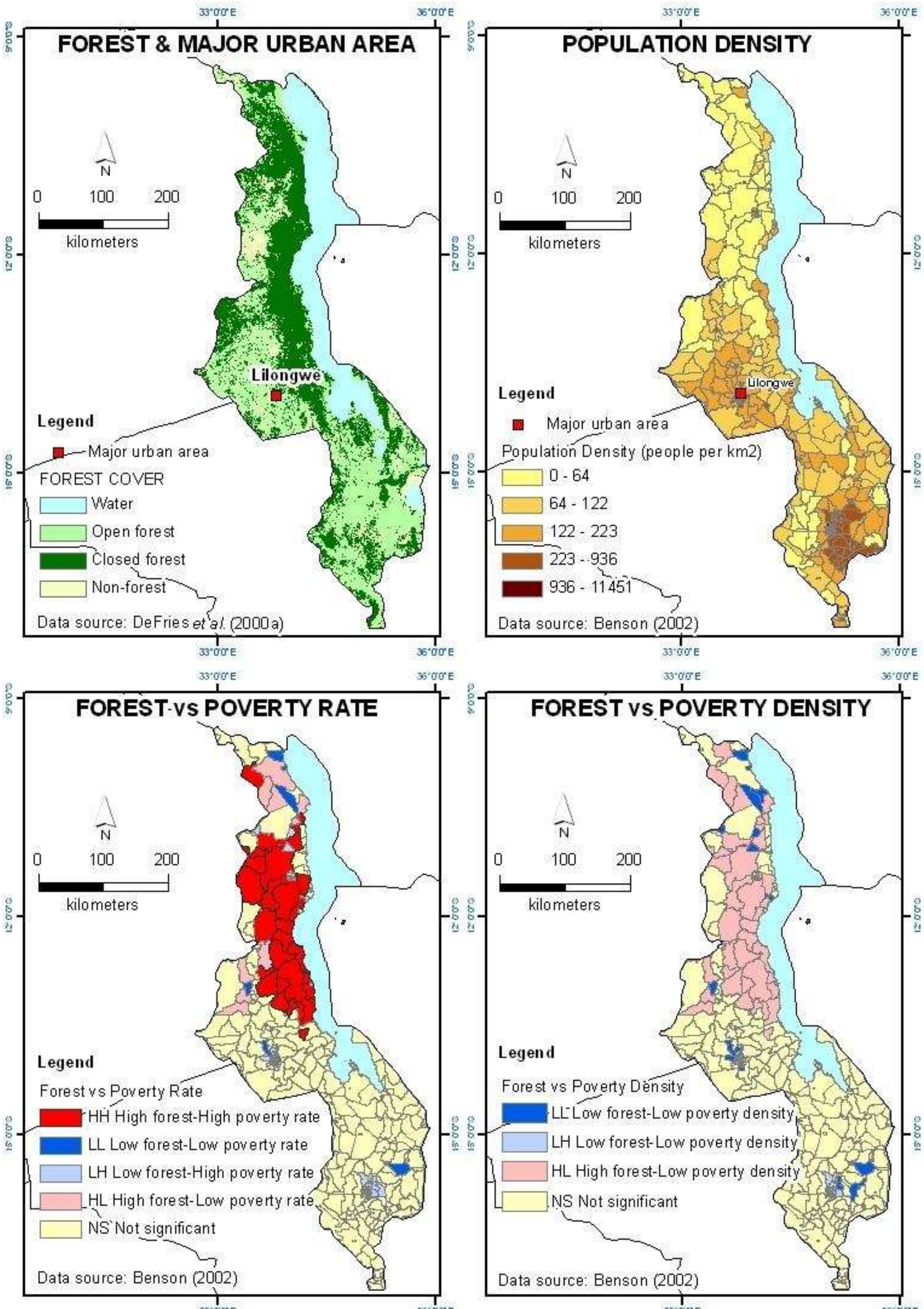


Figure 2 tends to indicate a greater supply of wood fuel in the Northern and Central regions compared with the Southern Region. This is corroborated by other data, for example the World Bank[105] presents a study estimating biomass availability in Malawi from satellite data.

[105]Malawi Poverty and Vulnerability Assessment: Investing in Our Future, World Bank and GOM June 2006 (p37)

It states 'Malawi's forests are mainly in the North region, with 41 percent of the country's biomass, or 159 cubic meters, followed by the Central region with 38 percent of biomass. The South region has the least' - i.e. just 11%.

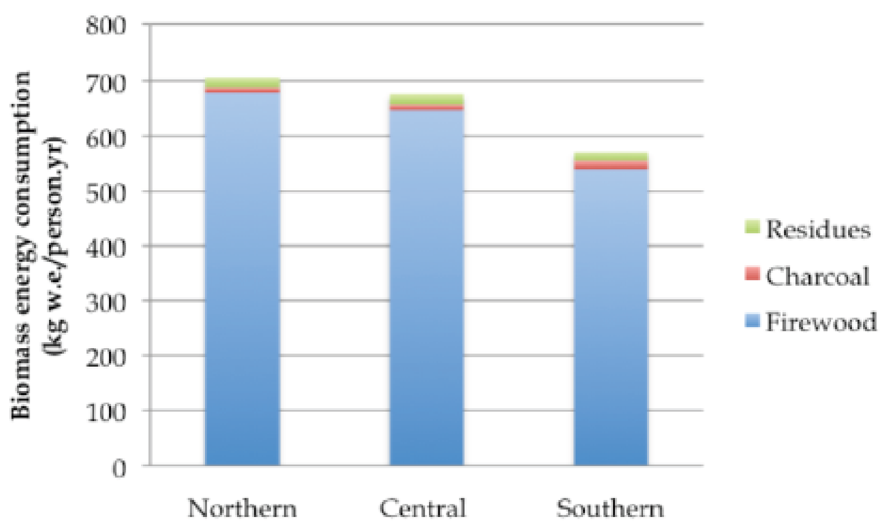
Other data indicates that rural per capita wood consumption decreases from north to south along with wood abundance. While consumption is similar in the Northern and Central Regions where wood supply is adequate, consumption decreases in the Southern region where wood is relatively scarce (Table 1).

Table 1: Rural per capita fuel consumption by region[106]

Region	Wood	Charcoal		Residues		*Total*	
	kg/yr	kg/yr	kg (w.e.)	kg/yr	kg (w.e.)	*kg (w.e.)/yr*	*cu.m.*
Northern	678.56	5.22	9.77	22.44	18.10	*706.43*	*1.06*
Central	646.28	5.93	11.09	23.13	18.65	*676.02*	*1.01*
Southern	538.62	8.92	16.69	18.85	15.20	*570.51*	*0.86*
Weighted average:	***601.10***	***7.21***	***13.49***	***21.10***	***17.02***	***631.61***	***0.95***

Furthermore, the BEST report 2009 corroborates this data, as shown in Figure 3 below.

Figure 3: Rural per capita household consumption of biomass energy by region



(Malawi Biomass Energy Strategy (BEST), Government of Malawi, 2009)

Poverty

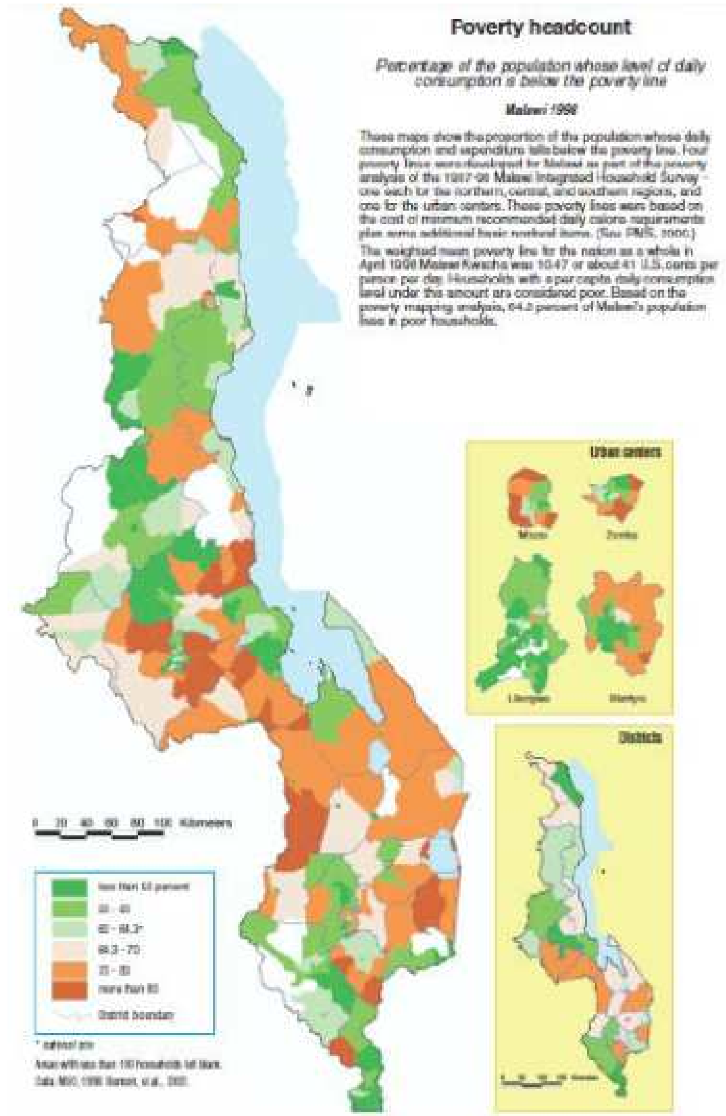
Malawi is among the poorest countries in the world. Out of the 187 countries ranked, the 2011 Human Development Index ranks Malawi number 171[107]. Rural communities are highly dependent on fuelwood. 94% of rural inhabitants cook with wood mostly on open fires.

Figure 4 presents poverty headcount data, showing the which indicate the proportion of the population falling below the poverty line, from less than 50% (green) to more than 80% (dark red).

[106]GoM, 2009.*Malawi Biomass Energy Strategy*, Lilongwe: Government of Malawi. P31

[107]UNDP. Human Development Report 2011.Available at http://hdr.undp.org/en/statistics/hdi/.

Figure 4: Poverty headcount in Malawi



http://www.ifpri.org/sites/default/files/pubs/pubs/cp/malawiatlas/malawiatlas_03.pdf

It is apparent that there is no clear trend in poverty across Malawi, nor clear large geographical areas defined by higher or lower rates of poverty.

Other data indicates a weak trend towards higher rates of poverty in the North and Central regions, compared with slightly wealthier Southern region. Notably:

- More professional and skilled jobs held by men in the South compared with North and Central, with more employed in agriculture in the North and Central regions.
- 7.3 and 6.4% of HHs in the North and Central regions have access to electricity, compared with 11.0% in the Southern region[108].

These data indicate that the North and Central regions tend to share higher levels of poverty, and that the South may be somewhat less poor (though still poor nevertheless).

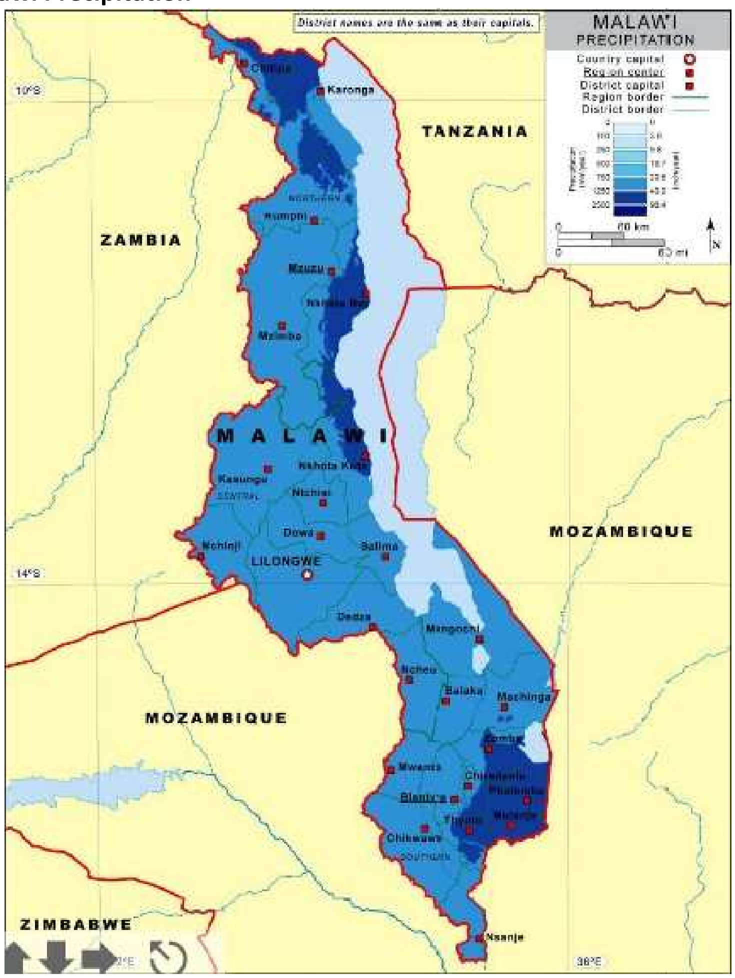
[108] Demographic and Health Survey, Malawi 2010. P35 and 280.

In many sub-Saharan countries one of the most powerful indicators of poverty is fuelwood consumption. These findings corroborate the conclusions drawn about the pattern of usage across Malawi – i.e. higher in the North and Central areas, and lower in the wealthier South.

Climate

Precipitation patterns were also considered for their potential impact on woodfuel consumption in Malawi. However, no evidence was found that rainfall had an impact on biomass consumption habits, and although some areas indicate higher rainfall, there are no distinct wet / arid areas in Malawi. Figure 5 shows precipitation patterns across the country.

Figure 5: Malawi Precipitation



http://www.atozmapsdata.com/zoomify.asp?name=Country/Modern/Z_Malawi_Precip

In light of this, precipitation was not considered a factor for clustering.

Proposed clusters

It is proposed that the primary consideration for clustering should be woodfuel supply and consumption, giving rise to two clusters in Malawi. Precipitation was considered as a basis for clustering, and although some patterns of poverty may be discerned from regional data, these were not strong, though do corroborate the conclusions of the woodfuel supply and consumption.

One Malawi cluster would include the Northern and Central regions where per capita fuel consumption is similar while the Southern region, where wood is relatively scare and per capita wood use is lower, would comprise the second cluster.

These clusters may be considered homogeneous as they represent areas where there is evidence of similar biomass consumption and supply, with no further variation in other factors that may impact on wood fuel consumption.

Malawi Baseline Firewood Consumption Questionnaire

Baseline Fuel Use Assessment: Malawi

- This survey is designed to be administered to the **primary cook** in selected households
- The objective of this survey is find out how much woodfuel is used on the MAIN COOKING STOVE on a daily basis in households
- Please note: Unless stated otherwise, all questions refer to general household cooking during the **present season.**

Italic text in [square brackets] are instructions for fieldworkers. This text should not be read out to respondents.

Bold underlined text should be read out to respondents as well as the questions

[IMPORTANT: *Before starting the survey, please ask the respondent if she/he is the main cook in the family unit. If it is not the main cook, ask to speak to the main cook, and arrange a convenient time when she/he will be available for interview****.]***

Introduction			
READ: Good morning/afternoon, my name is____________. Thank you for making time for us. I am here today to talk to you about your family cooking practices and fuel use. If you agree to participate in this survey, we would like to ask you a few questions; it will take about 25 minutes. There are no 'right' or 'wrong' answers and the information you provide will be very useful to help use improve cooking practices throughout Malawi. All the information will be kept private and your name will not appear anywhere publically. We will however keep it in our records so that we can contact you in future. Do you have any questions?			
F. Participation criteria & participant information			
A1	Do you mostly use **woodfuel on a traditional fire or stove** for cooking in your home?	1=Yes 2=No [*terminate interview*]	
A2	Do you use your household cooking stove to cook commercially (use it in a small enterprise)?	1=Yes [*terminate interview*] 2=No	
A3	Do you agree to participate?	1=Yes 2 = No [*terminate interview*]	
A4	Have you enough wood in your home to show me how much you need to cook for a whole day?	1=Yes 2 = No [*terminate interview*]	
A5	ID number [XX-YY-NN]		
A6	Date of interview [DD/MM/YYYY]		
A7	Start time of interview [Use 24-hour clock]		
A8	Interviewer's name		
A9	Respondent's name		
A10	Respondent's telephone number [if available]		
A11	Region / district		
A12	Group village/local community		
A13	Today's weather [to be adapted to country]	1 = Hot and dry 2 = Hot and wet 3 = Cold and dry 4 = Cold and wet	

		5 = Mixed	

	G. Household structure					
B1	How many people live in your **household** in total?					
B2	Within your **household**, do different family units or groups cook separately (for example in different locations or near each other but using separate fires or stoves			1=Yes 2 = No [*go to B5*]		
B3	How many **family units** live within your household?					
B4	How many people are in your own family unit					
B5	On average, how many people do you usually cook meals for each day, at this time of year?					
	Children 14 year or younger	Female adults 15 years and older	Male adults 15 - 59 years	Male adults 60 years or older	Total [NN] [add up B5_1 to B5_4]	
	B5_1	B5_2	B5_3	B5_4	B5_5	
B6	[Check: Is the total in B5_5 the same as B4?]			1=Yes [Go to C] 2 = No [Ask B7]		
B7	Why is there a difference between your family unit size and the number cooked for? *[Write down everything the respondent says]*					
	C. Cooking					
C1	On average, how many times each day do you use your stove to prepare food for your family?					
C2	What is your <u>main</u> type of <u>woodstove</u> at this time of year? *[use list below]*					**A.**
	Three stone fire 1	ChitetezoMbaula 2	Trad. metal stove 3	Other___________ 4		
	D. Simultaneous stove use for cooking using woodfuel					
D1	Do you ever cook on more than one woodfuel stove **<u>at the same time</u>** <u>at this time of year</u>? *[Make sure the respondent is* ***not simply talking about multiple <u>pots</u>]***			1 = Yes 2 = No [*Go to Section E]*		
D2	Do you do this at least <u>once per week</u>?			1 = Yes 2 = No [*Go to Section E]*		
D3	How many days each week do you use two **<u>woodfuel</u>** fires or stovesat the same time					

D4	How many meals do you use them for on those days?		
D5	During which seasons do you use more than one **woodfuel**fire or stove at the same time for cooking [*include as many seasons as required*]	1. Rainy season 2. Post-rainy season 3. Cold season 4. Dry hot season 5. All year	
	E. Stoves with more than one pot hole		
E1	Do you own a woodstove on which you can cook two dishes at the same time?	1 = Yes 2 = No [go to Section F]	
E2	Do you use both burners at the same time once a week or more?	1 = Yes 2 = No [go to Section F]	
E3	How many days do you use it to cook two dishes in two pots at the same time		
E4	On those days, how many meals do you use it for to cook two dishes in two pots at the same time		
E5	During which seasons do you use this stove to cook two dishes in two pots at the same *time [include as many seasons as required]*	1. Rainy season 2. Post-rainy season 3. Cold season 4. Dry hot season 5. All year	
	F. Space heating		
F1	Do you use a wood fire or woodstove for room heating at **any time of year**?	1 = Yes 2 = No *[Go to Section G]*	
F2	Is it the same stove as you use for cooking	1 = Yes 2 = No *[Go to Section G]*	
F3	Do you use it for heating when not cooking?	1 = Yes 2 = No *[Go to Section G]*	
F4	During which seasons do you use a wood fire or woodstove for room heating? *[include as many seasons as required]*	1. Rainy season 2. Post-rainy season 3. Cold season 4. Dry hot season 5. All year	
	G. Additional uses of fires/stoves		
G1	B. At this time of year do you use **woodfuel** fires or stoves for purposes other than cooking and heating your house at least once per week? C. [*Get the respondent to list all the **other** tasks for which they use **woodfuel** and the frequency of the task. If one or more task is not listed, use boxes G1.4 and G1.5.*		

	No other purpose	1	Heating water	2	Burning incense	3
	Brewing tea	4	Cassava drying	5	Ironing	6
	Roasting	7	Drying meat	8	Other [describe]	9
	D. Use [use coding]			**E. Number of days per week?**		

G1.1	F.	G.
G1.2	H.	I.
G1.3	J.	K.
	L. [Record any other tasks that are not on the list]	
G1.4	M.	N.
G1.5	O.	P.

	L. Woodfuel		
	[This question is very important** – please take time to ensure the question is understood and your measure reflects wood used for the respondents **family unit** in an **average day] **Ask:** How much woodfuel do you use in an **average day**? Please make a pile for me to weigh. [*If the respondent uses a large log over a few days, ask them to pile up the equivalent wood used in a day*]		
J1	[Weight of **woodfuel** including bag or binding *[Include decimal places]*	__ __ __ . __ __**Kg**	
J2	[Weight of bag/binding weighed without the woodfuel]	__ __ __ . __ __**Kg**	
J3	[Did you weigh all the woodfuel available in the household, or was some left besides that weighed?]	1= Weighed all available woodfuel 2= More wood remained	
J4	Do you buy **any** of your woodfuel?	1 = Yes 2 = No *(go to section K)*	
J5	About what proportion of total wood used do you buy at this time of year?	1 = I buy most of my fuel 2 = I buy about half my fuel 3 = I buy a small amount of fuel	
J6	How much do you spend each time you buy **woodfuel**?	MWK	
J7	How many days would this amount of **woodfuel** last	days	
J8	*[Add any other observations that you think are relevant about the woodfuel used by this family]*		

	M. Other fuels
	How much of your cooking is done with the following fuels at this time of year? [*Ask about each fuel in turn and circle the most appropriate response*]

		None	Q. Less than one meal per week	R. A few meals per week	S. About half of all cooking	T. More than half of all cooking
K1	Dung	1	2	3	4	5
K2	Charcoal	1	2	3	4	5
K3	Kerosene	1	2	3	4	5
K4	LPG [gas]	1	2	3	4	5
K5	Crop residues	1	2	3	4	5
K6	Other [*describe]* ______________	1	2	3	4	5

[Check with the respondent that you have discussed all of the fuels the household uses for cooking]

S. Seasonality

Season codes	**Rainy season**	**Post-rainy season**	**Cold season**	**Dry hot season**
	A	**B**	**C**	**D**

S1	How would you describe the current season? *[Read names of seasons from list above and enter code]*	

S2 Ask: **Over which months does each season occur?**

[Mark the calendar below using the letter codes above, putting one letter only in each box – e.g. if rainy season lasts from August to December, put an A in each box for August to December – similarly for each season]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Ask: How do each of these factors change with season compared to the current season?

[If things change, put '1 'in the second column, and fill in the sentences in the third column. If it does not change put '2 'in the second column and do not fill in the third column.]

	Factor	Does it vary? 1=yes 2=no	[IF YES go through all seasons with participants and record how the factors changes]
S3	Number of **people** for whom meals are cooked	S3_1	In Rainy season I usually cook for [.........................S3_2]people In Post-rainy season I usually cook for [...................S3_3]

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			people In Cold Season I usually cook for [..........................S3_4]people In Dry Hot season I usually cook for [....................S3_5] people
S4	Number of **meals** cooked per day	S4_1	In Rainy Season I usually cook [.....................S4_2] meals / day In Post-rainy season I usually cook [................ S4_3] meals / day In Cold season I usually cook [.......................S4_4] meals/ day In Dry Hot season I usually cook [................... S4_5] meals/ day
S5	Main **type of fuel** used for cooking *[use list below]*	S5_1	In Rainy Season the fuel I generally use is [........................S5_2] In Post-rainy season the fuel I generally use is [..................S5_3] In Cold Season the fuel I generally use is[.........................S5_4] In Dry Hot Season the fuel I generally use is [..................... S5_5]

Wood =1	Charcoal=2	Crop residues=3	Kerosene=4
LPG=5	Wood/ crop residues in equal quantities=6		Other=7

S6	[If answered yes to S5_1] Why do you use another fuel to replace wood fuel during other seasons?	1 = Wood to wet to burn 2 = It can be used indoors 3= Wood too expensive/scarce 4= Crop residues are available 5= Other [describe]	

S7

READ using the diagram on separate sheet: **Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.**

*[First **underline** the current season in the column below and circle number 5;*
*THEN circle the number that refers to the amount of woodfuel the participant indicates **for each season**]*

Underline current seasonin column below	**No woodfuel**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much woodfuel**

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S7_1	**Rainy**	1	2	3	4	5	6	7	8	9
S7_2	**Post-rainy**	1	2	3	4	5	6	7	8	9
S7_3	**Cold**	1	2	3	4	5	6	7	8	9
S7_4	**Dry Hot**	1	2	3	4	5	6	7	8	9
	N. Other observations									
N1	Is there anything else you would like to tell us about how you use your fuel for household purposes? [*Write down everything the participants says*]									
	Thank you for your time and help in providing us with this useful information									
N2	*[Write down any observations of your own that you feel would be helpful and relevant]*									

Proportional seasonal fuel change diagram

Baseline fuel Asses

READ: **<u>Here is a diagram showing relative sizes, with the amount of woc</u>**
<u>fuel at all' *[point to the cross]* and this big circle is 'twice as much wood</u>
<u>wood you think you would use in the XXX season [work through all seas</u>

X	○	○	○	
No wood	**Quarter**	**Half**	**Three quarters**	
1	2	3	4	

Calculation of adjustment for seasonal fuel use

The participants were asked ‘How would you describe the current season?’ and ‘When does each season fall in the year?’ This information was used to calculate the length of the current season and the ‘other’ seasons for each participant.

The participants were asked how much firewood they use in the ‘other’ seasons compared to their current use (see question M6.1 in Section 6.2/6.3). Each response provided a fraction related to the current firewood use as per the table below.

Relative amount of firewood	Adjustment fraction
No firewood	0
A quarter of the amount	0.25
Half of the amount	0.5
Three quarters of the amount	0.75
No change	1
A quarter more	1.25
A half more	1.5
Three quarters more	1.75
Double the amount	2

The current daily firewood consumption was multiplied by this fraction to give a daily amount during the ‘other’ seasons.

For example: If the HH currently using 10.08kg of fuel per day reported using a quarter more during the ‘other’ season, the daily fuel consumption for the ‘other’ season was calculated by:

10.08 *1.25= 12.6kg

The overall daily firewood consumption was adjusted to reflect the reported length of the current season and that of the ‘others’. For example, if the participant said the current season was ‘rainy’ and it carried on for 4 months of the year and the ‘other’ season was ‘dry’ which lasted 8 months the following calculation was applied:

((10.08*4) + (12.6*8))/12 = 11.76 kg/day

Calculation of simultaneous stove use

This section outlines the process of gathering and analysing information on simultaneous stove use in Malawi as part of the baseline assessment.

The survey provides the following information:

- average number of meals cooked per week;
- average number of 1 stove meals cooked per week;
- average number of 2 stove meals cooked per week; and
- average number of months per year this occurs.

Using this information and assuming equal amounts of fuel were used on each stove (which is the most conservative approach), the fuel correction factor is calculated as follows:

(2*total meals per week with 2 stoves)+total meal using 1 stove= stove meals

Stove meals/7= stove meals per day

Stove meals per day/number of meals per day= HH mean stoves used /day

Fuel correction factor= 1/ (HH mean stoves used /day)

The table below shows the calculations for various combinations of simultaneous stove use.

Total meals/week	Total meals with 2 stoves /week	Total meals with 1 stove /week	Stove meals total /week	Stove meals/day	HH mean stoves used per day	Fuel correction factor
21	21	0	42	6.00	2.00	0.50
21	18	3	39	5.57	1.86	0.54
21	14	7	35	5.00	1.67	0.60
21	10	11	31	4.43	1.48	0.68
21	7	14	28	4.00	1.33	0.75
21	4	17	25	3.57	1.19	0.84
21	1	20	22	3.14	1.05	0.95
21	0	21	21	3.00	1.00	1.00
14	14	0	28	4.00	2.00	0.50
14	12	2	26	3.71	1.86	0.54
14	10	4	24	3.43	1.71	0.58
14	8	6	22	3.14	1.57	0.64
14	7	7	21	3.00	1.50	0.67
14	4	10	18	2.57	1.29	0.78
14	3	11	17	2.43	1.21	0.82
14	2	12	16	2.29	1.14	0.88
14	0	14	14	2.00	1.00	1.00

Example

Total meals per week: 21   Total 1 stove meals: 17   Total 2 stove meals: 4

Daily HH firewood use: 12.32kg

Calculation

(2*4)+17= 25

25/7= 3.57 stove meals per day

3.57/3 meals per day= **1.19 stoves per day**

1/1.19= a fuel correction factor of 0.84

Therefore a HH with a daily firewood use of 12.32kg would be adjusted to

12.32*0.84 = 10.35kg of firewood used per day per stove.

Any HH reporting simultaneous stove use less than once per week was given a default adjustment factor

of 1.

Example monitoring questionnaire

Stove Use Patterns and Operation Monitoring Survey

Prepared by HED Consulting

	A. Identifying house and cook									
A1	Sales record number / Serial Number of Stove			A2	Village					
A3	Ward			A4	District					
A5	Participant telephone number									
A6	Date of interview [DD/MM/YYYY]									
A7	Start time of interview [Use 24-hour clock]									
A8	Interviewer's name									
A9	Date of stove installation									
	B. Stove use									
B1	Do you still use your '[INSERT INTERVENTION STOVE NAME]' for most cooking tasks?					1=yes 2=no [*go to D1*]				
B2	Visual confirmation of '[INSERT INTERVENTION STOVE NAME]'					1=yes 2=no				
B3	Do you still use your baseline stove					1=yes 2=no [*go to C2*]				
B4	Visual confirmation of baseline stove					1=yes 2=no [*go to C2*]				
	C. Woodfuel Consumption									
C1	How much baseline woodfuel do you use in your baseline stove in an average day? Please make a pile for me to weigh.					___________ kg				
C1_1	READ using the diagram on separate sheet: **<u>Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.</u>**									
C1_2	<u>Underline</u> current season <u>in column below</u>	No woodfuel	Quarter	Half	Three quarters	Current	One & a quarter	One & a half	One & three quarters	Twice as much
C1_3	Rainy	1	2	3	4	5	6	7	8	9
C1_4	Post-rainy	1	2	3	4	5	6	7	8	9
C1_5	Cold	1	2	3	4	5	6	7	8	9
C1_6	Dry Hot	1	2	3	4	5	6	7	8	9
C2	Do you use non-project woodfuel in the '[INSERT INTERVENTION STOVE NAME]'					1=yes 2=no [*go to C4*]				
C3	How much non-project woodfuel do you use in your '[INSERT INTERVENTION STOVE NAME]'in an average day <u>in the current season</u>? Please make a pile for me to weigh.					___________ kg				

C3_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.** *[First **underline** the current season in the column below and circle number 5; THEN circle the number that refers to the amount of woodfuel the participant indicates **for each season**]*									
C3_2	**Underline current season in column below**	**No woodfuel**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much**
C3_3	**Rainy**	1	2	3	4	5	6	7	8	9
C3_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C3_5	**Cold**	1	2	3	4	5	6	7	8	9
C3_5	**Dry Hot**	1	2	3	4	5	6	7	8	9
C4	Do you use renewable biomass supplied by '[INSERT NAME OF CPA IMPLEMENTOR]'						1=yes 2=no [*go to D1*]			
C5	How much renewable biomass do you use in your '[INSERT INTERVENTION STOVE NAME]' in an average day? Please make a pile for me to weigh.						____________ kg			
C5_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.** *[First **underline** the current season in the column below and circle number 5; THEN circle the number that refers to the amount of woodfuel the participant indicates **for each season**]*									
C5_2	**Underline current season in column below**	**No woodfuel**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much**
C5_3	**Rainy**	1	2	3	4	5	6	7	8	9
C5_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C5_5	**Cold**	1	2	3	4	5	6	7	8	9
C5_6	**Dry Hot**	1	2	3	4	5	6	7	8	9
	D. Reasons for stopping use of '[INSERT INTERVENTION STOVE NAME]									
D1	Why do you no longer use the '[INSERT INTERVENTION STOVE NAME]? [*Write down everything the participant says]*									
D2	Which stove do you use as your primary stove now?									
	E. **Stove breakage and repair**									
E1	Since starting to use your '[INSERT INTERVENTION STOVE NAME] stove has anything broken on it?							1=yes 2=no [*go to F1*]		

E2	If yes, please describe what broke [*Write down everything the respondent says*]				
E3	Did you repair the break?		1=yes 2=no		
	F. **Observations and comments**				
F1	[O*bserve the* '[INSERT INTERVENTION STOVE NAME] *and note any signs of recent use or otherwise]*				
F2	[*Please check the stove for all components- enter a 1 if present and if in correct position. Enter a 2 if not.]*	1=yes 2=no		Present	Correct
		[ENTER COMPONENT 1]			
		[ENTER COMPONENT 2]			
F3	[*Please note any comments from the stove user*]				
F4	[*Interviewer note and observations*:]				

Cities in Zambia

AMS IE

Baseline Charcoal Consumption Study

For C Quest Capital LLC

HED Consulting Ltd

Kirstie Jagoe

Liz Bates

***Project lead:* Jonathan Rouse**

With assistance from

Sam Bell, Shared Value Africa

Final

29 July 2013

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Contents

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Acronyms

CI	Confidence interval
CQC	C Quest Capital LLC
HED	HED Consulting
HH	Household
SD	Standard Deviation
SE	Standard Error
SVA	Shared Value Africa

Exchange rate (approximate at time of report)

1 USD= 5,245.50 ZMK

Interpreting the statistical tables in this report

Mean values are presented in tables alongside Standard Deviation (in [square brackets]); standard errors; 90 and 95% confidence intervals (CI); and margin of errors (10 and 5% of the means).

The relationship between the CI and margin of errors are used to indicate the precision of the data as follows:

- precision '90/10' requires the 90% CI to be ≤ 10% margin of error;
- precision '95/5' requires the 95% CI to be ≤ 5% margin of error;
- precision '95/10' requires the 95% CI to be ≤ 10% margin of error.

Document development record

Date	Content	
10April 2012	Initial analysis of data completed and submitted to CQC	KJ
30April 2012	Deeper analysis, including space heating and source of charcoal weighed	JR, LB and KJ
4 May 2012	Preparation of draft report Submission to CQC	JR KJ
14 May2012	Amendments to report following feedback, including multiple-stove adjustment sections	KJ and JR
15 May 2012	Submission of revised final draft report	JR
23 May 2013	Revisions post further comments Submission of final draft report	JR KJ
29 July 2013	Final submitted to CQC addressing further comments	JR

Executive summary

This report provides a summary of the results from the Baseline Study of Charcoal Consumption in Urban Zambia (defined as cities with population greater than 10,000) carried out in three locations during March and April 2012. The aims of the survey were to:

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- estimate the average amount of charcoal used per existing stove per day (kg/stove/day) in urban households (HH);
- account for seasonal variation and multiple stove use;
- investigate the differences in charcoal consumption between different locations (i.e. the degree of homogeneity); and
- investigate other factors to validate findings and inform successful implementation.

The results of this study are applicable to AMS IE projects. The study is further to a request from C Quest Capital LLC.

Methodology

This report describes the sampling methodology; presents the questionnaire and other methods for household fuel consumption measurement; and outlines analysis of the dataset including QA, data cleaning, assessing variability, and determining the precision of the key outcomes. The annexes present the survey tool used, as well as further detail on some of the key calculations.

The sampling strategy was designed in such a way as to be representative of the proposed area of dissemination of stoves. A literature review and consultation with local counterpart Sam Bell[109]revealed that the baseline area (all of urban Zambia) should be considered in two clusters: wet and dry areas. Lusaka was treated as a cluster in its own right; in each of the wet and dry areas one city with population greater than 10,000 was randomly selected using probability proportional to the population size. A small number of locations have been excluded from the sampling frame.

After cleaning and removal of outliers the baseline charcoal consumption was estimated at 2.49 kg/household/day. Two adjustments were made to the daily household fuel consumption estimates: the first to account for reported seasonal variation in charcoal consumption (resulting in an increase of 0.04 kg to the baseline); the second to account for the simultaneous use of multiple stoves (resulting in a decrease of 0.16 kg to the baseline).

Key results

The impact of reported current space heating with charcoal was investigated but this was shown to have no significant effect on the amount of fuel charcoal consumed. The impact of using all of the household's available charcoal for weighing on measured fuel consumption was also investigated but there was found to be no significant difference, and so no adjustments made to the data set.

The mean baseline charcoal consumption for all data, adjusted for seasons and multiple stove use, is 2.37 kg/stove/day. Analysis of the data from individual cities concludes that there is a statistically significant difference between them in terms of mean household charcoal consumption. However, there is not found to be any statistically significant difference between the dry city Livingstone and Lusaka (which also lies in the dry zone); therefore it is proposed that the country is described using two discrete zones: Dry and Wet areas, as follows:

- **Dry areas (Livingstoneand Lusaka data): 2.49kg/day/stove**
- **Wet areas (Chingola data): 2.11kg/day/stove**

The data for these calculations meets the precision requirements of the AMS IE methodology (90/10; 95/10 but not 95/5). The study and analysis were planned and executed to conform to the EB 65 Annex 2 and EB 69 Annex 4and 5 guidance.

[109]Of Shared Value Africa (SVA) Zambia (http://www.sharedvalueafrica.com)

Methods

Roles

A HED Consulting (HED) team led the planning of this study. Aspects of the study design, such as identification of study locations and questionnaire development, were carried out in collaboration with the team from Shared Value Africa (SVA) Zambia, who also trained and supervised the survey team in Zambia.

Analysis was undertaken using Excel and SPSS 16.0 by HED.

Sampling strategy

The following map[110] indicates the area described by this baseline study, which includes all cities with population greater than 10,000 in Zambia.

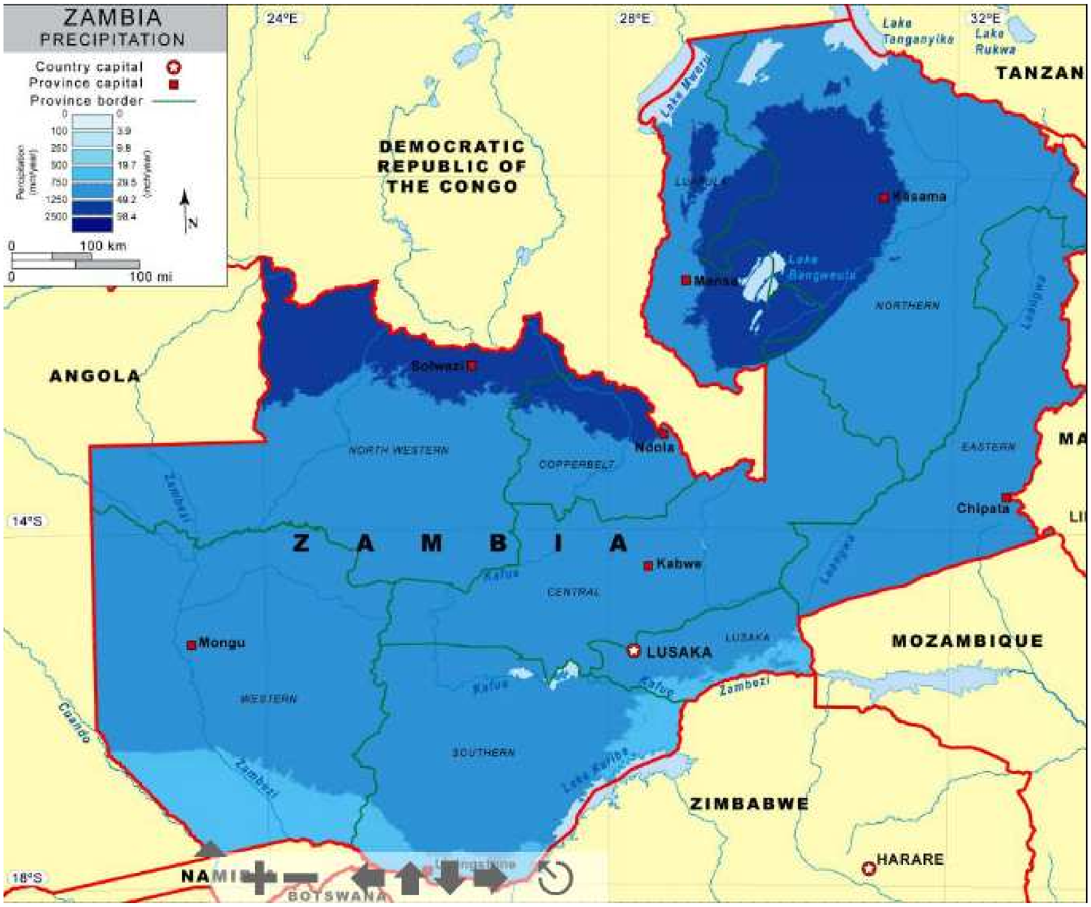
Exclusions from the area defined by this baseline are the city of Petauke in Eastern province as on arrival it was found that most HH used firewood for cooking, and neighborhoods in Livingstone (Zambezi (AKA Dambwa central), Kariba, Lizuma and Akapelwa) in which electricity is mainly used.

Defining likely clusters in the baseline area

Literature indicated that climate was a likely determinant of variation in baseline charcoal consumption, most likely due to the impact temperature and precipitation may have on space heating requirements,

[110] Map source: http://www.ezilon.com/maps/africa/zambia-maps.html

as well as other possible factors including quality and moisture content[111] of charcoal itself (Nyembe 2011 p32).The areas considered rainy are shown in the following map[112].



There is some evidence of a link between poverty and charcoal consumption: a study carried out in Zambia 2007-2008 showed per capita charcoal consumption was highest in the low income group and lowest in the high income (Nyembe 2011 p32). However, the difficulty of differentiating between income groups at point of sale meant that this was not considered a viable basis for clustering.

Therefore, evidence of the link between precipitation and charcoal consumption formed the basis for the clustering within the project area. A random sampling approach of wards/ neighbourhoods, as well as household identification, was also employed to ensure that the breadth of the socio-economic groups were represented within the sample.

Sampling approach

The study sample was selected using probability proportional to size on the primary unit (cities within a cluster, then the area of the city where that data was available). This takes into account the different populations in each area, giving more populous areas a higher chance of being selected. For all random and 'population proportional size' sampling steps below, a random number generator[113] was used.

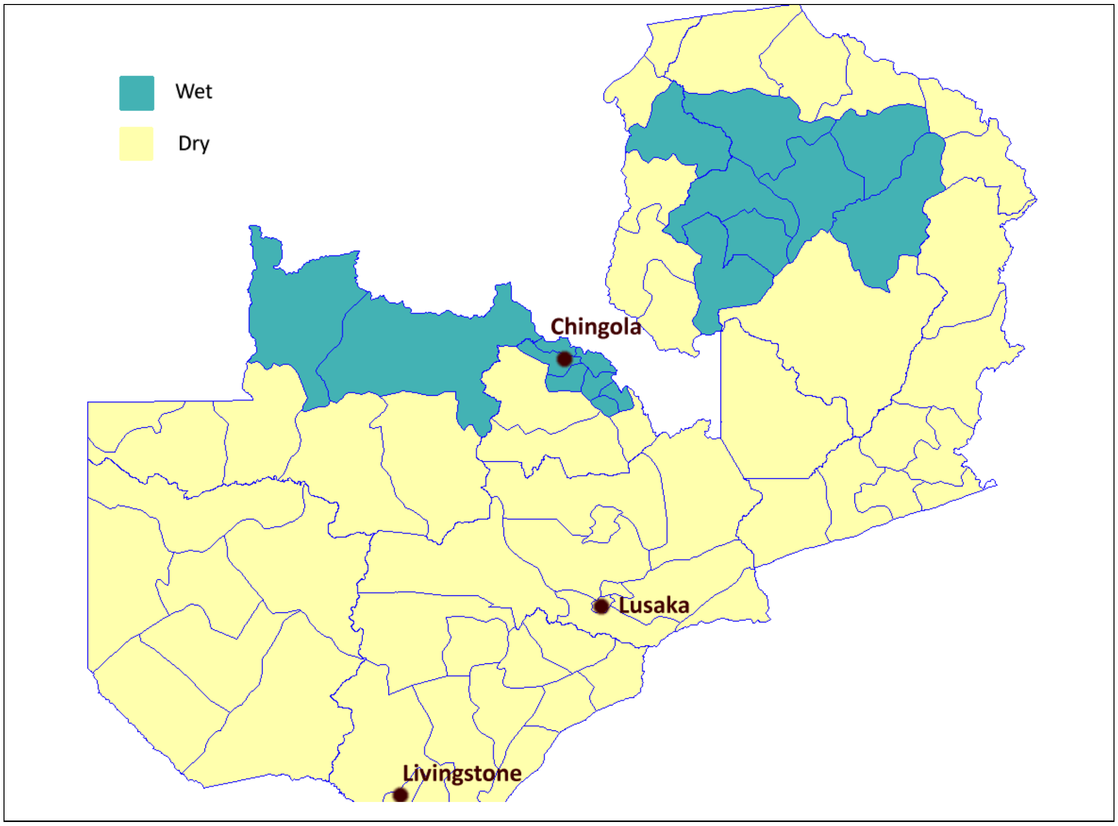
---

[111] The impact of precipitation on the quality and moisture content of charcoal is simply hypothesis for why the evidence indicates that precipitation has an impact on charcoal consumption. No evidence was found indicating that quality or moisture content of charcoal varied across the project area or should be accounted in clustering decisions.

[112] Map source: http://www.bestcountryreports.com/Precipitation_Map_Zambia.php

[113]www.random.org

Using a combination of Wikipedia and citypopulation.de[114] towns and cities with populations greater than 10,000 were divided into wet and dry areas (as defined in the map below) and a population-proportional sample was drawn from each cluster. The map also shows the final locations of the study locations. Section0 provides further resources and references used for sampling.



Attempts were made to minimize the impact of bias associated with non-response. If the household cook was not available, an appointment was made for the following morning. If they were not available at that time, they were classed as unavailable. Any actual refusals to take part were also documented.

Lusaka

As the biggest urban centre in Zambia, and a likely significant market for charcoal stoves, Lusaka was treated as an individual cluster. Two constituencies were randomly selected, and from each one ward was selected, as follows:

1. Kanyama: ward Kanyama
2. Munali: ward Chainda.

As per the Sampling approach outlined above, cities and neighbourhoods within the following areas were identified using a random number generator using probability proportion to size of population.

Wet area

The wet-area city selected was Chingola (pop 180k); from which neighbourhoods Soweto and Kasompe were sampled using simple random sampling.

Dry area

The dry area city selected was Petauke (pop 21k). However, on further investigation this was found to

[114] www.citypopulation.de/Zambia.html

have few charcoal users and so was excluded from the sample for this study, and a new city was sampled. This was Livingstone (pop 137k). The wards of South Dambwa and Namatama were selected for surveying.

Household recruitment

To qualify for participation in this survey, households were asked 'Is most of your cooking done on a **charcoal stove?'** 'Most cooking' is assumed to have been interpreted by HHs as 'more than half of cooking'. In line with the requirements of AMS IE methodology, this identified HH whose main fuel was charcoal, but did not exclude users of other fuels, and ensured the sample frame included users of the full range of stoves, including any 'improved cook stoves'[115].

Sample size determination

Based on the variance seen using the same approach to measuring daily charcoal fuel consumption in other Sub-Saharan African countries to meet the 90/10 precision, the target sample size was 90 HH for each city in order to give the required resolution to determine heterogeneity or homogeneity.

Questionnaire development

A questionnaire was developed to explore the many factors that can impact HH charcoal use, including seasonal variation; uses of the stove other than for cooking; and use of more than one stove at the same time (see Section0 Final version of questionnaire).

The questionnaire was then piloted in the field, along with the data transcribing and reporting spreadsheet and process. After this, any aspects of the questionnaire that caused confusion and/or failed to collect the correct data were reviewed and edited.

Measurement of charcoal

Households were asked 'How much charcoal do you use in an average day? Please make a pile for me to weigh'. In case the respondent did not have sufficient charcoal to demonstrate a full day's amount, the fieldworkers offered a bag of 'fieldwork charcoal' for them to use. It was made clear that this charcoal would be collected and removed at the end of the survey, and was not mixed with household charcoal.

Quality control

Local field staff received extensive training on how to administer the questionnaire and were given feedback on the pilot data to ensure that concise, complete data was collected. The team were then supervised daily by a trained field manager. The surveyors were given a field guide describing how to implement the survey and how to collect robust, accurate data.

The questionnaire was piloted as described in Section 2.4.

Double-entry of data was completed on a randomly selected 10% sample of transcripts. This was compared with the original dataset to identify the frequency and nature of data-entry error.

Analysis

Data checking

There was a minimal rate of refusal – <10% of the total sample – so this would not be expected to have introduced bias (for example, a significant proportion of a certain kind of household refusing to participate).

Examination of the double-entry data showed that there was less than 5% error in the key variables – i.e. charcoal-weighing data. Therefore the data-entry process was deemed accurate.

[115] In fact no households were found to use any form of improved/modified wood burning stove, and so the sample and the conclusions of this report may be applied legitimately to either AMS IIG or IE methodologies.

Raw data from all sites

A total of 280 households were interviewed from three study sites.

Study location	Number HH surveyed
Lusaka	92
Livingstone	103
Chingola	85[116]

National unadjusted data

One household was removed from the dataset as their value for daily charcoal amounts was implausible and clearly an error (21kg/per day). This left a total of 279 households.

The following table presents mean charcoal consumption from the full raw dataset across all areas. This data has not been adjusted in anyway.

[116] The number sampled here was slightly short of the intended minimum sample size of 90, determined through precedents of other studies. The reason for this was that data was analysed on a 'real-time' basis and when the team had interviewed 85 households, the required precision had been met. Therefore, they were not required to return to the field.

Table 3.1: National raw data for mean daily charcoal fuel use(kg/per household/per day)

	National N=279
Mean [SD[117]]	2.49 [1.03]
SE[118]	0.06
90% CI	0.10
95% CI	0.12
10% mean	0.25
5% mean	0.12

No further outliers were removed from the dataset.

Accounting for seasonal changes in amount of charcoal fuel used

Purpose of step: to account for households using more or less charcoal at different times of the year relative to current use.

Seasonal adjustment

All households except one cooked mainly with charcoal throughout the year and 60.2% reported that they did not change the amount they used.

The participants were asked to describe the quantities of charcoal that they used each month according to number of small bags of charcoal they used each day and how long a large bag would last. This information was then used to calculate an adjusted daily charcoal fuel consumption that takes into account seasonal changes throughout the year (see Section 5.3 for description of the calculation) (see table 3.2).

Table 3.2: National daily mean HH charcoal fuel consumption: adjusted for seasonal trends

	National N=279
Mean [SD]	2.53 [1.03]
SE	0.06
90% CI	0.10
95% CI	0.12
10% mean	0.25
5% mean	0.13

[117] The standard deviation is the magnitude of the distribution of the data around the mean.

[118] Standard Error (SE) this is the standard deviation of the sample mean and describes its accuracy as an estimate of the population mean. As sample size increases, the estimator is based on more information and becomes more accurate, so its standard error decreases.

The seasonal fuel use adjustment has resulted in an increase in the mean charcoal fuel value of 0.04kg/day compared with unadjusted data.

Simultaneous multiple stove use

Purpose of step: to account for households using more than one stove at once, and ultimately to account for occasional continued use of traditional stoves alongside improved stoves

The questionnaire included a series of questions about the simultaneous use of more than one stove for cooking. These were designed to establish the proportion of cooking (and therefore charcoal fuel consumption) that could be attributed to a single improved stove introduced through an improved cookstove project.

The calculation of the average number of stoves used simultaneously for cooking per family unit took into account the frequency of simultaneous stove use as well as the number of times cooking took place per day. This was compared with the stated number of times households cooked (Question C1 from the survey presented in Section 0) and then adjusted for any seasonal changes in multiple stove use patterns to give a fraction adjustment (see Section 0 for full description of this calculation) .

Any household using its stove less than once per week was excluded from this adjustment as the impact of this may be considered negligible.

Table 3.3: Simultaneous stove use from full dataset

	National N=279
% Using stoves simultaneously > once per week	37.6%
Stoves used per HH/family unit mean [SD]	1.08 [0.15]

Overall the average (mean) number of stoves used simultaneously for cooking per household unit was approximately 1.08, which equates to a mean adjustment to charcoal fuel weights of 1/1.08 = **0.93**.

Note that this mean value is presented to reflect the extent of second stove use but is not usedto adjust baseline fuel consumption for multiple stove use; rather, each household charcoal weight is adjusted individually according to its individual pattern of multiple stove use. All further steps in analysis use these adjusted daily charcoal fuel weight values. The result is presented in Table 3.4.

Table 3.4: National mean charcoal fuel consumption adjusted for seasonal changes and patterns of multiple stove use (kg/per stove/per day)

	National N=279
Mean [SD]	2.37 [0.95]
SE	0.06
90% CI	0.10
95% CI	0.12
10% mean	0.24

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5% mean	0.12

The multiple-stove adjustment has resulted in a decrease of 0.16kg/day compared with data adjusted for seasonal trends. This mean value meets the 90/10 and 95/10 precision requirements of the methodologies.

This reduction in mean charcoal consumption compared to mean charcoal consumption adjusted for seasonal trends is equivalent to an adjustment of

(Value adjusted for seasons/ value adjusted for seasons and multiple stove use)

= (2.53/2.37) = 1.068, which may be considered an adjustment factor for any calculations concerned with second stove use in the entire sample. This is close to, but slightly different from, the mean number of stoves used simultaneously per household unit (1.08), as this is applied to mean values; whereas the adjustment factor is applied to individual households.

Assessing the difference between region means

Purpose of step: to establish whether the Zambia baseline needs to be described in a series of discrete clusters due to discernible difference, or if it may be described as a homogenous area.

An ANOVA test was used to determine any statistical significance difference between the estimated means in each of region. The P value for difference between regions [p=0.01 ANOVA] showed that there is compelling evidence that the means between locations are significantly different.

Table 3.5: Mean charcoal fuel consumption adjusted for seasonal changes and patterns of multiple stove use (kg/per stove/per day) by study location

	Lusaka	Livingstone	Chingola
Mean	2.47	2.50	2.11
SD	1.2	0.89	0.58
SE	0.13	0.09	0.06
90%	0.21	0.15	0.10
95%	0.25	0.18	0.12
10% mean	0.25	0.25	0.21
5% mean	0.12	0.13	0.11
	n=91	n=103	n=85

Chingola has a lower mean daily charcoal consumption (kg/per stove/per day) compared to the other sites. Further tests were carried out to investigate if the locations other than Chingola could be described as a homogenous area. ANOVA showed that there was no statistically significant difference between the mean per day/per-stove consumption in Lusaka and Livingstone (p=0.885). As these both lie in the dry area defined during sampling, it is proposed that they be combined, as in the following tables which present data by cluster:

Table 3.6: National daily mean HH charcoal fuel consumption: adjusted for seasonal trends

	DRY AREAS Lusaka & Livingstone N=194	WET AREAS Chingola N=85
Mean [SD]	2.64 [1.12]	2.28 [0.74]
SE	0.08	0.08
90% CI	0.13	0.13
95% CI	0.16	0.16
10% mean	0.26	0.23
5% mean	0.13	0.11

Table 3.7: Simultaneous stove use with in the wet and dry areas

	DRY AREAS Lusaka & Livingstone N=194	WET AREAS Chingola N=85
% Using stoves simultaneously > once per week	35.6%	42.4%
Stoves used per HH/family unit mean [SD]	1.07 [0.13]	1.10 [0.18]

Table 3.8: Mean charcoal fuel consumption adjusted for seasonal changes and patterns of multiple stove use (kg/per stove/per day) for DRY area (Lusaka and Livingstone combined) and WET area (Chingola)

	DRY AREAS Lusaka & Livingstone N=194	WET AREAS Chingola N=85
Mean [SD]	2.49 [1.05]	2.11 [0.58]
SE	0.08	0.06
90% CI	0.13	0.10
95% CI	0.16	0.12
10% mean	0.25	0.21
5% mean	0.12	0.11

In summary, although three discrete locations were chosen for this baseline study, the analysis indicates that the country may be treated as two clusters, broadly defined as rainy and dry, as demarcated on the map in Section0.

Key parameters, including seasonal variation in fuel consumption will be monitored during the project. An example monitoring questionnaire is presented in Sections 0.

Other factors investigated

The questionnaire survey included a number of questions on other aspects of household energy behaviour, some of which may impact charcoal fuel consumption. This section presents the conclusions of analysis of this data.

Space heating

28.7% of respondents reported using their charcoal cooking stove for space heating when not cooking (27.5% Lusaka, 19.4% Livingstone 44.7% Chingola).

An independent T-test carried out showed that there was no statistically significant difference in the amount of fuel used per stove between the groups who currently space heat with their charcoal cooking stoves when not using it to cook (mean 2.37 SD 0.99) and those that do not (mean 2.37 SD 0.94) ($p=0.966$).

Conclusion

The use of charcoal stoves for space heating may be discounted as a factor affecting the integrity of the baseline measurement.

Impact of using all of a household's charcoal for weighing

Analysis was carried out to explore if there is a difference between the mean amount of fuel in those HH which had *all available* charcoal weighed, those which had some left in addition to that weighed and those in which the study charcoal was used to weigh the estimated daily amount used.

Analysis on national data**,** adjusted for seasonal trends and multiple stove use, showed that the mean charcoal fuel use for those HH where all available charcoal was weighed was 2.53 kg/day/stove [n=29 SD=1.46] whereas in those HH where there was some charcoal remaining in the original charcoal pile the mean was 2.30 kg/day/stove [n=104 SD=0.78] and HH where the study charcoal was used to approximate the daily consumption was 2.40 kg/day/stove [n=143 SD=0.95].

An ANOVA showed no statistically significant difference between these estimates of daily charcoal consumption [$p=0.462$].

Conclusion

Therefore although households in which all charcoal was used reported higher charcoal usage, as there is no statistical difference between the data, and no obvious explanation for this, it is not considered grounds for any adjustment or exclusion of data.

References

1. Nyembe, Misheck. *An Econometric Analysis of Factors Determining Charcoal Consumption by Urban Households: The case of Zambia.*Master's Programme Degree Thesis No. 641, Swedish University of Agricultural Sciences, Department of Economics, 2011.

Annexes

Supporting information for sampling approach

Literature review: Patterns in Zambia Household Charcoal Consumption

Summary

Review of the literature identified two factors that may affect the way in which HH use their charcoal to meet their household energy – rainfall and poverty.

1. Poverty

In a study carried out in Zambia 2007-2008 per capita charcoal consumption was shown to be highest in the low income group and lowest in the high income (Nyembe 2011 p32).

Provinces seem to break down into 4 wealth bands of which the middle two could be combined (CSO et. al. 2009 p30):

1. Wealthiest: Copperbelt and Lusaka
2. High middle: Central and Luapula
3. Low middle: Northern, North-Western, Southern
4. Poorest: Eastern and Western

Other poverty indicators such as educational attainment, is also highest in Lusaka and Copperbelt and lowest in Eastern and Western.

Table 2.11 Wealth quintiles

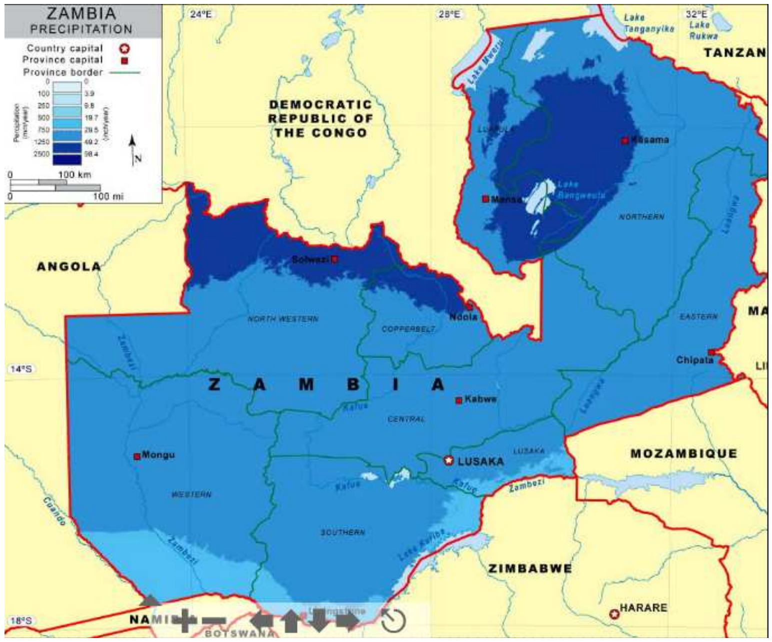
Percent distribution of the de jure population by wealth quintiles, according to residence and province, Zambia 2007

Residence/region	Wealth quintile					Total	Number of population
	Lowest	Second	Middle	Fourth	Highest		
Residence							
Urban	0.1	0.5	5.8	40.3	53.4	100.0	12,457
Rural	31.0	30.8	27.9	8.8	1.5	100.0	22,523
Province							
Central	17.6	24.1	27.9	21.5	8.9	100.0	3,450
Copperbelt	3.4	4.9	7.8	35.8	48.1	100.0	5,676
Eastern	44.8	23.8	15.8	12.5	3.0	100.0	5,216
Luapula	8.8	32.1	43.0	12.0	4.1	100.0	2,811
Lusaka	1.6	2.0	5.5	33.5	57.5	100.0	4,817
Northern	24.7	31.8	27.4	9.8	6.3	100.0	5,044
North-Western	21.7	37.3	28.2	9.9	2.8	100.0	2,023
Southern	21.9	14.8	29.0	22.0	12.3	100.0	3,610
Western	45.2	32.3	12.6	5.7	4.2	100.0	2,333
Total	20.0	20.0	20.0	20.0	20.0	100.0	34,980

Although there is evidence that poverty has a bearing on charcoal consumption, this is discounted as a basis for clustering because there is no clear way of differentiating between income groups at the point of sale.

2. Climate

There is evidence that charcoal consumption and its expenditure by households are higher in the rainy season than in the dry season (Nyembe 2011 p32). The following map clearly shows the differences in rainfall across Zambia.



Map source: http://www.bestcountryreports.com/Precipitation_Map_Zambia.php

Temperature data indicates that the warmest province is Eastern followed by Western, Lusaka and the northern sections of Northern and Luapula. The rest of the country is cooler. No evidence was found of a link between temperature and charcoal consumption, and this was discounted as a basis for clustering.

Source: http://www.bestcountryreports.com/Temperature_Map_Zambia.php

References

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1. Central Statistical Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia, and Macro International Inc. *Zambia Demographic and Health Survey 2007.* CSO and Macro International Inc, 2009.

2. Nyembe, Misheck. *An Econometric Analysis of Factors Determining Charcoal Consumption by Urban Households: The case of Zambia.* Master's Programme Degree Thesis No. 641, Swedish University of Agricultural Sciences, Department of Economics, 2011.

Zambia Baseline Charcoal Consumption Questionnaire

Baseline Fuel Use Assessment: Zambia

Designed by HED Consulting March 2012

- This survey is designed to be administered to the primary cook in selected households
- The objective of this survey is find out how much charcoal is used by the MAIN stove on a weekly basis in households
- Please note: Unless stated otherwise, all questions refer to general household cooking during the present season.

Italic text in [square brackets] are instructions for fieldworkers. This text should not be read out to respondents.
<u>Bold underlined text should be read out to respondents as well as the questions</u>

[IMPORTANT: *Before starting the survey, please ask the respondent if she/he is the main cook in the family unit. If it is not the main cook, ask to speak to the main cook, and arrange a convenient time when she/he will be available for interview****.]***

Baseline Fuel Use Assessment: SVA Zambia

H. Introduction

READ: Good morning/afternoon, my name is ____________. Thank you for making time for us. I am here today to talk to you about your family cooking practices and fuel use. If you agree to participate in this survey, we would like to ask you a few questions; it will take about 25 minutes. There are no 'right' or 'wrong' answers and the information you provide will be very useful to help use improve cooking practices throughout Zambia All the information will be kept private and your name will not appear anywhere publically. We will however keep it in our records so that we can contact you in future. Do you have any questions?

A1	Is most of your cooking done on a **charcoal stove?**	1=Yes 2=No [*terminate interview*]	
A2	Do you use your household cooking stove to cook commercially (use it in a small enterprise)?	1 = Yes[*terminate interview]* 2 = No	
A3	Do you agree to participate?	1 = Yes 2 = No [*terminate interview*]	
A4	Do you have a day's worth of charcoal in your home?	1 = Yes 2 = No	
A5	ID number [XX-YY-NN]		
A6	Date of interview [DD/MM/YYYY]		
A7	Start time of interview [Use 24-hour clock]		
A8	Interviewer's name		
A9	Respondent's name		
A10	Respondent's telephone number [if available]		
A11	Name of town/city		
A12	Name of compound/suburb		

A13	Today's weather			1 = Hot and dry 2 = Hot and rainy 3 = Cold and dry 4 = Cold and rainy 5 = Mixed		
	I. Household structure					
B1	How many people live in your household in total?					
B2	Within your household, do different family units or groups cook separately (for example in different locations or near each other but using separate fires and pots?)				1=Yes 2=No [*go to B5*]	
B3	How many family units live within your household?					
B4	How many people are in your own family unit?					
B5	On average, how many people do you usually cook meals for each day, at this time of year? *[put '0' if none]*					
	Children 14 year or younger	Female adults 15 years and older	Male adults 15 -59 years	Male adults 60 years or older	Total [NN] *[add up B5_1 to B5_4]*	
	B5_1	B5_2	B5_3	B5_4	B5_5	
B6	Is there a difference between your family unit size and the number cooked for?			1 = Yes 2 = No [Go to C]		
B7	Why is there a difference between your family unit size and the number cooked for? [*Write down everything the respondent says]*					
	J. Cooking					
C1	On average, how many times each day do you use your stove to prepare food for your family?					
C2	What is the <u>main</u> type of charcoal stove that you use at this time of year?	1= Small round brazier 2= Medium round brazier 3= Large round brazier 4 =Rectangular Brai 5= Other traditional stove [please describe] 6= 'improved stove' [please describe fully and give name if known]				
	K. Simultaneous stove use for cooking using charcoal					

D1	Do you ever cook on more than one **charcoal** stove **at the same time** at this time of year? *[Make sure respondent is **not simply talking about multiple pots**]*	1 = Yes 2 = No [*go to Section E]*	
D2	Do you do this at least once per week?	1 = Yes 2 = No [*go to Section E]*	
D3	How many days each week do you use two **charcoal** stoves at the same time		
D4	How many meals do you use them for on those days?		

D5	During which months do you use more than one **charcoal** stove at the same time for cooking?												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year

	L. Stoves which can cook more than one dish at once		
E1	Do you own a charcoal stove on which you can cook two dishes in two pots at the same time?	1 = Yes 2 = No [go to Section F]	
E2	Do you cook two dishes in two pots at the same time on this stove at least **once per week**?	1 = Yes 2 = No [*Go to Section F]*	
E3	How many **days** each week do you use the **charcoal**stove to cook two dishes at the same time?		
E4	On those days, how many **meals** do you use it for to cook food in two pots at the same time?		

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E5	During which seasons do you use this stove to cook two dishes in two pots at the same time?	1= Wet seasons 2= Dry warm season 3= Dry cold season 4= All year	All year

	F. Space heating		
F1	Do you use a charcoal stove for room heating at **<u>any time of year</u>**?	1 = Yes 2 = No *[Go to Section G]*	
F2	Is it the same stove as you use for cooking?	1 = Yes 2 = No *[Go to Section G]*	
F3	Do you use it for heating **<u>when not cooking</u>**?	1 = Yes 2 = No *[Go to Section G]*	

F4 During which months do you use a charcoal stove for room heating? [*Mark the calendar below using 1 for each month the HH uses a **charcoal stove** for heating their homes]*

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year

	H. Additional uses of fires/stoves		
G1	**<u>Other than for cooking (and heating your house</u>**), what are the **<u>three main purposes</u>** for which you use a **<u>charcoal</u>** stove more than once per week in this current season? [*Ask the respondent to list all the **other** tasks for which they use **<u>charcoal</u>**, and the frequency of the task. If a task is not is not listed, record '20' in the box, and write in the 'other task*]		
	1= No other purpose	2= Water heating for bathing	3= Burning incense

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	4= Brewing tea	5= Cassava drying	6=Ironing
	7= Roasting (nuts/corn/yams)	20= Other	

	Use [use coding]	**Number of days per week?**
G1.1	G1_1_1	G1_1_2
G1.2	G1_2_1	G1_2_2
G1.3	G1_3_1	G1_3_2
	Record any other ***regular*** *tasks mentioned by the respondent* ***that are not on the list***	**Number of days per week**
G1.4	G1_4_1	G1_4_2
G1.5	G1_5_1	G1_5_2

	N. Charcoal		
	[This question is very important – please take time to ensure the question is understood and your measure reflects charcoal used for the respondents ***family unit*** *in an* ***average day***] **Ask: Do you have a full day's charcoal here in the house to show us how much you use?** [If yes, carry on, if no, use the charcoal in your bag- do not use any of the household charcoal} **Ask: How much charcoal do you use on an average day at this time of year**? **Please make a pile for me to weigh.**		
J1	Weight of **charcoal** including bag, tin or binding *[Include decimal places]*		__ __ __ . __ __**Kg**
J2	Weight of bag, tin or bindingweighed with the charcoal		__ __ __ . __ __**Kg**
J3	Did you weigh all the charcoal available in the household, or was some left besides that weighed?	1= Weighed all available charcoal 2= More charcoal remained 3 = Used the study charcoal	
J4	If you weighed small bags of charcoal how many bags did you weigh?		
J5	Do you make any of your charcoal?	1 = Yes 2 = No [go to J7]	
J6	About what proportion of the total charcoal fuel you use do you make at this time of year?	1 = I make most of my charcoal fuel 2 = I make about half my charcoal fuel 3 = I make a small amount of charcoal fuel	
J7	How much do you spend each time you buy **charcoal**?		Kwacha
J8	How many days would this amount of **charcoal** last? *[Express as decimal if necessary, e.g. half a day = 0.5]*		......days
	O. Other fuels		
	How much of your cooking is done with the following fuels at this time of year? [*List each fuel in turn and circle the most appropriate response*]		

		None	Less than one meal per week	A few meals per week	About half of all cooking	More than half of all cooking
K1	Electricity	1	2	3	4	5
K2	Fuelwood	1	2	3	4	5
K3	Kerosene	1	2	3	4	5
K4	LPG [gas]	1	2	3	4	5
K5	Dung	1	2	3	4	5
K6	Other [*describe]* ___________	1	2	3	4	5
	[Check with the respondent that you have discussed all of the fuels the household uses for cooking]					
	Seasonality					
S1	Do you cook for the same number of **people** throughout the year?	1 = Yes*[skip to S3]* 2 = No				

S2											
About how many people do you cook for on a regular basis in each month of the year? *[Mark the calendar below with the number of people cooked for in each month, putting one number only in each box – e.g. if respondent cooks for 6 people from April to June, put an 6 in each box for April to June – similarly for each month – LEAVE NO MONTH BLANK]*											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

S3	Do you cook the same number of **meals** per day throughout the year?	1 = Yes*[skip to S5]* 2 = No

S4											
How many meals per day do you cook in each month of the year? *[Mark the calendar below with the number of meals cooked per day in each month, putting one number only in each box – e.g. if respondent cooks for 3 meals from April to June, put an 3 in each box for April to June – similarly for each month – LEAVE NO MONTH BLANK]*											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

S5	Do you cook **mainly with charcoal** throughout the year?	1 = Yes*[skip to S7]* 2 = No

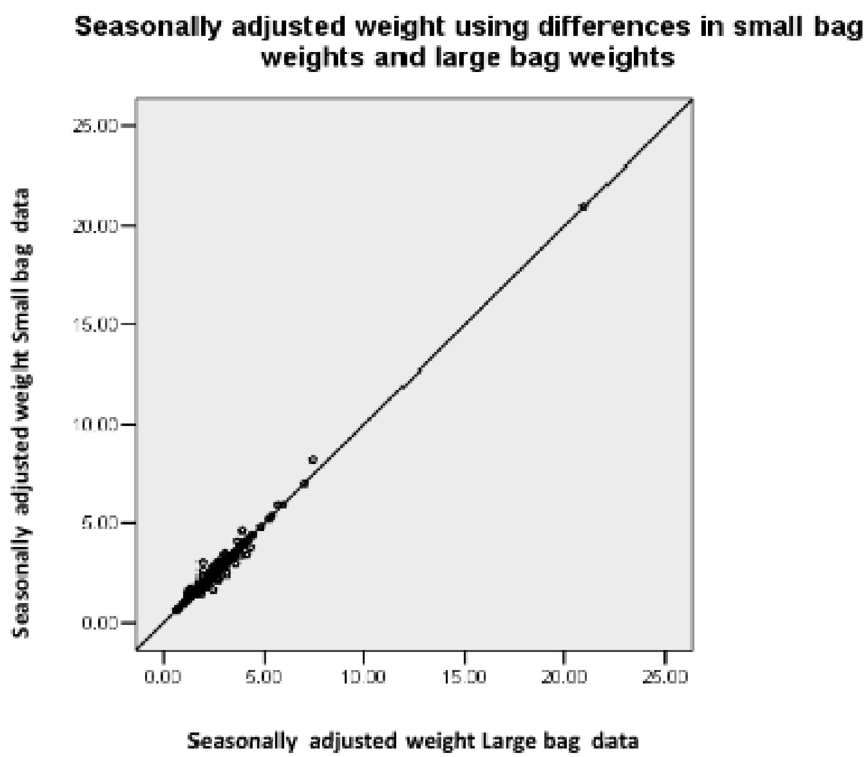
FUEL CODE	*1. Charcoal 2. Electricity 3. Fuelwood 4. Residues 5. Kerosene 6. Bottled Gas (LPG) 7. Other*

S6											
What is the *main* fuel used in each month of the year? *[Mark the calendar below with the FUEL CODE for the main fuel type used in each month, putting one number only in each box – e.g. if respondent cooks mainly with electricity from April to June, put an 2 in each box for April to June – similarly for each month – LEAVE NO MONTH BLANK]*											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Seasonality – Charcoal Use.											

<table>
<tr><td>S7</td><td colspan="8">Do you use the same amount of charcoal each day on average throughout the year?</td><td colspan="3">1 = Yes[skip to Z]
2 = No</td><td></td></tr>
<tr><td>S8</td><td colspan="8">Do you ever use small bags of charcoal that last less than one day?</td><td colspan="3">1 = Yes
2 = No[skip to S10]</td><td></td></tr>
<tr><td rowspan="3">S9</td><td colspan="12"><u>How many small bags of charcoal do you use per day in each month of the year?</u>
[Mark the calendar below with the number of small bags of charcoal used per day in each month, <u>putting one number only in each box</u> – e.g. if respondent uses 2 bags per day from April to June, put a 2 in each box for April to June – similarly for each month – LEAVE NO MONTH BLANK]</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>S10</td><td colspan="8">Do you ever use large bags of charcoal that last more than one day?</td><td colspan="3">1 = Yes
2 = No[skip to Z1]</td><td></td></tr>
<tr><td rowspan="3">S11</td><td colspan="12"><u>How many days on average will a large bag of charcoal last in each month of the year?</u>
[Mark the calendar below with the number of days a large bag of charcoal will last in each month, <u>putting one number only in each box</u> – e.g. if large bag lasts 10 days on average from April to June, put a 10 in each box for April to June – similarly for each month – LEAVE NO MONTH BLANK]</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="12">Z. Other observations</td></tr>
<tr><td>Z1</td><td colspan="12"><u>Is there anything else you would like to tell us about how you use your fuel for household purposes?</u> [Write down everything the participants says]</td></tr>
<tr><td></td><td colspan="12"><u>Thank you for your time and help in providing us with this useful information</u></td></tr>
<tr><td>Z2</td><td colspan="12">[Write down any observations of your own that you feel would be helpful and relevant]</td></tr>
</table>

Calculation of adjustment for seasonal fuel use

Households were asked about seasonal variation in their use of small and large bags of charcoal. Because of the way the questions were structured (Small bags = how many per day would you use? Large bags – how many days would one last?), it was preferable to use one size or the other to provide a proportional adjustment to the current fuel use. To verify that variations in small bag use matched variations in large bag use, the seasonal changes reported by each household in terms of large bags and small bags were compared. A strong linear relationship can be seen between the two variables in the graph below.



As more households had expressed the variation in charcoal use using large bags as their unit, the seasonal change in fuel use was determined using the reported change in large bag use, unless they only used small bags.

The length of time a large bag of charcoal lasted in the month of March was taken as 'current use'. Proportional adjustments were then made according to reported use in the other months.

Calculation of simultaneous stove use

This section outlines the process of gathering and analysing information on simultaneous stove use in Zambia as part of the baseline assessment.

The survey provides the following information:

- Average number of meals cooked per week
- Average number of 1 stove meals cooked per week
- Average number of 2 stove meals cooked per week.
- Average number of months per year this occurs

Using this information and assuming equal amounts of fuel used on each stove (which is the most conservative approach), the fuel correction factor is calculated as follows:

(2*total meals per week with 2 stoves)+total meal using 1 stove= stove meals

Stovemeals/7= stove meals per day

Stove meals per day/number of meals per day= Household (HH) mean stoves used /day

Fuel correction factor= 1/ (HH mean stoves used /day)

The table below shows the calculations for various combinations of simultaneous stove use.

Total meals/week	Total meals with 2 stoves /week	Total meals with 1 stove /week	Stove meals total /week	Stove meals/day	HH mean stoves used per day	Fuel correction factor
21	21	0	42	6.00	2.00	0.50
21	18	3	39	5.57	1.86	0.54
21	14	7	35	5.00	1.67	0.60
21	10	11	31	4.43	1.48	0.68
21	7	14	28	4.00	1.33	0.75
21	4	17	25	3.57	1.19	0.84
21	1	20	22	3.14	1.05	0.95
21	0	21	21	3.00	1.00	1.00
14	14	0	28	4.00	2.00	0.50
14	12	2	26	3.71	1.86	0.54
14	10	4	24	3.43	1.71	0.58
14	8	6	22	3.14	1.57	0.64
14	7	7	21	3.00	1.50	0.67
14	4	10	18	2.57	1.29	0.78
14	3	11	17	2.43	1.21	0.82
14	2	12	16	2.29	1.14	0.88
14	0	14	14	2.00	1.00	1.00

These adjustments are further refined according to seasonal variation. Based on the wet season lasting three months and the dry lasting nine months, adjusted fuel consumption for a HH reporting multiple stoves during the dry season but not during the wet season would be calculated as follows:

((3*1) + (1*fuel correction factor))/4

Example

Total meals per week: 21 Total 1 stove meals: 17 Total 2 stove meals: 4

Daily HH charcoal use: 2.32kg

Calculation

(2*4)+17= 25

25/7= 3.57 stove meals per day

3.57/3 meals per day= **1.19 stoves per day**

1/1.19= a fuel correction factor of 0.84

Therefore a HH with a daily charcoal use of 2.32kg would be adjusted to

2.32*0.84 = 1.95kg of charcoal used per day per stove.

If this HH **only used multiple stoves in the wet season** this would be adjusted to:

((3*1) + (1*0.84))/4 = 0.96

Any HH reporting simultaneous stove use less than once per week was given a default adjustment factor of 1.

Example monitoring questionnaire for AMS IE projects

Stove Use Patterns and Operation Monitoring Survey

Prepared by HED Consulting

	G. Identifying house and cook		
A1	Sales record number / Serial Number of Stove	A2	Village
A3	Ward	A4	District
A5	Participant telephone number		
A6	Date of interview [DD/MM/YYYY]		
A7	Start time of interview [Use 24-hour clock]		
A8	Interviewer's name		
A9	Date of stove installation		

	H. Stove use		
B1	Do you still use your '[INSERT INTERVENTION STOVE NAME]' for most cooking tasks?	1=yes 2=no [*go to D1*]	
B2	Visual confirmation of '[INSERT INTERVENTION STOVE NAME]'	1=yes 2=no	
B3	Do you still use your baseline stove	1=yes 2=no [*go to C2*]	
B4	Visual confirmation of baseline stove	1=yes 2=no [*go to C2*]	

	I. Charcoal Consumption	
C1	How much baseline charcoal do you use in your baseline stove in an average day? Please make a pile for me to weigh.	__________ kg
C1_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.**	

C1_2	Underline current season in column below	No charcoal	Quarter	Half	Three quarters	Current	One & a quarter	One & a half	One & three quarters	Twice as much charcoal
C1_3	Rainy	1	2	3	4	5	6	7	8	9
C1_4	Post-rainy	1	2	3	4	5	6	7	8	9
C1_5	Cold	1	2	3	4	5	6	7	8	9
C1_6	Dry Hot	1	2	3	4	5	6	7	8	9

C2	Do you use non-project charcoal in the '[INSERT INTERVENTION STOVE NAME]'	1=yes 2=no [*go to C4*]
C3	How much non-project charcoal do you use in your '[INSERT INTERVENTION STOVE NAME]'in an average day <u>in the current season</u>? Please make a pile for me to weigh.	__________ kg

C3_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.** *[First **underline** the current season in the column below and circle number 5; THEN circle the number that refers to the amount of charcoal the participant indicates **for each season**]*									
C3_2	**Underline current season in column below**	**No charcoal**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much charcoal**
C3_3	**Rainy**	1	2	3	4	5	6	7	8	9
C3_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C3_5	**Cold**	1	2	3	4	5	6	7	8	9
C3_5	**Dry Hot**	1	2	3	4	5	6	7	8	9
C4	Do you use renewable biomass supplied by '[INSERT NAME OF CPA IMPLEMENTOR]'						1=yes 2=no [*go to D1*]			
C5	How much renewable biomass do you use in your '[INSERT INTERVENTION STOVE NAME]' in an average day? Please make a pile for me to weigh.						___________ kg			
C5_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of charcoal you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much charcoal as you use now' *[point to the largest circle]* please show us the amount of charcoal you think you would use in EACH season.** *[First **underline** the current season in the column below and circle number 5; THEN circle the number that refers to the amount of charcoal the participant indicates **for each season**]*									
C5_2	**Underline current season in column below**	**No charcoal**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much charcoal**
C5_3	**Rainy**	1	2	3	4	5	6	7	8	9
C5_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C5_5	**Cold**	1	2	3	4	5	6	7	8	9
C5_6	**Dry Hot**	1	2	3	4	5	6	7	8	9
	J. Reasons for stopping use of '[INSERT INTERVENTION STOVE NAME]									
D1	Why do you no longer use the '[INSERT INTERVENTION STOVE NAME]? [*Write down everything the participant says*]									
D2	Which stove do you use as your primary stove now?									
	K. **Stove breakage and repair**									

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E1	Since starting to use your '[INSERT INTERVENTION STOVE NAME] stove has anything broken on it?			1=yes 2=no [*go to F1*]	
E2	If yes, please describe what broke [*Write down everything the respondent says*]				
E3	Did you repair the break?			1=yes 2=no	
	L. **Observations and comments**				
F1	[O*bserve the* '[INSERT INTERVENTION STOVE NAME] *and note any signs of recent use or otherwise]*				
F2	[*Please check the stove for all components- enter a 1 if present and if in correct position. Enter a 2 if not.]*	1=yes 2=no	Present	Correct	
		[ENTER COMPONENT 1]			
		[ENTER COMPONENT 2]			
F3	[*Please note any comments from the stove user*]				
F4	[*Interviewer note and observations*:]				

Zambia

AMS IE Baseline Wood Fuel Consumption Study

For C Quest Capital LLC

HED Consulting Ltd

Kirstie Jagoe

Liz Bates

***Project lead:* Jonathan Rouse**

With assistance from

Shared Values Africa, Zambia

Final

29 July 2013

HED|Consulting

Household energy & development

hedconsulting.com

Contents

Abbreviations

CQC	C Quest Capital LLC
HED	HED Consulting
HH	Household
SD	Standard Deviation
SE	Standard Error
SVA	Shared Values Africa

Exchange rate (approximate at time of report)

1 Zambia kwacha = 0.000196 U.S. dollars

Interpreting the statistical tables in this report

Mean values are presented in tables alongside Standard Deviation (SD) (in [square brackets]); standard errors (SE); 90 and 95% confidence intervals (CI); and margin of errors (10 and 5% of the means).

The relationship between the CI and margin of errors are used to indicate the precision of the data as follows:

- precision '90/10' requires the 90% CI to be ≤ 10% margin of error;
- precision '95/5' requires the 95% CI to be ≤ 5% margin of error; and
- precision '95/10' requires the 95% CI to be ≤ 10% margin of error.

Document development record

Date	Content	
1 February 2012	Final draft AMS IIG report submitted to CQC.	KJ KB JR
25 September 2012	Final AMS IIG report submitted.	KJ & JR
17 May 2013	Analysis of data according to AMS IE methodology and submission of Final Draft report.	JR & KJ
23 May 2013	Final draft submission further to comments	JR
29 July 2013	Final report submitted to CQC addressing further comments	JR

Executive summary

This report provides a summary of the results from the Zambia Baseline Fuel Use Survey carried out in three locations during December 2011- January 2012. The aims of the survey were to:

- estimate the average amount of wood fuel used per stove per day in rural households (HHs)(kg/stove/day);
- account for seasonal variation and multiple stove use;
- investigate the differences in wood fuel consumption between geographical zones (i.e. the degree of homogeneity);
- gather further data to inform successful implementation.

This work is further to a request from C Quest Capital LLC to conduct a baseline fuel consumption survey of wood-burning rural HHs in Zambia.

Key results

This report describes the sampling methodology; the questionnaire and other methods for in-field measurement; and analysis of the dataset including QA, cleaning, assessing variability, and determining the precision of the means.

The sampling strategy was designed in such a way as to be representative of the different climatic and economic aspects of the country. The analysis concludes that there is no significant difference in mean HH wood fuel consumption between the different areas (‘clusters’) of Zambia surveyed, and that collectively they can be seen as representative of the country as a whole. Therefore, the final analysis is undertaken on a national dataset that is found to meet the precision requirements of the AMS IE methodology, including for homogenous Programme of Activities (PoAs).

Prior to removal of outliers or any adjustment, the overall national baseline wood consumption was estimated at 13.70 kg/HH/day. HHs reporting use of logs which burned over a number of days were retained in the dataset: their consumption was averaged across the lifetime of the logs. Individual HH data was adjusted to account for the use of multiple stoves used simultaneously, resulting in an overall decrease of 0.41 kg/day to the baseline. The data was then considered by cluster, to determine whether each cluster was statistically different. No significant difference was found in the individual cluster data meeting the precision requirements of 90/10 for the methodology. These data were then combined to give the concluding national baseline. The **mean baseline HH wood fuel consumption across the whole of Zambia is estimated by this study to be 13.90 kg/day/stove.** The data for calculating this meets the precision requirements of the AMS IE methodology.

A detailed analysis of other factors, including seasonal variation in HH energy behaviour, the use of charcoal, drying of cassava, and space heating, indicated both that no further adjustments were required to the data and that the estimate of mean fuel consumption is conservative.

This study and analysis was planned and executed to conform to the EB 65 Annex 2 guidance and it is in line with the later revised standard EB69, Annex 4 and 5.

Methods

Roles

A HED Consulting (HED) team led the planning of this study. Aspects of the study design, such as identification of study locations and questionnaire development, were carried out in collaboration with Samuel Bell from SVA, Zambia, who also trained and supervised the survey team in Zambia.

Analysis was undertaken using Excel v14 and SPSS 16.0 by HED.

Sampling strategy

Clusters

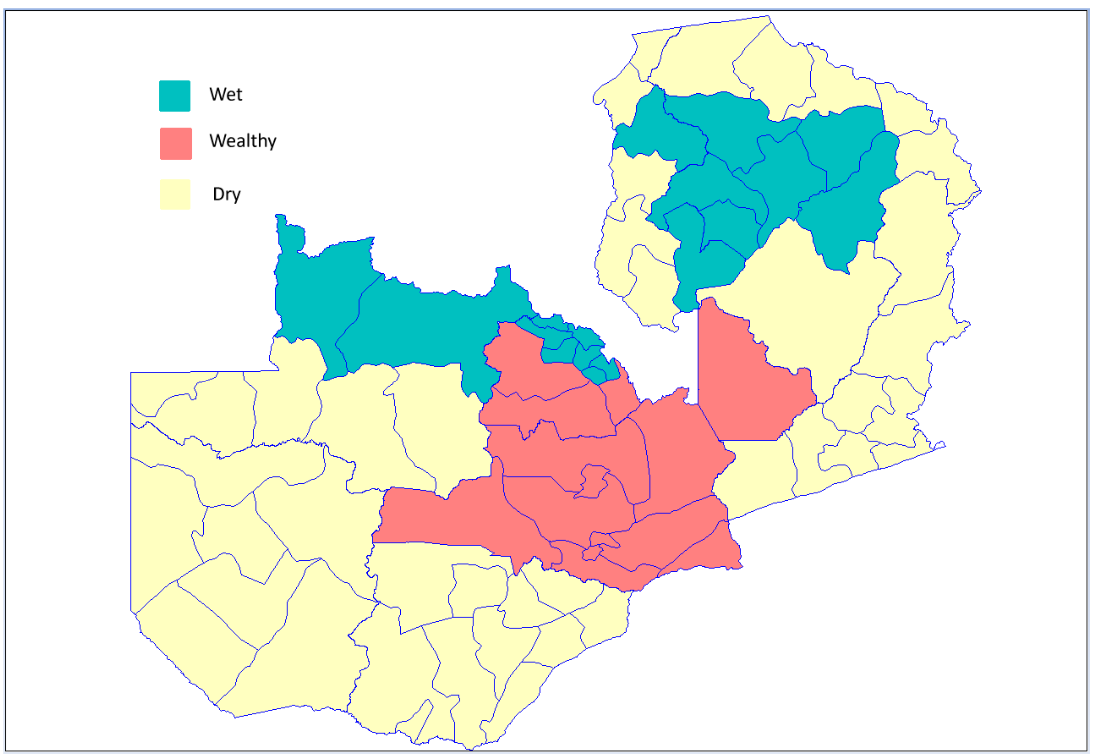
A literature review was carried out to explore factors within Zambia potentially influencing patterns of rural HH wood fuel use across the country. The collated data from this indicated that there were three broad zones within the country based on climatic and economic factors. The literature identified to support this process is described in Section 0.

Clusters may be broadly defined as:

- Wet: areas of higher rainfall;
- Wealthy: areas of low rainfall and higher incomes; and
- Dry: areas of low rainfall.

Note: no wealthy areas with higher rainfall were identified.

These clusters are outlined in the map below.



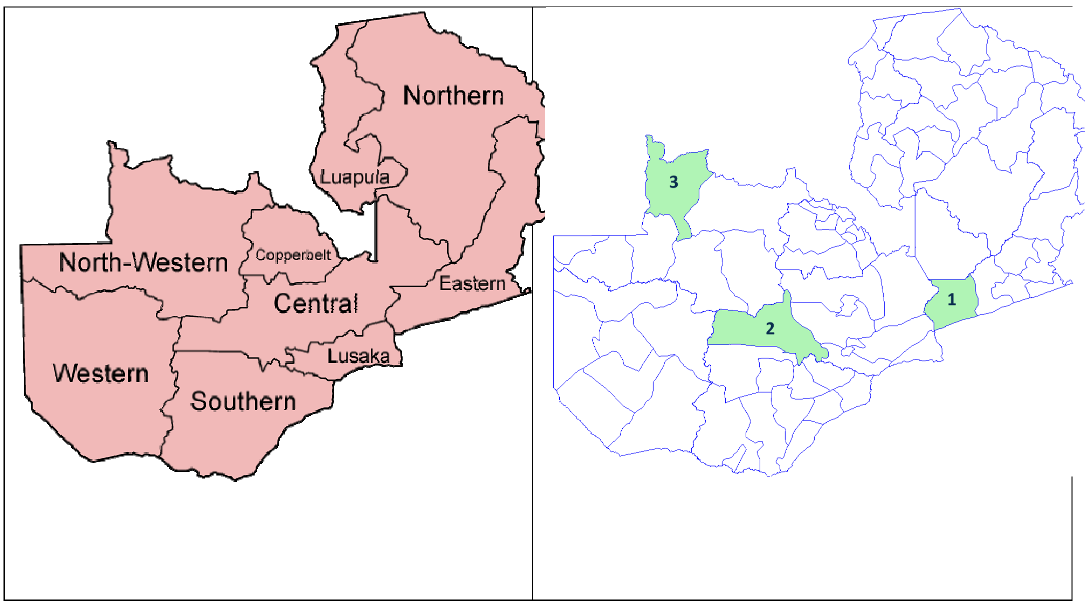
Sampling from within clusters

Zambia is divided into nine provinces. In turn, each province is subdivided into districts, each district into constituencies, and each constituency into wards. In order to ensure a nationally representative sample, study locations were identified from each of the three clusters .The

study sample was selected using a stratified two-stage cluster design (i.e. by district then ward) using probability proportional to size on the primary unit (the district) and then simple random sampling at the ward level. This takes into account the different rural populations in each district. The exception to this process was in the dry area, which was randomly sampled from within the Eastern province, the area in which project implementation is likely to begin.

The rural population for each district within each zone was taken from the 2010 preliminary census data (www.zamstats.gov.zm). Lusaka, Kabwe and Ndola districts were excluded because they included no rural populations[119] . A random number generator (www.random.org) was then used to select one district in each zone. Two wards were then randomly selected from within the chosen district.

The following maps indicate the provinces and districts of Zambia.



The locations selected for this study were:

1. the Kaumbwe and Ongolwewards in the district of Petauke, Eastern Province;
2. the Kalundu and Chisalufirst wards in the district of Mumbwa, Central Province; and
3. the Mundwiji and Kanonq'esha wards in the district of Mwinilunga, North-Western Province.

To remove the potential for bias created by selecting only larger or smaller villages, local advice was then taken to identify two to three villages of different sizes within each of these wards.

Household recruitment methodology and implications

A screening questionnaire was designed to identify HHs that used wood as their main cooking fuel and had sufficient fuel available to be able to show one full day's use. HH were asked 'Do you mostly use firewood for cooking in your home?**'** 'Most cooking' is assumed to have been interpreted by HHs as 'more than half of cooking'. In line with the requirements of AMS IE methodology, this identified HH whose main fuel was wood, but did not exclude users of other fuels, and ensured the sample frame included users of the full range of open fires and all types of wood-fuelled stoves, including any 'improved cook stoves' .

[119] Zamstats.gov.zm Summary of 2010 Census in monthly newsletter from Central Statistics Office, Volume 103, October 2011, page 19.

HHs were chosen at random within the villages and, once it was established that the HH met the inclusion criteria and were willing to participate, the survey was carried out. Attempts were made to minimize the impact of bias associated with non-response. If the HH cook was not available, an appointment was made for the following morning through the village headman. If they were not available at that time, they were classed as unavailable. Any actual refusals to take part were also documented.

Sample size determination

Based on the variance[120] seen using the same approach to measuring daily wood fuel consumption in other Sub-Saharan African countries to meet the 90/10 precision, the target sample size was 150 HH (which included a 15HH contingency for missing/unusable data). However, the precision of the data was analysed every few days so the fieldwork could stop once the requirements were comfortably met. Even with this measure, oversampling was possible as the fieldworkers were interviewing 40 HHs per day.

It was decided that the data would be analysed sequentially on key variables until the correct precision was achieved. This approach reduced the possibility of having to return to the field in the event of not having sufficient numbers to achieve the required precision.

Questionnaire development

A questionnaire was developed to explore the many factors that can impact on HH wood fuel use, including seasonal variation; uses of the stove other than for cooking; and use of more than one stove at the same time (see Section 0 Final version of questionnaire).

The questionnaire included complex concepts, so, to ensure its reliability and validity it was piloted in the field, along with the data transcribing and reporting spreadsheet and process. After this, any aspects of the questionnaire that caused confusion and/or failed to collect the correct data were reviewed and edited. A second pilot was carried out before progressing to the full study.

Measurement of woodfuel

HHs were asked 'How much wood do you use in an average day? Please make a pile for me to weigh'. If the respondent used a large log over a few days (as in Figure 1), they were asked how many days the log will last and they were also instructed to add any other wood they would use in that time period – to rekindle the fire etc. – prior to weighing.

Figure 1: Large logs used on three-stone fire

Quality control

Local field staff received extensive training on how to administer the questionnaire and were given feedback on the pilot data to ensure that concise, complete data was collected. The team were then supervised daily by a trained field manager. The surveyors were given a field guide describing how to implement the survey and how to collect robust, accurate data.

The questionnaire was piloted as described in Section 3.4.

[120] Average COV 70%: 90/10 precision requires sample size of 135 households.

Double-entry of data was completed in Zambia on a randomly selected 10% sample of transcripts. This was compared with the original dataset to identify the frequency and nature of data-entry error.

Analysis

Data checking

Data on 423 HHs were provided by SVA:

- 154 Petauke
- 139 Mumbwe
- 130[121] Mwinilunga

99.3% (n=420) of all HH in the study sample reported to be using a three stone fire as their main cooking stove. 1 HH was using a 'metal wood stove' and 2 HH did not specify their stove type.

There was a minimal rate of refusal –<5% of the total sample – so this would not be expected to have introduced bias (for example, a significant proportion of a certain kind of HH refusing to participate).

Examination of the double-entry data showed that there was less than 5% error in the key variables – i.e. wood-weighing data. Therefore the data-entry process was deemed accurate. Two HHs were removed as they had missing data in key variables. This left a final sample size of 421 HHs.

Adjusting for logs used over multiple days

As noted in Section 2.6 the pilot revealed that a number of HHs used large logs to fuel their cooking fires (as opposed to bundles of sticks), some of which lasted many days. Across the dataset, around 15% [n=53] of HHs use logs in this way, and therefore presented more than one day's wood for weighing. The median value of the number of days these logs lasted for was three [IQR 3]; recall for such a period might be expected to be accurate. For these HHs, the wood weight was divided by the stated number of days for which the log would last, giving an adjusted weight reflecting the amount used each day.

The mean daily wood fuel consumption of those HHs using logs was 9.07kg [SD4.81] compared with those using bundles of sticks consuming 13.96kg [SD 5.68 n=346]. This is a statistically significant difference (p=<0.01). However, it was felt this group should be left in the dataset for the following reasons:

- the question was worded in such a way that this should be treated as an equally reliable measure of daily fuel consumption as bundles of sticks
- 15% represents a significant group of users in the population, and it is quite possible that the lower consumption of firewood may be explained by the slower-burning nature of large logs
- including this group is in line with the conservative approach to determining baseline fuel consumption.

Subsequent analysis uses baseline fuel consumption data adjusted for logs.

[121] The number sampled here was slightly fewer than the intended minimum sample size of 135, determined through precedents of other studies. The reason for this was that the field team sent data to the analysis team from the field during data collection, giving the analysis team an opportunity to assess its precision. When 130 households had been interviewed, the required precision was found to have been met. Therefore, the analysis team instructed the fieldworkers that it was not necessary to continue surveying.

Raw data nationally

The following table presents mean woodfuel consumption from the full raw dataset across all areas. This data has had no outliers removed, nor has it been adjusted in anyway.

Table 3.1: National raw data for mean wood fuel use (kg/per HH/per day)

	National N=421
Mean [SD]	13.70 [8.01]
SE[122]	0.39
90% CI	0.64
95% CI	0.76
10% mean	1.37
5% mean	0.69

Accounting for simultaneous multiple stove use

Purpose of step: to account for HHs using more than one stove simultaneously, and ultimately to account for occasional continued use of traditional stoves alongside improved stoves.

The questionnaire included a series of questions about the simultaneous use of more than one stove for cooking. These were designed to establish the proportion of cooking (and therefore wood fuel consumption) that could be attributed to a single improved stove introduced through a carbon project.

The calculation of the average number of stoves used simultaneously for cooking per family unit took into account the frequency of simultaneous stove. This was compared with the stated number of times HHs cooked (Question C1 from the survey presented in Section 0) to give a fraction adjustment. This calculation is outlined in Section 0.

Any HH using its stove less than once per week was excluded from this adjustment as the impact of this may be considered negligible.

Table 3.2: Simultaneous stove use from full dataset

	National N=421
% Using stoves simultaneously > once per week	23.0%
Stoves used per HH/family unit mean [SD]	**1.03** [0.09]

Thus, 23% [n=97] of those surveyed reported cooking on more than one stove at once, at least once per week.

The following table presents data on the stated *reasons* for use of more than one stove simultaneously. Note: respondents could give more than one answer.

[122] Standard Error (SE) this is the standard deviation of the sample mean and describes its accuracy as an estimate of the population mean. As sample size increases, the estimator is based on more information and becomes more accurate, so its standard error decreases.

Table 3.3: Reasons for simultaneous stove use

Reasons given for using >1 stove at same time	Petauke N=35	Mumbwa N=38*	Mwinilunga N=20*
Faster/saves time	21	24	13
Need to finish dishes at the same time	11	11	7
Heating water	2	2	0
Other	7	4	1

*These groups had some data missing for HH that do cook on two stoves at least once per week

The majority (62%) of respondents giving a reason (n=93) stated that time saving was the most significant factor in motivating them to use more than one stove simultaneously. Therefore, the calculation of the impact of this uses the assumption that no more food is cooked, or wood used, in cooking a meal using two stoves, but that each stove cooks half the meal and consumes half of the fuel used to prepare a meal.

Overall the average (mean) number of stoves used simultaneously for cooking per HH unit was approximately 1.03, which equates to a mean adjustment to woodfuel weights of 1/1.03 = **0.971**.

Note that this mean value is presented to reflect the extent of second stove use but is not applied to B_{old}*mean* to adjust for multiple stove use, but each HH wood weight is adjusted individually according to its pattern of multiple stove use. All further steps in analysis use these adjusted daily woodfuel weight values. The result is presented in Table 3.4.

Table 3.4: National mean wood fuel consumption adjusted for multiple stove use (kg/per stove/per day)

	National
Mean [SD]	13.29 [7.76]
SE	0.38
90% CI	0.627
95% CI	0.741
10% mean	1.329
5% mean	0.6645

The multiple-stove adjustment has resulted in a decrease in the mean wood fuel value of 0.41kg/day compared with unadjusted data.

Cluster-wise trimmed means

Purpose of step: to establish estimates of mean wood fuel consumption in each district which meet the 90/10 precision requirements.

The total dataset was divided into three subsets by cluster. The distribution curve indicated the presence of some outliers, which seemed unlikely to be representative of the population. A 5% trimmed mean was deemed to be the most appropriate method of outlier removal. This process does not necessarily remove all outliers but does account for both high and low extreme values. This process removed the upper and lower 2.5% of data points within each cluster.

The data for each district was then analysed in a sequential manner until the 90/10 precision had been achieved. This was achieved after 80HH for each location, as shown in the below table.

Table 3.5: Mean adjusted cluster-wise baseline wood fuel consumption (kg/per stove/per day)

	Petauke N=80	Mumbwa N=80	Mwinilunga N=80
Mean [SD]	13.18 [5.92]	15.08 [6.98]	13.44 [5.30]
SE	0.66	0.78	0.59
10% mean	1.32	1.51	1.34
5% mean	0.66	0.75	0.67
90% [SE*1.65]	1.09	1.29	0.97
95% [SE*1.96]	1.29	1.52	1.15

Assessing the difference between cluster means

Purpose of step: to establish whether the Zambia baseline needs to be described in a series of discrete clusters due to discernible difference, or if it may be described as a homogenous area.

The ANOVA (analysis of variance) statistical test was used to determine if a statistically significance difference existed between the mean fuel consumption from each cluster.

The P value for difference between districts [p=0.106 ANOVA] showed that there is no compelling evidence that the means significantly differ.

Aggregating data for national mean

Purpose of step: to establish the mean baseline wood fuel consumption across the country, and to determine whether this meets the precision requirements of the methodology.

Because no significant difference was detected between the mean fuel consumptions in each of the three clusters, and because we are confident that the districts represent their respective zones and therefore collectively the entire country, we can combine the data to determine mean baseline fuel consumption for Zambia as a whole.

The following table presents the national mean. This dataset meets the precision requirements of 90/10 and 95/10.

Table 3.6: Mean adjusted national baseline wood fuel consumption (kg/per stove/per day)

	National N=240
Mean [SD]	13.90 [6.14]
SE	0.40
10% mean	1.39
5% mean	0.70
90% [SE*1.65]	0.66
95% [SE*1.96]	0.78

Thus, the mean baseline HH wood fuel consumption, adjusted for multiple stove use, across the whole of Zambia is 13.90 kg/day/stove.

This is 0.2kg higher than the unadjusted mean presented in Section 3.3 above and 0.61kg higher than the full data adjusted for multiple stove use (Table 3.4). This variation is because only a portion of total data was used to calculate this mean value. The data from a total of 240 HH from the original 421 was used to calculate this value. A sequential approach sampling was used until the precision requirements for the data were met.

This value for mean baseline HH wood fuel consumption meets 90/10 precision requirements.

Note on multiple stove adjustment for the 240 HH sample

Table 3.7 presents the data for the 240 HH selected to give the final national mean baseline, prior to adjustment for simultaneous stove use.

Table 3.7: National raw data for mean wood fuel use for 240 HH sample (kg/per HH/per day)

	National N=240
Mean [SD]	14.29 [6.45]
SE	0.42
10% mean	1.43
5% mean	0.72
90% [SE*1.65]	0.69
95% [SE*1.96]	0.82

The reduction in mean firewood consumption for the 240 HH in the final sample resulting from multiple stove adjustment is equivalent to an overall adjustment of:

(value for unadjusted data/ value adjusted for multiple stove use)

= (14.29/13.90) = 1.028 which may be considered an adjustment factor for any calculations concerned with second stove use in the entire sample. This is close to, but slightly different from, the mean number of stoves used simultaneously per HH unit (1.03), as this is applied to mean values; whereas the adjustment factor is applied to individual HHs.

Key parameters, including stove usage and seasonal variation in fuel consumption will be monitored during the project. An example monitoring questionnaire is presented in Section 0.

Other factors investigated

The questionnaire survey included a number of questions on other aspects of HH energy behaviour, some of which may impact wood fuel consumption. This section presents the conclusions of analysis of this data.

Seasonal adjustment

The questionnaire investigated the impact of seasonal changes on baseline wood fuel consumption as well as other factors, such as number of meals cooked (which is likely to

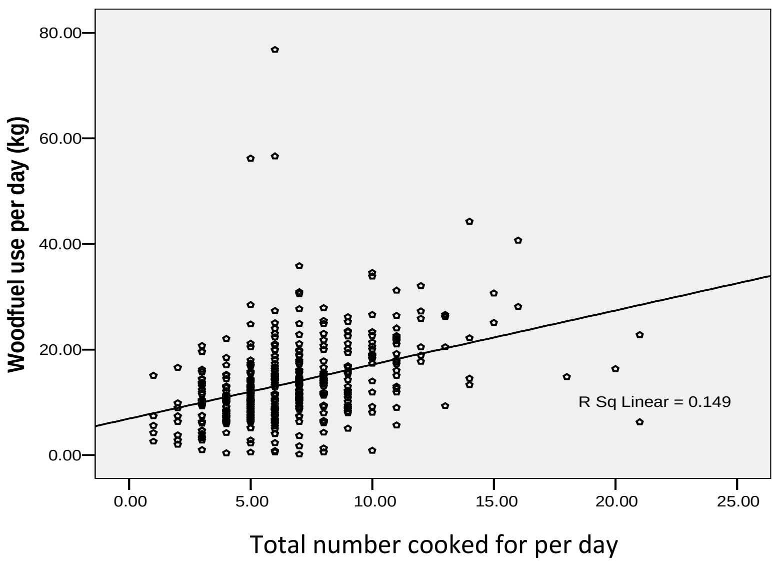
affect wood fuel consumption). These are described in turn below. The full trimmed national dataset was used for these analyses.

Number of people cooked for

Of the 366 HHs responding to this question, 154 (39%) stated that the number of people cooked for changed with season. When taking into account the changes in number of people cooked for, there is a marginal overall average increase [+0.1445] in the mean number of persons compared with the current season mean [6.51].

By correlating the change in fuel use per day with the total number cooked for in each HH, it can be seen that there is a direct relationship, as shown in Figure 2.

Figure 2: Relationship of woodfuel use to number of people cooked for per day



The linear function determined from this data is y=0.701x+8.271, where y is wood consumption, and x is total people cooked for.

This relationship is used to calculate the difference in quantity of woodfuel used for this season due to changes in numbers of people for whom meals are cooked. An increase of +0.1445 people in other seasons equates to an increase in fuel consumption of 0.087kg per day (in addition to the mean of 12.849kg/day for this dataset). **This results in a seasonal variation adjustment factor of (1+0.087/12.849) = +1.0068.**

Number of meals cooked per day

157 (40%) of the 391 HHs with complete data stated that the number of meals cooked per day varied with season. The data indicated a slight increase in number of meals cooked during the dry season (i.e. not at the time of survey), mainly due to increased food availability. Seasonal variation between the present season and dry resulted in a slight increase in mean number of meals cooked per day from 2.58 to 2.69.

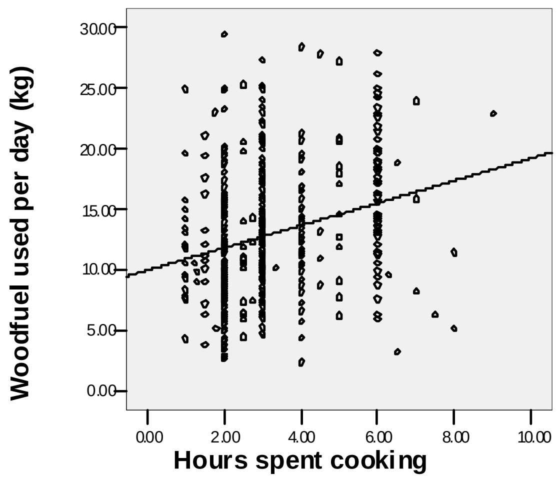
As there is a linear correlation between the number of meals cooked and fuel use, the impact of seasons on number of meals cooked would increase the national mean baseline by 0.24kg per day in addition to the mean of 12.86kg for this dataset. **This results in a seasonal variation adjustment factor of (1+(0.24/12.86)) = 1.0186.**

Hours spent cooking

49% of people reported that the number of hours spent cooking per day changes with the seasons, with a trend towards a slight increase in hours spent from 3.17 hours per day in the current season to 3.21 hours per day in the dry season.

Increased hours spent cooking impacts wood fuel consumption, as indicated by Figure 3.

Figure 3: Relationship between hours spent cooking and woodfuel consumption per day



As there is a linear correlation between the number of meals cooked and fuel use, the impact of seasons on number of hours spent cooking would increase the national mean baseline by 0.054kg per day in addition to the mean of 12.824kg for this dataset. **This results in a seasonal variation adjustment factor of 1+(0.054/12.824) = 1.004187.**

Quantity of woodfuel used

62% of respondents across the country reported seasonal variation in quantity of woodfuel used. Most responses were descriptive, and it was not possible to quantify the variation. There was little numerical data among the HHs reporting change (n=29), resulting from some surveyors requesting respondents to indicate how much fuel is used in other seasons and then weighing it using the digital scales. A further 150 HHs said that there was 'no change', thus providing numeric data for this larger group (total n=179).

Overall, more people reported greater wood fuel use in the wet season (i.e. the present season). However, there was considerable contradictory data: many HHs described the dryness of wood during the dry season as a reason for lower woodfuel consumption, while many others attributed the dryness to increased wood fuel consumption because it burned faster.

Numerical data on seasonal variation, combined with data from those who reported no seasonal change, indicates a minor negative adjustment to baseline wood fuel consumption during the dry season, with an **adjustment factor of 0.998** (n=179).

Conclusion of seasonal variation

All of the factors investigated for impact of seasonal variation on baseline wood fuel consumption indicate that very minor adjustments, if any, are warranted.

Three of the four factors (number of people cooked for, number of meals cooked, time spent cooking) indicate that the baseline presented in Section 3.7 is conservative, and maybe increased slightly to reflect the true picture across the seasons. One of the factors, the quantity of woodfuel used, indicated that a <0.1% negative adjustment should be applied to reflect seasonal variation across seasons. However, the reasons for this provided by respondents were contradictory and inconclusive.

In view of the small magnitude of the seasonal variations reported, and the fact that there is a mix of positive and negative adjustment factors, the results of this survey indicate that the

overall impact of the seasonal variation in woodfuel consumption in HHs in Zambia is negligible. Therefore it is recommended that no seasonal adjustment is applied to the baseline data.

Space heating

86% of respondents reported space heating at some point during the year, and 36.8% reported using wood to space heat during the season in which the survey was carried out.

The following table presents the mean woodfuel consumption from the trimmed national dataset adjusted for multiple stove use, for those presently using wood stoves for space heating, compared with the remainder not space heating with wood at the time of the survey.

Table 4.1: Mean kg fuel consumption per stove by current space-heating status

	n	Mean kg wood per day [SD]
Currently heating with wood	143	13.19 [5.78]
Not heating currently with wood	255	12.68 [5.37]

An independent T-test showed that there is no statistically significant difference in the amount of fuel used per stove between the two groups [p=0.383].

Conclusion

Although there is a small difference between the mean woodfuel consumption of both groups, and space heating appears to marginally increase the baseline, a statistical analysis concludes that the difference is not statistically significant. Therefore, the use of wood fires for space heating may also be discounted as a factor affecting the integrity of the baseline measurement.

Cassava drying

Many households reported drying of cassava as a significant activity throughout the year, using the hot sun to dry it in the dry season and using fires in the rainy season.

Approximately 22% of respondents reported using wood stoves during the present season for drying cassava. The following table presents the mean wood fuel consumption, from the trimmed national dataset adjusted for multiple stove use, for those presently using wood stoves for drying cassava compared with the remaining 78% who did not report this.

Table 4.2: Mean kg fuel consumption per stove by cassava-drying groups

	n	Mean kg wood per day [SD]
Currently drying cassava	86	13.07 [5.34]
Not currently drying cassava	313	12.82 [5.57]

Conclusion

There is no evidence of a statistically significant difference in wood fuel use per stove between the two cassava-drying groups [independent T-test p=groups 0.708]. This indicates that cassava drying has no significant impact on the baseline fuel consumption measured during the study.

Other baseline issues emerging

Use of charcoal during the present season

The respondents were asked if they used charcoal or another fuel source to replace wood fuel in the wet season. 11% [n=44] stated that they did. The reasons for doing this are presented in Table 6.1 below. Note: respondents could give more than one answer.

Table 5.1: Reasons for not using wood during the wet season

	National data N=49
Wood too wet to cook	13
To stay out of the rain	25
Space heating	11
Time saving	1
Total	49

The evidence that only 11% of HHs surveyed will change wood use in other seasons is likely to have a small impact on consumption, and quantifying this would be very difficult. This is not recommended as a basis of an adjustment to the baseline.

These findings indicate that the dataset on baseline wood fuel consumption is conservative as at other times of the year some HHs would switch away from charcoal use to wood use.

Impact of using all of a household's wood for weighing

Analysis was carried out to explore if there is a difference between the mean amount of fuel in those HH which had *all available* wood weighed and those which had some left in addition to that weighed.

Analysis on national trimmed data**,** adjusted for multiple stove use, showed that the mean wood fuel use for those HH where all available wood was weighed was 12.32kg/day/stove [SD=5.25] whereas in those HH where there was some wood remaining in the original wood pile the mean was 13.29 kg/day/stove [SD=6.16].

An independent T-test showed this difference to be borderline statistically significant [p=0.06]. Therefore we are not able to discount data from HHs in which all available wood was weighed, even though there appears to be a slight difference in the baselines. This decision to include these HHs makes the dataset conservative.

Annexes

Zambia clustering literature review

The aim of this review is to identify if geographically distinct zones exist within Zambia, which might impact on HH energy behavior, and therefore wood fuel consumption, in rural communities. To assess this, the following national patterns were investigated:

- Climate which may impact the need for space heating and, potentially, fuel switching when the wood is wet
- Poverty levels which may impact the affordability of wood fuel and quantity required for family cooking
- Forestry and wood fuel scarcity, which may impact the nature and quantity of wood fuel available, and therefore its utility in the home as a fuel

The above were characterized using available literature sources and informed by key informants.

Climate

Rainfall: The highest rainfall is in the north (about 1200 mm –- all figures are annual amounts), especially the north-west (1400 mm), decreasing towards the south (around 700 mm); the driest areas are in the Luangwa and middle Zambezi valleys (500 mm). None of the country is arid. The climate of Zambia is tropical modified by elevation. In the Köppen climate classification, most of the country is classified as humid subtropical or tropical wet and dry, with small stretches of semi-arid steppe climate in the south-west and along the Zambezi valley[123].

Map 1: Rainfall patterns in Zambia[124]

The clear demarcation between the area of higher and lower rainfall in Zambia is used as a basis for clustering for this study in Zambia, and the districts falling within the dark blue-shaded areas above define the wet areas.

Temperature and elevation: Although there is some variation in temperature – mainly with elevation – across Zambia the variation was not deemed sufficiently significant to define

[123]http://en.wikipedia.org/wiki/Climate_of_Zambia

[124]http://www.bestcountryreports.com/Precipitation_Map_Zambia.php

discreet clusters. This was supported by key informants within Zambia, who described the climate as relatively homogenous.

Poverty

Household size: HH size varies between 4.4-5.5 across all regions with no difference between rural and urban[125]. Therefore this is not used as a basis for clustering in this study.

Poverty variation across Zambia: North-western province is one of the poorest, most remote and least developed parts of the country. Eastern and Southern provinces also have a particularly high concentration of poverty. In general the broad central section of the country is more fertile, while in the north the soils tend towards acidity and in the south the climate is drier.[126]

Provincial analysis of poverty reveals that levels of poverty have continued to be high in predominantly remote provinces such as Luapula, Western, Eastern and Northern. The opposite is true for highly urbanised regions such as Lusaka and the Copperbelt provinces where levels of poverty have remained exceptionally low[6].

Overall, the current poverty analysis clearly indicates that poverty levels in Zambia are still very high despite recording some decline between 2006 and 2010. It is clear from these findings that poverty has continued to be more of a rural than an urban phenomenon. This is more of the case in the predominantly rural provinces such as Luapula, Western, Eastern and Northern provinces. The majority of the poor have continued to face extreme levels of poverty particularly in rural parts of the country. Furthermore, the poverty gap ratio in rural areas, especially in remote provinces has continued to be wide despite recording some reduction overtime. Finally, these results indicate that the country requires more effort towards poverty reduction especially in the rural parts of the remote provinces.[127]

The above evidence led to the 'wealthy and dry area' cluster consisting of a cluster of provinces around Lusaka.

Forestry

Forestry and availability of fuelwood were also considered as a possible basis for defining clusters. However, no reliable recent data describing regional variation in forestry all wood fuel availability was identified, and therefore this was also not used as a basis to define clustering

Baseline Fuel Consumption Questionnaire: Zambia

Baseline Fuel Use Assessment: SVA- Zambia

Designed by HED Consulting December 2011

- This survey is designed to be administered to the primary cook in selected households
- The objective of this survey is find out how much wood fuel is used PER STOVE on a weekly basis in households
- Please note: All questions refer to general household cooking **during the present season unless otherwise specified**.

[125] http://www.zamstats.gov.zm/media.php?id=7

[126] http://www.ruralpovertyportal.org/web/guest/country/home/tags/zambia

[127] Poverty Gap Ratio by Province and Residence, 2006-2010 Source: *Living Conditions Monitoring Survey, 2006 and 2010 (from* http://www.zamstats.gov.zm/media.php?id=7)

Italic text in [square brackets] are instructions for fieldworkers. This text should not be read out to respondents.

Bold text should be read out to respondents

[IMPORTANT: Before starting the survey, please ask the respondent if she/he is the main cook in the family unit. If it is not the main cook, ask to speak to the main cook, and arrange a convenient time when she/he will be available for interview**.]**

Introduction			
1	READ: Good morning/afternoon, my name is_____________. Thank you for making time for us. I am here today to talk to you about your family cooking practices and fuel use. If you agree to participate in this survey, we would like to ask you a few questions; it will take about 25 minutes. There are no 'right' or 'wrong' answers and the information you provide will be very useful to help use improve cooking practices throughout Zambia. All the information will be kept private but we will keep it in our records so that we can contact you in future. Do you have any questions?		

	A. Identifying house and cook		
A1	Do you mostly use firewood for cooking in your home?	Yes	No [terminate interview]
A2	Do you agree to participate?	Yes	No [terminate interview]
A3	Do you have enough wood in your home to last at least an average day?		
A4	ID number		
A5	Date of interview [DD/MM/YYYY]		
A6	Start time of interview [Use 24-hour clock]		
A7	Interviewer's name		
A8	Respondent's name		
A9	Respondent's telephone number [if available]		
A10	District		
A11	Village		
A12	Ward		
A13	Current season		
A14	Today's weather		

<table>
<tr><td></td><td colspan="5">B. Household structure</td></tr>
<tr><td>B1</td><td colspan="3">How many people are in your family unit?</td><td colspan="2"></td></tr>
<tr><td rowspan="3">B2</td><td colspan="5">On average, how many people do you usually cook meals for each day, at this time of year?</td></tr>
<tr><td>Children 14 years or younger</td><td>Female adults 15 years and older</td><td>Male adults 15 -59 years</td><td>Male adults 60 years or older</td><td>Total [NN]</td></tr>
<tr><td>B2_1</td><td>B2_2</td><td>B2_3</td><td>B2_4</td><td>B2_5</td></tr>
<tr><td>B3</td><td colspan="3">[Check: Is the total in B2_5 the same as B1?]</td><td>1 = Yes [Go to C]
2 = No</td><td></td></tr>
<tr><td>B4</td><td colspan="5">Why is there a difference between your family unit size and the number cooked for? [Write down everything the respondent says]</td></tr>
<tr><td></td><td colspan="5">C. Cooking - All questions refer to general household cooking <u>during the present season</u></td></tr>
<tr><td>C1</td><td colspan="4"><u>On average</u>, how many times is your fire or stove used/lit to cook meals or make drinks each day for family consumption?</td><td></td></tr>
<tr><td>C2</td><td colspan="4">On average, how many hours do you spend each day cooking? [Record to the nearest half hour]</td><td></td></tr>
<tr><td rowspan="3">C3</td><td colspan="4">▪ What is your <u>main</u> cooking fire or stove at this time of year? [Use the list below and put in the type for 'other']</td><td></td></tr>
<tr><td>1. Three stone fire</td><td>2. Mud wood stove</td><td>3. Metal wood stove</td><td colspan="2" rowspan="2">7. Other stove [describe]</td></tr>
<tr><td>4. Charcoal stove</td><td>5. Kerosene stove</td><td>6. LPG stove</td></tr>
<tr><td>C4</td><td colspan="3">What other fires or stoves do you use at <u>least once per week?</u> [Use the list above [or write down the name] for any stove or stoves mentioned]</td><td colspan="2">Enter 99 if no other stove</td></tr>
<tr><td></td><td colspan="5">D. Space heating</td></tr>
<tr><td>D1</td><td colspan="3">Do you use a fire or stove for warming your house and/ or keeping yourself warm at <u>any time of year</u>?</td><td>1 = Yes
2 = No [Go to Section E]</td><td></td></tr>
<tr><td>D2</td><td colspan="2">During which seasons do you use a fire or stove for room heating? [write season and stove type/fuel used]</td><td colspan="3"></td></tr>
<tr><td></td><td colspan="5">E. Simultaneous stove use for cooking</td></tr>
<tr><td>E1</td><td colspan="3">Do you ever cook on more than one wood-fuelled fire or stove <u>at the same time</u>? [Make sure the respondent is not simply talking about multiple</td><td>1 = Yes
2 = No [Go to Section</td><td></td></tr>
</table>

<table>
<tr><td></td><td colspan="6"><u>pots</u> on a single fire<u>]</u></td><td colspan="2">F]</td><td></td></tr>
<tr><td>E2</td><td colspan="6">Do you do this at least once per week?</td><td colspan="2">1 = Yes
2 = No [Go to Section F]</td><td></td></tr>
<tr><td rowspan="3">E3</td><td colspan="9">For what reasons do you use more than wood burning stoves <u>at the same time</u>?
[Do not prompt – circle as many as required]</td></tr>
<tr><td>Faster/ saves time</td><td>Need one hot and one cooler stove at once</td><td colspan="2">Need to finish dishes all together</td><td colspan="2">Guests visiting</td><td colspan="2">Heating water</td><td>Other</td></tr>
<tr><td>1</td><td>2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td><td>6</td></tr>
<tr><td>E4</td><td colspan="9">If ‘other reason [6], please describe [Write down everything the respondent says]</td></tr>
<tr><td rowspan="2">E5</td><td colspan="9">Which wood-fuelled fires or stoves do you use <u>at the same time</u> for cooking, AND how often?</td></tr>
<tr><td>Name of stove 1</td><td colspan="2">Name of stove 2</td><td colspan="6">How many MEALS/ DRINKS is this combination used each week?
Be specific: ‘occasionally’ is not sufficient detail</td></tr>
<tr><td>Example A</td><td>3 stone fire</td><td colspan="2">3 stone fire</td><td colspan="6">2 times per week for one meal each time</td></tr>
<tr><td>Example B</td><td>Mud woodstove</td><td colspan="2">3 stone fire</td><td colspan="6">Every Sunday for one meal</td></tr>
<tr><td>Combo 1</td><td>E5_1</td><td colspan="2">E5_2</td><td colspan="6">E5_3</td></tr>
<tr><td>Combo 2</td><td>E5_4</td><td colspan="2">E5_5</td><td colspan="6">E5_6</td></tr>
<tr><td>E6</td><td colspan="6">Which seasons do you use more than one wood-fuelled fire or stove?
[Write down all responses. E.g. wet season, dry season, all year etc]</td><td colspan="3"></td></tr>
<tr><td>E7</td><td colspan="8">About how many hours per week do you use a second <u>wood-burning</u> fire or stove <u>at the same time as the main stove</u>[Enter to the nearest half-hour]
[Help the person to recall by asking about whether cooking patterns are different at the weekend/ or during the week on certain days]</td><td></td></tr>
<tr><td></td><td colspan="9">F. Energy-efficient stoves</td></tr>
<tr><td>F1</td><td colspan="7">Have you ever heard anything about energy efficient wood-burning stoves? [stoves that use less fuel]</td><td>1 = Yes
2 = No</td><td></td></tr>
</table>

	READ: Energy efficient stoves burn less wood and tend to produce less smoke			
F2	If you had an energy-efficient stove, would you still need to use another woodfuel-burning fire or stove with it <u>at the same time?</u>	1 = Yes 2 = No		
F3	Can you tell me why/why not you would need to use another woodfuel-burning fire or stove with it <u>at the same time?</u>? [ask as appropriate]			
	G. Additional uses of fires/stoves			
G1	What else do you use fires or stoves for more than once per week other than cooking? [Get the respondent to list all the tasks they use a fire/ stove for and then ask about the type of stove they use and the frequency and duration of the task]			
	Use [e.g. heating water for bathing]	Type of fire / stove used	Number of times PER WEEK?	For how many hours each time?
G1.1				
G1.2				
G1.3				
G2	G2.1 If you had an efficient stove do you think you would be able to use it for all the tasks above?	1 = Yes [*Go to H*] 2 = No		
	G2.2 If no, please explain what tasks you will not be able to do and why [*Write down everything the respondent says*]			
	H. Stoves with more than pot hole			
H1	▪ Do you own a wood-fuelled stove on which you can cook two dishes at once?	1 = Yes 2 = No [go to Section J]		
H2	▪ Do you use both burners <u>at the same time</u> once a week or more?	1 = Yes 2 = No [go to Section J]		
H3	About how many hours per week do you use more than one burner <u>at the same time</u> *[enter to the nearest half-*			

	hour]						
H4	Are there particular reasons for using more than one burner <u>at the same time</u>? [Do not prompt & circle all that are mentioned]						
	Faster/ saves time	Need one hot burner and one cool burner	Need to finish dishes all together	One pot is too small	Guests visiting	Water heating	Other
	1	2	3	4	5	6	7
H5	If 'other reason [7], please describe						

	I. J. Wood fuel		
	[This question is very important – please take time to ensure the question is understood and your measure reflects wood used for the respondent's eating unit in an <u>average day</u>] How much wood do you use in an **<u>average day</u>**? Please make a pile for me to weigh. [If the respondent uses a large log over a few days, ask them how many days the log will last and request that they add any other wood they would use in that time period – to rekindle the fire etc]		
J1	Weight of **woodfuel** including bag or binding ***<u>[Include decimal places]</u>***	__ __ __ . __ __Kg	
J2	Weight of string/ bag used to weigh the wood	__ __ __ . __ __Kg	
J3	[If you had to weigh a large log that will last more than one day, indicate how many days will it last]	_______ days	
J4	Did you weigh all the wood available in the household, or was some left besides that weighed?	1. Weighed all available wood 2. More wood remained	
J5	About what proportion of total wood used do you buy at this time of year?	1 = I buy most of my fuel 2 = I buy about half my fuel 3 = I buy a small amount of fuel 4 = I buy no fuel (Go to J8)	
J6	How much do you spend on fuelwood, and how often? [Record the full answer. Make sure you **<u>include quantity, price and frequency</u>** etc.]		
J7	[Using the information above calculate the average weekly expenditure on woodfuel, and check with respondent that it makes sense]	__________ KWACHA	
J8	How often do you or your family gather woodfuel for household use at this time of year? *[Enter number of times, and circle time period [eg 3 per week]*		

	Number of times [J8_1]	Time period [J8_2]			
		Per day	Per week	Per month	Per year
		1	2	3	4
J9	Please show me how much wood you [/your family] bring home on each fuel collection trip? [*If feasible [i.e. not a cart load, weigh fuel] [Write 99 if full quantity not available]*]			__ __ . __ __Kg	
J10	Do you gather the same amount of wood throughout the year?			1 = Yes 2 = No	
J11	Have you noticed any change in the last three years in the effort required to gather wood fuel?				
	Much more effort to gather	A bit more effort to gather	About the same [Go to J13]	A bit less effort to gather	Much less effort to gather
	1	2	3	4	5
J12	Tell me the reasons you think the effort to gather wood fuel has changed in the last year? [*Write down everything the respondent says]*				
J13	Have you noticed any changes in prices of wood fuel in the last year?				
	Much more expensive	A bit more expensive	About the same [*Go to J15*]	A bit less expensive	Much less expensive
	1	2	3	4	5
J14	Tell me the reasons you think the price of wood fuel has changed in the last year? [*Write down everything the respondent says]*				
	[Observe the wood that the household is using and describe by circling as many as relevant]				
J15	Dryness of wood	Dry, well- seasoned	Wet [from rain]	Green: just cut from live	Not available to view
		1	2	3	4
J16	[Add any other observations that you think are relevant about the woodfuel used by this family – in particular if the household regularly **collects more than one quantity of wood fuel** (eg bundle, ox-cart, log) indicate this here]				
	Charcoal use				
K1	Do you use charcoal as a cooking fuel more than once per week?			1=Yes 2 = No [*Go to L*]	
K2	How much of your cooking is done with charcoal at this time of year?				

		None	Less than one meal per week	A few meals per week	About half of all cooking	More than half of all cooking
	Charcoal	1	2	3	4	5
K3	For what purposes do you use charcoal, and **why do you use charcoal rather than wood** for these purposes? [*Write down everything the respondent says]*					
K4	[Please take time to ensure this question is understood and your measure reflects charcoal used in an average day] On the days you use charcoal, what is the **average amount of charcoal** you use for all household purposes? Please make a pile for me to weigh.					
K5	Weight of **charcoa**l [including tin or bag] [*Include decimal places]*			__ __ __ . __ __Kg		
K6	Weight of container or bag used to weigh the charcoal [*Include decimal places]*			__ __ __ . __ __Kg		
K7	Have you noticed any changes in the price of charcoal over the last three years?			1=Yes 2 =No [Go to K9]		
K8	Describe changes (if any) in charcoal prices in the last three years?		Much more expensive	A bit more expensive	A bit less expensive	Much less expensive
			1	2	3	4
K9	[Record any other observations on charcoal use in this household]					
	Other fuels					
	How much of your cooking is done with the following fuels at this time of year? [Read out each fuel in turn and circle the most appropriate response]					

		None	Less than once meal per week	A few meals per week	About half of all cooking	More than half of all cooking
L1	Residues (Describe type) ________________ _	1	2	3	4	5
L2	Dung	1	2	3	4	5
L3	Kerosene	1	2	3	4	5
L4	LPG [gas]	1	2	3	4	5
L5	Electricity	1	2	3	4	5
L6	Other (Describe)	1	2	3	4	5

	____________					

	[Check with the respondent that you have discussed all of the fuels the household uses for cooking]		
	Seasonality		
M1	Do you use charcoal or another fuel source to **replace** wood fuel ***in the wet season***?	1 = Yes 2 = No *[Go to M3]*	
M2	Why do you use charcoal or other fuel sources to replace wood in the wet season?	1. Wood too wet to cook with 2. To stay out of the rain when cooking 3. Other *[specify:]*__________________	
	[In the table below, ask about each <u>factor</u> individually, and how it varies during the year compared with the current season. If it varies, describe how it varies. If it does not insert 2 into the first column. It is important that you gently probe for as much information as possible. Make any notes you need to in M12]		
	Factor	Does it vary? 1 = Yes 2 = No	If yes, describe how this varies during the year. Be very precise about quantities where possible, and the reason for the variation.
M3	Number of people cooked for		
M4	Number of meals cooked per day		
M5	Hours spent cooking each week		
M6	Quantity of wood fuel used		
M7	Quantity of charcoal used		
M8	Type of Main stove used		
M9	Location of cooking		
M10	Expenditure on wood fuel		
M11	Amount of wood fuel gathered		
M12	[Write down any other notes about changes with the season – if season terms unclear, describe your interpretation of modification for specific factors]		
M13	Is there anything else you would like to tell us about how you use your fuel for household purposes? [Write down everything the participants says]		

	Thank you for your time and help in providing us with this useful information
N1	[Write down any observations of your own that you feel would be helpful and relevant]

Example monitoring questionnaire

Stove Use Patterns and Operation Monitoring Survey

Prepared by HED Consulting

	G. Identifying house and cook		
A1	Sales record number / Serial Number of Stove	A2	Village
A3	Ward	A4	District
A5	Participant telephone number		
A6	Date of interview [DD/MM/YYYY]		
A7	Start time of interview [Use 24-hour clock]		
A8	Interviewer's name		
A9	Date of stove installation		

	H. Stove use		
B1	Do you still use your '[INSERT INTERVENTION STOVE NAME]' for most cooking tasks?	1=yes 2=no [*go to D1*]	
B2	Visual confirmation of '[INSERT INTERVENTION STOVE NAME]'	1=yes 2=no	
B3	Do you still use your baseline stove	1=yes 2=no [*go to C2*]	
B4	Visual confirmation of baseline stove	1=yes 2=no [*go to C2*]	

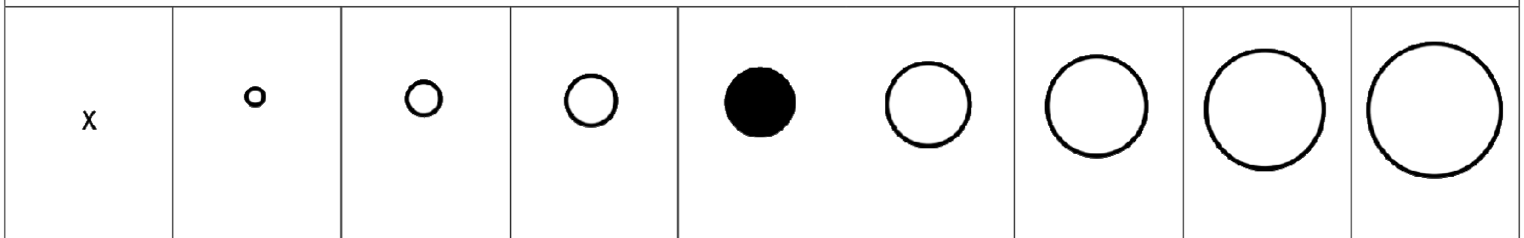
	I. Woodfuel Consumption	
C1	How much baseline woodfuel do you use in your baseline stove in an average day? Please make a pile for me to weigh.	__________ kg
C1_1	READ using the diagram on separate sheet: **Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.**	

C1_2	**Underline current season in column below**	**No woodfuel**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much woodfuel**
C1_3	**Rainy**	1	2	3	4	5	6	7	8	9
C1_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C1_5	**Cold**	1	2	3	4	5	6	7	8	9

C1_6	**Dry Hot**	1	2	3	4	5	6	7	8	9
C2	Do you use non-project woodfuel in the '[INSERT INTERVENTION STOVE NAME]'					1=yes 2=no [*go to C4*]				
C3	How much non-project woodfuel do you use in your '[INSERT INTERVENTION STOVE NAME]'in an average day <u>in the current season</u>? Please make a pile for me to weigh.					____________ kg				
C3_1	READ using the diagram on separate sheet: **<u>Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.</u>** *[First **<u>underline</u>** the current season in the column below and circle number 5; THEN circle the number that refers to the amount of woodfuel the participant indicates **<u>for each season</u>**]*									
C3_2	**<u>Underline</u> current season <u>in column below</u>**	**No woodfuel**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much woodfuel**
C3_3	**Rainy**	1	2	3	4	5	6	7	8	9
C3_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C3_5	**Cold**	1	2	3	4	5	6	7	8	9
C3_5	**Dry Hot**	1	2	3	4	5	6	7	8	9
C4	Do you use renewable biomass supplied by '[INSERT NAME OF CPA IMPLEMENTOR]'					1=yes 2=no [*go to D1*]				
C5	How much renewable biomass do you use in your '[INSERT INTERVENTION STOVE NAME]' in an average day? Please make a pile for me to weigh.					____________ kg				
C5_1	READ using the diagram on separate sheet: **<u>Here is a diagram showing the amount of woodfuel you use currently each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much woodfuel as you use now' *[point to the largest circle]* please show us the amount of woodfuel you think you would use in EACH season.</u>** *[First **<u>underline</u>** the current season in the column below and circle number 5; THEN circle the number that refers to the amount of woodfuel the participant indicates **<u>for each season</u>**]*									
C5_2	**<u>Underline</u> current season <u>in column below</u>**	**No woodfuel**	**Quarter**	**Half**	**Three quarters**	**Current**	**One & a quarter**	**One & a half**	**One & three quarters**	**Twice as much woodfuel**
C5_3	**Rainy**	1	2	3	4	5	6	7	8	9
C5_4	**Post-rainy**	1	2	3	4	5	6	7	8	9
C5_5	**Cold**	1	2	3	4	5	6	7	8	9

C5_6	**Dry Hot**	1	2	3	4	5	6	7	8	9
	J. Reasons for stopping use of '[INSERT INTERVENTION STOVE NAME]									
D1	Why do you no longer use the '[INSERT INTERVENTION STOVE NAME]? [*Write down everything the participant says]*									
D2	Which stove do you use as your primary stove now?									
	K. **Stove breakage and repair**									
E1	Since starting to use your '[INSERT INTERVENTION STOVE NAME] stove has anything broken on it?	1=yes 2=no [*go to F1*]								
E2	If yes, please describe what broke [*Write down everything the respondent says*]									
E3	Did you repair the break?	1=yes 2=no								
	L. **Observations and comments**									
F1	[O*bserve the* '[INSERT INTERVENTION STOVE NAME] *and note any signs of recent use or otherwise]*									
F2	[*Please check the stove for all components- enter a 1 if present and if in correct position. Enter a 2 if not.]*	1=yes 2=no	Present	Correct						
		[ENTER COMPONENT								
		[ENTER COMPONENT								
F3	[*Please note any comments from the stove user*]									
F4	[*Interviewer note and observations*:]									

READ: Here is a diagram showing relative sizes, with the amount of wood you currently use each day *[point to the all-black circle]*. If this cross is 'no fuel at all' *[point to the cross]* and this big circle is 'twice as much wood as you use now' *[point to the largest circle]* please show us the amount of wood you think you would use in the XXX season [work through all seasons other than the current and record responses on survey form].



No wood	Quarter	Half	Three quarters	Current	One and a quarter	One and a half	One and three quarters	Twice as much wood
1	2	3	4	5	6	7	8	9

Calculation of simultaneous stove use

This section outlines the process of gathering and analysing information on simultaneous stove use in Zambia as part of the baseline assessment.

The survey provides the following information:

- average number of meals cooked per week;
- average number of 1 stove meals cooked per week;
- average number of 2 stove meals cooked per week; and
- average number of months per year this occurs.

Using this information and assuming equal amounts of fuel used on each stove (which is the most conservative approach), the fuel correction factor is calculated as follows:

(2*total meals per week with 2 stoves)+total meal using 1 stove= stove meals

Stove meals/7= stove meals per day

Stove meals per day/number of meals per day= HH mean stoves used /day

Fuel correction factor= 1/ (HH mean stoves used /day)

The table below shows the calculations for various combinations of simultaneous stove use.

Total meals/week	Total meals with 2 stoves /week	Total meals with 1 stove /week	Stove meals total /week	Stove meals/day	HH mean stoves used per day	Fuel correction factor
21	21	0	42	6.00	2.00	0.50
21	18	3	39	5.57	1.86	0.54
21	14	7	35	5.00	1.67	0.60
21	10	11	31	4.43	1.48	0.68
21	7	14	28	4.00	1.33	0.75
21	4	17	25	3.57	1.19	0.84
21	1	20	22	3.14	1.05	0.95
21	0	21	21	3.00	1.00	1.00
14	14	0	28	4.00	2.00	0.50
14	12	2	26	3.71	1.86	0.54
14	10	4	24	3.43	1.71	0.58
14	8	6	22	3.14	1.57	0.64
14	7	7	21	3.00	1.50	0.67
14	4	10	18	2.57	1.29	0.78
14	3	11	17	2.43	1.21	0.82
14	2	12	16	2.29	1.14	0.88
14	0	14	14	2.00	1.00	1.00

These adjustments are further refined according to seasonal variation[128]. Based on the wet season lasting three months and the dry lasting nine months, adjusted fuel consumption for a HH reporting multiple stoves during the dry season but not during the wet season would be calculated as follows:

((3*fuel correction factor) + (1*1))/4

Example

Total meals per week: 21   Total 1 stove meals: 17   Total 2 stove meals: 4

Daily HH charcoal use: 2.32kg

[128] Although the fuel consumption data were not adjusted for seasonal variation, this parameter has been adjusted for seasonal variation because clear data was found for households reporting seasonal changes in second stove use. The adjustment was applied to second stove use on a HH basis. Applying seasonal adjustments to this parameter does not contradict or interfere with the decision not to apply the adjustment to consumption data; it makes it a more accurate estimate.

Calculation

(2*4)+17= 25

25/7= 3.57 stove meals per day

3.57/3 meals per day= **1.19 stoves per day**

1/1.19= a fuel correction factor of 0.84

Therefore a HH with a daily charcoal use of 2.32kg would be adjusted to

2.32*0.84 = 1.95kg of charcoal used per day per stove.

If this HH **only used multiple stoves in the wet season** this would be adjusted to:

((3*1) + (1*0.84))/4 = 0.96

Any HH reporting simultaneous stove use less than once per week was given a default adjustment factor of 1.

Appendix 5: Further background information on the monitoring plan

Not applicable

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History of the document

Version	Date	Nature of revision(s)
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the programme design document form for small-scale CDM programmes of activities" (EB 66, Annex 13).
01	EB33, Annex43 27 July 2007	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		